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Modelling the Cloud

Employment effects in two exemplary sectors in The United States, the United Kingdom, Germany and Italy[1]

Foreword

Cloud computing promises to change information handling practices with widespread effects on organizational structures and strategies, on small firms' access to advanced information technologies, on the costs of certain kinds of experimentation and innovation, and on the skills base and deployment of labour. These effects will differ according to numerous criteria, including the capabilities of particular firms and their current level of capital investment in IT, the characteristics of specific sectors, and the national context. In this study we have focused on the effects within the United States, the United Kingdom, Germany and Italy of cloud computing in the aerospace and the smartphone services sectors. Within those sectors the use of cloud services is likely to be significantly different depending upon factors including the size of firms, the style of work and the cost of performing particular tasks. This report presents the first effort to construct a dynamic model that accounts, in detail, for the likely impact of cloud computing in major industrial and services sectors. Here we can take into consideration how those sectors change and explain why the economic effects are likely to be different from country to country. We can also show how regulatory interventions, market trends or legal constraints might alter practices. This study shows how the microeconomic characteristics of cloud computing create a dynamic effect that will bring about changes that, when effectively implemented, will improve firm productivity, enhance new business development, and, while initially creating employment primarily in cloud services businesses and data centres, shift the character of work in many firms in the coming years. Some of the benefits that come about through productivity improvements will be seen as growth in jobs and in new firm creation.

This report presents the first effort to construct a dynamic model that accounts, in detail, for the likely impact of cloud computing in major industrial and services sectors.

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1 *This study was commissioned by Microsoft and has utilised a combination of data that are available in the public domain and of interviews, industry provided data and our own case research. The report does not necessarily reflect the views of Microsoft. It was conducted under the auspices of LSE-Enterprise, the business services and knowledge transfer unit of the London School of Economics.*

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Executive Summary

This report assesses the overall economic impact of cloud computing in two indicative sectors – aerospace and smartphone services – in the United States, the United Kingdom, Germany and Italy with a focus on total jobs created in the two sectors in each country, the shift in types of employment and their associated skills, and the managerial implications of these changes over the period 2010 to 2014.

Our key findings are that:

- The adoption of cloud computing by these two sectors contributes to significant job creation. For example, US cloud-related smartphone services jobs will grow from 19,500 in 2010 to 54,500 in 2014.
- The rate of growth in cloud-related jobs depends on a number of factors, such as rate of growth of the sector, structure of the sector, and national policy environment. A fast-growing sector (smartphone services) will create more cloud-related jobs than a slow-growing sector (aerospace). In Germany from 2010 through 2014, the rate of growth for cloud-related jobs will be 280% for smartphone services vs. 33% for aerospace.
- Data centre construction, direct staffing and jobs created in the ICT hardware sector supplying data centres explain almost all the short term net gains in IT jobs.
- Cloud computing will form the basis for a rapid expansion and high-start-up rate among SMEs 2010-2014 in all four markets in services, exemplified by smartphone services.
- There is little real risk of net unemployment caused by investing in the cloud.
- There are big differences between the US and Europe in current employment effects but few barriers in Europe to utilise cloud in ways that emulate effects in the U.S.
- If Europe can become more attractive than it currently is for public cloud investment, then the proportion of skilled cloud jobs created in the US will not be at the currently significant expense of European firms.
- *As firms shift from proprietary application servers towards virtualisation and cloud computing, related skills will be in demand among employers. New direct hires and up-skilling for public cloud enablement result in higher-than-average salaries, as we estimate that managers for IT facilities and IT core administration are in the higher salary bracket of $70k-120k in the US and £40k-60k in the UK (with Germany featuring an estimated 95% of UK salary levels, Italy with 80% of UK levels).*
- Productivity gains from cloud computing will enable the redeployment of skilled employees and managers to more strategic and revenue-enhancing activities at both enterprises and SMEs.
- Cloud computing is an environmentally friendly application, as can be seen in the energy utilization calculations that show opportunities for shifting less efficient firm-based data handling tasks to more energy efficient data centres.

These findings hold specific policy implications:

- Data transfer policies, having to do with either trade or concerns such as data security and privacy rights protection, can have significant effect upon the economic dimensions of cloud computing. These can be directly translated into job effects.
- Pricing of energy and the opportunity to affect pricing through the encouragement of green energy policies or other incentive mechanisms can make a major difference in a country's ability to attract investment in data centres.

Executive Summary (continued)

- Policies for education and retraining are affected because the skills needed for the cloud will be in demand, especially in the short term as lower entry barriers encourage the entry of new firms that will utilise cloud skills.

This study differs from prior ones in that we have studied two key sectors (high-tech manufacturing and high-tech services) in detail and estimated their respective utilization of IT resources and utilization of cloud computing through interviews and related research at London School of Economics[2]. This "bottom-up" research with a managerial-economic focus on micro elements such as IT utilization grades, technology choice, managerial responses, and detailed cost analysis (salaries, IT equipment, utilities, facilities, etc.) therefore complements and expands earlier research typically focusing on macros studies ("top-down") in the neo-classical tradition.

Through the detailed modelling of these two sectors this research opens up opportunity for further detailed studies of other sectors and countries. It also provides opportunity for further cost benefit analysis of policy options relating to skills and employment effects of IT investments, the green IT agenda, and trade implications of privacy and data storage regulation.

2 *We have further defined the smartphone service sector as an aggregate of smartphone data (non-messaging) revenues among mobile telecom operators, and revenues from enterprise and consumer applications (including search and advertisement).*

1. Introduction

The IT industry has been promoting cloud computing since the late 2000s as a profound shift for information technology services that will transform business opportunities and change the way IT work is done. Since then there have been a few efforts to quantify what these effects might turn out to be, mainly based on assumptions about the speed with which cloud services will expand and on how the benefits might accrue in terms of business productivity. To the best of our knowledge, this study is the first of its kind conducted at the national level with a focus on the detailed effects that we can expect in key sectors. We set out to measure as much as possible of the socio-economic impacts of cloud computing on the U.S., U.K., Italian, and German smartphone services and the aerospace industry. Even in a slow-to-medium growth manufacturing sector, the net employment effects and the opportunities to generate new firms are significant contributors to economic growth.

Cloud computing promises to change information handling practices with widespread effects on organizational structures and strategies, on small firms' access to advanced information technologies, on the costs of certain kinds of experimentation and innovation, and on the skills base and deployment of labour. These effects will differ according to numerous criteria, including the capabilities of particular firms and their current level of capital investment in IT, the characteristics of specific sectors, and the national context. Within those sectors the use of cloud services is likely to differ greatly depending upon factors including the size of firms, the style of work and the cost of performing particular kinds of tasks.

Cloud computing promises to change information handling practices with widespread effects on organizational structures and strategies, on small firms' access to advanced information technologies, on the costs of certain kinds of experimentation and innovation, and on the skills base and deployment of labour.

The analysis is far from straightforward. To capture the economic impact of a single technology within even one sector, it is necessary to take into account not only its direct effects but also the indirect and induced effects that result.

Direct effects include a labour component: jobs are created as additional frontline staff is hired to install cloud applications and infrastructure, and to fill other functions ranging from managers to customer service representatives. The labour component of direct cloud spending among firms varies from a small percentage for public cloud implementations up to well over 50% in specialist in-house data centres (further detailed in section 5 of this report).

Indirect jobs are those created to supply materials and other inputs to production. These include, for example, software, switches, fibre optic cable, steel and concrete. Induced jobs are those created by newly employed workers spending their salary, creating jobs in establishments such as restaurants and retail stores.

For public clouds much more so than private clouds, spending relates to software and capital equipment (such as optics, servers, and related computer equipment). Jobs are created in the industries that manufacture these products as demand

1. Introduction (continued)

increases for the telecommunications, electronic, and computer equipment (all forms of necessary capital) used to deploy cloud services. For all countries in the report most of the value-add related to equipment manufacturing remains within the country and the rest (as detailed in section 5) is likely to "leak out" to work from outside the domestic market.

When we analyse the use of cloud services we are not just assessing the spending on those services and the resultant shift in information management activities, we account for the business gained by those companies offering services, increased use of the infrastructure of telecommunications and energy consumption, the taxes that accrue and the effect of the goods they all purchase. These activities also create output and jobs indirectly, as the money they spend is re-spent by their suppliers. Furthermore, they have an induced effect in the form of the boost to the economy that improved business practices create and as the profitability of companies utilizing the new technology gets translated into greater earnings.

When these indirect and inducted effects are added, the impact of cloud services extends far beyond the use of software as a service or infrastructure as a service or the other key applications. Understanding this wider reach, or multiplier effect, is necessary for anyone interested in assessing how new technologies play a wide role in the economy.

The charts below summarise the growth in IT jobs and by cloud computing jobs generated by investments by each of the two sectors in each country studied. The first shows the situation as of 2010 and the second the growth effects derived from our model.

	2010 IT Jobs (direct, indirect and induced)	2014 IT Jobs (direct, indirect and induced)	2010 Direct Cloud Jobs	2014 Direct Cloud Jobs
US Aerospace	112,000	128,000	1,760	2,770
US SPS	84,000	148,000	2,060	5,210
UK Aerospace	11,200	12,100	210	320
UK SPS	5,890	13,990	200	870
Ger Aerospace	16,200	17,800	290	420
Ger SPS	8,840	16,840	230	800
It Aerospace	3,560	3,900	60	100
It SPS	6,950	12,730	200	700

Note: 'SPS' stands for "smartphone services"

1. Introduction (continued)

These summary charts demonstrate some of the key findings:

- **Cloud employment in manufacturing is different from services:** Aerospace employed only slightly fewer cloud workers than smartphone services in 2010 but smartphone services greatly extend employment by 2014 in all four markets.
- **The reskilling imperative:** Cloud drives start-ups in the smartphone sector but that is not the case in aerospace because of slow growth. Indeed, some sectors run risks by failing to compensate for job losses in the short term as the sector remains static or shrinks. Overall, however, cloud computing forms the basis for a rapid expansion and high-start-up rate among SMEs 2010-2014 in all four markets.
- **Smartphone growth:** Smartphone services are an archetypically cloud-based business and their growth is very largely attributable to cloud technologies and architectures. In the US, smartphone services were 13% of total telephone sector turnover in 2010 (and accounted for 87% of operator data charges) but this is estimated to rise to 31% in 2014 (while falling to 69% of operator data charges). Largely because of the opportunities afforded by cloud computing; this is becoming a very large industry with a total turnover of $13bn.

Our three areas of focus are on the total jobs created in the two sectors in each country, the shift in types of employment and their associated skills, and the managerial implications of these changes. While CEBR (the Centre for Economic and Business Research) and other industry analysts have offered macro estimates of the supposed productivity gains of cloud

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computing, it is through our analysis that we can see in more detail where those productivity gains come from. In particular, we can associate the opportunities that accrue to entrepreneurs by shifting time away from IT operations into general management and how that becomes in itself a productivity tool for SMEs. While job gains associated with SME spending on cloud are low, productivity gains could be disproportionately high.

The two sectors we have applied this analysis to in this instance, aerospace manufacturing and smartphone services, were chosen because they exemplify different features of the uptake of cloud and different kinds of consequences for labour markets. Both sectors are of significant size in all the countries studied, allowing us to demonstrate how different conditions nationally affect cloud take up. They also consist of business systems involving a myriad of relationships among suppliers and customers and of small, medium and large sized firms. Both are affected by public and industrial policy and by market trends but while aerospace is a mature sector and currently very slow growing everywhere, the smartphone sector is young, rapidly growing and fluid in its structural relations.

For both these sectors, as for all cloud services, a major determinant of costs and of labour market effects centre

1. Introduction (continued)

around the impact that is made upon the economics and business opportunities associated with data centres. Nationally the economic efficiency of data centres vary according to electricity costs but they also vary based on the extent to which firms are likely to be using private versus public cloud services.[3] In this context, some countries will affect practices by applying restrictions on the migration of data abroad, something which future analyses will take into account once the regulatory effects become clear. The propensity in aerospace for private cloud services explains both their lower potential for cost savings and their lower rate of job displacement.

Our analysis shows jobs shifting from distributed data processing facilities to consolidated data centres, resulting in a drop in data processing jobs overall as efficiency gains occur especially through public cloud services. We see a reduction in IT administrators within large firms in smartphone businesses (and most likely in many other similar sectors) compared to their level of employment otherwise expected by taking into account overall IT spending. Much employment is directly and indirectly created by the construction of new data centres needed to accommodate the burgeoning public cloud businesses, but an unanticipated effect is in job creation of site maintenance, janitorial staff and security guards in newly built data centres. Overall, more than 30% of short term new employment in cloud services originates from the construction of data centres and outfitting them accounts for around another third. Almost 25% of new jobs accrue from direct employment in public cloud services firms. While the construction employment effect can be considered a short-term benefit (and one explanation of why total job creation in the medium term is so much lower than the short term[4]), the positive employment growth effect in hardware and staffing is felt over the five years that our future scenarios cover. Jobs are displaced from countries with high energy costs that dissuade cloud services providers from locating data centres domestically. Some countries actively promote data centre construction, such as Ireland, and others enjoy low energy costs, such as Sweden, and these countries are likely to be the early beneficiaries of decisions to expand public cloud services. The United States is likely to be a beneficiary of this shift in jobs, although national energy pricing policy and European data protection policies could have major effects on the international migration of these job categories.

Data centre construction, direct staffing and jobs created in the ICT hardware sector supplying data centres explain almost all the net gains in jobs. Other jobs are created, and lost, within large firms but we have good evidence in surveys covering employment in enterprise computing functions (Liebenau & Karrberg, 2010) that senior executives expect efficiency savings and the "cloud dividend" to be in the form of shifting the work of existing IT staff towards general administrative responsibilities and strategic management rather than exploiting short-term payroll reduction opportunities. Herein lies one of the main new skills challenges to the existing labour force.

3 *We recognise that different configurations of private and public cloud services are used, largely dependent upon factors such as sector and firm size. In banking, for statutory as well as business and scale reasons, firms tend to use largely private cloud services. Other very large companies in most sectors tend to use private clouds while small firms take advantage of the opportunities to avoid large capital expenditure and use public cloud services as part of their operating expenditure. In practice so-called hybrid cloud services are common, and in some sectors business models and administrative practices associated with community cloud services occur, but these distinctions do not present analytical differences. In our analysis we take costings and employment effects into account through a simple distinction between public and private cloud.*

4 *Etro (2009) and others assume that employment jumps in the short term because of the shock effect of lower entry barriers that boost the number of new firms in the economy overall due to the shift from initial high capital expenditure needs to low operating expenditure costs at the time of firm creation. That boost then begins to disappear in the medium term.*

1. Introduction (continued)

There are many definitions of cloud computing and for most purposes it is not of great import exactly what is meant; firms can market their goods and services with such a label and customers can judge whether they might wish to engage. However, we need to make clear what it is that we are counting when we show what the costs are and we have identified which jobs are included. Our general definition is that cloud computing includes most managed virtualization services, ranging from those operating internally to a large enterprise, to outside firms that manage major computing and data handling tasks, to those providing small-scale services from centralised providers. We are cognizant of the history of cloud-based services that emerged from enterprise virtualization architectures on the one hand and early movers such as LoudCloud and NetSuite, both of which launched pioneering businesses in 1999, on the other hand. LoudCloud (now known as Opsware and owned by Hewlett Packard) began with infrastructure as a service products and NetSuite (established in 1998 as NetLedger with links to Oracle to provide on-demand CRM and ERP services) offered an on-demand, cloud-based accounting application. These dual origins established the main pattern of cloud structures as well as the distinction between private and public cloud. This legacy also helps us to understand the useful distinctions among different kinds of software, infrastructure and platform services that define the main business offerings.

