Research report: May 2008

NESTA Making Innovation Flourish

Taking services seriously

How policy can stimulate the 'hidden innovation' in the UK's services economy

Taking services seriously

How policy can stimulate the 'hidden innovation' in the UK's services economy

Foreword

Services are insubstantial and fleeting, dependent on a credit-fuelled 'binge economy'. At a time of financial uncertainty, we need to return to the solid foundations provided by a manufacturing-based economy.

At least, this is what some commentators would have you believe. Yet where innovation policy is concerned, despite recent movements in the right direction, we haven't fully departed from these foundations. Services have not yet been properly incorporated into our mechanisms for stimulating and supporting innovation. Even our current methods of measuring innovation often under-represent innovation in services. This is one aspect of what we call 'hidden innovation'.

This is beginning to change: policymakers are recognising that services should be more central to innovation policy. There is a growing awareness that innovation in services often differs fundamentally from innovation in advanced manufacturing, but no agreement about which forms of innovation matter most in services or how policy should support them.

Of course, the truth is that we need both innovative services and manufacturing. Rather than being mutually exclusive, both represent the kind of high-value, dynamic, creative economy that the UK needs.

This report examines how we can help our services firms to become more innovative and more productive. We think that it provides significant new evidence for policymakers and should prompt a new phase in the discussion on innovation in services. We would greatly welcome your comments.

Jonathan Kestenbaum
CEO, NESTA

May, 2008

NESTA is the National Endowment for Science, Technology and the Arts.

Our aim is to transform the UK's capacity for innovation. We invest in early stage companies, inform innovation policy and encourage a culture that helps innovation to flourish.

Executive summary

Policy could have an important role in stimulating innovation in services. However, policymakers have lacked robust evidence showing how these sectors innovate.

Drawing on a survey of more than 16,000 firms, this research reveals the high levels of 'hidden innovation' in some services sectors, especially in how they develop new business models and exploit technology. But the research also reveals that innovation is confined to a minority of service firms, and that many lack the skilled personnel or intelligence on markets and technology that would enable them to become more innovative.

Because of their dominance in the economy, improved performance by the UK's services sectors is necessary if we are to significantly close the productivity gap between the UK and other leading nations. However, if we are to take innovation in services seriously, we must recognise that they innovate differently from advanced manufacturing. We need policies to support increased training and development, and the effective dissemination and exploitation of technology.

Innovation in services is vital to the UK's future productivity

The UK economy is dominated by services

There has been significant restructuring in all advanced industrialised economies since the early 1960s, with the growth of services and a shift away from low value-added manufacturing. But the UK has moved to a more services-based economy more quickly than most of its competitors.

More than 75 per cent of the UK economy is based on a diverse range of services including retailing, financial services, insurance, business services, leisure and tourism. High-value 'knowledge-based services' generate more than five times as much for the UK economy as advanced manufacturing.

Services need to play a major role in closing the UK's productivity gap

The UK has a significant productivity gap with other leading nations. Because of their size, increasing the performance of the UK's services sectors is necessary if we are to close this gap. Improving the performance of services firms would raise the UK's aggregate productivity, but also, given their role, their improved performance would lead to increased productivity in other firms and sectors.

Innovation in services significantly improves firm productivity

Innovation in new products, processes and services is associated with higher labour productivity growth in services firms. Innovation in new processes and services particularly benefits low-technology sectors such as retail and wholesale.

There is no single event or process called 'innovation in services'. Its extent, form and purpose varies widely between sectors. Innovation particularly helps high-technology firms in sectors such as computer services or research and development services to access new markets, while it helps low-technology firms to reduce costs.

There are high levels of innovation in some of the UK's services sectors but their overall innovative performance could be significantly improved

The computer services and research and development services sectors are particularly innovative. Both have a relatively high percentage of firms reporting that they introduce new or improved products (60 per cent and 47 per cent of firms respectively). Innovation in these sectors is more common than in the average manufacturing firm: they are more likely to introduce new products and processes, and brand new innovations. Product innovation is also relatively widespread in the financial intermediation and business services sectors (32 per cent and 26 per cent respectively).

Overall, however, just 24 per cent of services firms introduce new products or services to the market, compared to over a third of

manufacturing firms (36 per cent). Only 16 per cent of retail firms innovate in new products or services. Surprisingly, fewer retail firms launch innovative services than do manufacturing firms (11 per cent compared to 14 per cent); they are also less active in other forms of innovation – such as in processes, strategies and organisational structures – than is sometimes assumed.

The innovation that matters in services differs fundamentally from the model assumed for advanced manufacturing

Innovation in services rarely depends on research and development (R&D)
Innovative services don't focus on developing new high-technology products and marketing them to their customers. Instead, they find new solutions to their customers' problems or needs, which may or may not involve technology. Hence, such firms often integrate technology effectively – exploiting existing technologies, including information and communications technologies (ICT), to provide solutions.

Organisational change often drives innovation in services
Overlooked forms of innovation – new corporate strategies, business structures and management techniques – can stimulate innovation in products and processes. This is particularly important for services, which can gain competitive advantage by capturing and responding to customers' needs, a process which itself drives further innovation.

Services firms invest in wider sources of knowledge and in training their staff
In some cases, services spend as much on R&D as manufacturing firms, but this is not their most significant investment in innovation. Of greater importance are their skilled, creative in-house staff and their ability to draw on external expertise, including from their suppliers. This is why, for the purposes of innovation, services firms invest more than manufacturing firms in training, marketing and acquiring external knowledge.

When these broader expenditures are taken into account, services firms invest £5,244 per employee in innovation each year compared with £3,532 in manufacturing firms. Much of the difference reflects higher spending in the computer and research and development services sectors.

Services experience particular barriers to innovation

Services firms struggle with a lack of expertise, resources and support
Many services firms that recognise the importance of innovation face significant barriers. Forty-eight per cent cite risk as a barrier, while 39 per cent fear uncertainty. Thirty-eight per cent say they have too few skilled workers, 22 per cent have too little information on technology, while 25 per cent lack sufficient information on markets. Regulations are also a concern, with 32 per cent saying the need to meet UK regulations was a barrier, and 28 per cent saying the same about European Union regulations. A third of all service firms find it too expensive to innovate and struggle to access suitable finance to support innovation.

Services firms under-invest in training because of high worker mobility
Although firms may recognise the need to train their staff, they often under-invest in training because of the risk that workers – including senior staff – leave for other firms. This weakens the innovative capacity of individual firms and of the economy as a whole.

There has been increasing recognition of the importance of innovation in services
An increasing body of academic research has focused on innovation in services. Most recently, NESTA investigated the 'hidden innovation' – the under-recognised and under-reported forms of innovation – in sectors as different as oil production and the creative industries. Its research suggests that the relative lack of support for this innovation represents an 'innovation gap' between policy and the reality of innovation in the UK.

This has encouraged increased interest in innovation in services amongst policymakers. The former UK Department of Trade and Industry (DTI) commissioned research papers on innovation in services, and one of its successors, the Department for Business, Enterprise and Regulatory Reform (BERR), established the Innovation in Services project in partnership with NESTA.

Until recently, innovation policy has remained fundamentally designed for advanced manufacturing and has neglected the innovation that matters to services
The UK's services sectors have remained relatively neglected by policymakers – another sense in which innovation in services has been

'hidden'. This is largely because policymakers have lacked sufficient evidence to inform new or revised policies.

Consequently, both the framework and the mechanisms to stimulate and support innovation in the economy remain rooted in advanced manufacturing. These include tax credits for R&D, collaborative technology research programmes, Knowledge Transfer Networks, Knowledge Transfer Partnerships, and Innovation Platforms. While some of these policy mechanisms are being adapted to encompass innovation in services, new mechanisms are also required.

'Innovation Nation', the White Paper published in March 2008 by the Department for Innovation, Universities and Skills (DIUS) gives a prominent place to hidden innovation and innovation in services. Should its implications be fully extended across innovation policy, it will represent the first time that innovation policy takes services seriously. This new rhetorical direction must, however, be followed by the development of specific new policy mechanisms.

Recommendations: Policy can help to stimulate and support this innovation, but more work is required to take services seriously

The UK needs high-value, innovative manufacturing and services. To achieve this, government should develop more mechanisms to realise the broader vision of innovation presented by the recent innovation White Paper.

Support innovative people, not just firms
Most services firms would benefit if the government incentivised training and staff development alongside research and development. UK government should assess the impact of introducing a Learning Tax Credit for small firms, which face particular barriers to investing sufficient time and resources in training their staff. Most workforce skills initiatives focus on improving basic and intermediate skills. So a new tax credit might initially focus on improving higher level skills for the management of innovation amongst senior staff. Universities and colleges should also be encouraged to respond to this demand by developing courses for these firms that combine business and management breadth with technical expertise.

Recognise that innovative firms integrate, not just invent, technology
Services firms that want to innovate need access to better advice and expertise on the selection, adoption and exploitation of ICT and other technology. While manufacturing firms can access the Manufacturing Advisory Service, which delivers hands-on advice and assistance from experts, no equivalent exists for services firms. An Innovation Advisory Service should be established within the brokerage networks already offered across the UK as a widely-recognised brand for regionally-delivered advice (some of which already exist). One of its areas of expertise should be acting as a brokerage service for advice and expertise on the effective exploitation of technology for innovation.

Widen knowledge exchange between universities and firms to include the arts and social sciences, not just science and engineering
Most services firms neither want nor need to engage in long-term technology transfer with universities. So, universities should identify how their research and knowledge – including that gained from the social sciences and humanities – could benefit services firms over shorter timescales. The planned mini Knowledge Transfer Partnerships for shorter-term projects between universities and firms should include disciplines relevant to services firms.

Stimulate innovation in existing sectors, not just emerging sectors and technologies
The BERR-NESTA Innovation in Services project has demonstrated the value of reviewing performance and producing specific and practical recommendations to improve policy and regulation. The project has operated in five services sectors, working closely with firms and trade associations. Similar time-limited, industry-led review groups should be established for five more sectors of the UK's services economy.

Measure innovation in services, not just advanced manufacturing
The measurement of innovation in services has been grafted onto a framework that was originally developed for traditional manufacturing industries. In surveys such as the Community Innovation Survey (CIS), these forms of innovation should be given the same precedence as high-technology manufacturing innovation, so that policymakers can more accurately compare the importance of 'traditional' and hidden innovation.

The UK should aim to be the best business environment for high-value services in the world by 2014

The UK government aims to increase the country's 'R&D intensity' (the total amount spent on R&D as a percentage of national GDP) to 2.5 per cent by 2014. To reflect the importance of services to the UK economy, the government should aim to create the most stimulating and supportive environment for high-value services by the same date, as indicated by the proportion of services firms innovating in the UK compared to other leading nations in the CIS and equivalent surveys.

Methodology

This research uses a multi-methodology approach to evaluate the behaviour and innovation activities of services sectors in the UK.

First, an analysis of the fourth UK Community Innovation Survey (CIS4), which provides data for more than 16,000 firms including nearly 10,000 services firms (see Appendix A). In analysing this data, various forms of disaggregation are used to understand the characteristics of different parts of the services economy, for example, between 'high-technology' services (such as firms providing computer services or research and development services), 'medium-technology' services (such as financial services), and 'low-technology' services (such as retail and wholesale). Part of this empirical work includes multivariate analysis to examine the impact of a range of variables at the same time. Details of these procedures are found in the relevant appendices referred to in the main text.

This quantitative analysis is complemented by case studies based on interviews with senior managers in 20 services firms (see Appendix B). The case studies were drawn from three sectors, within each of the three technology categories: the computer services industry including ICT consultancy, computer facilities management and systems integration; financial services; and retail and wholesale. The evidence from these firms is presented anonymously, although where appropriate the sector in which they operate is indicated.

Acknowledgements

This report was written by Maria Abreu, Vadim Grinevich, Michael Kitson and Maria Savona from the Programme on Regional Innovation (PRI), Cambridge-MIT Institute, The University of Cambridge. The research project was coordinated by Samantha Samarawickrama, the Programme Manager of PRI. This report was edited by Michael Harris, Senior Research Fellow at NESTA, who also managed the project on behalf of NESTA.

The authors would like to thank the participants at the North American Regional Science Conference (NARSC) in Savannah, the United States, in November 2007, for comments on earlier versions of this report, and the Department for Innovation, Universities and Skills (DIUS) for access to the CIS4 data and especially to Ray Lambert for advice about the dataset.

To cite this report: Abreu, M., Grinevich, V., Kitson, M., and Savona, M. (2008), Taking services seriously: How policy can stimulate the 'hidden innovation' in the UK's services economy, NESTA, Research Report, London: National Endowment for Science Technology and the Arts.

Contents

Part 1: There has been increasing recognition of the importance of innovation in services but fundamentally our policy mechanisms have been designed for innovation in advanced manufacturing

1.1 Advanced industrialised economies have been restructuring towards services

Advanced industrialised economies have significantly restructured since the early 1960s, as services have grown and manufacturing has declined, a change reflected in both Gross Domestic Product (GDP) and employment.

The causes of this restructuring are much debated. Prominent explanations include the increased ability of newly industrialising countries to compete based on low labour costs, particularly in manufacturing; the tendency to spend more on services as income rises; and the fragmentation of supply chains with the contracting of services functions to other firms.

1.2 The UK economy is dominated by services

Although de-industrialisation has been widespread in advanced countries, the pace of change has been particularly rapid in the UK. Britain is no longer the 'workshop of the world'.[1] In 1970, manufacturing accounted for 32 per cent of UK output whereas by 2004 it accounted for only 14 per cent.[2]

The UK is now primarily a service-based economy. The restructuring process has also led to the rise of knowledge-based activities including communication, finance, insurance and other business services, and community, social and personal services.[3] The services economy comprises a diverse range of activities, including sectors that are technology intensive (media, telecommunications and finance), capital intensive (transport), and those that rely on human contact (personal services). The UK also has a comparatively strong creative economy, which accounts for over 7 per cent of employment.[4]

According to the Sainsbury Review, 40.5 per cent of 'value added' in the UK in 2002 was in knowledge based activities, with 6.2 per cent in high technology manufacturing and 34.3 per cent in knowledge services.[5] Knowledge services therefore generate more than five times the economic value of high-technology manufacturing. In 2007, the UK exported £75 billion worth of knowledge services, 170 per cent more than a decade earlier. Knowledge services now form about a quarter of all UK exports, and generate a growing trade surplus.[6]

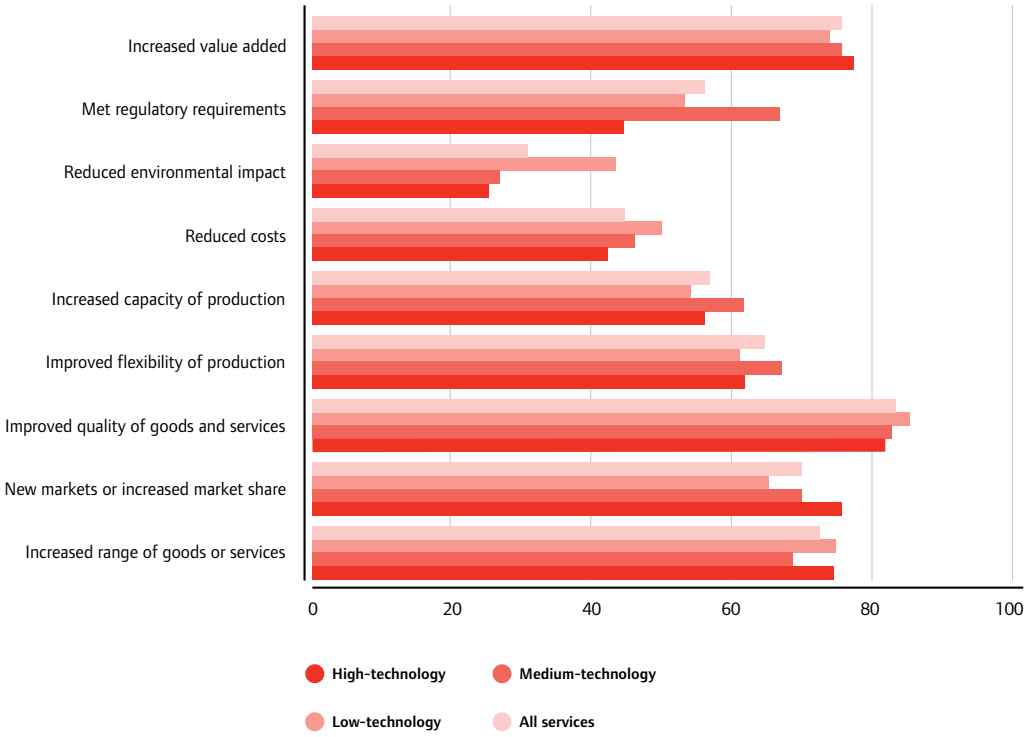
1.3 Services are an important part of the UK's productivity gap

The UK has a persistent productivity gap with other major industrialised countries including the US, France and Germany. Although the gap has narrowed in the last decade, productivity (output per worker hour) is 16 per cent higher in France, 14 per cent higher in the USA and 12 per cent higher in Germany.[7]

There are significant differences between sectors in their contribution to the productivity gap. The relatively poor productivity of business services, retail and wholesale contributes most to the overall gap with the US and their productivity has worsened since 1997.[8] American financial, computer, and research and development services are also more productive than their British counterparts.[9] Overall, the service industries

1. Coutts, K., Glyn, A. and Rowthorn, B. (2007) Structural Change Under New Labour. 'Cambridge Journal of Economics.' 31, pp.845-861.
2. p.23, Office for National Statistics (2006) 'United Kingdom Input-Output Analyses.' London: ONS.
3. As defined by the Sainsbury Review, p.16, HM Treasury (2007) 'The Race to the Top, A Review of Government's Science and Innovation Policies.' London: HM Treasury.
4. National Endowment for Science, Technology and the Arts (2008) 'Beyond the Creative Industries: Mapping the Creative Economy in the United Kingdom.' London: NESTA.
5. p.17, HM Treasury (2007) 'The Race to the Top, A Review of Government's Science and Innovation Policies.' London: HM Treasury. GVA measures the contribution to the economy of each individual producer or sector.
6. The Work Foundation (2007) 'Trading in Ideas and Knowledge.' London: The Work Foundation.
7. 2006 figures cited in HM Treasury and Department for Business, Enterprise and Regulatory Reform (2007) 'Productivity in the UK: Securing Long-term Prosperity.' London: HM Treasury. Another analysis suggests an even worse picture, with the US 33 per cent ahead of the UK, while France and Germany are 23 and 10 per cent ahead respectively, see Department for Business, Enterprise and Regulatory Reform (2008) 'Cross-Country Productivity Performance at Sector-Level: The UK Compared with the US, France and Germany.' London: BERR.
8. Griffith, R., Harrison, R., Haskel, J. and Sako, M. (2003) 'The UK Productivity Gap and the Importance of the Service Sectors.' AIM Briefing Note; HM Treasury and Department for Business, Enterprise and Regulatory Reform (2007) 'Productivity in the UK: Securing Long-term Prosperity.' London: HM Treasury.
9. Department for Business, Enterprise and Regulatory Reform (2008) 'Cross-Country Productivity Performance at Sector-Level: The UK Compared with the US, France and Germany.' London: BERR.

Figure 1: The benefits of innovation (percentage of innovating firms assessing benefits as important or very important)



Source: CIS4

contribute a significant share of economic activity and many contribute disproportionately to the overall productivity gap.

1.4 Innovation in services can increase economic growth

1.4.1 Innovation in services increases firm-level productivity

Innovation in services is a major contributor to economic growth and productivity. It helps improve economic prosperity by improving firm-level productivity and by generating ideas and know-how that spill over to other firms and other parts of the economy.

Empirical analysis of the fourth UK Community Innovation Survey (CIS4)[10] data shows that labour productivity increases in services firms that innovate. The CIS data also reveals how innovation benefits services sector firms. As shown in Figure 1, the benefits include improved quality and range of services, as well as access to new markets. Innovation generally generates similar benefits across the different sectors, although 'helping to access new markets' is most important for firms in high-technology sectors whereas 'reducing costs' is most important for firms in low-technology sectors.[11]

1.4.2 The activities of many services sector firms also benefit the rest of the economy

UK innovation policy assumes that the increased generation of knowledge generates 'spillover benefits' (often referred to as positive externalities) to the rest of the economy.[12]

This notion has been turned into a policy instrument through R&D support, most noticeably in tax credits which subsidise R&D expenditure by firms. However, this approach relies on two assumptions. First, that R&D is a good indicator of knowledge generation for all firms (at least, those that matter for innovation); and second, that such knowledge inevitably generates spillover benefits.

We need a better understanding of how ideas and knowledge move from firms to the rest of the economy. There are some empirical studies of the process[13] and they largely rely on standard techniques to reveal the extent of 'total factor productivity' in the economy. This is frequently measured as a 'residual' (basically, an observed value in the economy with unknown causes) and has been characterised as a 'measure of our ignorance'.[14]

10. See Appendix C for more on CIS4.
11. In parts of this analysis, services sectors are characterised, according to the extent to which they produce new technologies, into the following three groups: 'high-technology' services (for example, research and development services firms); 'medium-technology' services (for example, financial services firms); and 'low-technology' services (for example, retail and wholesale firms). See Appendix C for more details.
12. HM Treasury and Department for Business, Enterprise and Regulatory Reform (2007) 'Productivity in the UK: Securing Long-term Prosperity.' London: HM Treasury. Spillovers or externalities are positive or negative impacts on parties not involved in a given economic transaction.
13. Griliches, Z. (1992) The Search for R&D Spillovers. 'Scandinavian Journal of Economics.' 94 (Supplement), pp. 29-47.
14. According to Moses Abramovitz, the residual could be taken as "a measure of our ignorance about the causes of economic growth". Abramovitz, M. (1956) 'Resource and Output Trends in the United States Since 1870.' New York: National Bureau of Economic Research, p.10.

This uncertainty is particularly pronounced in the services economy, and the debate on externalities generated by services is far from resolved.[15] This may reflect the diversity of the sector; some sectors and firms generate significant spillover benefits, while others might not.

Despite the paucity of reliable empirical data, plenty of firms report the ways in which they benefit other firms and sectors through their innovation activities.[16] But it is not easy to generalise from such observations, as there is a high degree of firm-level specificity in routines, practices and culture.[17] In other words, some firms may have a very specific culture – a 'way of doing things' – that is not easily transferable to others. As a result, innovations that spring from this culture may not be replicable. This suggests that the extent of externalities is likely to vary significantly between firms, and will be determined by the transferability of skills, competencies, routines and networks.