The analysis draws on a combination of quantitative and qualitative evidence. The quantitative analysis focuses on the costing and employment practices of firms using cloud services and the service providers they purchase from. Using a modelling approach developed in conjunction with the Washington, D.C. based Information Technology and Innovation Foundation [ITIF] (see for example Liebenau et al. 2009), we account for the direct, indirect and induced employment effects and value added of these activities.

In constructing the required economic input-output model, we have made use of government data as much as is available. We also rely significantly on industry data where available. We have been careful not to overestimate the effects of cloud computing and we try to identify precisely which jobs are associated with cloud services.

The effect of cloud computing on direct employment is difficult to measure due to the heterogeneity of the providers and the need to estimate data on how cloud computing affects efficiency and productivity among specific activities. However, in chapter 6 we have brought together estimates of the effects within firms using cloud services within aerospace and smartphone services, in addition to indirect and induced employment effects. Total employment among those providing goods and services includes not only internet firms, but also software firms, telecommunications firms, and IT equipment providers. A shortage of skills with new technologies such as distributed computing, parallel computing and virtualization could hold back the development among cloud computing providers[5]. Virtualization will favor employment in the software industry and has a considerable impact on ICT skills. Traditional skills in server and network administration have to be complemented with specific virtualization skills (Dubie 2009). Virtualization makes security management more difficult, increasing the need

5 *OECD ICT Outlook 2010.*

1. Introduction (continued)

also for security expertise (Antonopoulos 2009). Skills for cloud computing should therefore be considered by educational policy makers but most especially by firms focusing on redeploying staff through in-house retraining.

In a survey conducted by OECD in 2010, "ICT skills and employment" was indeed regarded as the top policy priority, together with broadband build-out, in 15 of the countries surveyed. Both areas are intrinsically connected to the utilization of cloud computing. However, energy policy (affecting electricity prices and "green" incentives) should be integrated into an overarching ICT policy framework in order to capture the full potential of cloud computing.

Top ICT policies for the economic recovery

Based on 30 responses to the OECD IT Outlook Policy Questionnaire 2010, section "Current IT policy priorities and new directions".

ICT policy area	Number of countries
ICT skills and employment	15
Broadband	15
R&D programmes	11
Venture finance	11
Enabling environmental impacts of ICTs	11

Note: The table ranks ICT policy areas by the number of countries attributing particular prioritisation for the economic recovery.
http://dx.doi.org/10.1787/888932330365

1. Introduction (continued)

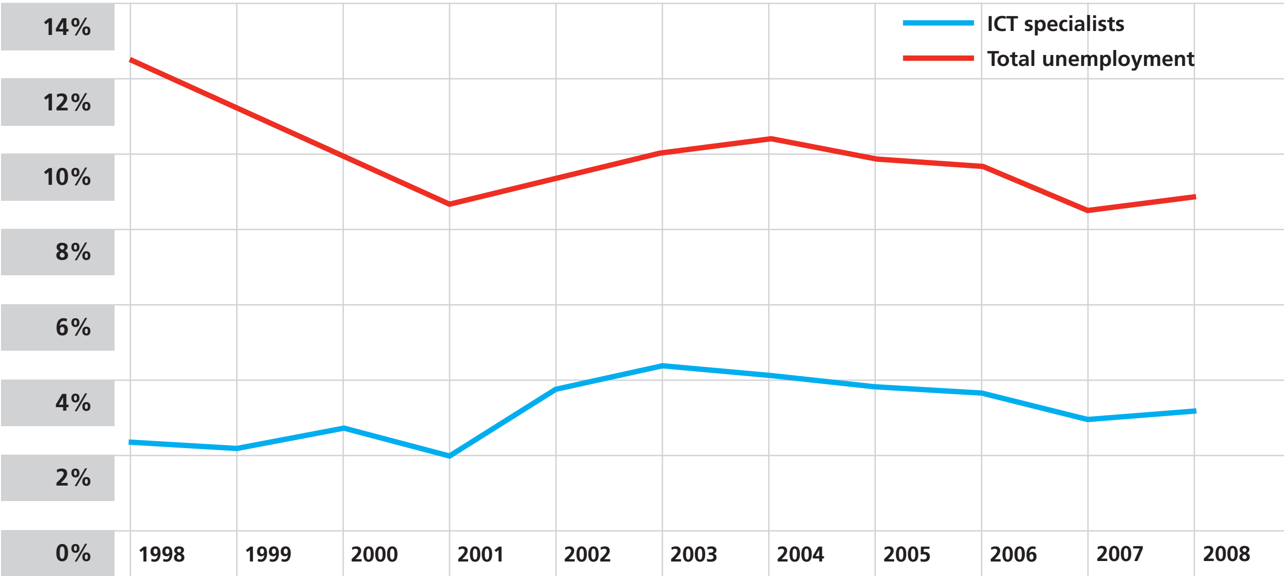
The job categories included in the category of ICT-skilled employment is defined by OECD in the following:

ISCO 88 code	Occupation description
121	Directors and chief executives
122	Production and operations managers
123	Other specialist managers
211	Physicists, chemists and related professionals
212	Mathematicians, statisticians and related professionals
213	Computer professionals
214	Architects, engineers and related professionals
241	Business professionals
242	Legal professionals
243	Archivists, librarians and related information professionals
312	Computer associate professionals
313	Optical and electronic equipment operators
341	Finance and sales associate professionals
342	Business services agents and trade brokers
343	Administrative associate professionals
411	Secretaries and keyboard-operating clerks
412	Numerical clerks
724	Electrical and electronic equipment mechanics and fitters

Note: All occupations listed are in the broad definition, only occupations shaded in blue are in the narrow measure.
Source: OECD ICT Outlook 2010

1. Introduction (continued)

Employment for ICT-skilled workers is strong with a long-term trend of low unemployment in the EU15:



http://dx.doi.org/10.1787/888932328598

We have made an effort to capture the situation in 2011 of spending on cloud, the growth of the two industries, relative trade effects and the impact on employment and skills. Where we projected into the future we disaggregated the effects into component parts and considered the growth trends of each part separately.

British firms' investment in cloud computing was around £2 billion (5% of total IT spending) in 2010 and is likely to rise to £5 billion by 2013, or 10% of total spending on information technology (IDC 2009). Spending on IT differs from sector to sector, and spending by small firms everywhere is disproportionately smaller in aggregate. Nevertheless, total cloud spending is likely to rise from around 1% of total industrial investment to over 1.5% over the coming five years, when overall ICT investment accounts for 14% of total UK investment.[6]

Estimates for cloud spending elsewhere vary tremendously depending on what is counted in total, and that is why we rely upon detailed sector-level spending that we can associate with the budgets of known firms. Italy's spending on cloud was estimated at €110 million in 2010 and IDC reports that it is likely to rise to over €150 million by 2013 (IDC, 2010).

6 *http://www.statistics.gov.uk/cci/nugget.asp?id=1714) The CEBR, 2010 report (p. 40) starts with Etro's model for business creation to estimate rising spending.*

The UK's electronic communications sector contributes around 2.3% of gross domestic product (GDP) with an industry turnover of £38.8 billion in 2007 (CMA). The mobile operator contribution to GDP of £138 billion, or 1% of total European Economic Area GDP, (AT Kearney, Mobile Observatory, 2009).http://www.thecma.com/press_policy/CMA_Communications_Manifesto/

1. Introduction (continued)

Germany's turnover in cloud computing is much higher, rising from €1.1 billion in 2010 and quadrupling in four years before, according to BITKOM, slowing growth to around 25% per annum from 2014 after having exceeded €4 billion in 2013. Etro (2009) consequently estimates that the total job creation for the UK could be between 119,519 jobs in the short term with slow cloud take up and 601,816 jobs with fast take up, and in the medium term between 70,333 jobs with slow take up and 353,293 jobs with fast take up. Germany's benefits are less, with short-term jobs creation ranging from 80,483 to 405,256 and medium term jobs ranging from 47,361 to 237,904 created. Italy, he estimates, gains less, with between 35,855 and 180,538 jobs created in the short term and between 21,099 and 105,984 in the medium term. The problem with these estimates, though seemingly precise, is that they vary tremendously not only because the scenarios are so different but also because by aggregating sectors there is little analysis of the real spending trends by existing firms and the effect that might have on job creation through specific shifts in employment patterns.

Those employment patterns shift for a few reasons. One is the effect on business creation, which Etro presents as numbers of new SMEs whose establishment might be explained by growth and opportunities specifically associated with the benefits of cloud economics. This analysis especially incorporates the well accepted assumption that entry barriers are reduced due in particular to the lower capital expenditure necessary to utilise IT with cloud services. Here he shows Italy gaining 81,000 new SMEs, Germany 39,000 and the UK 35,000. While we agree that a high proportion of new firms will enter utilizing almost exclusively cloud services, we do not go as far as the CEBR (2011) assumption that adoption of cloud services is likely to shift business workloads into cloud infrastructure from a current level of 20% of IT spending to 100% by 2014.[7] What we do find is that many new kinds of firms in smartphone services businesses, such as apps developers, are unlikely to have been founded at all if they had not had access to public cloud computing providers. Although capital requirements are central to the reasoning, the industry reports that it simply would not exist without cloud services. We interpret this to mean there would be fewer viable business models and risks would be huge.

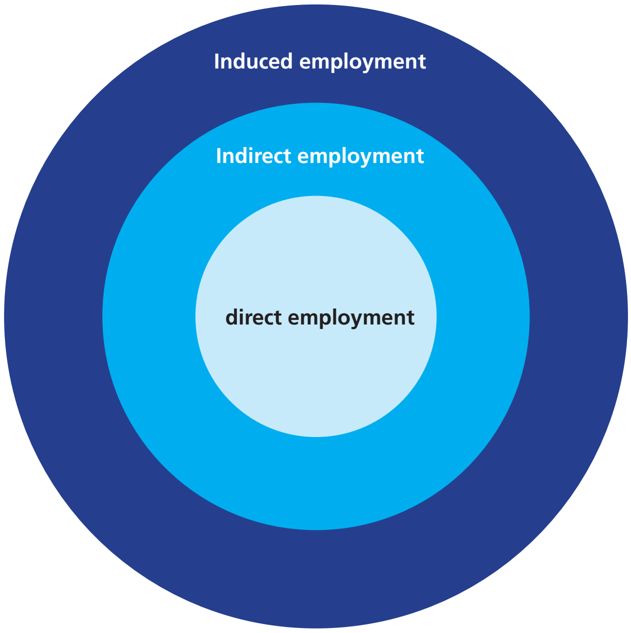
One source of the boost in start-up activity is provided by lower entry-barriers for IT infrastructure costs due to the shift from the need to deploy capital expenditure to the opportunity to pay for services out of operating expenditure (see Etro, 2009). Our interviews also indicate that business risk is lower when start-ups engaging in consumer applications quickly scale up and down depending on fickle consumer demand. Finally, investors appreciate shorter start-up times for new ventures, and are more likely to apply a "let's fund and see" approach when new products can be launched in a matter of days or weeks.

7 *CEBR 2011 p. 24; the same assumption is made in part one of the report, CEBR 2010, p. 16.*

1. Introduction (continued)

Underlying our analysis is an approach that takes into account not only the direct effects of cloud spending but also the indirect and induced impacts. The direct effect is the value added due to spending by firms that consume cloud services as they hire workers, pay taxes and purchase goods and services. It is also the value added through spending by the providers of cloud services as they hire workers, pay taxes, consume energy and purchase goods and services. The indirect impact is the value added associated with the suppliers to those cloud services firms, including especially the telecommunications companies, energy companies and construction and maintenance firms. The induced impact is a way of accounting for the added spending in the economy and the associated network effects of this growing business activity beyond the direct effects on the using firms and the indirect effects on their suppliers.

Figure: The relation between direct, indirect, and induced employment



1. Introduction (continued)

The multipliers we use to derive the indirect and induced impacts are somewhat conservative and follow the conventions of this sort of analysis whereby, for example, higher multipliers are applied for the effect of jobs created in the construction sector than for those in services.

Where goods and services are imported, significant numbers of jobs are not created domestically, so we take into account the effects of trade upon each activity (the main effects being that European public cloud investments will generate jobs in the U.S.). This is most straightforward for manufacturing but it can also be calculated for services.

We also can show how relatively high energy costs, for example, tend to push public cloud created jobs abroad to countries where lower electricity prices reduce the overall costs of data centres. Since electricity prices are lower in North America than Europe, we believe public cloud job creation is significantly less in Europe than it would otherwise be.[8]

Overall, the differences in the growth of cloud services are most strongly linked to the growth of those sectors that are using them, independent of cloud effects. Because, for example, the smartphone services sector is growing rapidly, its ability to generate jobs through cloud spending is significant. Aerospace, however, is an almost stagnant sector that, while growing in some places in some years at 4% and more, is generally growing at about 1% in the countries under study (taking into account some recent years of negative growth). Nevertheless, the aerospace industry is able to generate a small net increase in IT related jobs because of increases in productivity and redeployment of spending that accrue from being able to capitalise on the benefits of cloud services. When these are taken into account along with network effects we can see that even in a slow-growth manufacturing sector, the net employment effects and the opportunities to generate new firms are significant contributors to economic growth.

In the next section of this report, we describe in some more detail the methodology behind our analysis. Following that we present the analysis of the two sectors and in each of the four countries. In our conclusion, we compare and contrast these sectors and draw inferences for other kinds of economic activity. We also describe the skills effects and the managerial and policy implications that can be drawn from the application of our model and its analysis.

In chapter 6 we measure cloud jobs as an effect of IT spending by taking into account the labour component in IT spending. We also assess it as a contributing factor to industry growth. Further research is needed to measure the dynamic effects of new IT tools on firm growth on the micro level to discern, for example how improved customer response times affect firm profits and thereby support new hires. The positive growth rates for the two industries are supported indirectly by improved IT and managerial practices, stemming partly from cloud implementations. For aerospace, an annual growth rate of 2.5% in Europe and 3.5% in North America (Deloitte, 2010) is associated with a relatively small component of cloud services. In the case of smartphone services however, the cloud component is crucial to both the creation and provisioning of

The positive growth rates for the two industries are supported indirectly by improved IT and managerial practices, stemming partly from cloud implementations.

8 *We have taken into consideration that much (but not all) private cloud activity remains domestic. However, as much as 50% of public cloud job creation by European spending is likely to take place in the United States, partly because costs for power and cooling are the largest running cost for public data centres. In the future some of those jobs will migrate to lower labour cost locations if they also offer significant energy savings and political stability.*

2. Quantifying the cloud

services, supporting annual growth-rates of over 10% in the countries under study. This justifies our assumption that cloud implementations to have a relatively higher employment effect for the smartphone service industry than aerospace.