1.5 An increasing body of research has focused on innovation in services

The nature of innovation in services has come under increasing scrutiny as the share of services sectors in the economy has increased.[18] This new research finds several characteristics that distinguish services from manufacturing. For example, as services are highly interactive, innovation activities may focus on the links between firms, suppliers and clients, which may not be technological. Furthermore, many services products are intangible, and cannot readily be protected by traditional intellectual property methods (particularly patents).[19]

This research has also found substantial diversity in innovation activities across the services economy.[20] Some services industries invest substantially in R&D and pursue wide-ranging R&D programmes; others rely on relatively low-technology business processes, adopt innovations developed elsewhere or use 'off-the-shelf' knowledge in equipment and software. Innovation in services firms often relies on the use and development of information and communications technologies (ICT).

NESTA has also investigated the 'hidden innovation' – the under-recognised and under-reported forms of innovation – in sectors as different as oil production and the creative industries. It has suggested that the relative lack of support for this innovation represents an 'innovation gap' between policy and reality.[21]

1.6 But policymakers have lacked a sufficiently strong evidence base and explicit recommendations for policy

The growth in services innovation research has stimulated increasing interest amongst policymakers. The former UK Department of Trade and Industry (DTI) commissioned research papers on innovation in services, and one of its successors, the Department for Business, Enterprise and Regulatory Reform (BERR) established the Innovation in Services project in partnership with NESTA.

Yet at times policy has appeared somewhat uncertain about how innovation in services may differ from the assumed model for advanced manufacturing. For example, the Sainsbury Review acknowledged: "The different requirements of manufacturing and services… Services…are innovative, but do not undertake R&D in the traditional sense."[22] But the Review also stated: "[But] innovation in manufacturing and services is more similar than is sometimes thought…"[23] While the Review called for government (specifically, BERR) to make the resources available to "work effectively" with services sectors, it did not suggest what the role for government in innovation in services might be.

1.7 Until recently, innovation policy has remained fundamentally designed for advanced manufacturing and has neglected the innovation that matters to services

Due to this lack of evidence, the UK's services sectors have been relatively neglected by policymakers. The framework and the mechanisms to stimulate and support innovation in the economy has remained rooted in advanced manufacturing, with tax credits for R&D, collaborative technology research programmes, Knowledge Transfer Networks, Knowledge Transfer Partnerships and Innovation Platforms.

These mechanisms only directly benefit services firms when they undertake traditional forms of innovation, especially formal R&D. So, they might benefit research and development

15. Van Ark, B., Broersma, L. and den Hertog, P. (2003) Services Innovation, Performance and Policy: A Review. In: 'Synthesis Report in the Framework of the Project Structurele Informatievoorziening in Diensten (SIID) – Structural Information Provision on Innovation in Services.' Groningen: Groningen Growth and Development Centre, University of Groningen.
16. See Section 2 regarding the forms of innovation that are most prevalent in services firms and Section 3 for the drivers of this innovation.
17. Van Kox, H. (2002) 'Growth Challenges for the Dutch Business Services Industry: International Comparison and Policy Issues.' The Hague: Netherlands Bureau of Economic Policy Analysis (CPB), De Swart Publishers.
18. Department of Trade and Industry (2007) 'Innovation in Services.' Occasional paper no. 9. London: DTI.
19. Miles, I. (2004) Innovation in Services. In: Fagerberg, J., Mowery, D., and Nelson, R. (Eds) 'The Oxford Handbook of Innovation.' New York: Oxford University Press.
20. For example, Evangelista, R. (2000) Sectoral Patterns of Innovation in Services. 'Economics of Innovation and New Technology.' 9, pp. 183-221; Evangelista R. and Savona, M. (2003) Innovation, Employment and Skills in Services: Firm and Sectoral Evidence. 'Structural Change and Economic Dynamics.' 14, pp. 449-474.
21. National Endowment for Science, Technology and the Arts (2006) 'The Innovation Gap.' London: NESTA; National Endowment for Science, Technology and the Arts (2007) 'Hidden Innovation.' London: NESTA.
22. HM Treasury (2007) 'The Race to the Top: A Review of Government's Science and Innovation Policies.' London: HM Treasury, p.5, p.37.
23. HM Treasury (2007) 'The Race to the Top: A Review of Government's Science and Innovation Policies.' London: HM Treasury, p.38.

and computer services firms or a major financial institution introducing a novel ICT system. But, as will be shown later, this is not the primary form of innovation in most sectors, nor is it necessarily the main focus of investment in innovation by firms in research and development and computer services (see Section 2).

Furthermore, the policy relies on national income accounting designed in the early 20th century to help policymakers control the economy. Such accounting is inadequate for a modern knowledge-based economy, since it is difficult to quantify inputs and outputs in the production process in knowledge-intensive activities, especially in services.[24] Other traditional manufacturing-based indicators, such as investments in R&D and patenting rates, also inform and direct innovation policy.

1.8 The recent DIUS innovation White Paper represents an opportunity to take services seriously and to design new mechanisms to stimulate innovation

'Innovation Nation', the DIUS White Paper published in March 2008, presents a broad vision of innovation and its importance not only to manufacturing but also for services, the creative industries, the public sector and the third sector.[25] This is based on the argument that the UK will only prosper in a globalised economy if it unlocks the talents of all of its people, organisations and institutions (public as well as private).

The White Paper explicitly recognises the importance of forms of innovation beyond the invention of new (technological) products, by noting that the "changing face of innovation" also includes services, business processes and models, marketing and enabling technologies.[26] In doing so, it takes a significant step beyond the traditional focus of innovation policy, and provides a valuable (and challenging) new direction for innovation policy in the UK.

Some of the initiatives announced the White Paper are relevant for services as well as manufacturing, such as harnessing public procurement to drive innovation, ensuring open and competitive markets through better regulation, improving access to finance for innovative businesses, and providing more advice to help businesses protect their intellectual property. There are also important statements regarding broadening knowledge exchange between the research base and businesses into the arts and humanities and service sectors (such as the creative industries), and support for advanced management skills.

However, the White Paper has less to say about whether many new policy mechanisms are required to stimulate and support innovation in services and nor is it clear that it is underpinned by a deeper understanding by policymakers of the different way in which the services sectors innovate: simply applying existing manufacturer-centred techniques to services is unlikely to prove optimal. The prevailing sense in the White Paper is that more evidence is required about how services innovate and in particular the ways in which this might differ from manufacturing sectors. The proposed Innovation Research Centre is likely to go some way towards addressing this, but it will need a receptive ear at the highest levels of government if it is to have the desired effect on long-term policy.

24. Holcombe, R. G. (2004) National Income Accounting and Public Policy. 'The Review of Austrian Economics.' 17, pp. 387-405.
25. Department for Innovation, Universities and Skills (2008) 'Innovation Nation.' London: The Stationery Office.
26. Ibid., p.38.

Part 2: There is no single event or process called 'innovation in services' – it varies widely in extent and form between sectors

2.1 There are high levels of innovation in some of the UK's services sectors but overall innovative performance could be significantly improved

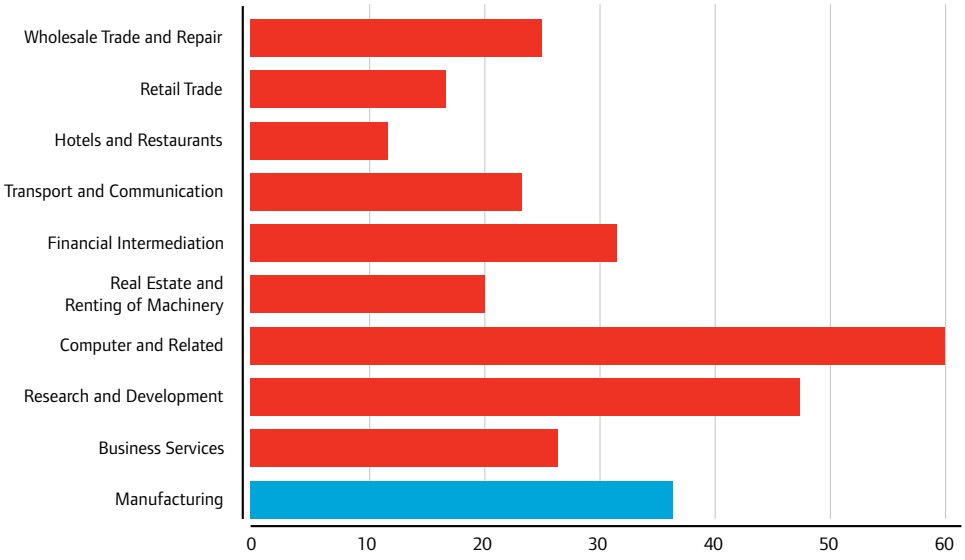
2.1.1 Some services sectors are highly innovative

Figure 2 shows the rate of product innovation in manufacturing and in a range of different services sectors.[27]

The Community Innovation Survey (CIS) defines product innovation as "the market introduction of new goods or services or a significantly improved product or service with respect to its capabilities, such as quality, user friendliness, software or subsystems". The CIS shows that while the average level of product innovation is generally lower in services than in manufacturing, it is substantially higher than the manufacturing average in two services sectors: computer services, where 60 per cent report the introduction of new or improved products, and research and development services (firms providing R&D services for others) where 47 per cent of firms do so. Product innovation is also relatively widespread in financial intermediation and business services (32 per cent and 26 per cent of firms respectively).

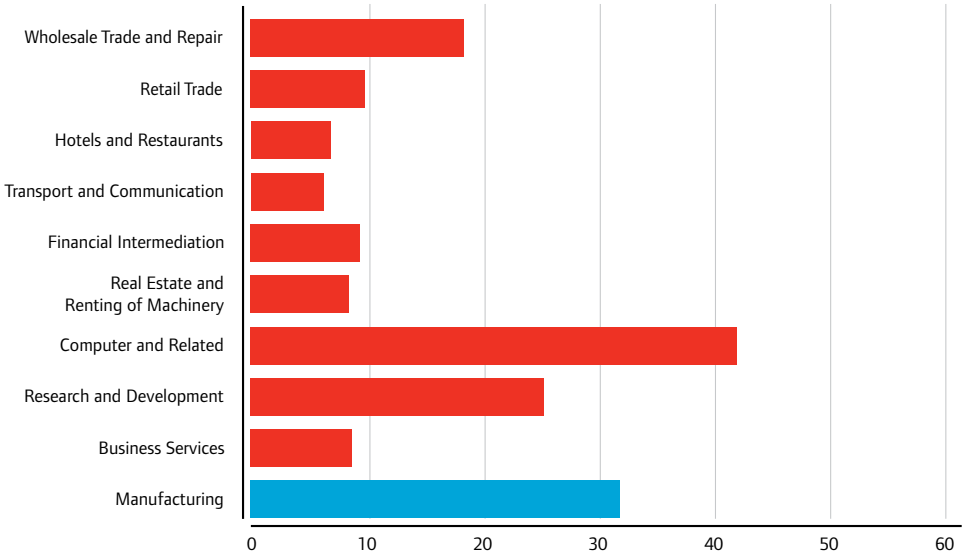
27. Measured at the two-digit Standard Industrial Classification (SIC) code level.

Figure 2: Product innovation (percentage of firms)



Source: CIS4

Figure 3: Manufactured product innovation (percentage of firms)



Source: CIS4

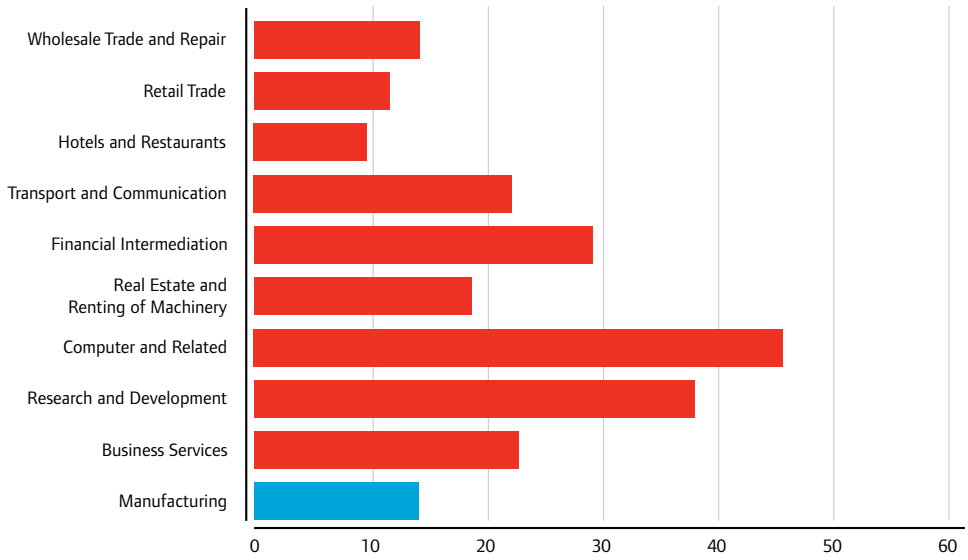
2.1.2 Services introduce both manufactured product and service innovations

The proportion of firms introducing product innovations can be further disaggregated into those that have introduced an innovative manufactured product and those that have introduced innovative services (known as a 'services product').

Figure 3 shows the rate of product innovation in manufacturing and various services. Although service firms might be expected to introduce innovative services and manufacturing firms innovative products, such a division is too simplistic. Company activities and outputs can cross traditional sector boundaries. For example, the percentage of firms in the computer services and research and development services sectors introducing a manufactured product innovation is higher or similar to the proportion of manufacturing firms doing so.

Service product innovation, as shown in Figure 4, is greater in most services sectors than in manufacturing (the exceptions are

Figure 4: Services product innovation (percentage of firms)



Source: CIS4

retail and hotels and restaurants). However, many manufacturing firms also offer service products, for instance in transportation, office work, commercial transactions and security, and have increased their provision of service products over time.[28] The rate of service innovation is highest, as with other forms of innovation, in computer services and research and development services.

2.1.3 Services innovate in the processes they use

A second important indicator of innovative activity is the rate of process innovation, defined in the CIS as 'the use of new or significantly improved methods for the production or supply of goods and services'. Process innovation is generally undertaken to improve production efficiency and reduce costs.

It has been argued that firms are more likely to implement process innovations as they grow, since large firms can benefit from economies of scale.[29] It might therefore be expected that process innovation is less important for services firms, which are generally smaller than manufacturing firms.

Figure 5 however shows that the rate of process innovation is similar or higher in four services sectors (computer services, research and development services, financial intermediation and business services) than that in manufacturing. This may reflect the degree of competition in these sectors, as greater price competition may lead to more process than product innovation.[30]

2.1.4 Services produce both novel and non-novel innovations

The innovation indicators discussed above make no distinction between ground-breaking and incremental innovations. Yet, a distinction can be made between 'novel' innovation – innovation new to the market or industry – and 'non-novel' innovation which is only new to the enterprise.

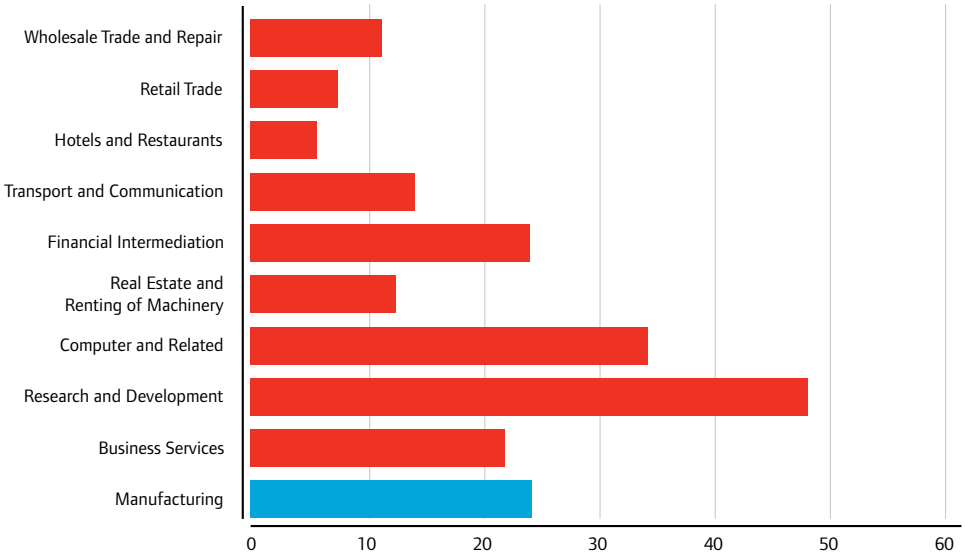
Figure 6 shows the rates of novel product and process innovation in manufacturing and in different services. It is striking that the rates of novel product and process innovation for sectors such as computer services and research and development services are substantially higher than the average for manufacturing.

2.1.5 Overall innovative performance could be significantly improved

Overall, however, just 24 per cent of services firms introduce new products or services to the market, compared to more than a third of manufacturing firms (36 per cent). Only 16 per cent of retail firms innovate in new products or services. Surprisingly, fewer retail than manufacturing firms launch innovative services (11 per cent compared to 14 per cent).

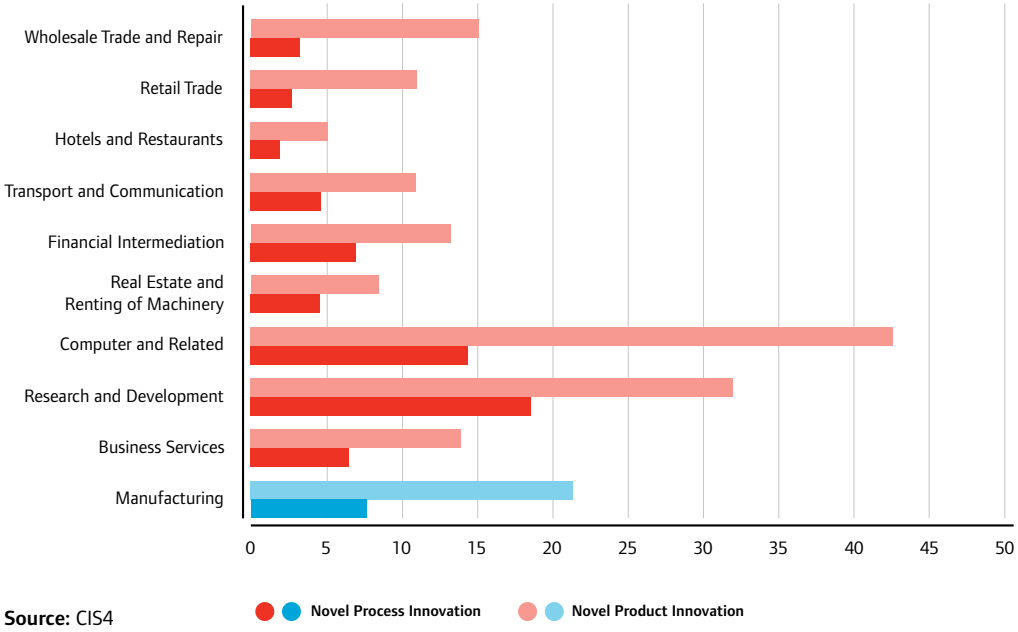
28. Kuusisto, J. (2000) 'The Determinants of Services Capability in Small Manufacturing Firms.' PhD thesis. Kingston: Kingston University Small Business Research Centre; Lay, G. (2002) 'Services Provider Industries: Industrial Migration from Manufacturing to Selling Products and Services.' Karlsruhe: Fraunhofer Institute for Systems and Innovation Research; Mathé, H. and Shapiro, R. D. (1993) 'Integrating Services Strategy into the Manufacturing Company.' London: Chapman and Hall.
29. Scherer, F.M. (1991) Changing Perspectives on the Firm Size Problem. In: Acs, Z. J. and Audretsch, D. B. (Eds) 'Innovation and Technological Change: An International Comparison.' Ann Arbor: University of Michigan Press; Cohen, W. and Klepper, S. (1994) Firm Size and the Nature of Innovations within Industries: The Case of Product and Process R&D. 'Review of Economics and Statistics.' 788 (2), pp. 232-243.
30. Pianta, M. (2001) Innovation, Demand and Employment. In: Petit, P. and Soete, L. (Eds) 'Technology and the Future of European Employment.' Cheltenham: Edward Elgar.

Figure 5: Process innovation (percentage of firms)



Source: CIS4

Figure 6: Novel innovation (percentage of firms)



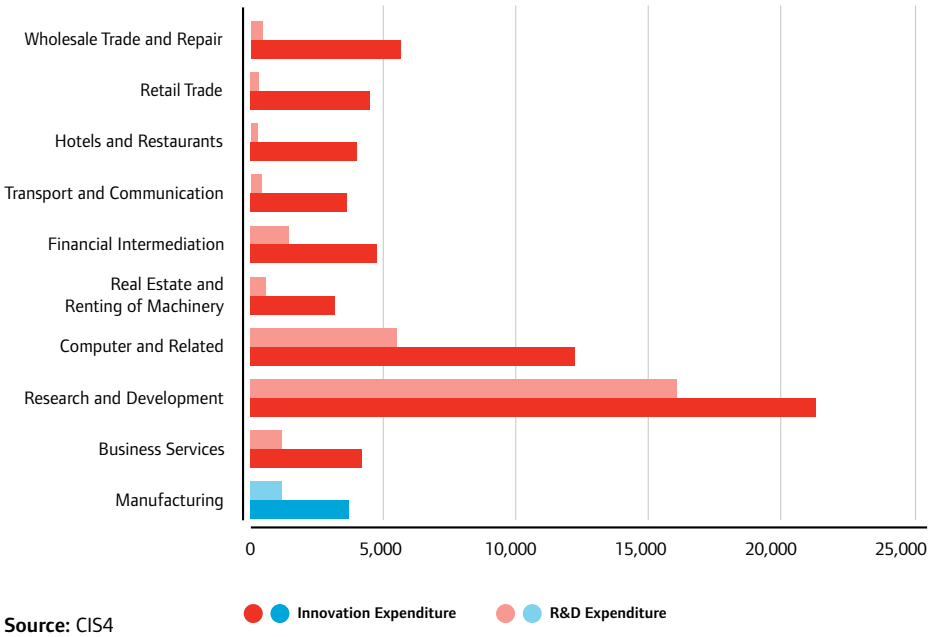
Source: CIS4

2.2 Services firms' investments in innovation are similarly diverse but do not depend for the most part on internal R&D

2.2.1 The R&D model of innovation is not as important for services as it is in manufacturing

Research and development is not a good indicator of innovation or knowledge generation in many services sectors. High levels of innovation activity are often not based on R&D expenditures. This is illustrated in Figure 7, which shows R&D annual expenditure and total innovation expenditure per employee. There are significant variations in the ratio of R&D to total innovation expenditure in different sectors: computer services firms spend £5,988 on R&D per employee, while retail firms spend only £178.

Figure 7: Innovation expenditure per employee (£ in 2004)



Source: CIS4

Figure 8 shows the percentage of innovation expenditure in each type of activity in manufacturing and services. The average R&D share in innovation expenditure is lower in services than in manufacturing, consistent with previous findings.[31] Services, however, spend a greater share of innovation expenditure than manufacturing firms on extramural R&D and external sources of knowledge.