Our focus on the details of IT spending and cloud effects within two sectors allows us to take into consideration the economic characteristics of specific business practices. Those practices create value, boost certain kinds of productivity, and stimulate jobs within these firms and in particular among firms that provide cloud services. Each sector is unique in the ways in which it utilises information technologies.

The worldwide aerospace industry is relatively highly integrated and is characterised by common precision standards in manufacturing. Although the leading firms such as Boeing and Lockheed in the USA and BAE and Airbus (and EADS, its parent company) in Europe are among the largest companies in the world, they all rely upon a very large number of SMEs as well as large firms in other sectors to supply goods and services. Because they also include many leading-edge companies and new technology champions in areas such as materials and avionics as well as aircraft design, this is well-suited to be regarded as a bellwether manufacturing sector.

We have selected smartphone services because it provides an opportunity to demonstrate the effects cloud is likely to have on a new and rapidly growing sector that has direct impact upon infrastructure usage plus high spending on apparently distantly related businesses in advertising and software development. The growth and dynamism of this sector is demonstrated in various surveys that show that young people often rank access to mobile services to be more important to them than cars or clothes. Mobile applications provide these young people with new skills to communicate and keep in touch with friends and colleagues. A growing portion of hardware spending is migrating from stationary PCs to laptops and smart phones. Ubiquitous email and Internet access have therefore spurred sales of telecommunications services and driven consolidation among service delivery and payment providers. A saturating market trend for traditional mobile access drives the industry towards innovating and supporting "apps". Innovative smartphone applications have become mass market products and users understand that data for these services are stored in the cloud. Awareness and skills related to privacy and security have become an important driver for new service development. Connected smart phones provide portable music, games, and banking applications that attract an increasingly large group of developers targeting new operating systems and platforms.

Given this general description of these two sectors, we have constructed models that are broadly parallel to analyse the structures that describe how cloud spending occurs. For each sector we have taken credible industry estimates of the scale of IT spending in large and small firms and used census data to calculate the structure of each sector in terms of higher IT spending large companies and smaller spending SMEs. Using interviews, firm visits and company accounts in addition to industry sources we have calculated the extent and character of existing and projected cloud spending. That spending has the effect first of all of generating employment for cloud services providers. The Uptime Institute (2010) studies of large data centre costs, coupled with our own investigation into private cloud costs and business practices, has provided us with a clear idea of how to assess the spending and employment effects at the core of cloud services. In this way

2. Quantifying the cloud (continued)

we are able to differentiate the economic characteristics of private versus public cloud provision.

Medium and large firms with their own IT capabilities seem to gravitate towards private cloud implementations as they often have made significant investment in their own data centres[9]. Our interviews further indicate that firms in manufacturing, including those in aerospace manufacturing, tend to migrate their virtualization architectures into private cloud provisions. Further, mobile telecom operators, the largest employer within what we define as "smartphone services", see public cloud provision and ownership as a business opportunity.

The uptake patterns differ partly because firms with large sunk costs are slower than new firms to utilise public cloud services. This consideration, which is especially important for a mature industry such as aerospace, is a contributing factor to the decision making process that guides any move from capital expenditure to operating expenditure. In future work we will investigate the accounting and taxation rules, policies and practices that further affect budgeting decisions of this sort but for the current work we are guided mainly by the behavior of known firms in the two sectors rather than speculation about what might theoretically optimise budgets.

Spending creates jobs, but the kind of employment differs according to different categories of tasks. Private cloud implementations generate more direct employment, and public cloud implementations generate more indirect spending on equipment. Moreover, each job category carries its own employment costs and these differ by sector and especially from country to country. We have taken into account national estimates of full employment costs (including employers' tax liabilities, pension contributions, and some overheads in addition to salary).

The overall accounting for net job creation as cloud services grow is the effect of redeploying staff as tasks shift from work such as IT maintenance into relationship management and information utilization in conjunction with cloud services. In some kinds of firms, most especially small companies, we began by assuming that some portion of cost savings results in job losses as tasks are shifted to cloud services providers. We have good evidence, however, that large enterprises take advantage of the opportunity to redeploy staff into new and often significantly more productive work (Liebenau & Karrberg 2010). Some of this redeployment comes in the form of taking on managerial responsibilities for work now done in the cloud that had previously consisted of administrative, maintenance, and lower-level tasks. Other redeployment contributes directly to business development through focus on sales and product improvements. It is more difficult to demonstrate how the "cloud dividend" affects small businesses, but there is considerable anecdotal evidence, especially from the aerospace industry, that entrepreneurs are anxious to free up staff for productivity-enhancing managerial tasks rather than getting rid of valued employees.

An insightful demonstration of the "cloud dividend" and the

Private cloud implementations generate more direct employment, and public cloud implementations generate more indirect spending on equipment.

9 *IBM survey (2011), own interviews (2009-2011).*

2. Quantifying the cloud (continued)

details of how to benefit from it emerge in a carefully analysed case conducted by the Danish IT and Telecom Agency into the transition to cloud by SMEs for email and desktop computing services. The case showed how the greatest cost was in the migration from in-house provision to the cloud and provides us with a model for how to assess the effects of redeploying staff. It is here that we can also show the economic gains that accrue from this shift, and to be able to generalise those sorts of gains to see their effect on sectors as a whole. Other studies point to lower migration costs than in the Danish study. This further accentuates the importance of the right skills in organizations in order to successfully migrate to the cloud.

Server hardware cost savings in these cases were smaller than expected, but the actual level of savings experienced by different businesses varies greatly. More significant savings were seen on the IT support side when migrating to email. There the advantages of cloud spending are estimated at:

- 30% savings for IT management costs
- 50% savings for support costs
- all local operations costs disappear completely.

The resulting total savings amounts to two thirds for costs for the management, support and operations of email.

A transition from a standard in-house application server environment to a cloud-based solution needs to take into account not only potential future savings but also the cost of transition itself, and. In the Danish email case the three firms analysed found that in order to take advantage of cloud services they would need to ensure high capacity broadband, and that upgrading would incur both a one-off additional expense and an increase in running costs for telecommunication services. Hence, we have taken these costs into consideration when calculating the real effects of cloud spending.

While the Danish IT and Telecom Agency found a transition of email from in-house to cloud solution economically positive in all three cases studied, with savings of over 50% of annualised total costs over a five year period, this advantage could not be generalised for apparently similar applications.

In their other cases of the migration of a standard desktop application (an office suite), the switch over costs are high and at 2010 prices might not pay off. For them the costs of such cloud license fees would need to come down in price before it becomes unambiguously a profitable switch[10].

The details of this analysis were modeled into a "cloud calculator" tool (allowing for excel simulations). In one SME of 20 employees, for the firm to take a first step into the cloud it would face transition costs of around £50,000. The modelling assumes an in-house email solution with two servers that have an expected life-time of 5 years. They use standard SAN (VMWare), anti-virus/anti-spam, 13,000kWh of energy consumption per server per year, and a cost of £3500 per TB (calculated using the EMC de-duplicating calculator). It is noteworthy in this study that 60% of the transition costs were incurred by a pilot study undertaken before actual implementation. In spite of the transition costs, it could be expected over a five year period that total costs are halved. The chances of savings were intuitive, but the source in this case may not have been: The largest savings by far come

10 *A similar finding emerged from a detailed study of a medium sized manufacturing firm in Sweden where migration from an existing desktop suite in a PC client environment to a public cloud service turned out to be too expensive.*

2. Quantifying the cloud (continued)

in the form of reduced back-up/restore and recovery costs, amounting to a gain of £35,000. The storage area network (SAN) and server energy savings both account for around £17,500. However, since electricity prices for SMEs are 20% higher for British than Danish companies, UK firms benefit even more from any energy savings. Those savings are even greater in Germany and larger still in Italy, which has significantly higher electricity prices than the other countries. They are correspondingly less in the United States.

We believe the pilot and evaluation costs in the Danish study are in the upper range among cloud implementations compared to other studies[11]. Apart from rigorousness in carrying out the pilot study (in order to avoid expensive changes during installation and operation) the Danish study was carried out during 2010, while further progress in standardization and experience has occurred during 2011 (when Forrester carried out its study). Another reason for pilot and implementation costs being the top expense in the Danish study could be a larger share of products offering little local vendor support (for example webmail utilizing open source clients), whereas the Forrester study focused on products from vendors offering a complete solution with a higher level of local support. The latter case would explain why license costs rather than pilot and implementation became the dominant expense. Another potential reason could be different retail models, where a solution being integrated by a consulting or service firm would render more evaluation and integration costs than a complete "off the shelf" product from a cloud vendor typically having such support being built into the license cost.

The disadvantage of migrating to a cloud email system is found in the detailed difficulties of supplier support and competences. The level of maturity of the application is also important, with tested systems incurring fewer risks and smaller costs. The Danish analysts and most others in their 2010 study expect that transition difficulties will diminish as service providers become more adept at assisting clients and structuring prices competitively. We take into account these effects of learning and assume lower transition costs over the period of analysis.

Summary

In this section we have described how aerospace manufacturing and smartphone services are good representatives of cloud implementations in high-tech manufacturing and the fast-moving service sector respectively. Large firms typically own and operate their own IT infrastructure, whereas smaller firms prefer to outsource core IT functions, with large variations between sectors and firms. We assume that larger firms migrate to virtualised solutions and have a higher proportion of private cloud implementation than smaller firms, who typically start their cloud journey by outsourcing email functions. Following the same logic, large firms prefer to relocate IT support staff they free up when migrating to the cloud. For smaller firms the picture looks different when comparing manufacturing and smartphone services, with manufacturing firms less prone to reskill IT support staff. Evidence from other studies point to migrations of email solutions generally being successful for firms in all industries and size, whereas profitable migration of desktop applications (e.g. office suites) depend on the size of the firm where larger firms can make profitable switches, in-house skills for migration, and the character of the application already in place. When migrating to the cloud, significant savings (up to two-thirds in other studies quoted) can be achieved on for IT support and management.

11 *As reported for example by Forrester on implementations in mid-sized firms (2011).*

3. International differences in managerial practices

The way a firm is managed has a strong effect on its performance, stronger indeed than other factors that are often associated with whether a business succeeds such as national norms, market conditions and regulation (Bloom & van Reenen, 2007). Joint global research by the LSE and McKinsey and Company in 10 countries encompassing 4,000 firms measured differences in managerial qualities and placed the US at the top of a scale of good management practices with Germany following marginally behind, and slightly ahead of the UK. Italy's management practices lag these countries, but are ahead of the lowest tier of countries comprised of India, Greece and China[12]. Furthermore, their work values an incremental improvement in management practices to be equivalent to a 25 per cent increase in the labour force or a 65 per cent increase in invested capital.

A large proportion of the addressable market for outsourcing, as for cloud, does not fall within public scrutiny. If these transactions are not of significant volume, Europe will continue to lead in outsourcing contract values compared to the US, and may be a contributing factor when Europe play catch-up with the US in cloud adoption rates 2012-2014

ICT continues to be an element of this expenditure, with its use intrinsic to the functioning of large multinational organizations, and increasingly to smaller organizations. The returns from ICT continue to be variable however. In ICT-using sectors in Europe, no productivity acceleration occurred in the late 1990s, in contrast to the US, which experienced annual growth rates in output per hour of 3.5 per cent[13].

With similar access to ICT globally, and at relatively similar costs, one of the explanatory factors in the variability of returns is how ICT is embedded and utilised in the firm. A reason for the slower growth of productivity in ICT-using sectors in Europe is likely to be that US firms have better internal firm organization to get more from their ICT[14]. When intensive ICT utilization is combined with better practices, a 20 per cent increase in total factor productivity can occur[15]. In contrast, poor practices and intensive ICT utilization may yield only a 2 per cent increase in total factor productivity[16]. Micro level research indicates that well run larger manufacturing firms have effectively disseminated ICT use to the shop floor and related areas and have combined this with best practices lean production tenets, reward structures and performance tracking to yield higher productivity (Grous 2008). Smaller SMEs often do not invest in ICT to the same degree or in making improvements in practices in these areas, which can result in lower performance in labour productivity, return on capital employed (ROCE) and sales growth. In Europe, German SME manufacturing firms combine more intensive ICT use with good operations management and fair people management practices, which positions them ahead of UK firms, which display both fair people and operations management practices but slightly less intensive ICT use. In contrast, Italian manufacturers do not on average utilise ICT as intensively, or deploy it as deeply in the firm, and display less developed people management practices. In the US both SMEs and multinationals lead European firms in the utilization and proliferation of ICT, and possess both strong people and operations practices. The contrasting management practices across countries influence the adoption of ICT and

12 *Ibid.*

13 *Ibid, p. 9.*

14 *Ibid.*

15 *Management Matters research, 2007*

16 *Ibid.*

3. International differences in managerial practices (continued)

the willingness of managers to review alternative approaches to both hardware and software utilization, including cloud. Concomitant to, or perhaps as a result of this, cloud offerings are at heterogeneous stages of development and implementation across countries. In some cases, cloud providers are helping to shape the views of managers in firms, whilst in others their development is being shaped by these. The interplay among these variables will continue to influence the evolution of cloud services.

For many firms and policy makers, the debate about skills and jobs in the cloud is closely related to that of outsourcing, which further helps us differentiating cloud uptake and utilization between the countries in our study. The character of outsourcing in the US in contrast with that of Europe helps us in quantifying the cloud. The outsourcing of services continues to be a topical political theme in the US, particularly in the current recession. This is in contrast to Europe, where the issue of outsourcing jobs and IT infrastructure suffers from less of a 'protectionist' ethos. This divergence in outlook can to a degree be explained by the way that SMEs in particular operate and are governed in Europe versus the US. In Europe, employees are often more closely involved in decision making including labour, industrial relations issues, and technology investments (Pontusson 2005). In return, this can engender a greater degree of employee 'security' within SMEs, reflected in their average tenure, which is 9.65 years in European SMEs, but 30 per cent lower in US SMEs, at 6.7 years[17]. European SMEs managers show a greater willingness to train both unskilled and skilled workers, particularly at lower levels, which can facilitate greater productivity[18]. In contrast, larger European firms have begun to accelerate outsourcing efforts, spurred by a number of drivers: (1) large multi-billion Euro public sector programs in health, social security, and other areas; (2) efficiency factors, and (3) problems associated with access to specialised skills (Tate et al 2009). At the end of 2009, European businesses spent US$1bn more on outsourcing than their US counterparts[19], reversing the previous trend[20], to finish the year with more than US$30bn in contracts being signed.[21] Outsourcing on both sides of the Atlantic is being led by IT at the functional level, with a particular growth area being applications services and 'bundled infrastructure', and by Northern European countries including Sweden, the Netherlands, Switzerland and Germany. Utilizing public cloud services is generally viewed as a parallel activity occurring with existing 'traditional' outsourcing. Both European and US companies view cloud as an additional IT outsource service, with an accelerated number of service offerings being released internationally in a bid by cloud providers to capture the continued reduction in in-house servers by many businesses, often with the marketing dictum that "it's about adding value, and not just about reducing costs."[22] Political pressure on the US will most likely continue to curtail outsourcing by some segments of the economy.