It has been debated whether the R&D tax credit encourages innovation in sectors that invest heavily in R&D.[32] But this data suggests that it is likely to have little influence over the majority of innovation in other sectors, including most services sectors. The most significant impact for most services sectors is likely to be that services firms may benefit indirectly from using some of the products developed from 'traditional' R&D innovation.

2.2.2 There are significant variations in innovation expenditure between services sectors

An interesting picture emerges if average annual expenditure is disaggregated by sector within the services economy (Figure 9). Firms in the computer services and research and development services spend a large proportion of their total innovation budget on a combination of intramural and extramural R&D, substantially exceeding the average for manufacturing. The financial intermediation sector also spends nearly as much as the manufacturing average on R&D.

Expenditure on design and marketing is also important for the development of innovative products and services. Expenditure on design is particularly important for the high and medium-technology sectors, whereas expenditure on marketing is most important in high-technology sectors where it is used to develop customer-oriented strategies that capture clients' needs. Expenditure on machinery and ICT is particularly important to process innovations. These might be examples of what NESTA has previously labelled as 'Type I' hidden innovation – investments in technology-related innovation that are not captured in R&D expenditure.[33]

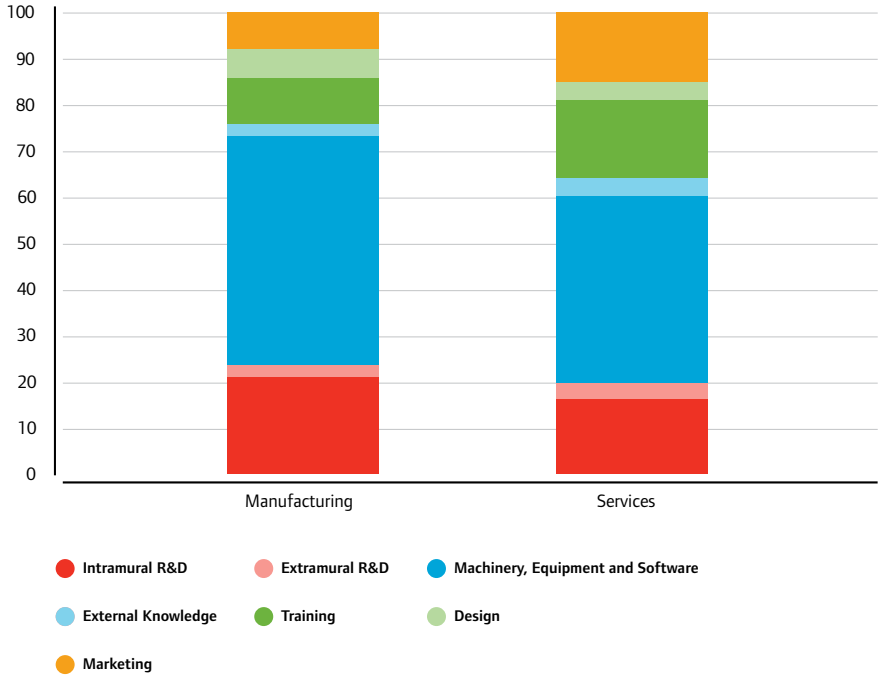
Firms in the wholesale, retail, and hotel and restaurants sectors spend a significant amount of their innovation budgets on marketing, suggesting that marketing innovation may be an important component of innovation in these sectors.

2.2.3 Services spend more on innovation per head compared to manufacturing

The analysis of innovation expenditures for the different service industries shows important differences from manufacturing,

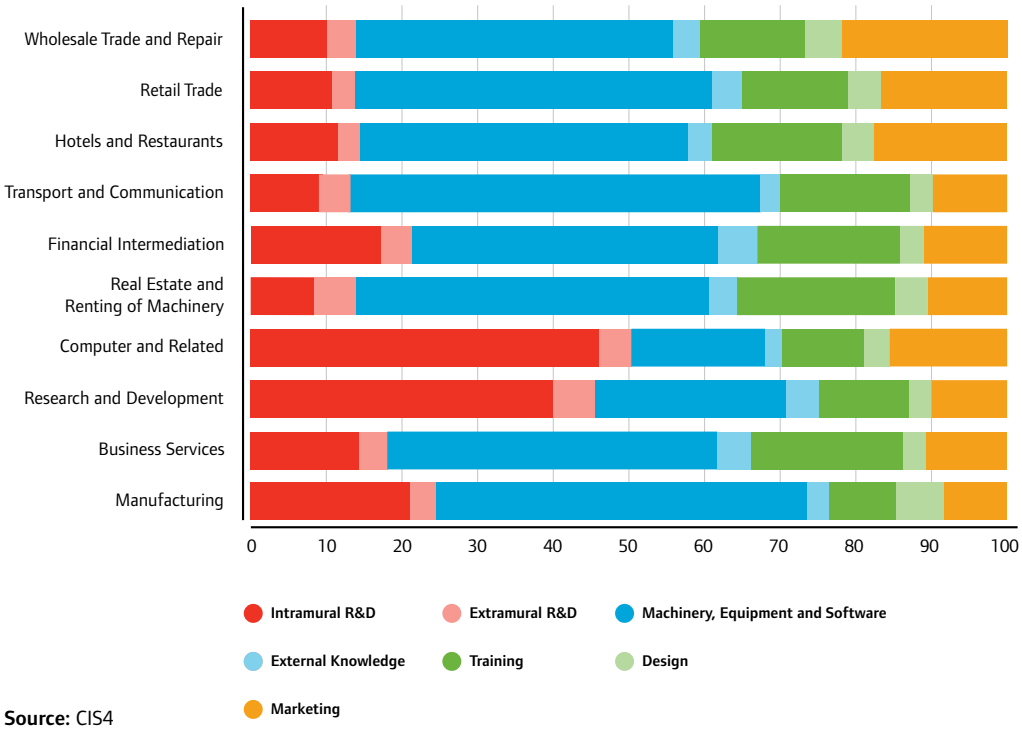
31. Evangelista, R. and Sirilli, G. (1995) Measuring Innovation in Services. 'Research Evaluation.' 5 (3), pp. 207-215; Evangelista, R. (2000), Sectoral Patterns of Innovation in Services. 'Economics of Innovation and New Technology.' 9, pp. 183-221.
32. For example, some studies find that firms' decisions to innovate are not directly influenced by the policy; see Abreu, M., Grinevich, V., Kitson, M. and Savona, M. (2008) 'Absorptive Capacity and Regional Patterns of Innovation.' Centre for Business Research. Cambridge: University of Cambridge.
33. National Endowment for Science, Technology and the Arts (2007) 'Hidden Innovation.' London: NESTA.

Figure 8: Innovation expenditure by type (percentage of total innovation expenditure in 2004)



Source: CIS4

Figure 9: Innovation expenditure by type and sector (percentage of total innovation expenditure in 2004)

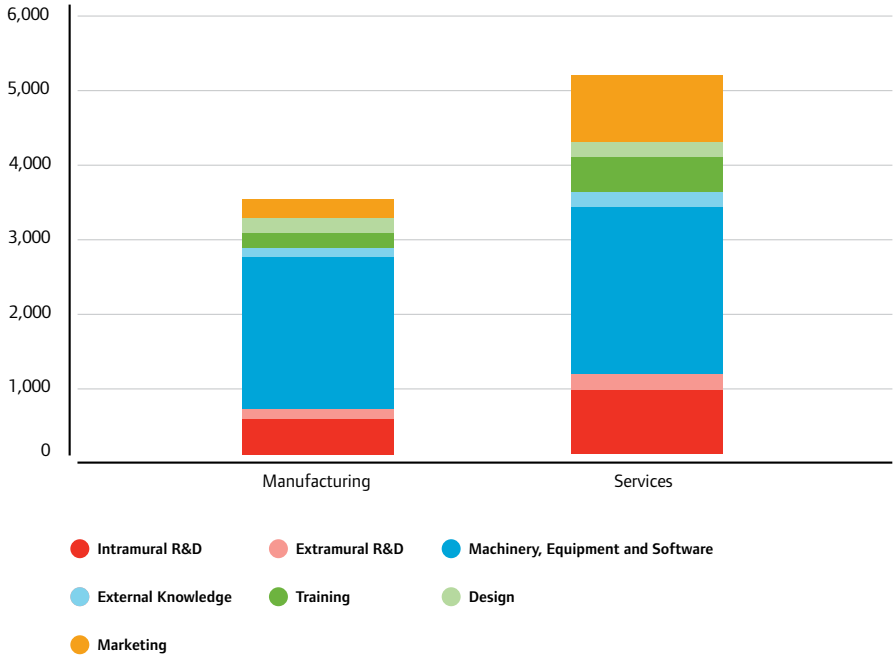


Source: CIS4

but some similarities too, particularly in R&D expenditure.

Figure 10 shows the average innovation expenditure per employee in manufacturing and services. It is notable that the average expenditure on innovative activities is substantially higher in services, including a significantly higher level of spending on R&D per employee. (This is for a number

Figure 10: Innovation expenditure per employee (£ in 2004)



Source: CIS4

of reasons: computer and research and development services firms spend much more than the average manufacturing firm on R&D; on average, manufacturing firms spend surprisingly little on R&D; and some larger firms in sectors such as retail and financial intermediation help to push up the average services spend on R&D).

Spending on training and marketing in services substantially exceeds that in manufacturing, perhaps reflecting the interactive nature of services innovation.

Figure 11 shows how innovation expenditure varies in different services. Compared to manufacturing, annual innovation expenditure per employee is five times higher in research and development services and three times higher in computer services.

2.2.4 Services firms spend a relatively high proportion of their innovation budgets on employee training and marketing

Services firms allocate more of their innovation budgets to employee training "specifically for the development and/or introduction of innovations" (as the CIS defines these investments) and to marketing. This supports the notion that innovation in services is more focused on interaction and communication than innovation in manufacturing. The proportion spent on 'machinery, equipment and software' is lower in services than in manufacturing, although a disaggregation might show a higher proportion of spending on machinery in manufacturing, and a higher proportion of spending on software in services.

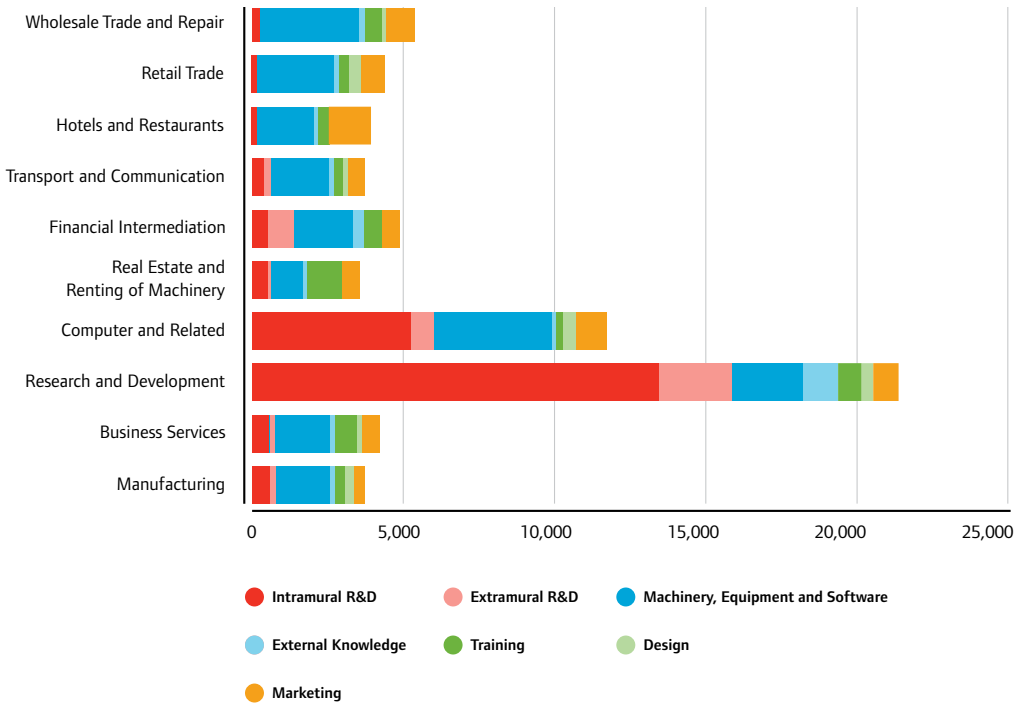
2.2.5 Business services in particular invest heavily in training

The business services sector includes support industries such as logistics, office and building services, administrative and technology support. It is therefore useful to disaggregate this sub-sector further as in Figure 12. Interestingly, the advertising industry spends a substantial proportion of its innovation budget on R&D; and the proportion is larger than the average for manufacturing. Furthermore, advertising, architectural and engineering firms spend a significant proportion of their innovation budgets on design. Business services firms also spend substantially more on training than other services sectors or manufacturing.

2.3 Wider forms of innovation such as organisational change are important for services firms

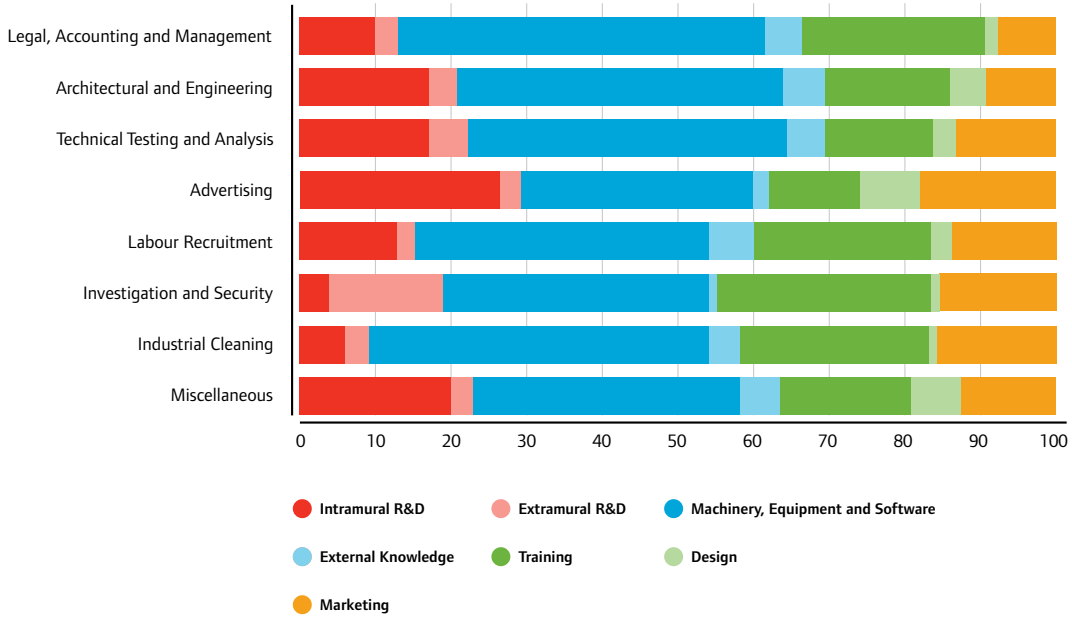
'Wider innovation' includes new forms of organisation and business practices "aimed at step changes in internal efficiency or in approaching markets and customers" (as the

Figure 11: Innovation expenditure per employee by sector (£ in 2004)



Source: CIS4

Figure 12: Innovation expenditure by type and sub-sector in business services (percentage of total innovation expenditure in 2004)



Source: CIS4

CIS defines it). NESTA has previously labelled this 'Type II' hidden innovation.[34]

Such innovation is closely linked to the practice of 'modularisation' – the unbundling of services products into separate components, in order to assess the efficiency of production and the quality of the individual components. Modularisation has in turn served as a catalyst for innovation in the services economy, by providing new insights into how the individual components can be rearranged into new products and processes.[35]

Figure 13 shows that many services firms engage in so-called 'wider innovation', particularly in developing new marketing or corporate strategies. Three sectors – financial intermediation, computer services and research and development services – are substantially more likely to introduce major changes in organisation and business structure than either manufacturing or the other services. Perhaps surprisingly, three further services not traditionally associated with innovation – transport and communication, real estate and the renting of machinery, and business services – show high rates of wider innovation, suggesting a previously unobserved dimension to the innovation process in these sectors.

Organisational change and the adoption of new management practices within services firms have often been facilitated by the use of ICT (see 3.1.6). The services sector has also followed the manufacturing sector in adopting and developing some forms of organisational innovation, particularly quality control procedures.[36]

Organisational innovation may, therefore, be a substantial part of the 'hidden' dimension of innovation in services.

2.4 Intellectual property in services goes well beyond patents

2.4.1 Traditional methods for protecting intellectual property are relatively unimportant for most services sectors

Traditional intellectual property (IP) rights arrangements such as patents are not well-suited to most services, due to the intangible nature of their products.[37] Services firms have tended to use trademarks and copyright to protect certain aspects of their business, but the adoption and development of new products and processes has raised the need for new forms of protection including 'business methods' patents.[38]

Figures 14-21 show the percentage of innovating firms assigning medium or high importance to different forms of formal and strategic protection methods.

34. National Endowment for Science, Technology and the Arts (2007) 'Hidden Innovation.' London: NESTA.
35. Sundbo, J. (1998) 'The Organisation of Innovation in Services.' Roskilde: Roskilde University Press.
36. Miles, I. (2005) Innovation in Services. In: Fagerberg, J., Mowery, D. and Nelson, R. (Eds) 'The Oxford Handbook of Innovation.' New York: Oxford University Press.
37. Coombs, R. and Miles, I. (2000) Innovation, Measurement and Services: The New Problematique. In: Metcalfe, J. S. and Miles, I. (Eds) 'Innovation Systems in the Services Economy: Measurement and Case Study Analysis.' Dordrecht: Kluwer Academic Publishers, pp. 83-102; Miles, I. and Boden, M. (2000) Services, Knowledge and Intellectual Property. In: Andersen, B., Howells, J., Hull, R., Miles, I. and Roberts, J. (Eds) 'Knowledge and Innovation in the New Services Economy.' Aldershot: Elgar.
38. Miles, I. and Boden, M. (2000) Services, Knowledge and Intellectual Property. In: Andersen, B., Howells, J., Hull, R., Miles, I. and Roberts, J. (Eds) 'Knowledge and Innovation in the New Services Economy.' Aldershot: Elgar; Miles, I. (2005) Innovation in Services. In: Fagerberg, J., Mowery, D. and Nelson, R. (Eds) 'The Oxford Handbook of Innovation.' New York: Oxford University Press.

Traditional patents are considered less important in the services industries, except in computer services and research and development services, and to some extent, surprisingly, in wholesale (Figure 14).

Protection of design is considered important by computer services and wholesale firms (Figure 15).

Two other familiar protection methods – trademarks and copyright – are relatively unimportant for most services, with the notable exception of trademarks in computer services (Figure 16) and copyright in computer services and research and development services (Figure 17).

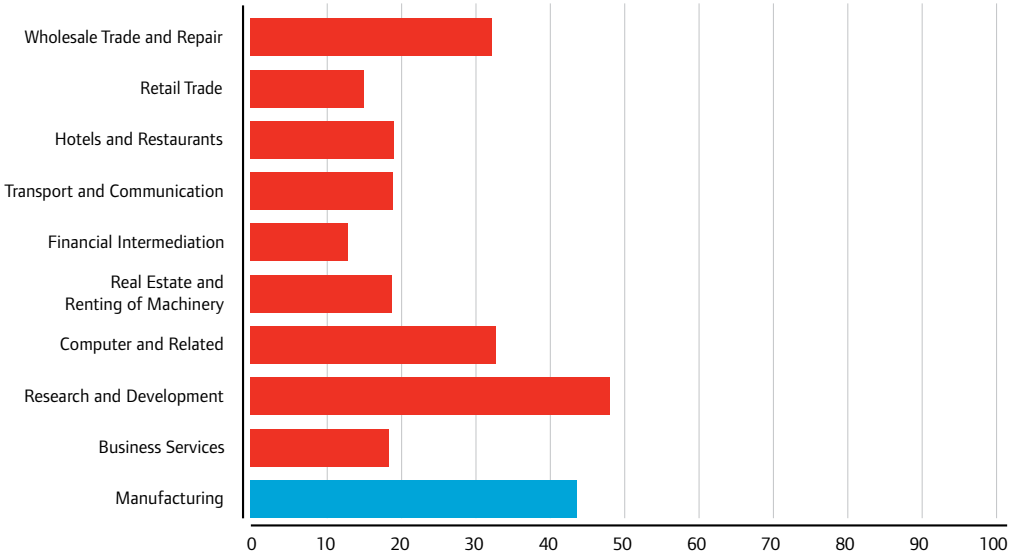
2.4.2 The most important protection methods for services are confidentiality agreements and informal means

Figures 18-21 indicate that the most important methods of protection are confidentiality agreements, particularly for financial intermediation, computer services and research and development services, and informal means such as secrecy, complexity of design and lead-time advantage on competitors.

Figure 13: Wider innovation (percentage of firms)

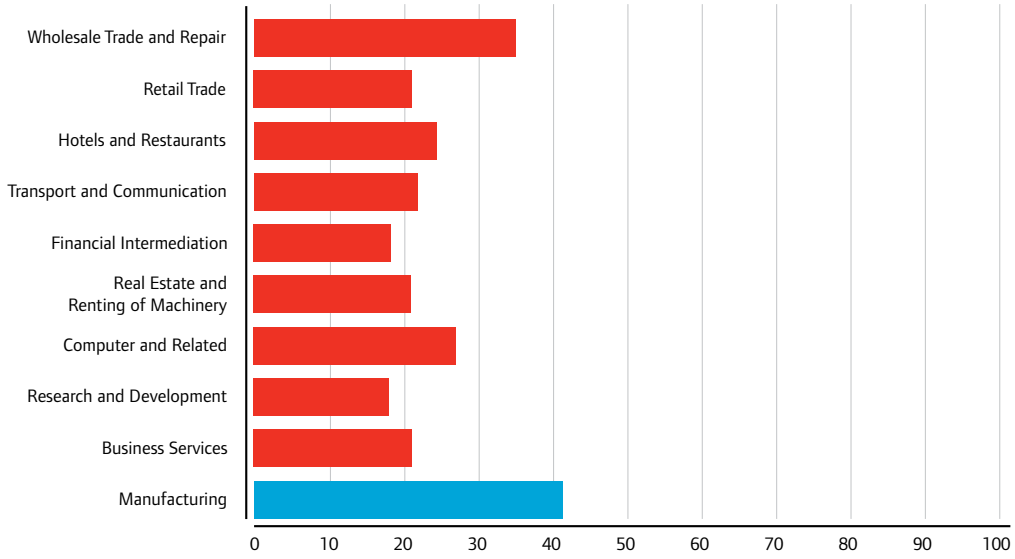
Source: CIS4

Figure 14: Protection of innovation by patents (percentage of innovating firms)



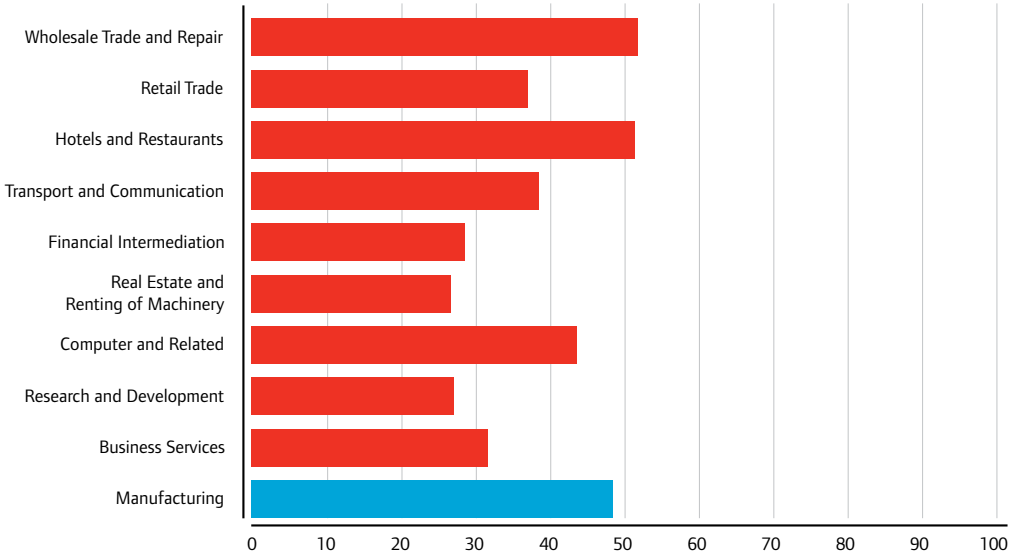
Source: CIS4

Figure 15: Protection of innovation by registration of design (percentage of innovating firms)



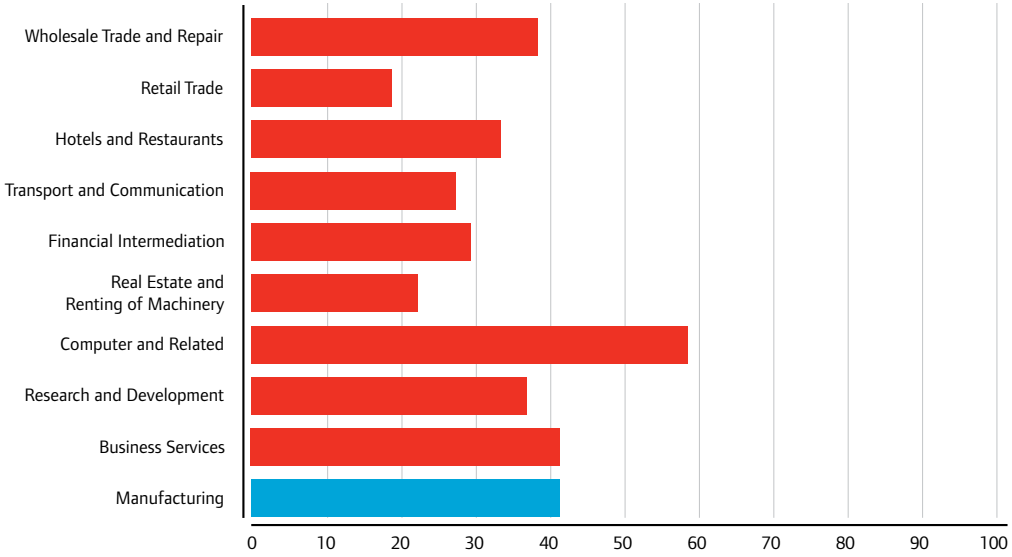
Source: CIS4

Figure 16: Protection of innovation by trademarks (percentage of innovating firms)



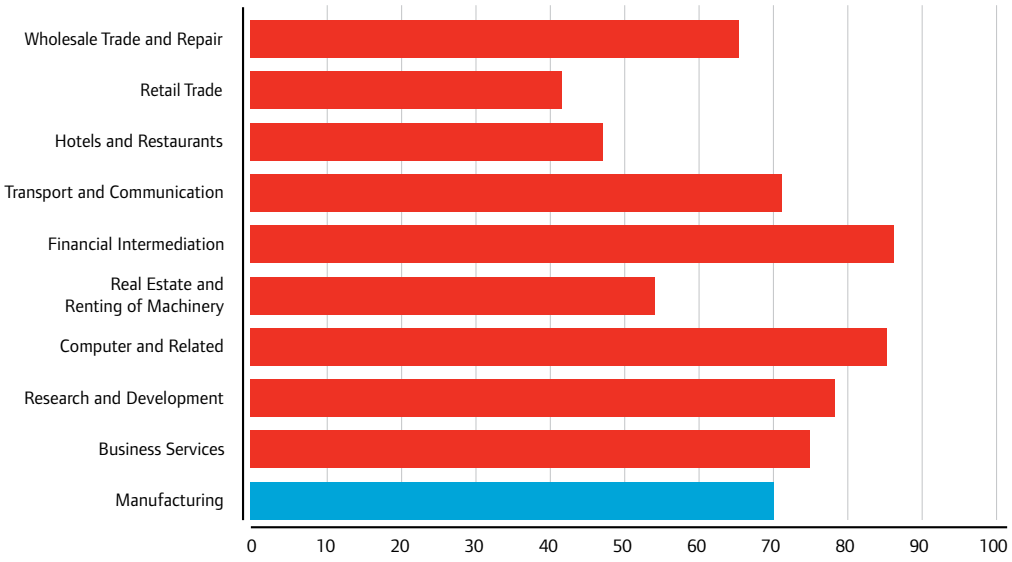
Source: CIS4

Figure 17: Protection of innovation by copyright (percentage of innovating firms)



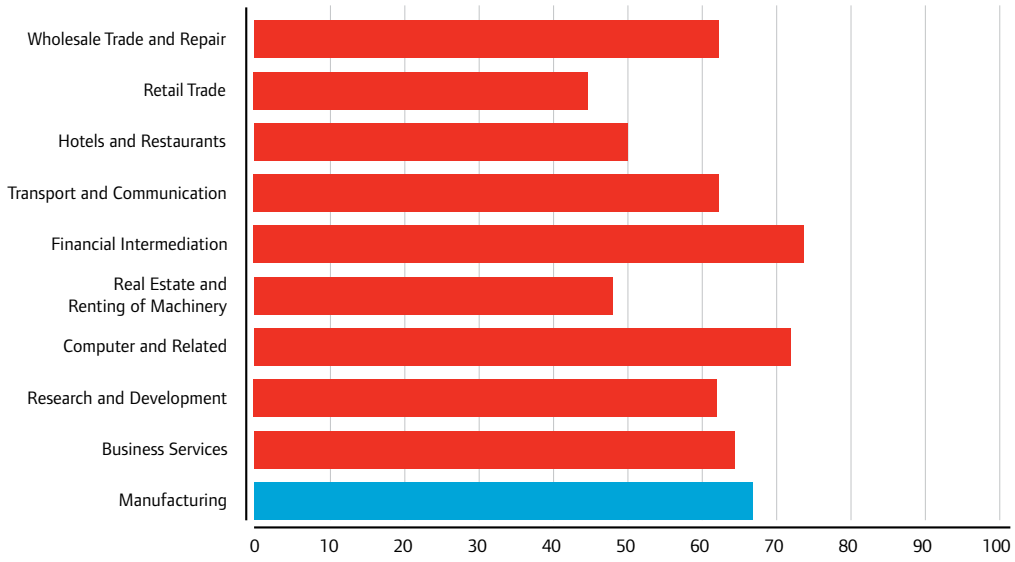
Source: CIS4

Figure 18: Protection of innovation by confidentiality agreements (percentage of innovating firms)



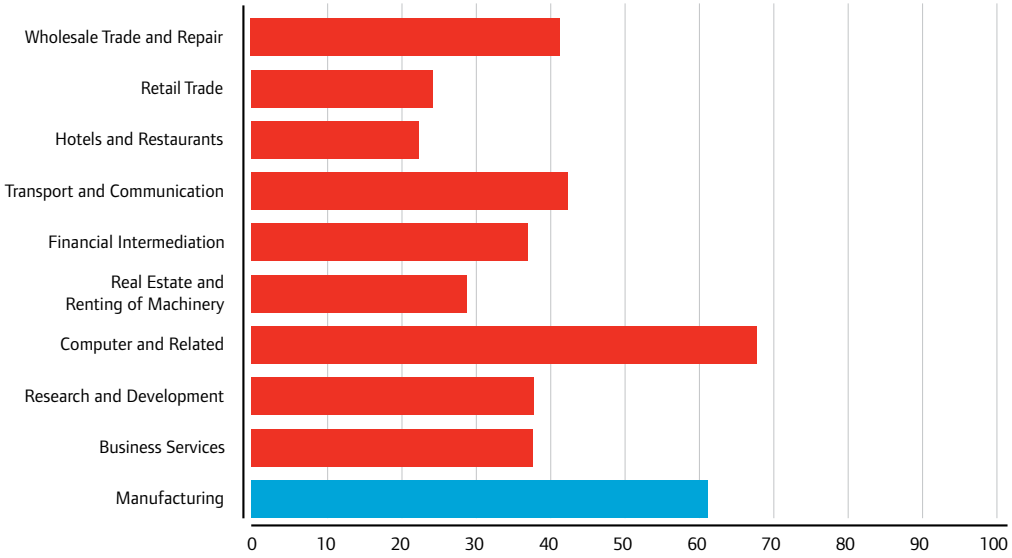
Source: CIS4

Figure 19: Protection of innovation by secrecy (percentage of innovating firms)



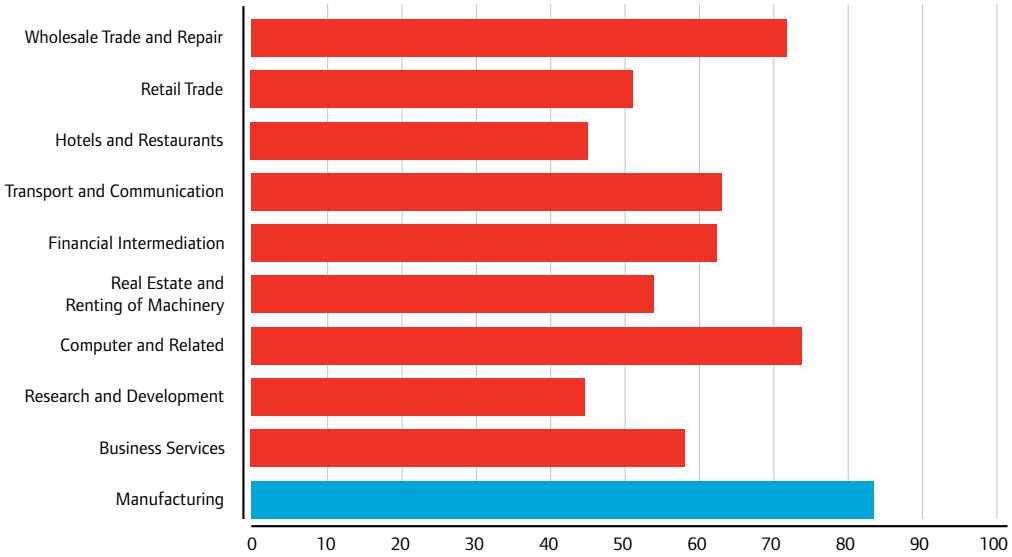
Source: CIS4

Figure 20: Protection of innovation by complexity of design (percentage of innovating firms)



Source: CIS4

Figure 21: Protection of innovation by lead-time advantage (percentage of innovating firms)



Source: CIS4

Part 3: Innovation in services differs fundamentally from the model assumed for advanced manufacturing – it is driven by organisational change and ICT, but inhibited by costs and uncertainty

3.1 Innovating services firms are driven by competition, problem-solving, suppliers and clients

3.1.1 Innovation is vital to remaining competitive

Innovation in services firms may be driven by suppliers, customers, internal needs or systemic technological changes. There are a number of drivers; there is no one dominant pattern or model of innovation.[39] Simply put, the innovation process is complex.[40]

Most of the firms interviewed for this research are active innovators. Their innovative activities may focus on their own firms or on trying to improve the performance of other firms; they can be primarily technological or non-technological, or a combination of the two.

Firms see sustained innovation as fundamental to remaining competitive. But they may not think about innovation as a distinct activity; they may be just trying to prevent a company from becoming stagnant and to secure its continued success.

> *"We have to work on the basis that we have come up with good ideas and innovative ideas because we have to. The company I think would not continue to grow."* (Computer services firm)

Sometimes this builds on the firm's existing product range.

> *"We came up with an offering... services that we offered together with our [new] product, so that's certainly one driver for how we innovate as far as our services offerings are concerned. We do product related services which is all around design, implementation, quality assurance around our own product set."* (Computer services firm)

Overall, services firms believe there is a lot of innovation in services, however much of it is only recognised after the event.

> *"Quite a lot of it doesn't work and is hastily scrapped and you do something else."* (Computer services firm)

> "(Some initiatives) *seem like a good thing to do, or a good approach, motivated by some other reason."* (Computer services firm)

Many services are increasingly traded in international markets, although some parts of the services sector are sheltered from global competition. On the basis of data from the CIS, a firm with an overseas market is generally more likely to innovate in goods or processes than services. This is not the case, however, in export firms at the lower-technology end of the services economy, as they tend to innovate in all three areas – goods, services and processes.

3.1.2 Innovation is prompted by problems

One widely cited definition of services views such activities as solving problems which do not involve supplying goods.[41] This can mean placing at a customer's disposal many capabilities and competencies related not only to technology, but also to staff and organisation. Inevitably, any innovation in services will involve both technological and non-technological factors.

This is one reason why innovation in services firms may be less distinctive than it is in some

39. According to one analysis – also reflected in this research – there are four main patterns of innovation in services. First, suppliers, especially ICT hardware and software manufacturers. Second, innovation within services, initiated and implemented in services firms themselves. Third, customer-led innovation, undertaken directly in response to the needs of specific customers or changing market conditions. Fourth, innovation through services, when services firms influence and support innovation within client firms. See Van Ark, B., Broersma, L. and den Hertog, P. (2003) Services Innovation, Performance and Policy: A Review. In: 'Synthesis Report in the Framework of the Project Structurele Informatievoorziening in Diensten (SIID) – Structural Information Provision on Innovation in Services.' Groningen: Groningen Growth and Development Centre, University of Groningen.
40. This section relies on a multiple methodology approach, combining empirical analysis of CIS data with evidence from the case studies. For further details on methodology and the results, see Appendix D.
41. Gadrey, J., Gallouj, F. and Weinstein, O. (1995) New Models of Innovation, How Services Benefit Industry. 'International Journal of Services Industry Management.' 6 (3), pp. 4-16.

advanced manufacturing firms: it is often responsive rather than predetermined.

> *"It (innovation) is about problem solving. It has to be a new solution to an identified problem. You either identify a problem or an opportunity and then you find a solution to it."* (Computer services firm)

As noted, this problem-solving may not be related to new technologies.

> *"They (clients) do not need special technology, they need a special approach. You need to relate the technology to their requirements."* (Computer services firm)

3.1.3 Skilled workers are crucial to innovation processes

Increased innovation intensity is associated with employing graduates, especially in lower-technology sectors. Services innovation appears to rely on the skills and knowledge of employees with degrees in both 'hard' (science based) and 'soft' (non-science based) disciplines, whereas the science degree tends to be associated with the introduction of good (physical) product innovation. As might be expected, the implementation of process innovations does not generally require graduates.

The quality of in-house expertise is of critical importance to innovation in every firm. Considerable effort and resources are put into recruiting the best experts, ensuring that they get challenging and exciting projects, and rewarding them for their success. Since some firms may have to resort to external expertise, they face the organisational challenge of introducing mechanisms to absorb the relevant knowledge from outside the firm.

3.1.4 Firms also draw heavily on suppliers and external expertise

Data from CIS shows a strong relationship between collaborative behaviour by firms and their innovation performance. Services firms tend to cooperate closely with other firms in their vertical supply chains. Collaborations with suppliers is particularly important for firms in low and medium-technology sectors for the purpose of developing innovative services products, whereas for high-technology sector firms, the most important collaborations are with customers. Collaborations with universities are generally very limited, consistent with previous research.[42]

Computer services firms are particularly promiscuous in how they access external knowledge, using external consultants, contacts and strategic alliances with other 'solution providers', open source systems, long term and project-based collaborations with universities, as well as more informal links with academics.

3.1.5 ICT is important for many forms of innovation in services

While most services do not invent technologies, one form of technology is universally important: ICT is one of the major determinants of the growth in the services economy as a whole.[43]

ICT's information-processing characteristics provide services sectors with a technology that can be widely applied and used as the basis for future innovative activities. By increasing productivity in technology-using sectors, ICT is playing a similar role to the steam engine or electricity in manufacturing.

Unlike the classic manufacturing product life-cycle, ICT-based innovation in services follows a 'Reverse Product Cycle' (RPC). This has three phases: improved efficiency, improved quality and the development of new services.[44] Firms may initially adopt new ICT to improve efficiency, use it later to improve the quality of existing products, and finally go on to develop innovative services. This contrasts with the traditional product cycle, which moves in the opposite direction, from product innovation to radical process innovation and finally to more incremental process innovations.[45] For example, insurance companies progressed from computerising their records to providing online quotations and finally to supplying complete online services.[46] NESTA has previously labelled this form of innovation – the use of largely existing technologies in new ways to provide new services – as 'Type III' hidden innovation.[47]

Services spend a relatively large proportion of their 'innovation budgets' on machinery, equipment and software; the proportion is only slightly lower than that of manufacturing firms (see Figure 10, above). This suggests that software may be a particularly important component of the innovative process in services firms, which generally spend less on machinery and equipment than manufacturing firms.

For example, retail and wholesale firms use ICT extensively for customer data and inventory management, and purchasing

42. See for instance Cosh, A.D., Lester, R.K. and Hughes, A. (2006) 'UK Plc: Just How Innovative Are We?' Cambridge, UK and Cambridge, MA: Cambridge-MIT Institute; Kitson, M. (2007) Regional Variations in Competitiveness and the Implications for Regional Policy. In: Cosh, A. and Hughes, A. (Eds) 'British Enterprise: Surviving, Thriving – or Dying?' Cambridge: ESRC Centre for Business Research, University of Cambridge; Tether, B. (2002) Who Cooperates for Innovation and Why. An Empirical Analysis. 'Research Policy.' 31 (6), pp. 947-967.
43. Miles, I. and Matthews, M. (1992) Information Technology and the Information Economy. In: Robins, K. (Ed.) 'Understanding Innovation.' Luxembourg: European Innovation Monitoring Services; Organisation for Economic Co-operation and Development (2000) 'A New Economy? – The Role of Innovation and Information Technology in Recent OECD Economic Growth.' Paris: OECD; Miles, I. (2005) Innovation in Services. In: Fagerberg, J., Mowery, D. and Nelson, R. (Eds) 'The Oxford Handbook of Innovation.' Oxford: Oxford University Press; Cainelli, G., Evangelista, R. and Savona, M. (2006) Innovation and Economic Performance in Services, A Firm Level Analysis. 'Cambridge Journal of Economics.' 30, pp. 435-458; Marrano, M. G., Haskel, J. and Wallis, G. (2007) 'What Happened to the Knowledge Economy? ICT, Intangible Investment and Britain's Productivity Records Revisited.' Working Paper no. 603. London: Queen Mary University of London.
44. Barras, R. (1986) Towards a Theory of Innovation in Services. 'Research Policy.' 15 (4), pp. 161-73; Barras, R. (1990) Interactive Innovation in Financial and Business Services: The Vanguard of the Services Revolution. 'Research Policy.' 19, pp. 215-237.
45. Abernathy, W. and Utterback, J. (1978) Patterns of Innovation in Technology. 'Technology Review.' 80, pp. 40-47.
46. Barras, R. (1990) Interactive Innovation in Financial and Business Services: The Vanguard of the Services Revolution. 'Research Policy.' 19, pp. 215-237.
47. National Endowment for Science, Technology and the Arts (2007) 'Hidden Innovation.' London: NESTA.

systems. Some firms developed significant in-house capabilities to customise ICT systems for internal needs, including analysis of customer behaviour patterns or website service improvements.

> *"We have developed our own [computer systems] for stock controls, ordering, processing, pricing, delivery management, everything on the sales side, we even have one for services."* (Retail firm)

> *"People can order electronically from the website or they can use a system which is a nationwide electronic data interchange operation."* (Wholesale firm)

Similarly, most financial firms have a team of ICT specialists who can tailor core ICT systems or software packages to the firm's specific requirements. ICT has been crucial to increased productivity and efficiency in financial services. At the same time, some firms are careful not to go beyond customers' requirements.

> *"We have just done a survey of our clients to see what more we can move across to the web. In general the response was lower than I would have expected. The web is still connected in people's minds with a quite impersonal touch and things that are more personal they still want to see in hard copy or sent to them through the mail… And now one of the impacts of our next generation of IT systems, for example, is that it will allow our clients…to tailor our reporting to them. The principle is self design and it will save us an enormous amount of work."* (Financial services firm)

3.1.6 Wider innovation strategies, such as new corporate strategies, are a major driver of innovation

This result is consistent across all wider innovation mechanisms (corporate strategy, management techniques, organisational structure, and marketing strategies) and nearly all forms of innovation (goods, services and process).

In general, a new corporate strategy has the biggest impact on the introduction of innovative services in high-technology sectors. New marketing strategies are important for both service and manufacturing innovations; new management techniques are important for process innovations, particularly in high-technology firms.

ICT often facilitates or triggers organisational or wider innovation. In many cases, ICT makes a firm's technological innovations more responsive to client needs. A typical example is a computer services firm, which set up a strategy group to look for radical new opportunities in various industries.

> *"So that they were tasked with identifying real business problems within these industries, which were being dealt with in very traditional manners… We then took the results of that analysis and set up teams of software experts to write software and to create solutions…which we could then take back to these industries and say okay, you invest this amount of money but we can save you that amount of money... So very much our approach was moving away from one of technological excellence... for the sake of it and more towards a situation where we could demonstrate real savings to these [client] organisations and real return on investment."* (Computer services firm)

Firms face the organisational challenge of striking a balance between 'mass production' of particular services and personalisation for customers. This is especially important for companies in the finance sector.