17 *Ibid.*

18 *Grous, A. (2008). Ibid.*

19 *TPI Momentum Market Trends and Insights 3Q0 Geography Report. www.tpi.net*

20 *Ibid.*

21 *http://www.ft.com/cms/s/0/13761480-a118-11e0-9a07-00144feabdc0.html#axzz1SBoM3uT2*

22 *Grous, A. Op cit.*

3. International differences in managerial practices (continued)

Previous LSE research (Liebenau & Karrberg 2009-2010), including surveys of executives in enterprises, showed that efficiency savings in IT budgets are likely to spur training and redeployment of employees rather than lay-offs. The surveys further indicated that lack of communication skills among technologists seems to explain some of the difficulties in realizing the value of IT in the actual business units. Savings and innovation from IT result from a range of actions with complex relations that are challenging to communicate outside the sphere of the IT department. In the LSE survey executives, in all countries under study, found "managerial capabilities" much more of an inhibiting factor on the business than "inflexible IT infrastructure". In other words, lack of project management skills rather than lack of IT capacity was seen as the main inhibiting factor by managers when implementing efficient IT solutions. . We take this as further evidence in our modelling that firms generally prefer reskilling and retaining staff rather than the alternative.

Lack of project management skills rather than lack of IT capacity was seen as the main inhibiting factor by managers when implementing efficient IT solutions.

4. Smartphone services and aerospace manufacturing

Smartphone services

Smartphone users dominate the non-messaging data revenues collected by mobile telecom operators. This market is expanding in all advanced and many developing economies and the youthfulness of the industry and its dynamic growth makes it a ready user of cloud services. Juniper Research estimates the total cloud-based consumer market to be of similar size in Western Europe and North America, whereas the enterprise cloud-based market for smartphone applications in Western Europe is estimated to be 50% larger than North America. This points to the relatively large size of the European smartphone market but, as for PC cloud applications, it was estimated that more than 50% of the world market was in North America (IDC, 2011).

Qualitative elements

Since the mid-1990s mobile communications has been the single fastest growing spending category for individuals (OECD 2006) and is the major part of an industry that contributes over 4% to the GDP in each of the four countries under study (OECD). Service delivery technologies and payments are increasingly standardised by global IT firms and SMEs develop many of the apps, supported by an active private investment community (Karrberg 2011).

Economic data show a direct relationship between an increase in mobile phone penetration and GDP growth. Smartphone services contribute to labour market productivity and it is the key driver for handset purchase and network investments among telecom operators. Such infrastructure investments (such as telecom and utilities) relate in economic models to high job multipliers compared to most other industries; they are enablers and catalysts for many other economic activities.

Smartphone services can be considered as a lead indicator for investments and innovation in the telecom industry overall. Our previous studies further indicate that its effects on the economy far exceed that; managers deploy new skills when developing operating systems and platforms targeted towards mobile usage and they generally do so because they see a link with increased productivity or competitive advantage. Growth in mobile telecom industry is also expected to come mainly from applications and increased data usage rather than voice and text messaging. As smartphone services are integrated for social networking services among lead users, the sector is also a lead indicator of the effects of privacy and security on cloud computing, given that most apps are hosted and maintained in the cloud. Users have low switching costs between devices and applications and therefore provide a fast-moving environment with space for new firms.

As with computer and software services in general, a mix of industrial categories [SICs] needs to be considered when creating the compound economic statistics. However, the benefits of relatively transparent corporate reporting, the fact that most of the traffic is carried by a limited number of mobile network operators, and our detailed knowledge of the sector provide us with the necessary tools for economic estimates. New jobs in this sector are mostly in the higher wage brackets. We have defined the smartphone services sector as consisting of three areas: applications (apps), related

4. Smartphone services and aerospace manufacturing (continued)

advertisement, and non-messaging data revenues accrued by carriers. North America is the largest market, representing 60% of worldwide cloud spending in 2009 and will still be the largest area for cloud services in the short term.

Smartphones services have until recently not provided full mobility of enterprise and productivity applications with the exception of email. However, we expect cloud implementations to remove many of these boundaries unleashing a productivity increase as a subset of dynamics similar to that described by Waverman et al. (2001), who estimate that a 10% increase in smartphone penetration supports a 0.5% GDP increase in developed economies.

Productivity - Time to market

The mobile telecom industry is a good example of how cloud provides the double benefits of increased productivity and the ability to offer new services. The effects of increased productivity are integrated in our estimates of growth for the two sectors. Regarding new services, significant revenues are generated by fees from mobile data (for 2010 we estimate close to £1.8bn in non-messaging data) and they are driving investments in mobile infrastructure. Mobile operators are increasingly also leveraging their own server infrastructure and billing relations to launch proprietary cloud solutions for both the enterprise and consumer market. Both broadband and mobile operators reportedly plan the launch of applications and services that utilise resources in the underlying infrastructure in order to compete with so called "over the top" (OTT) players, such as Google, Skype, and others. US operators (such as Verizon and AT&T) already spend more on capital investments in their mobile networks than their European counterparts and have taken the initiative in cloud offerings; the UK and Germany follow, with Italy trailing. Vodafone and other international operators are also applying an international roll-out strategy.

The IT market as a whole in Western Europe will drive the formation of 17,336 new IT businesses and 157,200 new SMBs across all sectors (23,900 and 73,100 respectively in North America) and create 523,300 new IT jobs (1,785,600 in North America) between 2010 and 2015 according to data from IDC (Oct 2011). In the same data, IDC estimates 42% of IT employment will be software-related. In the software sector two thirds of employees work in large firms, but smartphone applications and related creative services (such as mobile advertisement) are areas with a high start-up ratio and SME activity. This is partly due to low entry barriers. Email and desktop applications are well understood by consumers and therefore suitable as a first step also into the enterprise cloud. Angel and venture capital investors are attracted by low capital expenditure requirements and shortened launch cycles of new ventures. Lately, large acquisitions and IPOs by cloud-based SaaS firms such as Facebook have raised the profile of the cloud-based software industry. Mobile use cases increased the value of such offerings and often the potential for charging users for increased convenience (30% of mobile usage among 20 year olds in the UK were on Facebook in 2010, according to Ofcom). IDC estimated that 80% of smartphone applications

We expect cloud implementations to remove many of these boundaries [for smartphone services] unleashing a productivity increase.

4. Smartphone services and aerospace manufacturing (continued)

are made available by apps providers through the public cloud (IDC, 2011). Consequently app providers can easily scale up and down their supply of bandwidth and access to their services with a pay per use rather than engaging in capital investments.

Productivity - Scaling

The mobile telecom industry in Europe is similar in scale to the aerospace industry in terms of turn-over, but employs 5 times as many people (this is largely accounted for by the high materials costs of aerospace manufacturing). Telecom firms invest heavily in IT, on average more than 20% of budgets. Cloud will clearly be a catalyst with great potential to change the way IT infrastructure, platforms and applications are launched both internally and to its customer base. Analysts have pointed out a positive correlation between size and earnings (EBITDA) margin among operators (Karrberg 2011). Small and nimble firms have in other words underperformed large and strong enterprises with bargaining power. We believe cloud could change this balance among operators, as smaller operators could buy into resources offered by cloud providers in order to scale up infrastructure and offer an increased amount of applications over multiple platforms. However, network coverage and the access layer will still limit the bandwidth available to operators. Similar economies of scale apply to SMEs in other sectors when they can access cloud services. However, sunk costs from existing infrastructure and business models among cloud service providers, means that flexibility of services will contribute to decisions of migration, not only cost.

Management time: shift from operations to strategy & marketing

It is a commonplace of IT organizations that 80% of resources and management time goes to "keeping the lights on" and only 20% to introducing new applications and infrastructure. Early implementations of cloud email and desktop applications in Denmark showed that the single largest savings were achieved in the area of contingency management and backup. Doing automated backups of data in the cloud rather than on-site is a prime example of freeing up management time. Not surprisingly, IT managers report how cloud computing moved up their priority list between 2009 and 2010 (Gartner), and a survey by LSE in 2009-10 identified "better IT project management" as the most important driver of effective use of technology. Furthermore, "workforce mobility" was identified as the second most important driver for enterprise innovation, highlighting the potential of the mobile cloud. The same LSE survey showed that IT managers were reluctant to reduce headcount when savings were realised; priority was given instead to redeploy staff in order to achieve higher customer value and product innovation. SMEs have fewer opportunities for redeploying, so cloud will rather contribute to new firms being formed and service efficiency among SMEs.

Policy significance

Access to telecom services is highly regulated and politically charged both in the US and Europe. However, there are few strict regulations on the application layer of smartphone services, which is seen by many as a major reason for its boom during the last decade. Smartphone services challenge

4. Smartphone services and aerospace manufacturing (continued)

traditional thinking in the silo structures typically applied by regulators, making the sector a lead indicator also of evolving regulatory change. Privacy is an area of regulatory concern due to the abundance of personal information that could be collected from smartphone service users. In the UK and the US, privacy and data protection are dealt with in the general legislation, whereas in Germany the telecom operators are covered by specific regulations on data handled by them. It is not yet clear how such differences in regulation could affect the marketing of cloud based smartphone services by operators.

Software providers set their hope in cloud as a way of decreasing piracy. A related example that could inspire the industry comes from music consumption in Britain. Downloading practices are seemingly moving away from file sharing to streaming services such as YouTube and Spotify to take advantage of the increased convenience. Less than a third of teenagers were illegally downloading music in a January 2009 survey, when 26% of 14 to 18 year olds admitted file sharing at least once a month, compared with 42% in December 2007[23].

Aerospace Manufacturing

The aerospace sector is characterised by a high degree of polarization, with over ninety five per cent of all companies engaged in aerospace activities in most countries being SMEs, with the remainder comprised of 'primes': very large organizations that assemble and consolidate multiple supplier inputs such as Boeing, Airbus, Rolls Royce and BAE Systems. Rapid "time to market" is a standard operating dictum in the sector, with timelines established by primes in contractual arrangements with airlines and cascaded through the supply chain. In addition, SMEs are under persistent price-reduction pressure from primes year on year. During the 1990s and early 2000s many aerospace firms entered an "offshore phase" in which they distributed varying degrees of "shop floor" manufacturing overseas as they sought to reduce operating costs. The new millennium has shifted this focus to technology as many manufacturing efficiencies have been exhausted.

Qualitative elements

Aerospace firms are: (i) integrating their systems with suppliers and customers, and (ii) beginning to displace ICT and software with outsourced options including non-traditional models such as cloud (Grous 2008). Our earlier work shows that aerospace firms are engaging in these strategies for three primary reasons: (1) facilitate rapid ordering and delivery; (2) reduce costs, and (3) accelerate the launch of products. The latter of these applies equally to primes, which are responsible for driving the majority of R&D led innovation in the aerospace supply chain, and smaller SMEs, which are able to focus on accommodating innovation in their products with the benefit of reduced operational overheads and often costs, as a result of greater cloud use.

Organizations [in the aerospace industry] that adopted a more aggressive cloud policy reported a marginally enhanced agility in the launch of new products across the sample countries.

23 *http://www.guardian.co.uk/music/2009/jul/12/music-industry-illegal-downloading-streaming.*

4. Smartphone services and aerospace manufacturing (continued)

Productivity: Time to Market - Shortened with Cloud

Organizations that adopted a more aggressive cloud policy reported a marginally enhanced agility in the launch of new products across the sample countries. They also were engaged in more innovative activity, due to four main factors: (1) rapid sourcing and implementation of software; (2) diminished licensing negotiations with vendors; (3) reduced IT assessment and overhead; (4) no requirement for in-house technical support. Agility varies by country, with the US depicting a 5 per cent improvement in product launch and innovation that coincides with the period when cloud was first adopted, followed by 3 per cent in the UK and Germany, and 1 per cent in Italy. These results generally apply where organizations embraced cloud wherever possible. In fewer instances, isolated areas of an organization were able to generate perceived benefits in the use of cloud due to the strategic nature of the function.

Productivity: Scale of Implementation Yields Positive Productivity Benefits

The more intensive use of cloud by organizations yielded additional productivity benefits in some staffing areas. Smaller SMEs were in some cases able to adopt a greater degree of cloud services and software than they were utilizing previously, and not increase their headcount in order to manage this. The productivity benefits cited by organizations included servicing a larger customer base with the same costs, increasing the sophistication of the organization due to the adoption of incremental tools such as analytics, and adopting software such as CRM, database management tools and marketing suites. This strategy has only been possible due to two key supply-side changes: (1) innovation in product offering by suppliers of software applications that to date have been available through a 'traditional' in-house mode only; and (2) the proliferation of cloud infrastructure that companies have to date maintained in-house together with required support (either with 3rd party organizations and/or in-house resources). US organizations had the highest productivity benefits from the adoption of cloud services, followed by the UK and Germany on a relatively equal basis.

Management Time: Shift from Operations to Strategy & Marketing

Managers reported an improvement in productivity because of the time they were able to focus on key business activities due to the migration of previous services to a cloud base. The key benefits included: reduced time spent in the establishment of infrastructure and services; the removal of attention diverted to dealing with operational problems related to these; addressing funding issues for ad hoc requests in relation to 'emergencies' or revised plans; managing operational and business risks caused by infrastructure, hardware and software considerations. The majority of organizations in which significant benefits occurred as a result of cloud implementation displacing in-house IT, software and support, indicated that 5 per cent or greater additional time was available for other tasks. This was consistent across all four countries, with US and UK managers reflecting a higher proportion of additionally available time than German and Italian managers.

5. Cloud characteristics in US, UK, Germany, and Italy

Many of the features of cloud services are common among advanced industrial countries. The leading firms compete directly with one another across international borders and charges and qualities of service also approximate international standards. However, growth rates vary considerably country by country because of factors such as the macroeconomic trends and industry structures and because of the qualities of information society infrastructures including skills in the labour pool and among managers of ICT functions.

In this section we describe the general cloud services trends in each country and present the quantative outcomes of our model of growth and jobs that are the direct consequences of cloud implementation in smartphone services and aerospace manufacturing. Following that we describe how productivity gains associated with cloud services help to generate new firm growth and we account for the total employment effects associated with that gain. After that we build upon this to describe how skills are shifted from, for example, the results of efficiency gains in large enterprises into ICT employment in small firms. For all of these features, national context creates distinct effects. We use these findings in the final chapter to show how different outcomes can be affected by policy changes and link the quantitative measures derived from our analysis here to the policy options such as those associated with energy pricing, taxation and data handling laws that might be taken, which could improve national conditions.

Cloud computing has done to hardware what open source has done to software.

The two industry sectors leading in the use of cloud computing are high-tech/communications and financial services. High tech companies are using cloud computing to develop their own cloud-based services and to lower their IT infrastructure costs. Financial services are using cloud computing for data analytics and to meet variable demand for internal and customer-facing services.

Many of the most popular cloud-based applications are business productivity tools such as email (e.g. Hotmail and Gmail), online productivity software (e.g. Google Docs and Microsoft Office 365), conferencing services (e.g. Microsoft LiveMeeting and WebEx), and customer relationship management software (e.g. Salesforce or Dynamics CRM). These investments in cloud computing allow firms to consolidate their IT infrastructure, reduce energy usage, engage their mobile workforce, and reduce up-front capital investments.