> *"About two years ago we did change the organisational structure from a product-based one to a much more customer-based structure. So instead of having investment tax, pensions, and the small groups…we now have a very high net worth team and those other [customer categories] teams... We turned what were quite individual services for each client [into a] more product-based approach, so we have services like directors' office, partners' office, family office… These are all distinct products… People sign up for that."* (Financial services firm)

> *"As a group…[we have]…a manufacturing model. So wherever we have volume and scale we will have a single platform that produces whatever it is. So, if we took credit cards for example, there is one credit card system…that supports all of the different credit cards that we operate…but what is different is the way those are packaged and presented to the client, and there are also some features about ours, which are quite unique… For a number of these innovations what we have got is, we've got a dedicated person who is running with*

each of them and that's providing the focus that we need." (Financial services firm)

Organisational culture, communication and transparency are also very important. As part of their organisational change, many firms have introduced staff incentive schemes. Some directly facilitate innovation, but most are firm-wide bonus schemes applied to everyone and linked to the firm's annual financial performance.

"We are trying to build up a culture in the business that when we see a problem we set up teams; it is actually an evolution of total quality management…we are not going down a six sigma route[48] *but practical process – and the key word is practical. That forces us to innovate as well and the issue is not about a systems solution, it might be about how we handle something…and we are trying to spread that across the business, so the innovation is not limited to a relatively small group, be they in marketing, sales or IT."* (Wholesale firm)

"We do recognise innovation. We have various awards that we give out. We have the recognition scheme, Level 1, where the local manager says 'well done' for whatever. Here's something and then if it's particularly good it goes up to a Level 2 award, and the best of those get taken for three or four days out in Spain…and people can get on there for…great teamwork, innovative ideas, good problem solving." (Financial services firm)

"As an organisation we have a global knowledge sharing site… A component of it is…(our)…'university' which is where we have a lot of online courses where any members of staff have the ability to log on…and pick a course and take a course and that gives them accreditation or schools… Our whole annual review… is all held on that site so it's all linked in so someone can set their objectives for the year, can select courses within their objectives for the year that they need to complete, they can all be delivered on line, etc. If you like, our business is driven through the one repository of information." (Computer services firm)

3.1.7 Clients can be a major source of inspiration for innovation

Innovation is often informed by market demands or the needs of specific clients. Such innovation can be technological, non-technological or a combination of both. Customer-driven innovation, which often starts as a very specific response to the needs of a particular client, might exemplify the locally-developed small-scale innovations that NESTA has previously labelled as 'Type IV' hidden innovation.[49]

Services often play a major role in innovation processes within client firms, by initiating, facilitating or implementing internal innovation, or by transferring innovations from one firm (or industry) to the client firm. This is most obvious in computer services.

Many computer services firms 'co-innovate' – work together to find solutions – with their client firms to develop new solutions. These innovations may subsequently become a standard product offered by the firm.

"The phone call from the CIO or the CFO… basically says, 'what do you guys know about this subject?' and we go 'well, a little bit but not really sure. It sounds like an interesting problem, we'd love to come and have a look at it'…and we'll work it out together and you do one project like that and then you realize, well, if that company's had that issue then that probably applies to most of the companies as well and that's how the best projects get generated… So as a result of that we've generated an awful lot of collateral thinking working through the problem and we are now answering similar questions for similar organisations in the same area." (Computer services firm)

In other cases, computer services firms validate emerging techniques and technologies with client firms. It can also work in reverse, with clients providing intelligence about the market.

"Customers will sometimes come to us and say, "I saw this product at an exhibition", or "a friend of mine has told me about this product", or all those sort of things, or they have seen it advertised somewhere, do you do it or do you do something similar?" (Wholesale firm)

Client-informed innovation is also common in financial services, especially in financial intermediation services.

"I'm trying to come up with ideas that other people don't have and be one step ahead of the market and also give [clients] information on holdings which they've got.

48. Six sigma is a set of methodologies and culture for continuous quality improvement originally developed by Motorola in the 1980s.
49. National Endowment for Science, Technology and the Arts (2007) 'Hidden Innovation.' London: NESTA.

So my job is to help my clients which are managers to do a better job…you are just giving advice and you don't even know if you're going to get paid back, even though you've given the guy the best advice in the world." (Financial services firm)

"Innovation is a very topical issue in an industry where there are a lot of commodities, trying to find a different way of presenting yourself; and that client interaction is really, really important… It's all about tailored services… We have client sounding boards… We have a monthly rolling client survey that goes out to our clients. One of our challenges is to make sure we are in the clients' shoes… We've done quite a lot of innovative work around women… Shortly, women will own the majority of wealth in the UK, not men, so we've been looking at what does a private bank look like if you're a woman, what do you want, what differs?… A couple of years ago we had a big push on philanthropy. We recognised that many of our clients were not actually interested in investing more money for themselves, but wanted to make a contribution to society, and wanted to give. So, we have developed a philanthropy service." (Financial services firm)

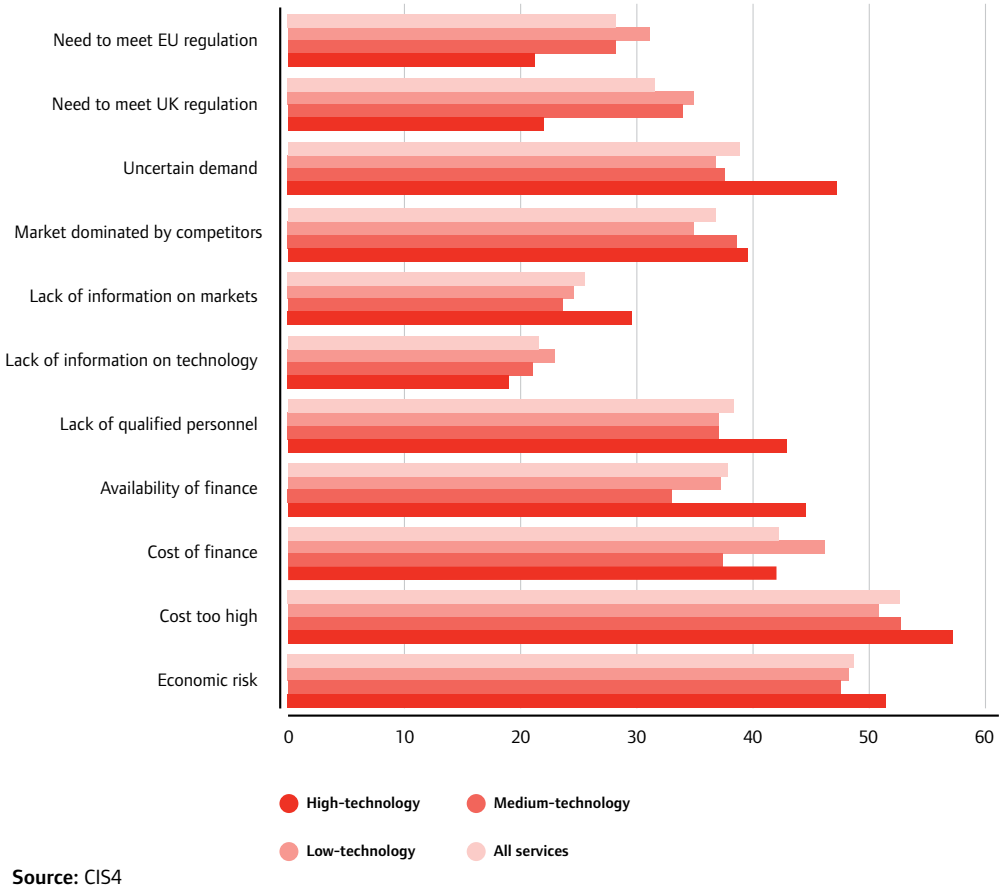
3.2 Services firms are inhibited from innovating by a lack of expertise, resources and support

3.2.1 Half of all services firms find it too expensive to innovate and struggle to access suitable finance to support innovation

Not every firm needs to innovate. Some may operate in markets where innovation is less of a priority, or they may be successfully trading off earlier innovations. But other firms don't innovate because they face constraints, as illustrated in Figure 22.

Significant constraints include: risk and uncertainty (48 per cent and 39 per cent respectively); a lack of skilled labour (38 per cent); a lack of information on technology

Figure 22: Barriers to innovation (percentage of innovating firms assessing barriers as important or very important)



Source: CIS4

and markets (22 per cent and 25 per cent respectively); and the need to meet UK and EU regulations (32 per cent and 28 per cent respectively). A third of all service firms – that is, not just those that are currently innovating – find it too expensive to innovate and struggle to access suitable finance to support these activities. (The reason why the equivalent figures for innovating firms are higher than for all services firms is because innovating firms are more likely to perceive obstacles to innovation).

A firm's decision not to innovate because of the costs of doing so may represent the right choice: the expected benefits may not be sufficient to justify the investment. However, this may also reflect uncertainty about future benefits, especially when up-front investments would be large (for example, an expensive new ICT system). And, of course, most services firms – unlike those in manufacturing – have limited access to support like the R&D tax credit or grants for technology development. Even so, access to finance appears particularly difficult for services firms in high-technology sectors. This may reflect the short-termism and risk-aversion prevalent in financial markets, already identified as a long-term constraint on capital investment in the UK.[50]

3.2.2 Risk and uncertainty reinforce decisions not to innovate

Firms are obviously reluctant to innovate when they perceive market uncertainty and excessive risks. Again, these inhibitors particularly impact on services firms in high-technology sectors. But it is also clear that many firms cannot judge an innovation's chances of success because they lack much of the information needed to assess such probabilities, including access to internal and external expertise.

Services also lack appropriate metrics to evaluate their innovation activities. As a result, managers can struggle to justify innovation-related expenditures. This appears to be particularly important with ICT expenditure in retail and wholesale.

Firms use a variety of metrics (see Table 1). To assess the impact on outputs, some use final performance indicators such as growth or profitability, while others use intermediate metrics including the number of customer leads or patents. In assessing innovations driven by interactions with customers, firms often employ a mix of quantitative and qualitative measures such as the volume and quality of referrals and relationships introduced. Services firms that enable other firms to innovate also focus on client performance indicators.

> *"…some quantifiable benefits that a client has obtained as a result of a product or service that you provided to them…it's something as simple as reduction of number of incidents or severity of incidents an IT department has incurred."* (Computer services firm)

As firms recognise, most of these metrics fail to capture all the hidden innovation investment and activity that take place. Yet, no firm interviewed kept a separate account of their complete innovation budget.

> *"We do identify R&D expenditure because there are tax benefits to doing that. We have been encouraged to make sure that it's all recorded in such a way that we can get credit for it, but I don't think we've done that for innovative thinking if you like."* (Computer services firm)

3.2.3 More than a third of firms lack suitable skilled labour

Many firms provide training. But the ease with which their staff can subsequently leave, acts as a disincentive to investing in their development. Yet again, this constraint is even higher for firms in high-technology sectors.

At the same time, there is a wider economic benefit in the knowledge exchange achieved by workers moving jobs; it circulates know-how, new practices and access to new networks between firms. So, this under-investment in training and staff development is a problem for the economy as a whole.

This is a particular issue in the UK. Relatively poor qualifications and skills are a major contributor to the UK's comparatively poor productivity. Clearly, the issue of skills goes far beyond firms and has been a significant focus for policy for many years. But this issue is not limited only to basic skills, it includes leadership and management skills. The available evidence suggests that while good UK managers match the best in the world, there is a 'long tail' of poor management in the UK which affects company performance, particularly compared to the US.[51]

3.2.4 Some firms lack information on technology and markets

With such a variety of potential innovation inputs and strategies, the problem for many firms is to assess which would work best for

50. Kitson, M. and Michie, J. (1996) Britain's Industrial Performance Since 1960: Underinvestment and Relative Decline. 'The Economic Journal.' 106 (434), pp. 196-212.

51. See the discussion in section three, Department for Business, Enterprise and Regulatory Reform (2008) 'BERR's Role in Raising Productivity: New Evidence.' London: BERR.

Table 1: Innovation-related indicators in three services sectors

Sector	Input	Output
Computer services	Cost related to R&D, people involved in innovation, technical resources such as software and hardware Number of leads	Profit, profitability Sales Number of leads Leads turned into actual client facing discussions Contracts signed Business plan achieved Clients retained, client satisfaction Client performance and other quantifiable client benefits such as reduction of ICT incidents Publications, conference papers, citations
Financial services	Costs related to people involved in innovation Opportunity costs Assets invested Number of process changes made Number of ideas submitted	Market share and volumes going through Profits, increase in commissions, fee earnings Increase in leads, volume Productivity Quality of referrals, relationships introduced
Retail/wholesale	Costs related to people involved in innovation Alternative costs	Sales

them. For instance, for many firms there is confusion about appropriate ICT options and their potential benefits. And while many know the potential benefits of acquiring external knowledge and expertise, they don't know how to access it, perhaps because suitable knowledge exchange networks may not exist.

3.2.5 Regulation can inhibit but also spur innovation

Business commonly cites regulations ('red tape') as a burden on their performance and a brake on innovation. However, there are fewer regulatory constraints felt in high-technology sectors than other parts of the services economy; many firms interviewed also considered that new regulations could stimulate innovation.

3.3 Size is sometimes but not always a factor in innovative capacity

It has been suggested that large firms are more innovative because they enjoy economies of scale in innovation,[52] and that the share of process relative to product innovation increases

52. As first proposed by Schumpeter, J. A. (1942) 'Theory of Economic Development.' Cambridge, MA: Harvard University Press. For a review of the literature, see Cohen, W. (1995) Empirical Studies of Innovative Activity. In: Stoneman, P. (Ed.) 'Handbook of the Economics of Innovation and Technological Change.' Oxford: Blackwell. pp. 182-264.

with firm size because larger firms can spread the efficiency benefits of process innovation over larger volumes of output.[53] It has also been argued that R&D increases faster than firm size up to a certain threshold.[54]

Figures 23-28 show the relationship between innovation rates for different services sectors and manufacturing (taken as a whole) for different firm size bands (based on employees in 2004). The rate of product innovation is fairly constant across size bands for most services sectors, with the exception of computer services and research and development services, which show a positive relationship between innovation and size. A similar relationship is apparent for manufacturing (Figure 23) although Figures 24 and 25 suggest that this is due to a size effect in manufactured product innovation and not services product innovation. The relationship is more striking for process innovation, with most sectors exhibiting a positive relationship between innovation and size, particularly financial intermediation and research and development services (Figure 26).

As already noted, new forms of organisation, business practices and marketing are important in promoting innovation in services products and processes. The CIS4 data shows some positive relationship between firm size and the introduction of wider innovation (Figures 27 and 28). In particular, there is a substantial increase in innovation in several sectors: research and development, financial intermediation, and more surprisingly, real estate and renting of machinery.

Companies interviewed suggested that size is likely to affect a firm's ability to innovate. As with aggregate data, however, the relationship between firm size and innovation is complicated. On the one hand, larger firms are less constrained by the cost or people needed to initiate and implement services innovation.

> *"It's a percentage of our earnings that we allocate to R&D now on the services side, like the way we've grown over the last six to seven years for sure has increased our ability to innovate."* (Computer services firm)

> *"…so yes, having the resources to spread the workload around the business is definitely a factor and the time to think about it is also a factor."* (Wholesale firm)

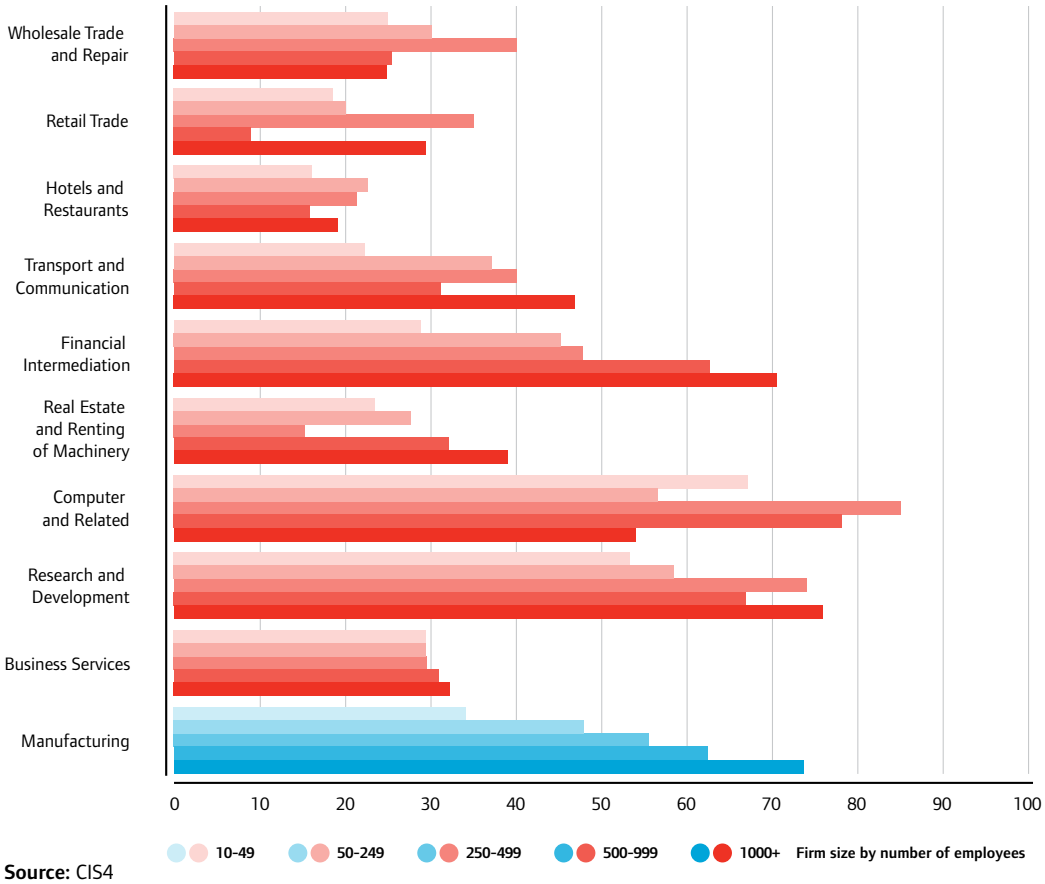
> *"We would like to have a bit more scale because that scale would give us the ability to attract and pay higher quality because this sort of business is all about intellectual capital really."* (Financial services firm)

On the other hand, smaller firms have to be extremely innovative to survive and compete with the bigger ones.

> *"The radical ideas come from the smaller firms. In the bigger firms you don't want to get it wrong, the mediocre ideas get you enough business. If you get it wrong then it's prominent to everyone but in the mid-sized firms you've got to get attention to yourself so generally it's the mid-sized firms that come up with the ideas, and that's what mid-sized firms will normally look for…"* (Financial services firm)

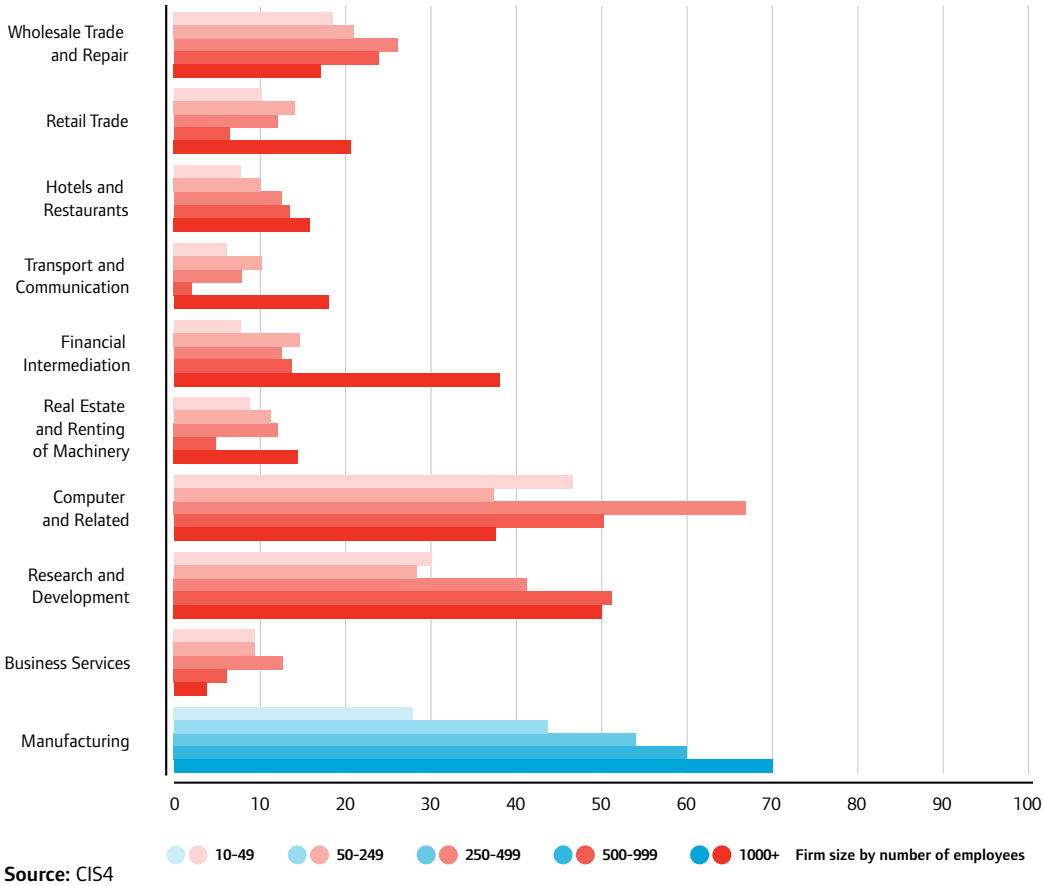
53. Scherer, F. M. (1991) Changing Perspectives on the Firm Size Problem. In: Acs, Z. J. and Audretsch, D. (Eds) 'Innovation and Technological Change: An International Comparison.' Ann Arbor: University of Michigan Press.
54. Scherer, F. M. (1965) Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions. 'American Economic Review.' 55 (5), pp. 1097-1125.