Cloud computing has been a boon to startups as it reduces their need for capital investments to build, run and maintain

Cloud computing has been a boon to startups as it reduces their need for capital investments to build, run and maintain IT infrastructure.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

IT infrastructure. As the CEO of one cloud computing startup noted, "Cloud computing has done to hardware what open source has done to software." The availability of low-cost cloud computing infrastructure allows startups to create products without having to make a heavy investment in IT infrastructure. Instead, they can scale to meet their user needs as they grow. Unlike existing firms, which must integrate cloud computing with legacy IT systems, startups can start fresh.

Economic effects: Business productivity and core IT employment

Effects of increasing business productivity due to utilization of cloud services were derived from interviews and divided into three types: decreased time-to-market for new products, efficient scaling (up and down) of operations, and management time savings. The majority of aerospace organizations in which significant benefits occurred as a result of cloud implementation displacing in-house IT, software and support, indicated that 5 per cent or greater additional management time was available for other tasks.

We now turn to focus on what we call "core IT functions" when analyzing employment effects and the need for reskilling when firms migrate to the cloud. Core IT functions refer to the facilities, equipment, and connectivity needed for business users to run their software applications. The IT core could be located in-house or elsewhere. IT core staff is often co-located or working towards the assets in such data centres and their job and skills are directly affected by what type of cloud infrastructure is in use. IT staff will have to reskill and be deployed to avoid redundancies when firms move their computing and storage capacity away from traditional in-house data centres. The associated cost structures when moving to the cloud are outlined in this chapter for each country.[24]

When firms make use of cloud services, especially with the public cloud, they provide business to firms that operate or themselves depend upon datacentres. For some forms of private cloud services datacentres are used either as dedicated facilities or dedicated sectors of larger datacentres. In the financial services sector, large datacentres are central to their private cloud provisions. This is also the case for large firms within the aerospace sector, and so we focus on these costs. For each country analysed, we calculate the proportion of costs that are relevant for job creation.

Modelling of smartphone services

In our model we have three revenue streams creating employment in smartphone services:

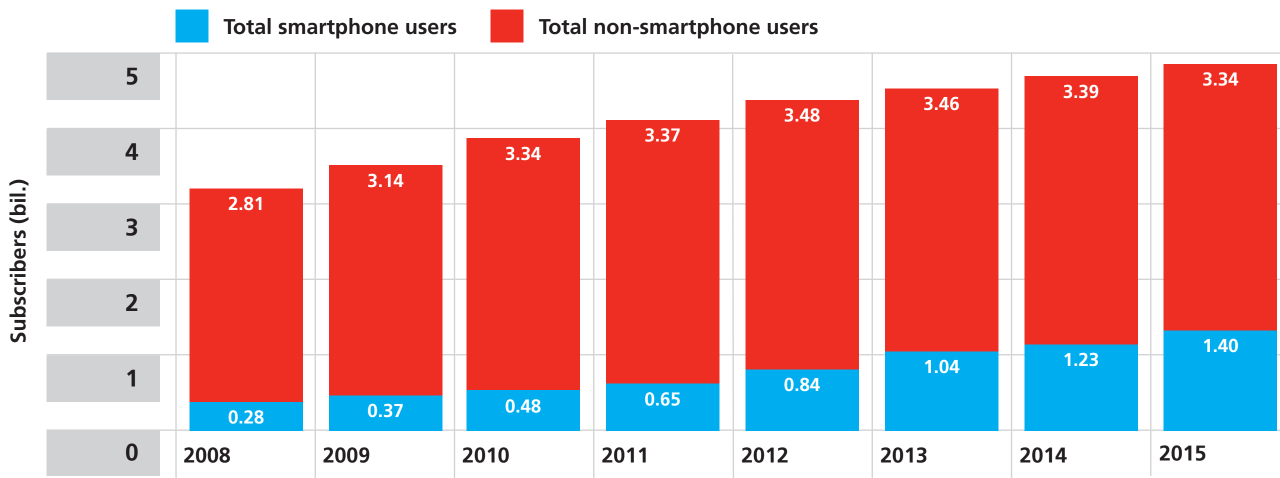
1. Application development and distribution (enterprise and consumer applications)
2. Internet advertisement driven by mobile usage
3. Data traffic in operator networks (cloud infrastructures among operators)

24 *In this report we assume that aerospace firms and smartphone service providers buy into the same cost structure with their cloud provider in order to directly compare spend with employment effects.*

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

In our initial modelling, point 3 addresses cloud implementations among operators due to increased smartphone data traffic. It has larger impact on employment than the application providers themselves and Internet advertisement, due to higher revenue . However, for start-ups and SMEs clearly the first group has highest potential. Internet advertising is dominated by Google and other search engine firms, but there is throughout a high level of entrepreneurship around new models of capitalizing on advertisement using social networking and related applications. Smart phone users are increasing in importance as consumers of cloud services as shown by growth in subscribers:

Global mobile subscribers, by smartphone and non-smartphone users 2008-2015

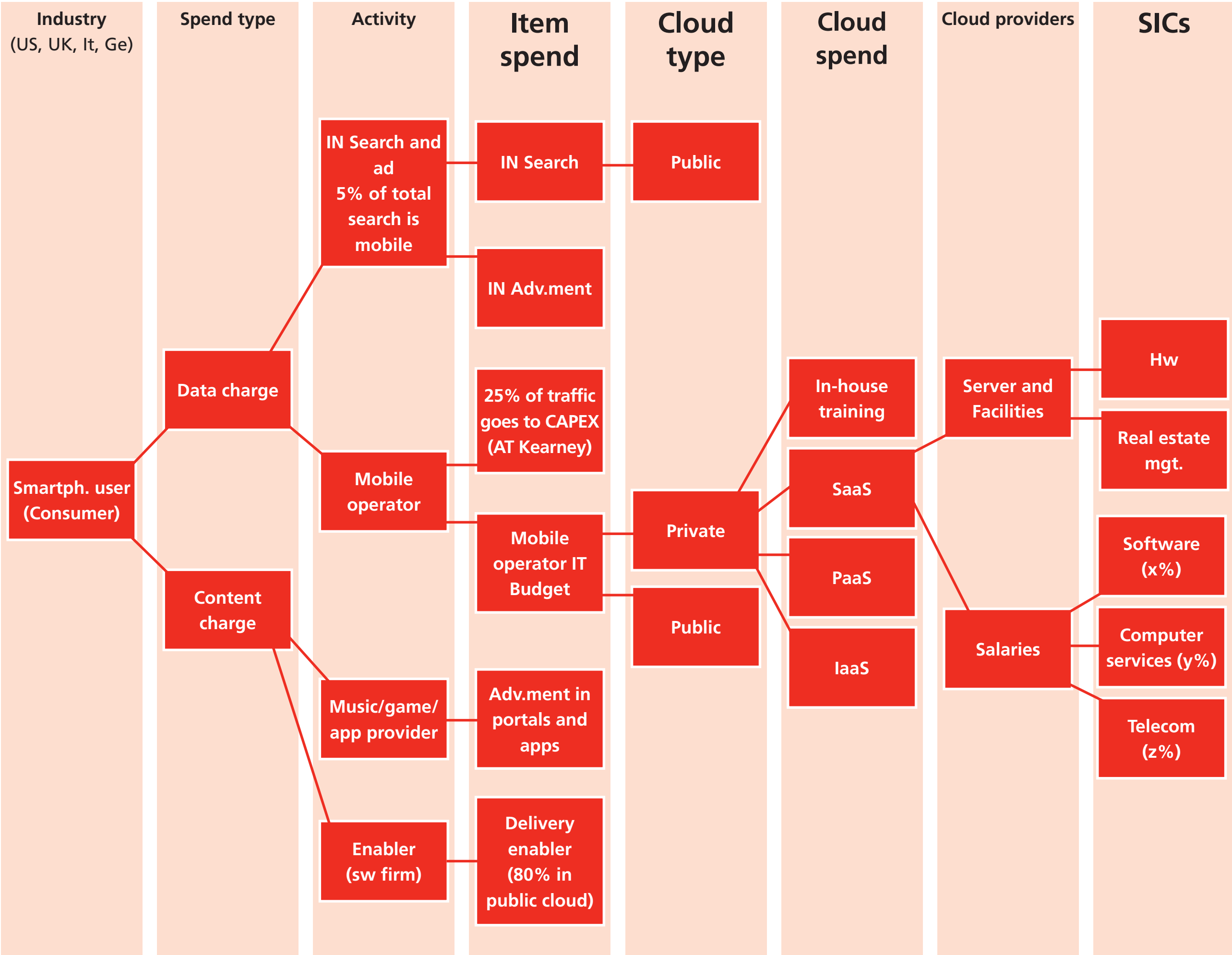


Note: Fifure referr to year-end
Source: Informa Telecoms and Media

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

We take the growth in the number of subscribers as one factor describing the growth of the sector. The other major factor is the increasing uptake of mobile data and other smartphone functions by users.

For the purposes of our analysis, we devised the following structure for our smartphone model:



Note: Above figure is a simplified view whereas in the model all item spends are broken down and analysed into cloud type and eventually SICs.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Within this model we make many assumptions, including:

- We assume that application software firms spend 30% of revenues on IT. This is high for other services sectors but appropriate for these companies.
- For app and mobile advertisement firms, we assume that most of their IT spending (with some country differences) is devoted to cloud services[25].
- We assume that capital spending resulting from operator data revenues also contributes to cloud investments, as IT is built out in parallel with expanding the mobile network.
- Among telecom operators we assume the share of private cloud investments to be 80% vs 20% for public cloud investments and the reverse for application and mobile advertisement providers.
- Trade effects: we assume 50% of public cloud jobs and 10% of private cloud jobs in the EU will be generated abroad (mainly the US). This is a result of distinctly favorable cost structures and labour productivity in North America, especially as regards energy prices. In the US we assume 10% of both public and private cloud jobs to be allocated abroad due to such "trade leaks". In smartphones we can see features of new service sectors and especially the heavy reliance on public cloud computing. We can also show how the sector relies upon other services, such as advertising, and what effect this has on the indirect economic impacts (Juniper Research, 2010).

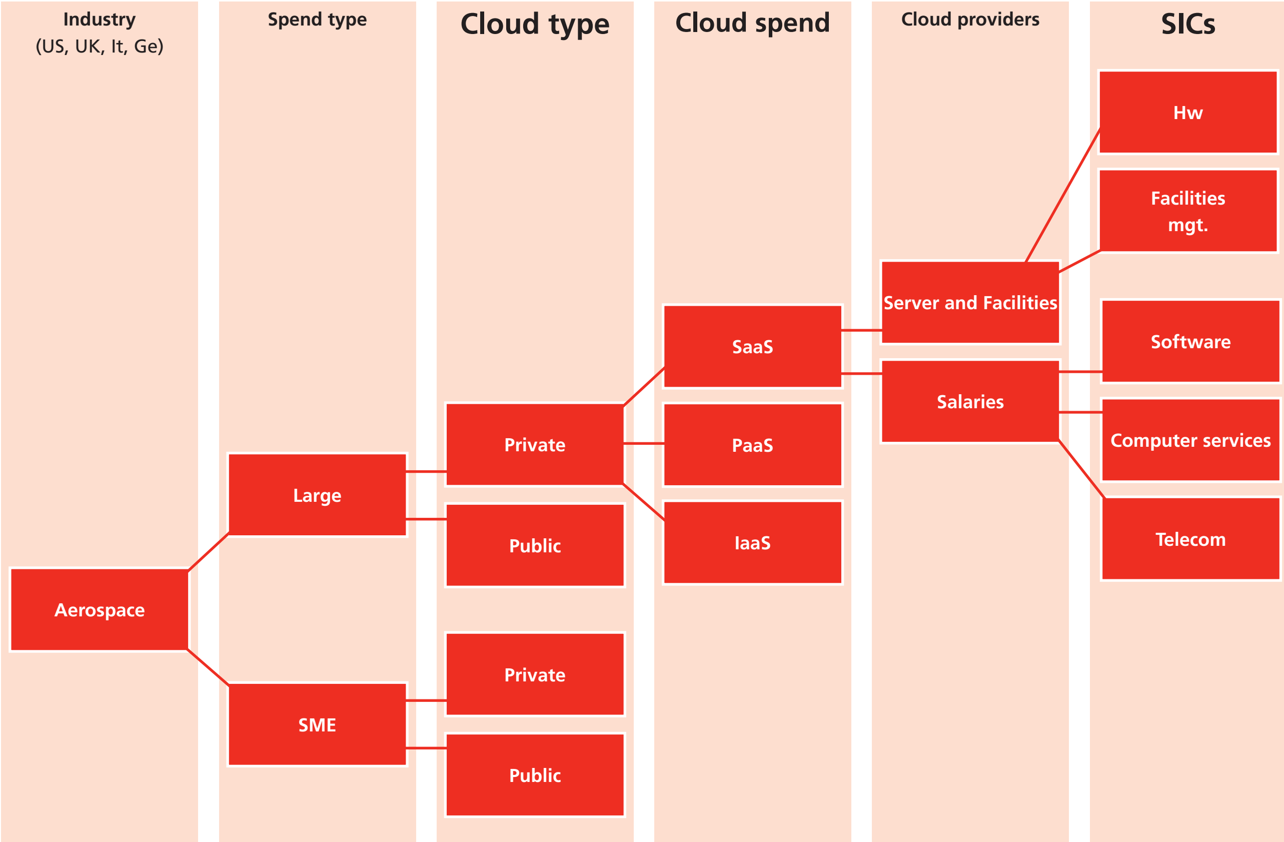
In smartphones we can see features of new service sectors and especially the heavy reliance on public cloud computing.

25 We use industry indicators by country to approximate that non-messaging data revenue is 18% for US operators compared to 10% in the UK, 11% in Germany, and 13% in Italy for 2010. We take telecom internal IT spending to be 10% of total firm spending, and about 15% of that was on cloud already in 2010, although there are significant national differences (with a 5% increase 2010-2011, followed by 1% annual increase in line with IDC global estimates). This can be compared with NTT DoCoMo in Japan who benefit from extensive smartphone adoption and earn 45% of revenue from non-messaging data. This illustrates the upside potential among US and European operators to increase the non-messaging data share of revenues further.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling of aerospace

The analytical structure of our aerospace model can be depicted as follows:



Note: Above figure is a simplified view whereas in the model all item spends (Private/Public; SaaS, PaaS, IaaS; Server and facilities/Salaries) are broken down and analysed into cloud type and eventually SICs.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Within this model we make many assumptions, including:

- The share of turn-over between large firms and SMEs varies among the countries (from 90% of the turn-over among large firms in the US to 50% in the UK).
- We assume that large aerospace firms command IT budgets corresponding to 3% of their turn-over, and small aerospace firms only 1%.
- Among large firms we assume the cloud share of IT spending being in line with the IDC global average (slightly above 10% in 2010) and increasing, with a lower share among SMEs.
- Among large firms we assume the share of private cloud investments to be 90% versus 10% for public cloud investments and that contrasts with our assumption of 80% private cloud and 20% public cloud investments among SMEs respectively.
- We assume a relatively slow growth rate of the global aerospace industry with a compound annual growth rate of 1% evenly distributed among the markets under study.
- Trade effects: we assume 50% of public cloud jobs and 10% of private cloud jobs in the EU will be generated abroad (mainly the US). This is a result of distinctly favorable cost structures and labour productivity in North America, especially as regards energy prices. In the US we assume 10% of both public and private cloud jobs to be allocated abroad due to such "trade leaks".