Figure 23: Product innovation by firm size (percentage of firms)



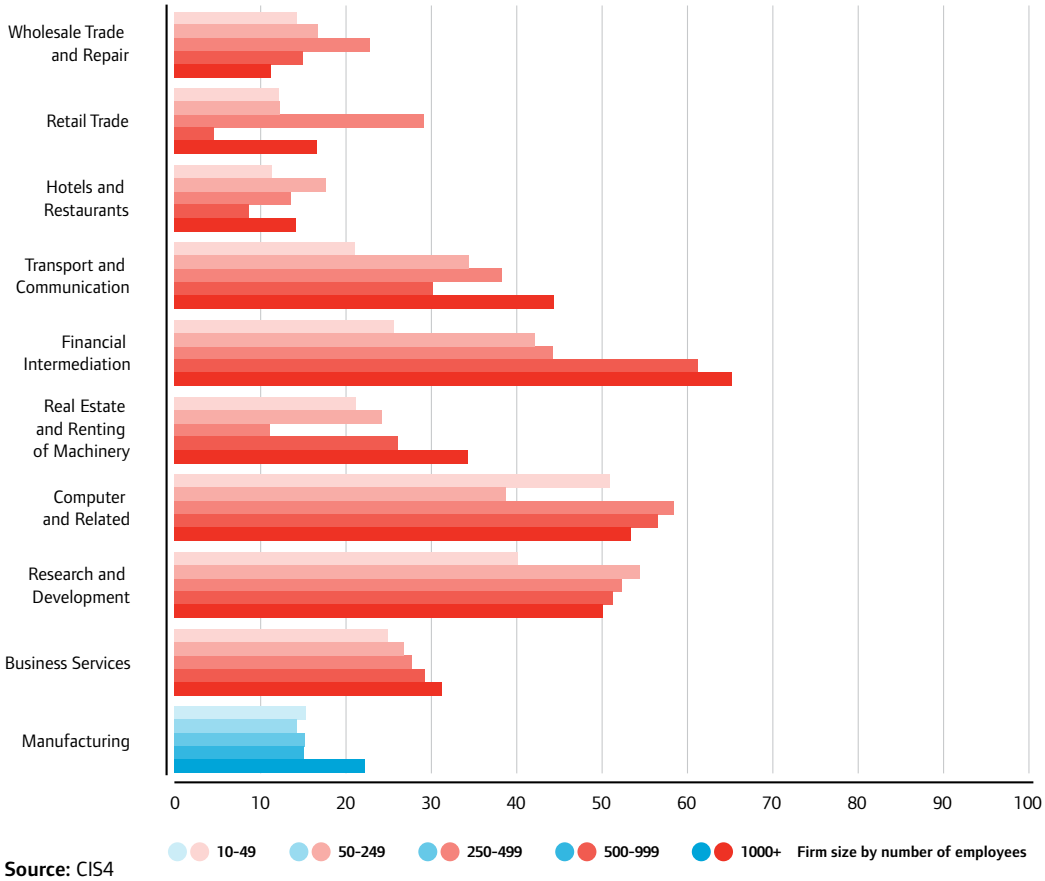
Source: CIS4

Figure 24: Manufactured product innovation by firm size (percentage of firms)



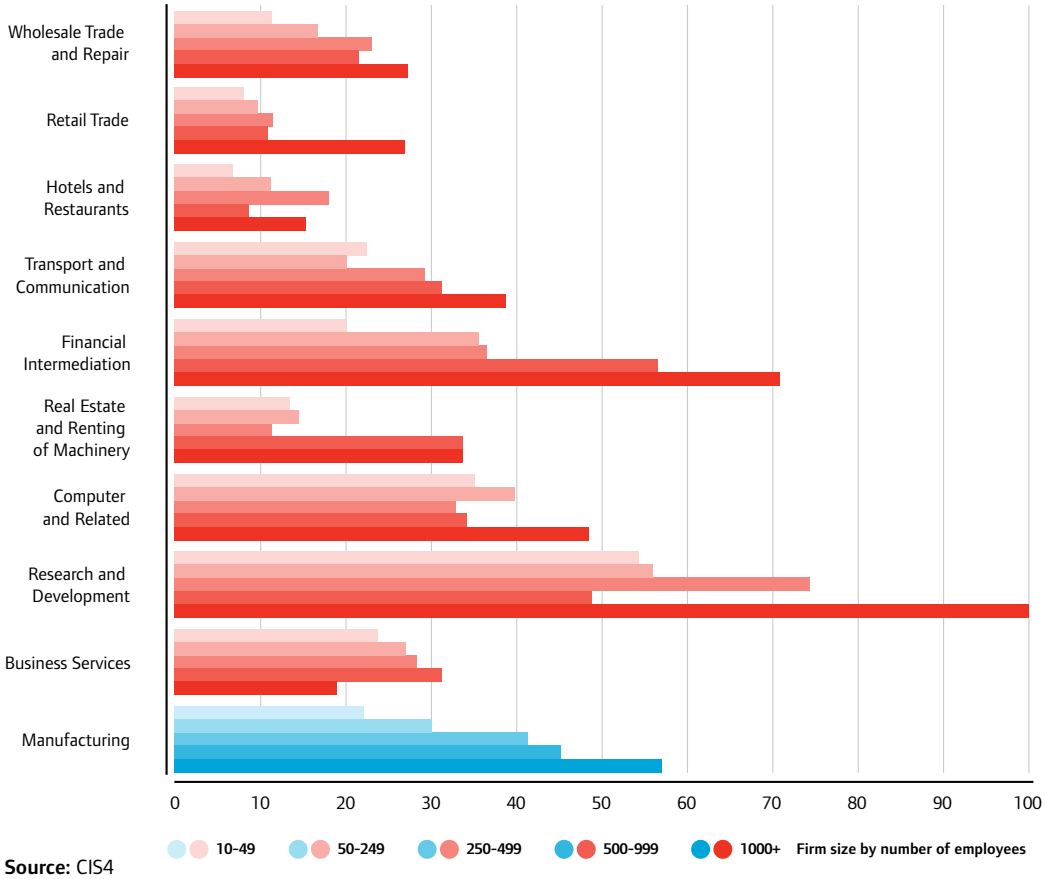
Source: CIS4

Figure 25: Services product innovation by firm size (percentage of firms)



Source: CIS4

Figure 26: Process innovation by firm size (percentage of firms)



Source: CIS4

Figure 27: Advanced management techniques by firm size (percentage of firms)

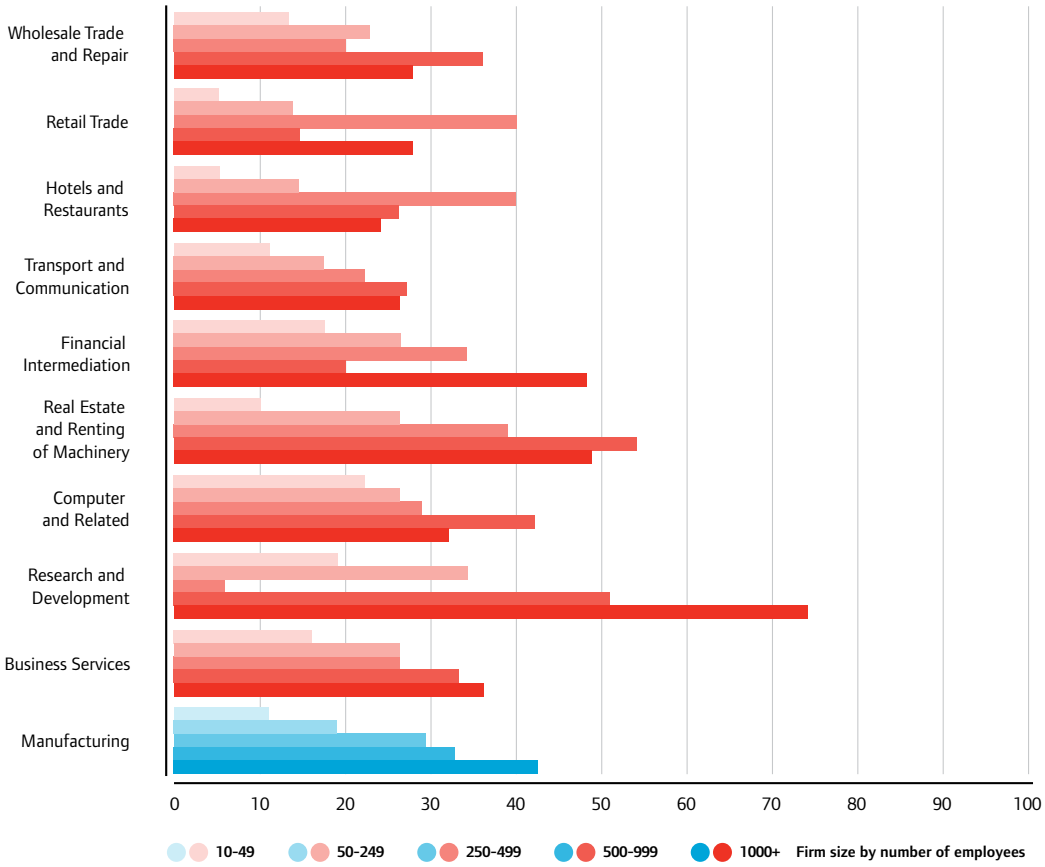
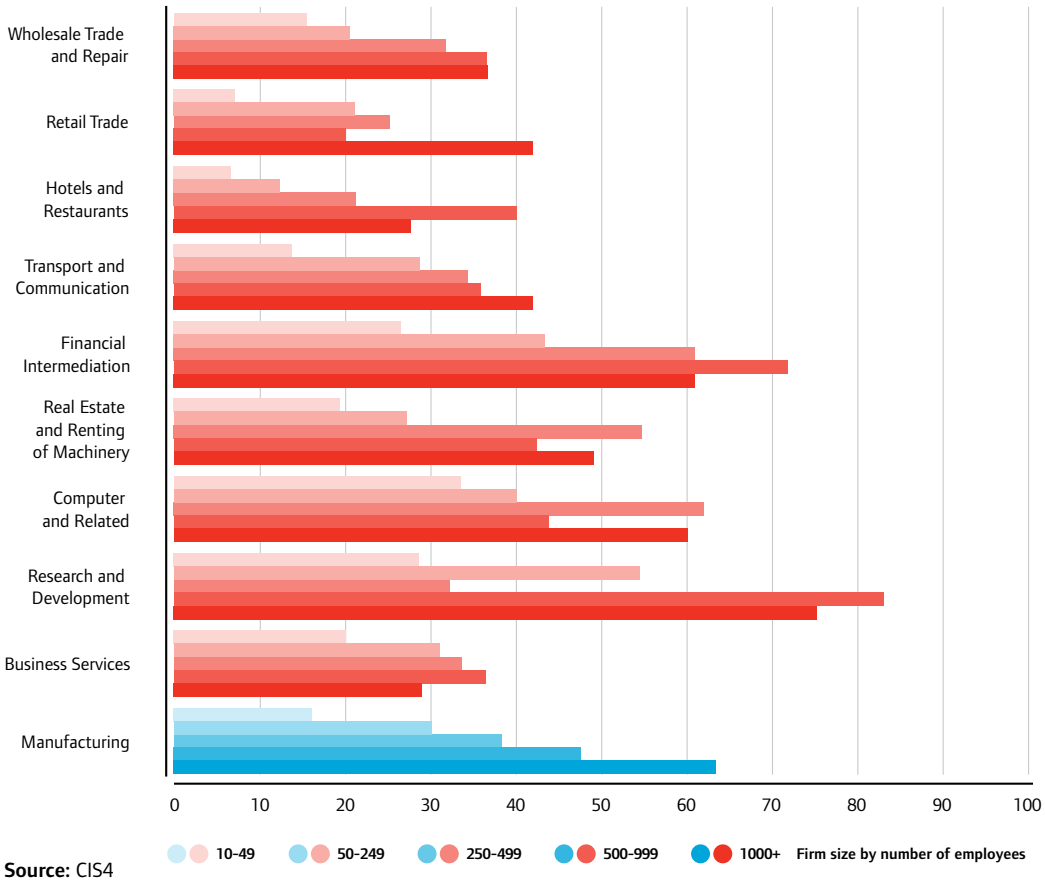


Figure 28: New organisational structure by firm size (percentage of firms)



Source: CIS4

Part 4: Taking services seriously requires innovation policy which explicitly stimulates and supports innovation in services

4.1 Innovation policy could do more to stimulate and support the innovation that matters to services

In its vision of a much broader approach to innovation, the recent DIUS White Paper represents an opportunity for policy to take services seriously. But this will require the development of new mechanisms to stimulate innovation in services. These mechanisms need not be exclusive to services sectors, but they should better reflect the innovation that matters most to services.

4.1.1 Support innovative people, not just firms

Innovation is mobile. It is embodied in talented people, not just new technology. The movement of skilled labour is the main process through which services firms generate positive externalities. The current focus on technology underestimates the role of people in exchanging and circulating knowledge.

But while this movement of labour benefits the economy, firms that invest in their workers' skills may not capture the benefits. Hence, firms tend to under-invest in training and staff development, which undermines this 'warm' form of technology transfer. Small firms face particular barriers in investing sufficient time and resources in training their staff. However, most service companies would benefit more if government incentivised training rather than research and development.

The government's focus has been on improving basic and intermediate skills rather than higher-level skills beyond STEM (science, technology, engineering and mathematics), such as new management techniques. However, such skills would enhance innovative capacity.

The DIUS White Paper explicitly recognises the importance of advanced management skills to innovation,[55] but public support for their development remains relatively limited compared to other initiatives.[56]

4.1.2 Recognise that innovative firms integrate, not just invent, technology

Policy currently emphasises the invention and generation of technology, exemplified by a strong focus on the science research base, technology transfer and regional initiatives to develop and support business clusters centred on university departments.

This is an important part of the innovation process. But the use and integration of technology by services has potentially a much larger impact on the economy than that of technology-producing sectors.

4.1.3 Stimulate innovation in existing sectors, not just emerging sectors and technologies

Robert Solow observed in 1987 that "you can see the computer age everywhere these days, except in the productivity statistics".[57] Not until the mid-1990s did ICT generate a productivity surge in the US, and technology-using services sectors led the way. According to Solow, the three largest contributors to the productivity surge in the US were wholesale trade, retail trade, and security and commodity brokerage.[58]

A similar story can be told with previous major innovations such as the steam engine, the railway, electricity and the internal combustion engine. The conventional, 'low-technology' parts of the economy often generate the biggest impacts on economic growth. Increasingly, these are the service sectors – they innovate not by developing new

55. Paragraph 7.2, Department for Innovation, Universities and Skills (2008) 'Innovation Nation.' London: The Stationery Office.
56. As part of UK Government's Skills Strategy, under the Leadership and Management Programme up to £1,000 was made available to managers in firms employing between 20 and 250 people to further develop their leadership and management skills (now extended to firms employing 10 or more people following the Leitch Review of Skills). However, this still represents a relatively small investment of £30 million per year, compared to around £600 million for the R&D tax credit.
57. Solow R. (1987) We'd Better Watch Out. 'New York Times.' Book Reviews. 12th July.
58. Solow, R. (2001) 'Information Technology and the Recent Productivity Boom in the US.' Paper presented at the Cambridge-MIT Institute Summit, November 2001.

technological products but by exploiting new ideas and integrating them into their business activities.

Similarly, larger established firms contribute more to aggregate growth of output and productivity than the high-technology small firms that are often university spinouts. So, the emphasis in innovation policy on start-ups should be balanced by greater attention to industry dynamics and the relationships between new entry and large firm success.[59]

4.1.4 Widen knowledge exchange between universities and firms to include the arts and social sciences, not just science and engineering

There has been increasing emphasis on the role of universities in the innovation ecosystem, but this has typically been characterised by a narrow focus on technology transfer, with a corresponding concentration on patents, licences and spin-outs.

There are four reasons why this is could usefully be broadened:

- First, it fails to capture the wide range of other interactions between businesses and universities including education, problem-solving, networking, meetings, conferences, entrepreneurship and personnel exchanges.[60]
- Second, it neglects the importance of diversity and local economic structure in shaping the most effective interactions.[61]
- Third, it ignores the important contributions that are and could be made by the social sciences and the humanities.
- Fourth, these are not usually linear technological innovations; rather, they are interactive, reflecting the exchange and co-production of knowledge between entrepreneurs, firms and universities.

The DIUS White Paper recognises the need to broaden knowledge exchange.[62] However, there is currently a lack of detail regarding how this might happen; DIUS is to commission studies into economic impact, looking at good practice from around the world and identifying ways to improve practice in the UK.

4.1.5 Measure innovation in services, not just advanced manufacturing

Conventional metrics – such as R&D expenditure and patents – do not capture the complexity of the innovation process, especially in services. Yet measurement of the services innovation has been grafted onto a framework designed for traditional manufacturing innovation. For example, the Europe-wide Community Innovation Survey (CIS) characterises forms of innovation such as changes in organisational structure and advanced management techniques as 'wider innovation', and neglects to ask firms about their investments in these forms of innovation.

We need better indicators of innovation in services. So the existing 'wider innovation' data, including that used by CIS, needs to be developed and more widely used. We also need better data on the use and impact of ICT.

Furthermore, the complexity and variability of the innovation process means that new and different indicators will be appropriate in different sectors of the economy. Ideally, new metrics should meet four criteria – accuracy, longevity, comparability and ease of collection[63]– though these may make it harder to compare sectors.

Finally, any new metrics need to be used sensitively so that they do not distort policy. In the past, innovation policy may have been subject to Goodhart's Law whereby an economic indicator becomes less reliable once it is made a policy target.[64] For example, subsidising R&D encourages firms to reclassify other related expenditures as R&D; while using spin-outs from universities as an indicator of the successful commercialisation of science encourages an acceleration of spin-out firms without sufficient consideration of their long-term viability and impact.

4.2 Recommendations

4.2.1 An ambitious objective should be established to help drive the realisation of the broader vision presented by the DIUS White Paper

As argued in 'Innovation Nation', the DIUS White Paper: "Harnessing all the different types of innovation across all sectors is essential if we wish to create the conditions in which our economy can prosper."[65]

Increasing innovation in the services sector is crucial to improving the productivity of the economy, which itself will lead to greater prosperity and enhanced quality of life. We should therefore embrace the UK as a successful services-based economy as well

59. Hughes, A. (2008) Innovation Policy as Cargo Cult: Myth and Reality in Knowledge Led Productivity Growth. In: Bessant, J. and Venables, T. (Eds) 'Creating Wealth From Knowledge Meeting the Innovation Challenge.' Cheltenham: Edward Elgar.
60. Cosh, A. D., Lester, R. K. and Hughes, A. (2006) 'UK Plc: Just How Innovative Are We?' Cambridge, UK and Cambridge, MA: Cambridge-MIT Institute.
61. Lester, R. K. (2005) 'Universities, Innovation and the Competitiveness of Local Economies: A Summary Report from the Local Innovation Systems Project – Phase I.' MIT Industrial Performance Center Working Paper 05-010. Cambridge, MA: Industrial Performance Center, Massachusetts Institute of Technology.
62. Paragraph 5.30, Department for Innovation, Universities and Skills (2008) 'Innovation Nation.' London: The Stationery Office.
63. National Endowment for Science, Technology and the Arts (2007) 'Hidden Innovation.' London: NESTA.
64. Named after Charles Goodhart, a leading monetary economist, who originally stated the law to explain the limitations of targeting measures of the money supply to control inflation. It has been argued that Goodhart's Law is an alternative expression of Heisenberg's Uncertainty Principle in quantum mechanics whereby measuring a system usually disturbs it.
65. Department for Innovation, Universities and Skills (2008) 'Innovation Nation.' London: The Stationery Office, p.12.

as a world leader in some areas of advanced manufacturing.

In recognition of this, the UK should aim to be the best business environment for high-value services in the world by 2014. Government already aims to increase the UK's R&D intensity to 2.5 per cent by 2014. To reflect the importance of services to the UK economy, government should aim to create the most stimulating and supportive environment for high-value services by the same date.[66]

Policy can help to stimulate and support innovation in services, but it requires more mechanisms that better reflect the nature of innovation in services.

4.2.2 Assess the impact of introducing a Learning Tax Credit for small firms

We should recognise and celebrate the contribution of people – rather than patents, publications or licensing agreements – to innovation. After all, an environment that stimulates talented people to exchange their knowledge and skills is most likely to realise the innovation potential of the services sectors.

Public support for 'warm' technology transfer could be increased through a new Learning Tax Credit to support investment in education and training by firms.

Such a tax credit could be paid to small firms who invested in upgrading their workers' skills. Eligible training could include transferable skills that enhance the firm's wider innovation capacity, including advanced management training. Initially then, this support might focus on improving higher level skills amongst senior staff, reflecting the importance to innovation of new management practices, corporate strategies and organisational changes.[67]

The potential of such an initiative would of course have to be properly assessed. This assessment should include a systematic review of evidence regarding the drivers and barriers to training and development in small firms, evidence of the impact of similar tax credits in other countries, and consideration of alternative mechanisms alongside a tax credit (such as vouchers or direct provision).

Universities and colleges should also be encouraged to respond to this demand by developing courses that combine business and management breadth with technical expertise. There is a particular need to improve small firms' access to management and executive education courses and expertise. A Learning Tax Credit would help to support access to these courses.

4.2.3 Establish an Innovation Advisory Service to advise services firms on the effective exploitation of technology for innovation

New and better use of ICT is one of the most important drivers of innovation in services,[68] but lack of knowledge about appropriate technology and uncertainty about its impact and cost effectiveness are discouraging such investments. Some regions have already established equivalents to the Manufacturing Advisory Services for a broader range of firms, but there is no UK or English national brand. In the context of the ongoing simplification of services and within the brokerage networks of Business Link in England, Business Gateway and Highlands and Islands Enterprise in Scotland, Business Eye in Wales, and Invest NI in Northern Ireland, an Innovation Advisory Service should be established as a UK-wide brand for regionally-delivered advice. One of its areas of expertise should be acting as a brokerage service for advice and expertise on the effective exploitation of technology for innovation.

4.2.4 Ensure that mini Knowledge Transfer Partnerships for shorter-term projects between universities and firms include disciplines relevant to services firms

Universities should identify how their research and knowledge could benefit services firms over shorter timescales and across a broader range of disciplines and research areas. Policymakers should also ensure that planned mini Knowledge Transfer Partnerships[69] are promoted across this wider range of disciplines, and are accessible to them.

4.2.5 Establish industry-led review groups for five services sectors

Greater attention to conditions in existing sectors could lead to more innovation-friendly policies towards firms in these sectors. Such policies will tend to be sector-specific. The BERR-NESTA Innovation in Services project has demonstrated the value of working closely with firms and trade associations in five services sectors to review performance and produce specific and practical recommendations as to where policy and regulation can be improved. Similar time-limited, sector-specific review groups should be established for five more sectors.

66. A good measure of this would be the proportion of services firms innovating in the UK compared to other leading nations in the CIS and equivalent surveys.
67. Bloom, N. and Van Reenen, J. (2006) Measuring and Explaining Management Practices Across Firms and Countries. Discussion Paper. London: Centre for Economic Performance, London School of Economics and Political Science; Engineers Employers Federation (2001) 'Catching Up with Uncle Sam – The EEF Final Report on US and UK Manufacturing Productivity.' London: Engineers Employers Federation; Porter, M. and Ketels, C. (2003) 'UK Competitiveness: Moving to the Next Stage.' DTI Economics Paper No.3. London: Department of Trade and Industry.
68. As noted in the recent DIUS White Paper, see paragraph 4.25, Department for Innovation, Universities and Skills (2008) 'Innovation Nation.' London: The Stationery Office. However, the White Paper does not propose any new policy mechanisms to support this form of innovation.
69. Knowledge Transfer Partnerships aim to enhance knowledge and skills and stimulate innovation through collaborative projects between business (including social enterprises) and the knowledge base. In 2006, services accounted only for 22 per cent of their 1,000 partnerships. See www.ktponline.org.uk

4.2.6 Measure innovation in services equally to innovation in advanced manufacturing

In surveys such as CIS, forms of 'wider innovation' should be recorded similarly to technology-producing innovation, so that policymakers can more accurately compare the importance of 'traditional' and hidden innovation.

Furthermore, new sector-specific metrics should be developed to capture innovation performance in major UK services sectors, based on projects such as the BERR-NESTA Innovation in Services groups. These could form part of the new Innovation Index to be developed by NESTA with other partners. A pilot Index will be published in 2009 with a fuller system in place by 2010.[70]

70. Paragraph 5.35, Department for Innovation, Universities and Skills (2008) 'Innovation Nation.' London: The Stationery Office.

Appendix 1: Fourth UK Community Innovation Survey

The fourth UK Community Innovation Survey (CIS4) is a UK-wide survey of small, medium and large enterprises, which is stratified to allow for comparability across regions and sectors. The survey, conducted between 2002 and 2004, includes data on more than 16,000 enterprises in England, Wales, Scotland and Northern Ireland. It is the largest survey of its kind ever conducted for the UK, and covers most of the services sector, itself comprising over 70 per cent of the UK economy. Data were collected on the innovative characteristics of UK firms, including measures of innovation-related expenditure, rates of innovation and factors which have either encouraged or hindered innovation. In this research, three sub-samples have been identified based on an analysis of the innovation data in CIS4. These are:

- High-technology: research and development, and computer and related sectors (over 600 observations);
- Medium-technology: financial and business services (about 3,000 observations);
- Low-technology: wholesale and retail trade, hotel and restaurants, real estate and renting of machinery, transport, post and telecommunications (about 6,000 observations).

Appendix 2: Case study firms

Interviews were conducted with firms in the following sectors:

- Computer and related services: three large; four medium.
- Financial intermediation: four large; one medium.
- Financial services: one small.
- Retail: one medium; one small.
- Wholesale: two large; one medium.
- Software publishing: one large.
- Other business activities: one medium.

Size guide:

- Small: 50 employees or fewer.
- Medium: 51–250 employees.
- Large: 251 employees or more.

Appendix 3: Innovation and firm growth

Tables C1 and C2 report the results of an instrumental variables (IV) two-stages least square (2SLS) estimations of firms' labour productivity growth over 2002-2004 as a result of the introduction of successful innovation. The estimations have been carried out on the whole sample (Table 2) and across the sub-samples of high, medium and lower-technology sectors (Table 3).

The econometric model employed consists of a two-stage estimation. The choice of the econometric specification is based on the belief that the probability of introducing innovation depends on a set of (innovation-related) independent variables (the instruments). The first stage estimations produce a set of fitted innovation variables which – together with other independent variables having a direct impact on labour productivity growth – have been used as regressors (instrumented variables) in the second stage estimations, testing the effect of innovation on labour productivity gains.

In the first stage we have included the whole set of regressors related to:

- type of innovation expenditures;
- wider innovation;
- open innovation;
- public support to innovation;
- perception of obstacles to innovation.

The first stage estimation is a linear probability model, run respectively for manufactured product, services product and process innovation.

The second stage estimation is a traditional OLS, which tests the impact on the compound annual labour productivity growth between 2002 and 2004 of a set of independent variables which includes:

- the fitted values of respectively good product, services product and process innovation;
- the level of labour productivity in 2002 (log values);
- the age, size, size square, ownership structure and internationalisation of the firm;
- the fraction of employees with a high degree in science and non-scientific disciplines.

The results of the IV 2SLS estimations carried out on the whole sample are summarised in Table 2. Overall, the model fits well the determinants of labour productivity growth. The estimated values of the probability to introduce product, services and process innovation all affect positively and significantly labour productivity growth. The introduction of manufactured product innovation shows a higher impact on labour productivity growth, compared to process innovation and services innovation.

Consistently with the convergence literature, the level of labour productivity in the beginning of the period is negatively related to the compound annual growth over 2002 and 2004. The age of the firm also negatively affects the productivity performance.

Also in line with previous empirical evidence and the findings illustrated in the previous sections, firms belonging to a group and

serving international markets are significantly more likely to have productivity increases over the period considered.

The results of the estimation carried out on the three different sub-samples of high, medium and low-technology sectors, and reported in Table 3, provide further interesting evidence on how the effect of innovation on labour productivity growth is shaped across sectors and by type of innovation introduced.

Interestingly, Table 3 shows that the introduction of product innovation has a u-shaped effect on the compound labour productivity growth, as the coefficient turns out to be positive and significant for the group of high and low-technology sectors. Perhaps surprisingly, the introduction of services innovation emerges as having a positive impact on labour productivity especially for the low-technology sectors, as if they were involved in the first stage of a catching-up process. The coefficients for high and medium-technology sectors are not significantly associated to economic performance.

The effect of process innovation on labour productivity growth is higher than the other two types of innovation for the sub-sample of low-technology sectors only. This is not surprising, as process innovation is mainly aimed to rationalise production processes and improve efficiency. It can be conjectured that the gains in labour productivity might be due to the decreasing numerator (number of employees) of the ratio of turnover per employee rather than to increases in the turnover. That the result only holds for the sub-sample of low-technology sectors might be related to the characteristics of the three sub-samples – the high-technology sectors are less likely to introduce process innovation, which explains the statistical insignificance of the coefficients.

The effect of the age of firms is not significant, which suggests that such a link involves mainly manufacturing firms. When tested within the sample of services only – across the three sub-samples with different innovation intensity – the coefficients of the (negative) link between age and productivity growth lose significance. The role of international competition on innovation and economic performance is confirmed to be positive, especially for medium and low-technology sectors. Overall, we find that the introduction of innovation, especially good product innovation, exerts a positive impact on the economic performance of firms. This result holds for the whole economy and especially for low-technology services sectors.

Table 2: Effects of Innovation on Labour Productivity Growth 2002-2004, whole sample Instrumental variables (2SLS) regression

Dependent variable: Compound annual labour productivity growth (2002-04)			
Product Innovation (Goods)	0.093***		
	[0.016]		
Product Innovation (Services)		0.038*	
		[0.020]	
Process Innovation			0.054***
			[0.018]
Turnover per employee in 2002	-0.100***	-0.099***	-0.099***
	[0.002]	[0.002]	[0.002]
Age	-0.016*	-0.015	-0.016*
	[0.009]	[0.009]	[0.009]
Size (employees)	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]
Size squared (employees)	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]
Ownership Structure	0.042***	0.046***	0.044***
	[0.007]	[0.007]	[0.007]
Exporter	0.034***	0.054***	0.049***
	[0.008]	[0.006]	[0.007]
Fraction Employees with Science Degree	-0.002	0.008	0.004
	[0.020]	[0.021]	[0.020]
Fraction Employees with Other Degree	0.018	0.004	0.008
	[0.018]	[0.018]	[0.018]
Constant	0.418***	0.418***	0.417***
	[0.013]	[0.013]	[0.013]
Observations	11467	11473	11487
R-squared	0.13	0.13	0.13

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Instrumented: Product (good, service) and process innovation
Instruments: Innovation investments (internal and external R&D, capital and ICT, training, design and marketing); Wider innovation (corporate strategy, management techniques, organisational structures, marketing strategies); Collaborations (suppliers, clients, HEI, consultants competitors, others); Public support (local and regional, national, EU, tax credit); Obstacles to innovation (finance, knowledge, market and others); All sectoral dummies are included; First stage estimation not reported

Table 3: Effects of Innovation on labour productivity growth 2002-2004
Instrumental variables (2SLS) regression

Dependent variable: Compound annual labour productivity growth (2002-04)	High	Medium	Low	High	Medium	Low	High	Medium	Low
Product Innovation (Goods)	0.156**	0.072	0.209***						
	[0.078]	[0.066]	[0.055]						
Product Innovation (Services)	0.06	-0.001	0.087**						
				[0.074]	[0.035]	[0.039]			
Process Innovation							0.019	0.011	0.106***
							[0.098]	[0.040]	[0.040]
Turnover per employee in 2002	-0.148***	-0.062***	-0.121***	-0.149***	-0.061***	-0.117***	-0.148***	-0.063***	-0.118***
	[0.013]	[0.005]	[0.004]	[0.013]	[0.005]	[0.004]	[0.014]	[0.005]	[0.004]
Age	-0.011	-0.012	0.001	-0.026	-0.013	-0.004	-0.023	-0.012	-0.009
	[0.046]	[0.020]	[0.017]	[0.045]	[0.020]	[0.016]	[0.045]	[0.020]	[0.016]
Size (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Size Squared (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ownership Structure	0.043	0.022	0.056***	0.04	0.024	0.061***	0.039	0.027*	0.057***
	[0.035]	[0.015]	[0.012]	[0.035]	[0.016]	[0.012]	[0.035]	[0.015]	[0.012]
Exporter	0.039	0.046***	0.055***	0.054	0.050***	0.067***	0.056	0.051***	0.066***
	[0.038]	[0.017]	[0.014]	[0.037]	[0.017]	[0.013]	[0.038]	[0.017]	[0.013]
Fraction Employees with Science Degree	-0.090	0.012	-0.099	-0.062	0.024	-0.082	-0.065	0.019	-0.089
	[0.057]	[0.037]	[0.065]	[0.055]	[0.037]	[0.065]	[0.057]	[0.037]	[0.064]
Fraction Employees with Other Degree	0.027	0.072**	-0.042	0.039	0.069**	-0.028	0.047	0.067**	-0.02
	[0.070]	[0.030]	[0.039]	[0.070]	[0.029]	[0.039]	[0.070]	[0.029]	[0.038]
Constant	0.598***	0.254***	0.479***	0.630***	0.256***	0.475***	0.640***	0.258***	0.482***
	[0.072]	[0.025]	[0.022]	[0.071]	[0.026]	[0.023]	[0.086]	[0.026]	[0.022]
Observations	561	2358	4236	561	2363	4238	561	2371	4243
R-squared	0.19	0.07	0.15	0.20	0.07	0.16	0.20	0.07	0.16

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Instrumented: Product (good, service) and process innovation
Instruments: Innovation investments (internal and external R&D, capital and ICT, training, design and marketing); Wider innovation (corporate strategy, management techniques, organisational structures, marketing strategies); Collaborations (suppliers, clients, HEI, consultants competitors, others); Public support (local and regional, national, EU, tax credit); Obstacles to innovation (finance, knowledge, market and others); All sectoral dummies are included; First stage estimation not reported

Appendix 4: Drivers of innovation: evidence from CIS4

Probit analysis was used to analyse the main drivers of innovation in the CIS4 data. The dependent variable is the probability of introducing an innovation and the independent variables are various possible drivers of innovation which have been chosen based on the determinants identified in the innovation literature.

Table 4: Probability of introducing a good, service product and process innovation
Probit estimation, marginal effects, CIS4 , whole sample

Dependent variable: introduction of product good, service, process innovation	Innovation	Product (Goods)	Product (Services)	Process
Firms' Characteristics				
Age	-0.002	0.004	-0.019*	0.001
	[0.015]	[0.011]	[0.011]	[0.012]
Size (employees)	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]
Size Squared (employees)	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]
Ownership Structure	0.037***	0.021***	-0.003	0.022**
	[0.011]	[0.008]	[0.008]	[0.009]
Exporter	0.097***	0.095***	0.004	0.031***
	[0.012]	[0.009]	[0.009]	[0.009]
Human Capital				
Fraction Employees with Science Degree	0.143***	0.058**	0.090***	0.032
	[0.039]	[0.027]	[0.024]	[0.028]

Dependent variable: introduction of product good, service, process innovation	Innovation	Product (Goods)	Product (Services)	Process
Fraction Employees with Other Degree	0.068**	0.019	0.071***	0.007
	[0.030]	[0.023]	[0.020]	[0.023]
Innovation investments				
Internal R&D Expenditure p.e.	0.009***	0.004***	-0.001	0.001
	[0.002]	[0.001]	[0.001]	[0.001]
Acquisition of External R&D p.e.	-0.001	-0.001	-0.002	0.002
	[0.002]	[0.001]	[0.001]	[0.001]
Equipment and ICT Expenditure p.e.	0.001**	0.000	0.000	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]
Training Expenditure p.e.	0.001	0.001	0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.001]
Design Expenditure p.e.	0.000	0.004***	0.001	-0.002
	[0.002]	[0.001]	[0.001]	[0.002]
Market Expenditure p.e.	0.001*	0.001***	0.001**	0.001
	[0.001]	[0.000]	[0.000]	[0.000]
Wider innovation				
New Corporate Strategy	0.073***	0.034***	0.067***	0.047***
	[0.015]	[0.011]	[0.011]	[0.012]
New Management Techniques	0.057***	-0.005	0.031***	0.081***
	[0.015]	[0.010]	[0.010]	[0.012]
New Organisational Structure	0.057***	0.037***	0.034***	0.042***
	[0.014]	[0.011]	[0.010]	[0.011]
New Marketing Strategies	0.197***	0.125***	0.102***	0.114***
	[0.013]	[0.011]	[0.010]	[0.011]
Open innovation				
Collaborations: Suppliers	0.234***	0.094***	0.092***	0.169***
	[0.027]	[0.021]	[0.021]	[0.023]
Collaborations: Customers	0.097***	0.080***	0.046**	0.039*
	[0.029]	[0.021]	[0.019]	[0.021]
Collaborations: Higher Education	-0.006	0.030	-0.036**	0.026
	[0.034]	[0.021]	[0.017]	[0.022]
Collaborations: Consultants	-0.059*	-0.011	-0.023	-0.034*
	[0.030]	[0.018]	[0.017]	[0.018]

Dependent variable: introduction of product good, service, process innovation	Innovation	Product (Goods)	Product (Services)	Process
Collaborations: Similar Firms	0.085***	0.044**	0.034*	0.055***
	[0.028]	[0.019]	[0.018]	[0.020]
Collaborations: Others	-0.018	-0.050***	0.059***	-0.052***
	[0.035]	[0.017]	[0.023]	[0.019]
Public support				
Local and Regional Public Support	0.085***	0.024	0.040**	0.031*
	[0.024]	[0.016]	[0.016]	[0.017]
Central Government Public Support	0.184***	0.089***	0.044**	0.149***
	[0.031]	[0.024]	[0.022]	[0.027]
EU Public Support	-0.012	-0.028	0.046	-0.011
	[0.047]	[0.025]	[0.030]	[0.029]
Claimed Tax Credit	0.079*	0.149***	-0.042**	-0.029
	[0.043]	[0.034]	[0.021]	[0.024]
Obstacles				
Obstacles: Finance	0.138***	0.063***	0.085***	0.076***
	[0.012]	[0.009]	[0.009]	[0.010]
Obstacles: Knowledge	0.062***	0.029***	0.033***	0.030***
	[0.012]	[0.009]	[0.009]	[0.009]
Obstacles: Market	0.023*	0.023***	0.010	-0.007
	[0.012]	[0.009]	[0.009]	[0.009]
Obstacles: Other	-0.021*	-0.004	0.007	-0.005
	[0.012]	[0.009]	[0.009]	[0.009]
Sectoral dummy				
Manufacturing	Reference	Reference	Reference	Reference
Trade and Repair of Motorvehicles	-0.055*	-0.083***	0.070**	-0.099***
	[0.033]	[0.017]	[0.031]	[0.021]
Wholesale Trade	0.009	-0.041***	0.074***	-0.031*
	[0.023]	[0.013]	[0.021]	[0.017]
Retail Trade	-0.159***	-0.124***	0.011	-0.100***
	[0.017]	[0.008]	[0.016]	[0.012]
Hotels and Restaurants	-0.203***	-0.119***	0.029	-0.127***
	[0.020]	[0.010]	[0.020]	[0.013]
Land Transport	-0.157***	-0.174***	0.108***	-0.106***
	[0.024]	[0.006]	[0.025]	[0.016]

Dependent variable: introduction of product good, service, process innovation	Innovation	Product (Goods)	Product (Services)	Process
Water Transport	-0.125	-0.139***	0.159	-0.036
	[0.109]	[0.032]	[0.121]	[0.088]
Transport and Travel Auxiliary	0.046	-0.165***	0.395***	-0.119*
	[0.114]	[0.012]	[0.108]	[0.063]
Post and Telecommunication	-0.117***	-0.173***	0.161***	-0.032
	[0.031]	[0.005]	[0.032]	[0.024]
Financial Intermediation	-0.025	-0.136***	0.252***	-0.062***
	[0.034]	[0.010]	[0.034]	[0.023]
Insurance	0.077	-0.136***	0.348***	0.057
	[0.048]	[0.012]	[0.046]	[0.040]
Other Financial Services	-0.006	-0.085***	0.202***	0.019
	[0.069]	[0.029]	[0.066]	[0.054]
Real Estate	-0.046	-0.160***	0.156***	-0.006
	[0.030]	[0.007]	[0.029]	[0.023]
Renting of Machinery and Equipment	-0.117***	-0.170***	0.118***	-0.085***
	[0.031]	[0.006]	[0.031]	[0.021]
Computer and Related Activities	-0.092***	-0.086***	0.139***	-0.079***
	[0.034]	[0.017]	[0.035]	[0.024]
Research and Development	0.099***	-0.065***	0.250***	-0.014
	[0.033]	[0.015]	[0.029]	[0.021]
Other Business Services	0.089*	-0.156***	0.166***	0.135***
	[0.051]	[0.007]	[0.039]	[0.039]
Air Transport	-0.031**	-0.188***	0.142***	0.005
	[0.016]	[0.006]	[0.015]	[0.012]
Observations	12025	12004	12011	12025
Log Likelihood	-6306.05	-4770.77	-5178.03	-5581.06

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Probability of introducing a good, service product and process innovation Probit estimation, marginal effects, CIS4, subsamples of high-, medium- and low-technology service firms

Dependent variable: introduction of product good, service, process innovation	Product or process innovation			Good product innovation			Service product innovation			Process innovation		
	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Firms' characteristics												
Age	0.016	-0.027	-0.002	-0.053	0.023**	-0.01	-0.01	-0.060**	-0.028*	-0.087	-0.019	0.021
	[0.018]	[0.029]	[0.020]	[0.062]	[0.011]	[0.013]	[0.061]	[0.027]	[0.016]	[0.058]	[0.025]	[0.013]
Size (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Size squared (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ownership Structure	-0.014	0.019	0.057***	-0.065	0.020*	0.021**	-0.055	0.063***	0.005	-0.107**	-0.004	0.033***
	[0.013]	[0.024]	[0.016]	[0.049]	[0.011]	[0.010]	[0.049]	[0.021]	[0.012]	[0.048]	[0.021]	[0.011]
Exporter	0.019	0.038	0.102***	0.089*	0.046***	0.055***	0.053	0.011	0.037***	0.066	0.003	0.029**
	[0.016]	[0.027]	[0.019]	[0.050]	[0.014]	[0.013]	[0.051]	[0.023]	[0.014]	[0.049]	[0.023]	[0.013]
Human Capital												
Fraction Employees with Science Degree	0.021	0.113*	0.313***	-0.013	0.008	0.062	-0.002	0.091*	0.214***	0.049	0.073	0.206***
	[0.020]	[0.060]	[0.084]	[0.082]	[0.024]	[0.049]	[0.083]	[0.050]	[0.060]	[0.080]	[0.049]	[0.051]
Fraction Employees with Other Degree	0.000	0.031	0.117**	0.140	-0.061***	0.061**	0.075	0.059	0.072**	-0.131	0.032	0.000
	[0.018]	[0.047]	[0.048]	[0.097]	[0.022]	[0.028]	[0.098]	[0.040]	[0.035]	[0.096]	[0.040]	[0.033]
Innovation expenditures												
Internal R&D Expenditure p.e.	0.000	0.049***	0.007**	0.003*	0.002	0.002	-0.005**	0.002	0.004	0.003*	-0.001	-0.002
	[0.001]	[0.013]	[0.004]	[0.002]	[0.001]	[0.002]	[0.002]	[0.003]	[0.003]	[0.002]	[0.004]	[0.003]
Acquisition of External R&D p.e.	-0.001	0.007	0.001	-0.002	-0.001	0.004	-0.005	-0.001	-0.001	-0.002	0.020***	0.001
	[0.001]	[0.007]	[0.004]	[0.003]	[0.001]	[0.002]	[0.005]	[0.002]	[0.003]	[0.003]	[0.007]	[0.003]
Equipment and ICT Expenditure p.e.	0.014*	0.002	0.001	-0.001	0.000	0.000	0.019*	-0.001	0.000	0.000	0.006***	0.001
	[0.008]	[0.002]	[0.000]	[0.005]	[0.000]	[0.000]	[0.009]	[0.001]	[0.000]	[0.001]	[0.002]	[0.000]
Training Expenditure p.e.	0.016	-0.002	-0.001	-0.004	-0.001	0.000	0.013	-0.001	0.001	0.011	-0.008**	-0.002
	[0.016]	[0.004]	[0.002]	[0.018]	[0.004]	[0.001]	[0.021]	[0.004]	[0.001]	[0.018]	[0.004]	[0.003
Design Expenditure p.e.	0.059***	0.081*	-0.004	0.028**	0.039***	-0.002	-0.004	0.021	-0.001	-0.003	-0.012	-0.001
	[0.019]	[0.043]	[0.003]	[0.013]	[0.010]	[0.002]	[0.006]	[0.014]	[0.002]	[0.005]	[0.016]	[0.002]
Market Expenditure p.e.	0.001	0.001	0.001*	0.039***	-0.001	0.001***	0.000	0.004	0.000	0.012	0.003	0.000
	[0.003]	[0.003]	[0.001]	[0.012]	[0.001]	[0.000]	[0.011]	[0.004]	[0.000]	[0.010]	[0.003]	[0.000]