In the aerospace sector we can see certain characteristics that typify high technology manufacturing where the use of IT, in particular the propensity to rely upon private cloud services occur, and the way that trade effects emphasise the international character of the industry.

By applying these conditions to our model we are able to capture the real use of cloud services within the context of current and near future applications. We can also assess differing country conditions in a systematic manner. For each country we have modeled costs for the core IT function for an internal data centre, private, and public cloud implementation respectively. The variables that differ between the countries are electricity and staff costs. Otherwise we assume a similar cost structure for equipment and facilities[26].

United States

U.S. firms are leading the way on cloud utilization. A 2011 survey of U.S. IT professionals in business, government, healthcare and education found that 84 percent of organizations are using at least one cloud-based application. In particular, large businesses are the primary users of cloud computing with 37 percent of these firms using cloud technology. In comparison, 21 percent of small and medium sized enterprises are using cloud computing.[27] There is a general consensus that cloud computing is expected to grow over the next five years. Current cloud users predict that 34 percent of their IT budget will be spent on cloud computing in 2016; non-cloud users predict that 28 percent of their IT budget will be spent on cloud computing.[28]

26 *Based on a model provided by the Uptime Institute (2009)*

27 *CDW 2011 Cloud Computing Tracking Poll, June 2011, http://webobjects.cdw.com/webobjects/media/pdf/Newsroom/CDW-Cloud-Tracking-Poll-Report-0511.pdf*

28 *CDW 2011 Cloud Computing Tracking Poll, June 2011, http://webobjects.cdw.com/webobjects/media/pdf/Newsroom/CDW-Cloud-Tracking-Poll-Report-0511.pdf*

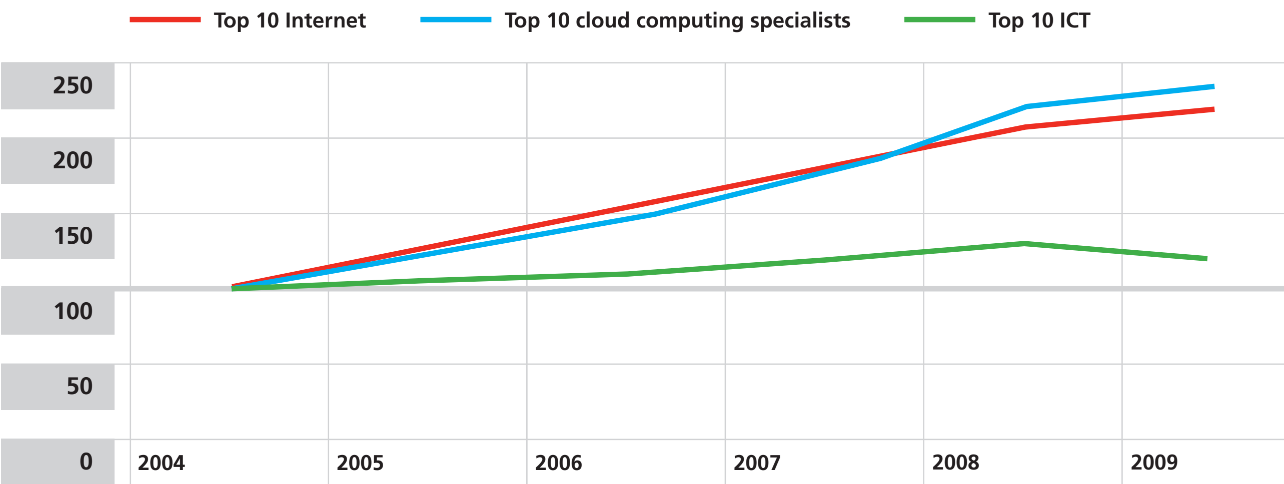
5. Cloud characteristics in US, UK, Germany, and Italy (continued)

The U.S. has seen a strong growth in advertisements for jobs directly related to cloud computing. The job search engine Indeed.com reports a massive growth in job listings mentioning "Azure" (Microsoft cloud service) and even greater growth in jobs mentioning "EC2" (Amazon cloud service) between January 2006 and January 2011.[29]

The US has the lowest electricity costs among the countries under study. According to our interviews, only geopolitical stability is more important than energy costs when public cloud firms locate their data centres[30]. As can be seen below, IT hardware followed by facilities costs are the two main costs items for cloud data centres (public and private), whereas staff costs and electricity feature as important costs items for internal data centres.

The chart below describes the distribution of costs associated with establishing and operating a data centre in the USA. For each country we will show the relative costs of elements, demonstrating, for the case of the USA, the relatively high cost of labour but electricity costs that are considerably lower than comparators. This demonstrates very high rates of growth for the sector, with especially high growth for enterprise applications and advertising. In the U.K. the cost of electricity is significantly higher than in the United States and staff costs for internal data centres is significantly below that of their American counterparts. Hardware costs are proportionately higher for UK data centres.

Figure 3.22. Employment trends by the top 10 cloud computing firms in the United States (Index, 100 = 2004)



Note: Based on averages for those firms reporting in 2004-09.
Top 10 Internet does not include IAC/InterActiveCorp, where employment dropped by 34% a year between 2004 and 2009.
Top 10 cloud computing specialists include firms which mainly generate their revenues through the provision of cloud computing services: NetAPP, Salesforce.com, Rackspace, Informatica, Taleo, RightNow Technologies, ServePath, NetSuite, Terremark Worldwide and SoundBite Communications. Data partly estimated.
Source: OECD Information Database, compiled from annual reports, SEC filings and market financials.
StatLink http://dx.doi.org/10.1787/888932328731

29 *Authors' research from Indeed.com. July 10, 2011.*

30 *Facebook recently decided to locate its first overseas data centre in northern Sweden, featuring a combination of low electricity costs and cool outdoor temperatures in combination with a well built out fibre infrastructure.*

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

The chart below describes the distribution of costs associated with establishing and operating a data centre in the USA. For each country we will show the relative costs of elements, demonstrating, for the case of the USA, the relatively high cost of labour but electricity costs that are considerably lower than comparators. This demonstrates very high rates of growth for the sector, with especially high growth for enterprise applications and advertising. In the U.K. the cost of electricity is significantly higher than in the United States and staff costs for internal data centres is significantly below that of their American counterparts. Hardware costs are proportionately higher for UK data centres.

This distribution of costs between staffing and equipment and especially between staffing and electricity is a most important indicator of the feasibility for growth. Even where staffing costs are high, as in the United States, the low cost of energy compensates to some degree. This is in particular a feature of the choice between locating services domestically versus abroad and while it may make little difference to many consumers of cloud services, it will make a difference to the business models of service providers.

Data centre cost breakdown in the US[31]	**Public cloud**	**Private cloud**	**Internal Data Centre**
Cost-break-down in respective IT configuration			
Facilities/Infrastructure	32%	24%	17%
IT Hardware (server+network)	46%	35%	25%
Software	0%	4%	3%
Electricity costs	10%	11%	17%
Network fees	2%	2%	1%
Property taxes	3%	2%	2%
Staff	7%	22%	35%
Facilities site management	3%	2%	1%
Maintenance	1%	1%	1%
Janitorial & landscaping	1%	0%	0%
Security	1%	1%	1%
IT Administrators (operations+support)	2%	18%	32%

31 *The cost distribution for the core IT function (operation and support of data centres) vary between the four countries under study. Costs for constructing facilities, install cooling and utility infrastructure, IT hardware, software, network fees, and property taxes are annualised and taken from Uptime Institute's estimations (2009). Data for staff costs and electricity costs have been sourced from own interviews, OECD, Eurostat, Office of National Statstics in UK, and the IT and Innovation Foundation (ITIF, 2009).*

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling - Smartphone Services in the US

We foresee considerable growth in the U.S. smartphone services with revenues from mobile search growing very rapidly and continued strong growth in data revenues. The aggregate effect on cloud related jobs growing from below 20,000 to almost 55,000 in the five years. Below are our estimations for non-messaging data revenue among mobile telecom operators, and revenues from smartphone cloud applications:

Overview of the US Smartphone Service Sector			
United States	**2010**	**2014**	**Cloud Jobs 2014**
Smartphone service turn-over	**$27.8bn**	**$46.5bn**	**54,500**
Data revenues (non-messaging)	$27bn	$42.5bn	31,400
Enterprise Applications	$248m	$1.2bn	6,770
Consumer Applications (subs)	$23m	$478m	2,720
Consumer Apps (advertisement)	$16m	$138m	790
Mobile Search (advertisement)	$503m	$2.25bn	12,780
Related US cloud jobs	**19,600**	**54,500**	
SME Cloud spending as share of (total)			
Public cloud:	**55%**	**63%**	
Private cloud:	**22%**	**27%**	

Sources: Juniper Research, AT Kearney, HSBC, IDC, Corporate reports (2011)

From the cost structure of the core IT organization, taking into account the assumptions for our smartphone model, we can calculate how much of IT spending goes to employ direct staff in US. By using employment multipliers, derived from input/output tables, we also provide estimates of indirect and induced jobs that are created in the public and private cloud environment respectively.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

US Smartphone sector:

The breakdown between public and private cloud is described in detail as follows.

Public Cloud – Employment US (2014)	Total
Direct Hires	145
IT Administrators (FTEs)	21
Facilities site management (FTEs)	21
Maintenance (FTEs)	27
Janitorial & landscaping (FTEs)	48
Security (FTEs)	27
Total Direct, Indirect, Induced from Hires	435
Total Direct, Indirect, Induced from IT Hardware	1,094
Total Direct, Indirect, Induced from Software	0
Total Direct, Indirect, Induced from Construction	1,061
Total Direct, Indirect, Induced from Utilities	111
Total Direct, Indirect, Induced from Network	36
Trade leak due to allocation abroad: Direct hires (10%)	-44
Trade leak: Direct spending	-355
Total Public Cloud Jobs	**2,340**

Private Cloud – Employment US (2014)	Total
Direct Hires	2,931
IT Administrators (FTEs)	141
Facilities site management (FTEs)	141
Maintenance (FTEs)	178
Janitorial & landscaping (FTEs)	316
Security (FTEs)	2,155
Total Direct, Indirect, Induced from Hires	8,794
Total Direct, Indirect, Induced from IT Hardware	7,182
Total Direct, Indirect, Induced from Software	774
Total Direct, Indirect, Induced from Construction	6,967
Total Direct, Indirect, Induced from Utilities	1,076
Total Direct, Indirect, Induced from Network	239
Trade leak due to allocation abroad: Direct hires (10%)	-879
Trade leak: Direct spending	-2,291
Total Private Cloud Jobs	**21,862**

LSE

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

In these, as with the following charts, we can see the breakdown into categories and indications of the direct, indirect and induced employment from hardware, software, construction, utilities and network jobs, as well as direct hires, the largest single category. We can note the significant effects upon employment on IT hardware and for construction. We also note the way trade leaks are accounted for and the resulting losses in jobs. What is notable for the US case is that job losses through imports are relatively low, compared with the situation in other countries.

Modelling - Aerospace

When modelling the aerospace industry, the process is more straightforward than for smartphones services, as the IT spending in firms is used directly to enhance cloud employment. We approximate a 10% share of staff outsourcing for both private and public cloud, due to the strong position among US cloud providers.

The aerospace industry in the US is characterised by large firms who typically spend most on private cloud. SMEs make up a small proportion of the US aerospace cloud spending.

Despite the larger scale of the aerospace industry currently, the potential for job creation is lower than for smartphone services. Nevertheless, the total employment effect is strongly positive and despite the significantly higher proportion of private as opposed to public cloud activity.

Overview of the US Aerospace Sector

	2010	2014
Aerospace service revenues	**$210bn**	**$241bn**
Total induced, indirect, and direct jobs	**15,400**	**24,200**
SME Cloud spending as share of (total)		
Public cloud:	**7%**	**8%**
Private cloud:	**3%**	**4%**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

US Aerospace sector:

The breakdown between public and private cloud is described in detail as follows.

Public Cloud – Employment US (2014)	Total
Direct Hires	145
IT Administrators (FTEs)	21
Facilities site management (FTEs)	21
Maintenance (FTEs)	27
Janitorial & landscaping (FTEs)	48
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Trade leak due to allocation abroad: Direct hires (10%)	-879
Trade leak: Direct spending	-2,291
Total Private Cloud Jobs	**21,862**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

United Kingdom

The data for the United Kingdom differs from that of the United States in that staff costs for data centres are proportionately less while electricity costs are higher. We will later see how these factors differ in other European countries.

The UK has relatively higher electricity costs and lower staffing costs than its US cloud data centre counter parts.

Data centre cost breakdown	Public cloud	Private cloud	Internal Data Centre
Unit costs (per M $)			
Facilities/Infrastructure	29.9%	22.4%	16.1%
IT Hardware (annualised)	43.2%	32.3%	23.3%
Software	0.0%	2.9%	2.6%
Electricity costs	15.5%	17.6%	24.9%
Network fees	1.9%	1.4%	1.0%
Property taxes	2.7%	2.0%	1.5%
Staff	6.8%	21.3%	30.7%
IT administrators	1.8%	17.5%	28.0%
Facilities site management	1.9%	1.5%	1.1%
Maintenance	1.0%	0.8%	0.5%
Janitorial & landscaping	0.6%	0.5%	0.3%
Security	1.4%	1.1%	0.8%

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling - Smartphone Services

UK	2010	2014	Cloud Jobs 2014
Smartphone service turn-over	**£1.6bn ($2.5bn)**	**£3.9bn ($6.1bn)**	**4,040**
Data revenues (non-messaging)	£1.5bn	£3.3bn	2,144
Enterprise Applications	£47m	£235m	787
Consumer Applications (subs)	£2.8m	£73m	246
Consumer Apps (advertisement)	£2.2m	£21m	72
Mobile Search (advertisement)	£26m	£236m	791
Total induced, indirect, and direct jobs	**900**	**4,040**	
SME Cloud spending as share of (total)			
Public cloud:	**57%**	**63%**	
Private cloud:	**27%**	**33%**	

Sources: Juniper Research, AT Kearney, HSBC, IDC, Corporate reports (2011)

In all markets we assume that smartphone data revenues will increase by below or just above 100%. Smartphone applications and search see higher growth rates still, supporting a rapid job creation in cloud-related areas.

For the smartphone sector we have assumed the SME share of revenue in application firms to be 70% (approximate UK situation in 2009 for SIC "computer services") and for mobile telecom operators only 19% (approximate situation in 2009 for SIC "Post and Telecommunications").

Among the four markets we expect the UK to have the highest growth rates in mobile data and overall revenues from smartphone services (even though much smaller in size than the US). We approximate a 50% share of public cloud jobs are generated in data centres being created outside the UK, mainly in the US.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

The breakdown between public and private cloud is described in detail as follows.

Public Cloud – Employment	Total
Direct Hires	
IT Administrators (FTEs)	74
Facilities site management (FTEs)	58
Maintenance (FTEs)	58
Janitorial & landscaping (FTEs)	73
Security (FTEs)	131
Total Direct Hires	395
Total Direct, Indirect, Induced from Hires	822
Total Direct, Indirect, Induced from IT Hardware	1,072
Total Direct, Indirect, Induced from Software	0
Total Direct, Indirect, Induced from Construction	704
Total Direct, Indirect, Induced from Utilities	324
Total Direct, Indirect, Induced from Network	40
Trade leak: Direct spending	-245
Total Public Cloud Jobs	**1,358**

Private Cloud – Employment	Total
Direct Hires	2,931
IT Administrators (FTEs)	559
Facilities site management (FTEs)	36
Maintenance (FTEs)	36
Janitorial & landscaping (FTEs)	43
Security (FTEs)	77
Total Direct Hires	752
Total Direct, Indirect, Induced from Hires	1,563
Total Direct, Indirect, Induced from IT Hardware	630
Total Direct, Indirect, Induced from Software	60
Total Direct, Indirect, Induced from Construction	414
Total Direct, Indirect, Induced from Utilities	289
Total Direct, Indirect, Induced from Network	23
Trade leak due to allocation abroad: Direct hires (10%)	-156
Trade lead: Direct spending	-141
Total Private Cloud Jobs	**2,682**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling - Aerospace

The UK aerospace industry is in contrast to the US industry more SME-oriented, with about half of the value-add coming from large firms. This explains the higher ration of cloud spending from SMEs. As large firms spend more on IT and move faster on cloud than small firms, large firms make up two-thirds of total cloud spending.

UK	**2010**	**2014**
Aerospace revenues	**£22.2bn ($34.7bn)**	**£24.3bn ($37.8bn)**
Total induced, indirect, and direct jobs	**880**	**1,340**
SME Cloud spending as share of (total)		
Public cloud:	**30%**	**33%**
Private cloud:	**16%**	**18%**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Public Cloud – Employment UK (2014)	Total
Direct Hires	20
IT Administrators (FTEs)	4
Facilities site management (FTEs)	3
Maintenance (FTEs)	3
Janitorial & landscaping (FTEs)	4
Security (FTEs)	7
Total Direct, Indirect, Induced from Hires	42
Total Direct, Indirect, Induced from IT Hardware	55
Total Direct, Indirect, Induced from Software	0
Total Direct, Indirect, Induced from Construction	36
Total Direct, Indirect, Induced from Utilities	17
Total Direct, Indirect, Induced from Network	2
Trade lead: Direct spending	-13
Total Public Cloud Jobs	**70**

Private Cloud – Employment UK (2014)	Total
Direct Hires	347
IT Administrators (FTEs)	256
Facilities site management (FTEs)	17
Maintenance (FTEs)	17
Janitorial & landscaping (FTEs)	21
Security (FTEs)	38
Total Direct, Indirect, Induced from Hires	723
Total Direct, Indirect, Induced from IT Hardware	307
Total Direct, Indirect, Induced from Software	29
Total Direct, Indirect, Induced from Construction	202
Total Direct, Indirect, Induced from Utilities	141
Total Direct, Indirect, Induced from Network	11
Trade leak due to allocation abroad: Direct hires (10%)	-72
Trade lead: Direct spending	-69
Total Private Cloud Jobs	**1,271**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Germany

Germany has relatively higher electricity costs and lower staffing costs than the UK and the US.

Data centre cost breakdown	Public cloud	Private cloud	Internal Data Centre
Unit costs (per M $)			
Facilities/Infrastructure	29.2%	21.9%	15.8%
IT Hardware (annualised)	42.1%	31.7%	22.8%
Software	0.0%	2.8%	2.5%
Electricity costs	17.7%	20.7%	28.6%
Network fees	1.8%	1.4%	1.0%
Property taxes	2.7%	2.0%	1.4%
Staff	6.5%	19.4%	27.9%
IT administrators	1.8%	15.9%	25.3%
Facilities site management	1.8%	1.4%	1.0%
Maintenance	0.9%	0.7%	0.5%
Janitorial & landscaping	0.6%	0.5%	0.3%
Security	1.4%	1.0%	0.7%

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling - Smartphone Services

Germany	2010	2014	Related Jobs 2014
GER smartphone service turn-over	**€3.1bn ($4.3bn)**	**€4.8bn ($6.5bn)**	**4,840**
Data revenues (non-messaging)	€2.2bn	€4.2bn	2,520
Enterprise Applications	€57m	€266m	970
Consumer Applications (subs)	€3.3m	€83m	300
Consumer Apps (advertisement)	€2.6m	€24m	90
Mobile Search (advertisement)	€30m	€267m	970
Total induced, indirect, and direct jobs	**1,273**	**4,840**	
SME Cloud spending as share of (total)			
Public cloud:	**54%**	**62%**	
Private cloud:	**25%**	**32%**	

Sources: Juniper Research, AT Kearney, HSBC, IDC, Corporate reports (2011)

Germany is the largest smartphone service market in Europe 2010 but grows slower than both Italy and the UK. The UK is not far behind Germany in cloud job creation by 2014 in smartphone services.

For all smartphone markets in the study we assume that SMEs support over half of total 2010 public cloud spending, and this rises to about two-thirds in all four markets by 2014. Corresponding share of private cloud spending in smartphone services rises from around one quarter to one third in Europe and from 22% to 27% in the US. Most jobs are being created by mobile operators who capitalise on being the conduit for increasing spending on non-messaging data.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

The breakdown between public and private cloud is described in detail as follows.

Public Cloud – Employment	Total
Direct Hires	368
IT Administrators (FTEs)	69
Facilities site management (FTEs)	54
Maintenance (FTEs)	54
Janitorial & landscaping (FTEs)	68
Security (FTEs)	122
Total Direct Hires	368
Total Direct, Indirect, Induced from Hires	766
Total Direct, Indirect, Induced from IT Hardware	1,577
Total Direct, Indirect, Induced from Software	0
Total Direct, Indirect, Induced from Construction	864
Total Direct, Indirect, Induced from Utilities	372
Total Direct, Indirect, Induced from Network	49
Trade lead: Direct spending	-71
Total Public Cloud Jobs	**1,778**

Private Cloud – Employment	Total
Direct Hires	686
IT Administrators (FTEs)	505
Facilities site management (FTEs)	33
Maintenance (FTEs)	33
Janitorial & landscaping (FTEs)	41
Security (FTEs)	74
Total Direct Hires	686
Total Direct, Indirect, Induced from Hires	1,426
Total Direct, Indirect, Induced from IT Hardware	955
Total Direct, Indirect, Induced from Software	90
Total Direct, Indirect, Induced from Construction	523
Total Direct, Indirect, Induced from Utilities	351
Total Direct, Indirect, Induced from Network	30
Trade leak due to allocation abroad: Direct hires (10%)	-143
Trade lead: Direct spending	-173
Total Private Cloud Jobs	**3,060**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling - Aerospace

The German and UK aerospace industries have similar total revenues. However, we estimate that almost 96% of German cloud spending is done by large firms, compared to only around 70% in the UK, generating more cloud jobs in German aerospace compared to the UK.

Germany	**2010**	**2014**
Aerospace revenues	**€24.7bn ($34bn)**	**€27.2bn ($37.6bn)**
Total induced, indirect, and direct jobs	**1,490**	**2,100**
SME Cloud spending as share of (total)		
Public cloud:	**5%**	**6%**
Private cloud:	**2%**	**3%**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Public Cloud – Employment Germany (2014)	Total
Direct Hires	22
IT Administrators (FTEs)	4
Facilities site management (FTEs)	3
Maintenance (FTEs)	3
Janitorial & landscaping (FTEs)	4
Security (FTEs)	7
Total Direct, Indirect, Induced from Hires	44
Total Direct, Indirect, Induced from IT Hardware	96
Total Direct, Indirect, Induced from Software	0
Total Direct, Indirect, Induced from Construction	52
Total Direct, Indirect, Induced from Utilities	23
Total Direct, Indirect, Induced from Network	3
Trade lead: Direct spending	-18
Total Public Cloud Jobs	**100**

Private Cloud – Employment Germany (2014)	Total
Direct Hires	449
IT Administrators (FTEs)	331
Facilities site management (FTEs)	22
Maintenance (FTEs)	22
Janitorial & landscaping (FTEs)	27
Security (FTEs)	49
Total Direct, Indirect, Induced from Hires	934
Total Direct, Indirect, Induced from IT Hardware	626
Total Direct, Indirect, Induced from Software	59
Total Direct, Indirect, Induced from Construction	343
Total Direct, Indirect, Induced from Utilities	230
Total Direct, Indirect, Induced from Network	19
Trade leak due to allocation abroad: Direct hires (10%)	-93
Trade lead: Direct spending	-113
Total Private Cloud Jobs	**2,005**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Italy

Italian firms have the highest costs for electricity and the lowest overall cost for staff in the study.

Data centre cost breakdown	Public cloud	Private cloud	Internal Data Centre
Unit costs (per M $)			
Facilities/Infrastructure	27.9%	20.9%	15.0%
IT Hardware (annualised)	40.3%	30.2%	21.7%
Software	0.0%	2.7%	2.4%
Electricity costs	21.9%	26.4%	34.8%
Network fees	1.8%	1.3%	0.9%
Property taxes	2.5%	1.9%	1.4%
Staff	5.6%	16.6%	23.8%
IT administrators	1.9%	16.9%	27.0%
Facilities site management	2.0%	1.5%	1.1%
Maintenance	1.0%	0.7%	0.5%
Janitorial & landscaping	0.7%	0.5%	0.4%
Security	1.5%	1.1%	0.8%

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling - Smartphone Services

Italy	**2010**	**2014**	**Related Jobs 2014**
GER smartphone service turn-over	**€2.1bn ($2.9bn)**	**€3.9bn ($5.4bn)**	**3,450**
Data revenues (non-messaging)	€2bn	€3.37bn	1,790
Enterprise Applications	€40m	€199m	600
Consumer Applications (subs)	€2.4m	€62m	190
Consumer Apps (advertisement)	€1.9m	€18m	60
Mobile Search (advertisement)	€31m	€277m	820
Total induced, indirect, and direct jobs	**937**	**3,450**	
SME Cloud spending as share of (total)			
Public cloud:	**54%**	**63%**	
Private cloud:	**25%**	**33%**	

Sources: Juniper Research, AT Kearney, HSBC, IDC, Corporate reports (2011)

Italian mobile operators had a higher proportion of data revenues of total revenue per user in 2010 than the UK. However, while they anticipate becoming level with the UK in terms of revenue forecast for 2014, the UK generates more cloud jobs.

In the UK we expect the highest growth rates in mobile data and overall revenues from smartphone services.

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Public Cloud – Employment	Total
Direct Hires	337
IT Administrators (FTEs)	63
Facilities site management (FTEs)	50
Maintenance (FTEs)	50
Janitorial & landscaping (FTEs)	62
Security (FTEs)	112
Total Direct Hires	337
Total Direct, Indirect, Induced from Hires	700
Total Direct, Indirect, Induced from IT Hardware	858
Total Direct, Indirect, Induced from Software	0
Total Direct, Indirect, Induced from Construction	564
Total Direct, Indirect, Induced from Utilities	393
Total Direct, Indirect, Induced from Network	32
Trade lead: Direct spending	-176
Total Public Cloud Jobs	**1,186**

Private Cloud – Employment Germany (2014)	Total
Direct Hires	595
IT Administrators (FTEs)	438
Facilities site management (FTEs)	29
Maintenance (FTEs)	29
Janitorial & landscaping (FTEs)	36
Security (FTEs)	64
Total Direct Hires	595
Total Direct, Indirect, Induced from Hires	1,238
Total Direct, Indirect, Induced from IT Hardware	493
Total Direct, Indirect, Induced from Software	47
Total Direct, Indirect, Induced from Construction	324
Total Direct, Indirect, Induced from Utilities	363
Total Direct, Indirect, Induced from Network	18
Trade leak due to allocation abroad: Direct hires (10%)	-124
Trade lead: Direct spending	-93
Total Private Cloud Jobs	**2,266**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Modelling - Aerospace

The profile of the Italian aerospace industry is similar to the UK with a strong impact from SMEs, but the sector is relatively smaller compared to the overall economy.

Italy	**2010**	**2014**
Aerospace revenues	**€8bn ($11bn)**	**€8.8bn ($12.2bn)**
Total induced, indirect, and direct jobs	**280**	**380**
SME Cloud spending as share of (total)		
Public cloud:	**30%**	**32%**
Private cloud:	**16%**	**18%**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Public Cloud – Employment Italy (2014)	Total
Direct Hires	6
IT Administrators (FTEs)	1
Facilities site management (FTEs)	1
Maintenance (FTEs)	1
Janitorial & landscaping (FTEs)	1
Security (FTEs)	2
Total Direct, Indirect, Induced from Hires	12
Total Direct, Indirect, Induced from IT Hardware	15
Total Direct, Indirect, Induced from Software	0
Total Direct, Indirect, Induced from Construction	10
Total Direct, Indirect, Induced from Utilities	7
Total Direct, Indirect, Induced from Network	1
Trade lead: Direct spending	-3
Total Public Cloud Jobs	**21**

Private Cloud – Employment Italy (2014)	Total
Direct Hires	97
IT Administrators (FTEs)	71
Facilities site management (FTEs)	5
Maintenance (FTEs)	5
Janitorial & landscaping (FTEs)	6
Security (FTEs)	10
Total Direct, Indirect, Induced from Hires	201
Total Direct, Indirect, Induced from IT Hardware	85
Total Direct, Indirect, Induced from Software	8
Total Direct, Indirect, Induced from Construction	56
Total Direct, Indirect, Induced from Utilities	63
Total Direct, Indirect, Induced from Network	3
Trade leak due to allocation abroad: Direct hires (10%)	-20
Trade lead: Direct spending	-16
Total Private Cloud Jobs	**381**

5. Cloud characteristics in US, UK, Germany, and Italy (continued)

Summary

Cloud employment in manufacturing is different from services: Aerospace employed only slightly fewer cloud workers than smartphone services in 2010 but smartphone services greatly extend employment by 2014 in all four markets.

The reskilling imperative: Cloud drives start-ups in the smartphone sector but that is not the case in aerospace because of slow growth. Indeed, some sectors run risks by failing to compensate for job losses in the short term as the sector remains static or shrinks. Overall, however, cloud computing forms the basis for a rapid expansion and high-start-up rate among SMEs 2010-2014 in all four markets.

Smartphone growth: Smartphone services are an archetypically cloud-based business and their growth is very largely attributable to cloud technologies and architectures. In the US, smartphone services were 13% of total telephone sector turnover in 2010 (and accounted for 87% of operator data charges) but this is estimated to rise to 31% in 2014 (while falling to 69% of operator data charges). Largely because of the opportunities afforded by cloud computing; this is becoming a very large industry with a total turnover of $13bn.

The US is a first mover in cloud services with relatively lower electricity costs, and less labour market regulation than Europe. We therefore expect US firms to continue lead over its European counterparts through to 2014. Combined with higher cloud utilization rates than elsewhere this results in more jobs being created in the US from cloud computing investments than elsewhere.

In the smartphone sector the following factors mainly define the overall cloud spending and employment effects: The size of IT budgets, share of the IT budget going to cloud, operator revenue from mobile Internet usage, the market forecast for paid smartphone applications and advertisement, and the division between private and public cloud implementations. Most companies pursue a hybrid strategy depending on the individual application with email having the highest propensity for public cloud implementation.

As the aerospace industry is larger in the US the turn-over is naturally much larger than in European countries (employing over 620,000 people compared to around 100,000 in the UK and Germany respectively, and about 38000 in Italy).

Public cloud usage becomes increasingly attractive with higher electricity costs. The argument would be that small providers have little say over their data centre location, i.e. the data centres are mostly going to be on-site or near place of business, so not as responsive to electricity price changes. Cloud computing data centres on the other hand tend to migrate to the low electricity cost areas, often close to hydro power sites.

6. Job effects of new firm creation

The creation of new firms associated with cloud effects in the economy is a significant source of economic growth. That growth in the number of new firms, many believe, comes from a combination of the increased productivity as firms use improved technologies and the opportunities afforded by lower entry barriers. While we have already accounted for the differences in the growth rates of the two sectors generally, we can also estimate the effect of new firm creation within these sectors on overall employment effects of clouds and upon the concomitant shift in skills. These new firms will have a demand for employees with cloud-related skills as they engage in business activities that utilise the relationship between customers and suppliers of cloud services. As these are likely to be disproportionately large in new smartphone and aerospace firms, we can estimate that as many as 10% of total new positions will be new cloud-related jobs.

The table below shows the accumulation of firms, total jobs and number of cloud related jobs by year, split between the two sectors in each of the four countries. The total number of firms created in the two sectors over the five years are estimated to be q for the USA, r for the UK, s for Germany and t for Italy, while the employment effects for the sectors are of two types. One is the total creation of IT employment and the other the creation of specifically cloud-related jobs. Some of these jobs created will be accounted for by individuals displaced from IT functions within firms, as seen in column "F". Others are entirely new jobs. The model demonstrates how displacement of employees through jobs that shift out of cloud customers might be absorbed into new firm creation.[32]

The chart shows the scale of the impact of cloud job creation on the economy. We can point out in particular that the effect of job creation in the smartphone sector has a larger impact than the whole of the aerospace sector. This is a phenomenon both of the growth in the sector and in the effect of additional job creation from knock-on benefits that are associated with the particular kinds of jobs most common in the smartphone services sector.

The quantitative analysis presented in the preceding section demonstrates the scale of job shifts and provides a clear indication of the effects that cloud services has on productivity gains as they prompt new firm creation. While the net number of cloud related jobs directly created in the two sectors we have analysed is relatively small, their effect is large. What we see in the figures is a large scale change in the way that ICT work is conducted and the opportunities created by shifting skilled staff from relatively low productivity tasks such as systems maintenance to information handling responsibilities associated with harnessing powerful cloud based services. These shifts require managerial responses.

In previous LSE research (Liebenau & Karrberg 2009-2010) including surveys of executives in large enterprises, we have shown that efficiency savings in IT budgets are likely to spur training and redeployment of employees rather than lay-offs.

32 *Etro (2009), for example, assumes for Italy that between 4,000-10,000 new jobs will be created in manufacturing. We can estimate that, given the proportion of the Italian industry accounted for by aerospace that 200-500 of those jobs will be in aerospace. With 108 jobs shifting from ICT positions within firms among those working on data processing (i.e. within corporate data centres), even our lowest estimate of new job creation demonstrates around a doubling of jobs.*

6. Job effects of new firm creation (continued)

Large firms in particular recognise that the staffing burden associated with maintaining legacy systems is a drain on valuable staff that could be redeployed to more productive functions and that the managerial drain is especially disadvantageous. Senior managers of enterprise computing functions often regard their efforts to be split 80/20 between maintenance of legacy systems and strategically valuable functions such as technical and organizational innovation.[33]

Intangible spending in software, intellectual property and services dominate firms' investment in the advanced industrial nations. For example, in 2008 UK firms spent £137 billion on intangible investments including IP, compared to £104 billion on fixed assets in 2008 (see figure below). Global trade in patent and creative industry licenses alone is now worth more than £600 billion a year, over five per cent (and rising) of all world trade (Hargreaves 2011). In this context the attitudes of senior managers is especially significant with regards to the ways they determine how to utilise ICT skills in their workforce.

Most IT decision makers are convinced IT provides value, but 30% say they can't quantify how much value IT provides to their business[34]. The longstanding problem of ascribing a clear value to IT spending still burdens CIOs. There is a general concern among CIOs about waste in the form of poorly exploited IT investments, and a belief that improvements can eliminate between 10 to 15% of unnecessary costs. There seems to be a paradox in that a large share of IT decision makers point to potential savings, but still 6 out of 10 of the respondents found it difficult to identify IT solutions that increase efficiency. IT managers indicate they need to be able to link IT investments better with business performance metrics.

We believe that cloud services provide an important opportunity for CIOs to ascribe clear value to their IT investments when it is linked to easily measured, activity-based operating expenditure. For most firms fixed costs are inherently difficult to break down to variable product and service costs in business units.

Lack of communication skills among technologists seems to explain some of the difficulties in realising IT savings. Such savings result from a range of actions with complex relations that are challenging to communicate outside the sphere of the IT department. As one CIO expressed it:

"IT departments have failed in the past to create collaboration within the firm. IT organizations need strong communicators to facilitate this collaboration."

In the LSE survey executives found "managerial capabilities" much more of an inhibiting factor on the business than "inflexible IT infrastructure".

A key driver for more efficient IT utilization among CIOs was "better IT project management". This accentuates the importance of the right skills in project management when introducing new cloud technologies into the organization.

It is clear from our survey that IT departments are attempting to shift away from being reactive technology providers to proactive technology advisors. In our survey, 85% of respondents expect increased IT systems support from

33 *VM Ware survey of Fortune 100 firms in 2009*

34 *The LSE-Dell "Efficient Enterprise" project 2009-2010*

6. Job effects of new firm creation (continued)

"internal skills development". The dynamics of up-skilling therefore happens all the way from the introduction of cloud services until projects have been implemented. "Surplus" IT staff are available to be trained for other tasks, and increasingly we see commitment to do so in large enterprises worldwide.

Most enterprises try to measure return on IT investment in terms of productivity and improvements in processes and speed. A shift towards a stronger advisory role for IT departments will link IT investments closer to business processes. One CIO expressed the need for aligning IT departments with the business thus:

"Efficient IT understands the business to be proactive rather than reactive and this means business specialists are embedded in the tech organization."

In our survey, executives indicate that they expect a firm-wide expansion of technology to be spent mainly on custom-built systems (37%), and integrated suites of business products (30%). Very few planned spending on off-the-shelf products (9%). These custom-made systems and integrated suites need tailoring, which demands good knowledge about the underlying infrastructure to reuse what you have instead of creating yet another silo. From interviews, only the most technically advanced customers seem to feel confident that resources can be saved by tinkering with the infrastructure to support the core business processes and innovation.

Without a clear understanding of the interfaces in cloud computing among technology, products, and other firms, the IT organization will not be able to support business units effectively.

We can expect different kinds of firms to react differently to the shifts in skills and the opportunities afforded by cloud services, especially as they effect changing business interfaces. Small firms are more likely to eliminate rather than redeploy staff and so the managerial challenge, and indeed a challenge to those who can improve the qualities of management in small firms is to devise ways that skilled personnel released from outmoded tasks such as IT maintenance can be utilised for productivity enhancing jobs.

These demonstrate the employment effects by country of ICT workers available for re-deployment based on the shift from internal data centre staff levels to cloud services. While the rapid deployment of smartphone services affects job shifts more rapidly, this is occurring within a sector that is growing rapidly. The corresponding trend in the aerospace sector is much less dramatic, indicating both the lower level of job displacement as well as the effect of slow growth in the sector.

Skills Effects

In our calculation of shifts in jobs, we also note that there are many implications for changing job types. These have been variously described by our survey respondents as an in-house capability for wider-spread use of information analysis and for the managerial skills necessary to maintain high quality of services, appropriate terms of contract, and the knowledge of industry trends, including pricing, necessary to make informed choices about where to find the best terms and services. These are similarly described by the Danish Technical Institute study (2011) in terms of "enhanced technical knowledge and contract negotiation skills". (p. 32) A well-conceptualised

6. Job effects of new firm creation (continued)

study by Insead (2011) further describes the changing role of the CIO as they move to more strategic responsibilities.

Our model captures the relationships among new spending of particular kinds in the industry, the employment effects, impact upon SMEs as a proportion of change, and trade. This is highly data-rich at the base and allows us to estimate, for example, the extent to which spending for a new product or service is likely to remain local, regional, or will require imports from far afield. This gives us a good idea of what kinds of changes in skills are likely to come about from such changes in business practices. It allows us to estimate the extent to which such economic benefits will be in the form of outsourced services or imported components, as opposed to drawing upon available labour and productive capacity. The analysis is coordinated with national salary data, directly connecting ICT spending to hiring of employees in particular professions. This relates to skills and educational backgrounds among employees. It also opens up for discussion how access to such competences could be strengthened, especially among SMEs.

We concur with the E-skills study for ICT practitioners conducted by the Danish Technology Institute (2011) that describes the character of skills needed. Our quantitative analysis is generally consistent with the implications they draw from the effect of shifting skills, as described below:

	Cloud Computing
Strategy and Innovation	Understand the possibilities in cloud computing and how this translates into the business strategy
Enterprise Architecture	Skills around the cloud such as built-in browsers and knowledge about the users. The architects do not need to build everything as before.
Demand Management	Capturing and prioritising demand, assigning resources based on business objectives and doing projects that deliver business value.
Global Sourcing	Negotiating skills. Insights into legal issues of privacy.
Management	Transportation and storage of data.
Project Delivery	Skills regarding specification and deployment of ICT-solution. Knowledge about standards and webservice design.
IT Support and Execution	Maintenance of hardware. Brokers and translaters between business and vendors.
Quality, Risk and Compliance	Risk and compliance.

Danish Technology Institute (2011) E-skills for ICT practitioners and entrepreneurs, First Interim Report pp. 33-34.

7. Conclusions

Our key findings are that:

- Little real risk of net unemployment caused by investing the cloud
- There are big differences between the US and Europe in employment effects but there are few barriers in Europe to utilise cloud in ways that emulate effects in the U.S.
- We believe that if Europe can become more attractive than it currently is for public cloud investment then the proportion of skilled cloud jobs created in the US will not be at the current high level of expense of European firms.
- Cloud computing is an environmentally friendly application, as can be shown in the energy utilization calculations that show opportunities from shifting less efficient firm-based data handling tasks to more energy efficient data centres. Since ICT usage overall emits a similar level of CO_2 as the airline industry, this is clearly an important consideration both as an environmental policy matter and as a matter of economic efficiency. This may imply revisions to energy pricing practices.
- We expect smartphone services to become a major sector in itself, employing more IT workers that the aerospace sector by 2014 in Europe and U.S.
- The biggest differences are that smartphone is growing in terms of turnover and so we see higher cloud utilization.

These findings hold specific policy implications:

- Data transfer policies, having to do with either trade or concerns such as data security and privacy rights protection, can have significant effect upon the economic dimensions of cloud computing. These can be directly translated into job effects.

Most significantly, we show that by making it possible to redeploy staff, firms in these sectors can gain efficiencies and seize opportunities to enhance productivity.

- Pricing of energy and the opportunity to affect pricing through the encouragement of green energy policies or other incentive mechanisms, can make a major difference in a country's ability to attract investment in data centres.
- Skills that are needed for the cloud are going to be in demand, especially in the short term as lower entry barriers encourage the entry of new firms that will utilise cloud skills.

The central importance of this analysis is in the dynamic character of the model and its utility as a tool for creating scenarios and assessing comparisons. These have been demonstrated both in the structure of the model itself and in the data that have been generated. We have shown where jobs are shifting and the effects of exogenous factors such as energy prices and data handling regulations. While some sectors in some countries can be shown to shed jobs as work moves from within firms to cloud services providers operating data centres abroad, other areas of business gain employment. Most significantly, we show that by making it possible to redeploy staff, firms in these sectors can gain efficiencies and seize opportunities to enhance productivity.

The more intensive use of cloud by organizations yielded additional productivity benefits in some staffing areas. Smaller SMEs are in some cases able to adopt a greater degree of cloud services and software than they were utilizing previously, and they can avoid the cost of increasing their headcount in order to manage this. The productivity benefits

7. Conclusions (continued)

cited by organizations included servicing a larger customer base with the same costs; increasing the sophistication of the organization due to the adoption of incremental tools such as analytics; adopting CRM, database management tools, marketing suites, and others. This strategy has only been possible due to two key supply-side changes: (1) innovation in product offering by suppliers of software applications that to date have been offered through a 'traditional' in-house mode only; and (2) the proliferation of cloud infrastructure that companies have to date maintained in-house together with required support (either with 3rd party organizations and/or in-house resources). US organizations had the highest productivity benefits from the adoption of cloud services, followed by the UK and Germany on a relatively equal basis.

Managers reported an improvement in the time they were able to focus on key business activities due to the migration of previous services to a cloud base. The key benefits included: reduced time spent in the establishment of infrastructure and services; the removal of attention diverted to dealing with operational problems related to these; addressing funding issues for ad hoc requests for 'emergencies' or revised plans; managing operational and business risks caused by infrastructure, hardware and software issues. The majority of organizations in which significant benefits occurred as a result of cloud implementation displacing in-house IT, software and support, indicated that 5% or greater additional time was available for other tasks. This was consistent across all three countries, with UK managers reflecting a higher proportion of additionally available time than German and Italian managers.

A major reason for the indicated relatively lower cloud employment in Europe is our assumption that 50% of public cloud jobs generated by European business activities will be realised in the US. Although we have underestimated this trade effect on the numbers for the US because we cannot be certain that all those jobs will accrue to American companies, if we did so the public cloud employment in the US would correspondingly increase. Policy makers in Europe can address this and other exogenous factors.

Electricity	New investments in data centres are driven by cheap operational cost and electricity prices rather than employee costs (e.g. access to hydro power is attractive). We would expect firms utilizing cloud services to set an environmental cost on applications and usage in order to market themselves.
Accounting	Operational efficiency and cost determine uptake, but costs are accounted for in different ways. Implementation of internet services (saas, iaas) and return on investment could become stalled in many cases due to sunk costs in current outsourcing and IT services contracts. Firms will need to develop or hire accounting skills for analyzing such situations.
New Standards	Our interviews indicate that financial institutions are some of the largest users of private cloud and are standardizing on hardware (servers) and buying horizontal solutions. They find it problematic that hypervisors and virtual layers are not interoperable. SMEs may also find that gradual cloud implementation implies an increasingly scattered IT infrastructure if the organization lacks skills in managing a move to the cloud.
Start-up Structure Changes	Our interviews indicate that investors in new firms can annualise costs for IT into chunks that are easier to fit into a business plan and while this makes it easier to account for, it does not necessarily make IT a smaller part on their budgets. As IT can be mapped into particular services for customers, this cost can be more accurately factored into the product price.[35]

35 Our interviews with new start-ups in smartphone service applications show they are particularly prone to set up their whole application infrastructure with public cloud services. This is a strong indicator for what will happen in other sectors as we move forward.

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