Dependent variable: introduction of product good, service, process innovation	Product or process innovation			Good product innovation			Service product innovation			Process innovation		
	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Wider innovation												
New Corporate Strategy	0.004	0.029	0.123***	-0.006	0.016	0.056***	0.148***	0.060**	0.069***	0.026	0.015	0.061***
	[0.011]	[0.031]	[0.025]	[0.056]	[0.014]	[0.016]	[0.055]	[0.027]	[0.019]	[0.056]	[0.026]	[0.017]
New Management Techniques	0.014	0.045	0.089***	-0.069	0.005	0.004	0.078	0.061**	0.021	0.146***	0.073***	0.072***
	[0.013]	[0.030]	[0.023]	[0.056]	[0.012]	[0.013]	[0.057]	[0.026]	[0.017]	[0.055]	[0.026]	[0.017]
New Organisational Structure	0.029	0.106***	-0.047**	0.096*	0.016	-0.018	0.101*	0.074***	0.013	0.075	0.078***	0.001
	[0.021]	[0.029]	[0.022]	[0.056]	[0.013]	[0.013]	[0.056]	[0.025]	[0.017]	[0.055]	[0.025]	[0.014]
New Marketing Strategies	0.029	0.159***	0.205***	0.194***	0.052***	0.107***	0.118**	0.126***	0.107***	0.023	0.104***	0.110***
	[0.021]	[0.029]	[0.022]	[0.052]	[0.015]	[0.016]	[0.053]	[0.026]	[0.018]	[0.053]	[0.026]	[0.017]
Open innovation												
Collaborations: Suppliers	0.011	0.224***	0.269***	0.123	0.017	0.081**	-0.153*	0.125**	0.143***	0.071	0.250***	0.138***
	[0.017]	[0.063]	[0.048]	[0.078]	[0.025]	[0.033]	[0.080]	[0.057]	[0.040]	[0.078]	[0.058]	[0.037]
Collaborations: Customers	0.031	0.045	-0.017	0.091	0.029	0.009	0.326***	0.022	0.002	0.144*	-0.012	-0.019
	[0.023]	[0.069]	[0.044]	[0.080]	[0.027]	[0.026]	[0.074]	[0.053]	[0.032]	[0.078]	[0.050]	[0.024]
Collaborations: Higher Education	-0.015	0.096	-0.111**	-0.069	0.038	-0.001	-0.090	0.070	-0.091***	0.100	0.043	-0.015
	[0.030]	[0.078]	[0.047]	[0.088]	[0.032]	[0.031]	[0.094]	[0.063]	[0.023]	[0.090]	[0.059]	[0.031]
Collaborations: Consultants	-0.053	-0.148**	0.026	-0.068	0.006	0.004	0.043	-0.04	0.007	0.035	-0.075*	-0.024
	[0.049]	[0.063]	[0.049]	[0.086]	[0.023]	[0.026]	[0.093]	[0.047]	[0.032]	[0.089]	[0.043]	[0.024]
Collaborations: Similar Firms	0.005	0.201***	0.054	0.074	0.021	0.032	0.075	0.143***	0.017	-0.054	0.096*	0.068**
	[0.016]	[0.059]	[0.046]	[0.071]	[0.024]	[0.028]	[0.074]	[0.053]	[0.032]	[0.071]	[0.051]	[0.033]
Collaborations: Others	0.022	-0.128*	0.071	-0.010	-0.033**	-0.047**	-0.001	-0.051	0.181***	-0.071	-0.080*	-0.018
	[0.019]	[0.071]	[0.061]	[0.094]	[0.015]	[0.020]	[0.100]	[0.052]	[0.055]	[0.092]	[0.047]	[0.028]
Public support												
Local and Regional Public Support	0.024	0.049	0.113**	0.073	0.030	-0.018	-0.066	0.085	0.059*	-0.031	0.005	0.012
	[0.018]	[0.063]	[0.045]	[0.078]	[0.027]	[0.022]	[0.077]	[0.055]	[0.035]	[0.075]	[0.048]	[0.027]
Central Government Public Support	0.003	0.240***	0.154**	-0.102	0.064	-0.026	0.083	0.156**	0.076	0.093	0.230***	0.153***
	[0.025]	[0.078]	[0.063]	[0.114]	[0.043]	[0.029]	[0.117]	[0.077]	[0.049]	[0.111]	[0.076]	[0.052]
EU Public Support	0.005	0.033	-0.076	-0.058	-0.012	-0.049	0.179*	0.134	0.061	0.000	-0.028	-0.019
	[0.024]	[0.126]	[0.068]	[0.103]	[0.030]	[0.031]	[0.106]	[0.112]	[0.069]	[0.105]	[0.082]	[0.045]
Claimed Tax Credit	0.014	-0.142	0.034	0.300***	0.041	0.248***	-0.113	-0.073	-0.067*	0.007	-0.130**	-0.046
	[0.022]	[0.112]	[0.083]	[0.113]	[0.050]	[0.091]	[0.117]	[0.076]	[0.038]	[0.112]	[0.059]	[0.033]

Dependent variable: introduction of product good, service, process innovation	Product or process innovation			Good product innovation			Service product innovation			Process innovation		
	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Obstacles												
Obstacles: Finance	0.017	0.149***	0.134***	0.023	0.043***	0.041***	0.117**	0.090***	0.099***	-0.010	0.102***	0.071***
	[0.017]	[0.026]	[0.018]	[0.056]	[0.012]	[0.012]	[0.056]	[0.023]	[0.014]	[0.056]	[0.023]	[0.013]
Obstacles: Knowledge	0.005	0.071***	0.052***	0.083*	0.004	0.028**	0.043	0.059***	0.035**	-0.031	0.018	0.038***
	[0.010]	[0.026]	[0.019]	[0.049]	[0.011]	[0.012]	[0.049]	[0.023]	[0.014]	[0.048]	[0.022]	[0.013]
Obstacles: Market	0.000	0.064**	0.000	0.066	0.023*	0.008	-0.012	0.099***	-0.016	0.067	0.019	-0.022*
	[0.011]	[0.027]	[0.018]	[0.053]	[0.012]	[0.012]	[0.053]	[0.024]	[0.013]	[0.052]	[0.023]	[0.012]
Obstacles: Other	-0.016	-0.057**	-0.014	-0.077	0.000	-0.008	-0.002	-0.024	0.012	0.016	-0.055***	-0.007
	[0.017]	[0.026]	[0.018]	[0.054]	[0.011]	[0.011]	[0.057]	[0.022]	[0.014]	[0.055]	[0.021]	[0.012]
Observations	584	2504	4469	583	2491	4462	584	2496	4464	584	2504	4469
Log Likelihood	-227.3	-1385.83	-2224.13	-322.05	-644.42	-1488.11	-333.24	-1213.11	-1816.13	-353.89	-1275.81	-1609.91

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Probability of introducing a good, service product and process innovation, whole sample Multivariate Probit estimation

Dependent variable: introduction of product good, service, process innovation	Product (Goods)	Product (Services)	Process
Age	0.015	-0.066*	0.009
	[0.043]	[0.039]	[0.039]
Size (employees)	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]
Size Squared (employees)	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]
Ownership Structure	0.089***	0.003	0.077***
	[0.031]	[0.031]	[0.029]
Exporter	0.358***	0.022	0.111***
	[0.032]	[0.033]	[0.031]

Dependent variable: introduction of product good, service, process innovation	Product (Goods)	Product (Services)	Process
Human Capital			
Fraction Employees with Science Degree	0.212**	0.333***	0.101
	[0.105]	[0.093]	[0.094]
Fraction Employees with Other Degree	0.101	0.266***	0.027
	[0.090]	[0.078]	[0.079]
Innovation expenditure			
Internal R&D Expenditure p.e.	0.017***	-0.003	0.004
	[0.003]	[0.003]	[0.003]
Acquisition of External R&D p.e.	-0.004	-0.007	0.005
	[0.005]	[0.005]	[0.004]
Equipment and ICT Expenditure p.e.	-0.001	0.001	0.002***
	[0.001]	[0.001]	[0.001]
Training Expenditure p.e.	0.004	0.002	0.000
	[0.003]	[0.003]	[0.003]
Design Expenditure p.e.	0.015***	0.003	-0.007
	[0.005]	[0.006]	[0.006]
Market Expenditure p.e.	0.004***	0.003**	0.002
	[0.001]	[0.001]	[0.001]
Wider Innovation			
New Corporate Strategy	0.125***	0.237***	0.149***
	[0.040]	[0.038]	[0.037]
New Management Techniques	-0.013	0.121***	0.261***
	[0.040]	[0.037]	[0.036]
New Organisational Structure	0.133***	0.129***	0.142***
	[0.039]	[0.037]	[0.036]
New Marketing Strategies	0.449***	0.371***	0.369***
	[0.036]	[0.034]	[0.033]
Open innovation			
Collaborations: Suppliers	0.349***	0.316***	0.511***
	[0.067]	[0.064]	[0.063]
Collaborations: Customers	0.273***	0.187***	0.128**
	[0.068]	[0.066]	[0.065]
Collaborations: Higher Education	0.093	-0.159**	0.078
	[0.076]	[0.072]	[0.071]

Dependent variable: introduction of product good, service, process innovation	Product (Goods)	Product (Services)	Process
Collaborations: Consultants	-0.051	-0.076	-0.104
	[0.071]	[0.068]	[0.067]
Collaborations: Similar Firms	0.164**	0.117*	0.176***
	[0.064]	[0.061]	[0.060]
Collaborations: Others	-0.202**	0.201***	-0.211***
	[0.080]	[0.074]	[0.074]
Public support			
Local and Regional Public Support	0.101*	0.154***	0.106*
	[0.057]	[0.055]	[0.054]
Central Government Public Support	0.315***	0.172**	0.437***
	[0.076]	[0.074]	[0.072]
EU Public Support	-0.105	0.151	-0.033
	[0.106]	[0.100]	[0.100]
Claimed Tax Credit	0.453***	-0.168*	-0.098
	[0.095]	[0.091]	[0.088]
Obstacles			
Obstacles: Finance	0.256***	0.335***	0.267***
	[0.036]	[0.035]	[0.033]
Obstacles: Knowledge	0.112***	0.128***	0.106***
	[0.033]	[0.032]	[0.031]
Obstacles: Market	0.095***	0.043	-0.023
	[0.034]	[0.033]	[0.032]
Obstacles: Other	-0.01	0.032	-0.015
	[0.034]	[0.032]	[0.032]
Sectoral dummy			
Manufacturing	Reference	Reference	Reference
Trade and Repair of Motorvehicles	-0.375***	0.267***	-0.355***
	[0.098]	[0.099]	[0.103]
Wholesale Trade	-0.171***	0.256***	-0.111*
	[0.060]	[0.066]	[0.062]
Retail Trade	-0.626***	0.053	-0.389***
	[0.058]	[0.059]	[0.057]

Dependent variable: introduction of product good, service, process innovation	Product (Goods)	Product (Services)	Process
Hotels and Restaurants	-0.641***	0.108	-0.543***
	[0.073]	[0.070]	[0.074]
Land Transport	-1.318***	0.382***	-0.416***
	[0.119]	[0.074]	[0.082]
Water Transport	-0.914**	0.502	-0.148
	[0.448]	[0.329]	[0.339]
Air Transport	-1.342***	1.085***	-0.542
	[0.485]	[0.269]	[0.353]
Transport and Travel Auxiliary	-1.473***	0.524***	-0.118
	[0.140]	[0.088]	[0.091]
Post and Telecommunication	-0.854***	0.760***	-0.255***
	[0.108]	[0.087]	[0.095]
Financial Intermediation	-0.842***	1.015***	0.185
	[0.141]	[0.116]	[0.120]
Insurance	-0.441**	0.642***	0.055
	[0.186]	[0.175]	[0.177]
Other Financial Services	-1.135***	0.514***	-0.008
	[0.110]	[0.080]	[0.081]
Real Estate	-1.347***	0.401***	-0.328***
	[0.143]	[0.089]	[0.094]
Renting of Machinery and Equipment	-0.427***	0.450***	-0.315***
	[0.107]	[0.100]	[0.108]
Computer and Related Activities	-0.284***	0.770***	-0.023
	[0.078]	[0.075]	[0.075]
Research and Development	-1.075***	0.516***	0.407***
	[0.123]	[0.106]	[0.105]
Other Business Services	-1.089***	0.488***	0.036
	[0.053]	[0.044]	[0.042]
Constant	-1.207***	-1.734***	-1.306***
	[0.053]	[0.053]	[0.050]
Observations	11997	11997	11997
Log Likelihood	-14981.03	-14981.03	-14981.03

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Probability of introducing a good, service product and process innovation Multivariate Probit estimation, CIS4, subsamples of high-, medium- and low-technology service firms

Dependent variable: introduction of product good, service, process innovation	High-technology			Medium-technology			Low-technology		
	Good	Service	Process	Good	Service	Process	Good	Service	Process
Firms' characteristics									
Age	-0.153	-0.015	-0.229	0.192*	-0.183**	-0.066	0.111	-0.048	-0.113*
	[0.158]	[0.152]	[0.147]	[0.112]	[0.077]	[0.076]	[0.071]	[0.064]	[0.070]
Size (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Size Squared (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ownership Structure	-0.153	-0.137	-0.280**	0.199***	0.143*	-0.02	0.130**	0.174***	0.044
	[0.126]	[0.122]	[0.122]	[0.063]	[0.063]	[0.084]	[0.053]	[0.055]	[0.051]
Exporter	0.232*	0.127	0.173	0.027	0.324***	0.011	0.143**	0.284***	0.154***
	[0.130]	[0.128]	[0.125]	[0.069]	[0.070]	[0.088]	[0.058]	[0.057]	[0.055]
Human capital									
Fraction Employees with Science Degree	-0.032	0.014	0.113	0.246	0.030	0.246	0.262	1.025***	0.869***
	[0.210]	[0.206]	[0.202]	[0.151]	[0.191]	[0.152]	[0.252]	[0.250]	[0.275]
Fraction Employees with Other Degree	0.357	0.224	-0.280	0.086	0.167	-0.427**	0.300**	-0.001	0.366**
	[0.249]	[0.246]	[0.246]	[0.123]	[0.121]	[0.176]	[0.161]	[0.156]	[0.146]
Innovation expenditures									
Internal R&D Expenditure p.e.	0.009*	-0.012**	0.007*	0.016*	0.007	-0.004	0.015	0.014	-0.015
	[0.005]	[0.005]	[0.004]	[0.011]	[0.009]	[0.009]	[0.010]	[0.016]	[0.010]
Acquisition of External R&D p.e.	-0.006	-0.012	-0.006	0.056***	-0.007	-0.002	0.002	0.008	0.022*
	[0.009]	[0.011]	[0.007]	[0.007]	[0.014]	[0.020]	[0.013]	[0.015]	[0.013]
Equipment and ICT Expenditure p.e.	-0.005	0.048**	0.000	0.017***	0.000	-0.003	0.001	0.002	0.003
	[0.015]	[0.023]	[0.003]	[0.002]	[0.007]	[0.003]	[0.001]	[0.002]	[0.001]
Training Expenditure p.e.	-0.009	0.025	0.040	-0.023**	-0.003	-0.007	0.002	0.002	-0.011
	[0.046]	[0.055]	[0.048]	[0.034]	[0.011]	[0.010]	[0.007]	[0.015]	[0.006]
Design Expenditure p.e.	0.063**	-0.008	-0.007	-0.033	0.279***	0.061	-0.013	-0.006	-0.006
	[0.032]	[0.014]	[0.013]	[0.041]	[0.051]	[0.074]	[0.008]	[0.009]	[0.011]
Market Expenditure p.e.	0.097***	0.001	0.031	0.013	-0.005	0.012	0.002	0.002	0.005***
	[0.031]	[0.027]	[0.025]	[0.013]	[0.011]	[0.006]	[0.002]	[0.002]	[0.002]
Wider innovation									
New Corporate Strategy	-0.026	0.363***	0.066	0.042	0.130	0.191**	0.271***	0.275***	0.286***
	[0.143]	[0.140]	[0.141]	[0.101]	[0.079]	[0.078]	[0.073]	[0.069]	[0.068]

Dependent variable: introduction of product good, service, process innovation	High-technology			Medium-technology			Low-technology		
	Good	Service	Process	Good	Service	Process	Good	Service	Process
New Management Techniques	-0.177	0.193	0.360**	0.207***	0.176**	0.051	0.332***	0.099	0.042
	[0.146]	[0.144]	[0.140]	[0.096]	[0.075]	[0.074]	[0.066]	[0.066]	[0.071]
New Organisational Structure	0.252*	0.273*	0.191	0.213***	0.122	0.239***	0.036	-0.106	-0.012
	[0.142]	[0.140]	[0.139]	[0.074]	[0.074]	[0.097]	[0.075]	[0.068]	[0.070]
New Marketing Strategies	0.503***	0.302**	0.067	0.315***	0.345***	0.370***	0.487***	0.404***	0.467***
	[0.137]	[0.135]	[0.134]	[0.094]	[0.073]	[0.073]	[0.065]	[0.062]	[0.061]
Open innovation									
Collaborations: Suppliers	0.309	-0.413**	0.198	0.702***	0.125	0.378**	0.396***	0.538***	0.503***
	[0.197]	[0.209]	[0.197]	[0.152]	[0.150]	[0.173]	[0.119]	[0.120]	[0.127]
Collaborations: Customers	0.216	0.877***	0.327	-0.047	0.202	0.081	-0.085	0.030	0.050
	[0.203]	[0.214]	[0.200]	[0.157]	[0.170]	[0.155]	[0.136]	[0.129]	[0.128]
Collaborations: Higher Education	-0.170	-0.262	0.263	0.246	0.177	0.197	-0.149	-0.035	-0.532***
	[0.235]	[0.242]	[0.227]	[0.171]	[0.177]	[0.185]	[0.173]	[0.163]	[0.166]
Collaborations: Consultants	-0.165	0.140	0.096	0.049	-0.150	-0.268*	-0.096	0.036	0.049
	[0.228]	[0.234]	[0.224]	[0.154]	[0.169]	[0.152]	[0.129]	[0.136]	[0.131]
Collaborations: Similar Firms	0.190	0.181	-0.128	0.297**	0.183	0.374***	0.140	0.270**	0.041
	[0.178]	[0.183]	[0.180]	[0.157]	[0.140]	[0.141]	[0.123]	[0.129]	[0.125]
Collaborations: Others	-0.029	0.010	-0.168	-0.151	-0.311*	-0.331*	-0.082	0.604***	-0.308*
	[0.244]	[0.254]	[0.239]	[0.178]	[0.194]	[0.173]	[0.149]	[0.161]	[0.150]
Public support									
Local and Regional Public Support	0.186	-0.165	-0.088	0.214	-0.021	0.233	0.215*	-0.077	0.067
	[0.192]	[0.195]	[0.191]	[0.146]	[0.163]	[0.149]	[0.116]	[0.136]	[0.120]
Central Government Public Support	-0.276	0.254	0.214	0.432**	0.609***	0.391*	-0.132	0.282*	0.565***
	[0.305]	[0.299]	[0.281]	[0.190]	[0.214]	[0.198]	[0.191]	[0.155]	[0.156]
EU Public Support	-0.159	0.396	0.036	0.427	-0.123	-0.066	0.206	-0.094	-0.303
	[0.271]	[0.284]	[0.270]	[0.289]	[0.292]	[0.266]	[0.232]	[0.265]	[0.247]
Claimed Tax Credit	0.770**	-0.333	0.032	-0.262	0.279	-0.482*	-0.258	0.830***	-0.324
	[0.308]	[0.303]	[0.282]	[0.279]	[0.264]	[0.275]	[0.218]	[0.242]	[0.220]
Obstacles									
Obstacles: Finance	0.078	0.296**	-0.018	0.290***	0.360***	0.315***	0.412***	0.226***	0.345***
	[0.146]	[0.142]	[0.140]	[0.098]	[0.071]	[0.070]	[0.057]	[0.060]	[0.063]
Obstacles: Knowledge	0.221*	0.125	-0.090	0.056	0.034	0.160**	0.137**	0.147**	0.188***
	[0.126]	[0.123]	[0.121]	[0.087]	[0.068]	[0.068]	[0.062]	[0.059]	[0.056]

Dependent variable: introduction of product good, service, process innovation	High-technology			Medium-technology			Low-technology		
	Good	Service	Process	Good	Service	Process	Good	Service	Process
Obstacles: Market	0.162	-0.038	0.171	0.178*	0.298***	0.056	-0.113*	-0.054	0.051
	[0.135]	[0.132]	[0.131]	[0.070]	[0.070]	[0.091]	[0.062]	[0.060]	[0.057]
Obstacles: Other	-0.199	-0.016	0.049	0.005	-0.077	-0.157**	-0.040	-0.037	0.051
	[0.143]	[0.142]	[0.138]	[0.067]	[0.067]	[0.087]	[0.061]	[0.059]	[0.055]
Constant	-1.148***	-0.913***	-0.491**	-2.333***	0.132***	0.296***	0.492***	-1.842***	0.263***
	[0.215]	[0.207]	[0.196]	[0.044]	[0.135]	[0.046]	[0.033]	[0.070]	[0.032]
Observations	583	583	583	2486	2486	2486	4461	4461	4461
Log Likelihood	-997.31	-997.31	-997.31	-3047.58	-3047.58	-3047.58	-4695.7	-4695.7	-4695.7

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Probability of developing innovation within the firm, in collaboration or adoption, whole sample Probit estimation, marginal effects

Dependent variable: Innovation developed mainly within the firm, in collaboration or adopted	Within Firm	Collaboration	Adoption
Firms' characteristics			
Age	-0.008	-0.002	0.015***
	[0.013]	[0.008]	[0.005]
Size (employees)	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]
Size squared (employees)	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]
Ownership Structure	0.022**	0.028***	-0.005
	[0.009]	[0.006]	[0.004]
Exporter	0.089***	0.018***	-0.007*
	[0.010]	[0.007]	[0.004]
Human Capital			
Fraction Employees with Science Degree	0.141***	-0.017	-0.004
	[0.030]	[0.019]	[0.015]

Dependent variable: Innovation developed mainly within the firm, in collaboration or adopted	Within Firm	Collaboration	Adoption
Fraction Employees with Other Degree	0.017	0.024	0.006
	[0.025]	[0.016]	[0.012]
Innovation expenditures			
Internal R&D Expenditure p.e.	0.006***	-0.001	-0.001*
	[0.001]	[0.001]	[0.001]
Acquisition of External R&D p.e.	-0.001	0.000	0.000
	[0.001]	[0.001]	[0.001]
Equipment and ICT Expenditure p.e.	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]
Training Expenditure p.e.	0.001	-0.001	0.000
	[0.001]	[0.001]	[0.000]
Design Expenditure p.e.	0.000	0.001	-0.004
	[0.002]	[0.001]	[0.003]
Market Expenditure p.e.	0.000	0.000	-0.003*
	[0.000]	[0.000]	[0.002]
Wider Innovation			
New Corporate Strategy	0.023*	0.019**	0.014**
	[0.012]	[0.008]	[0.006]
New Management Techniques	0.028**	0.024***	0.003
	[0.012]	[0.008]	[0.006]
New Organisational Structure	0.060***	0.006	-0.015***
	[0.012]	[0.007]	[0.005]
New Marketing Strategies	0.152***	0.032***	0.014**
	[0.012]	[0.008]	[0.005]
Open Innovation			
Collaborations: Suppliers	0.047**	0.099***	0.056***
	[0.022]	[0.017]	[0.015]
Collaborations: Customers	0.080***	0.038***	-0.015*
	[0.024]	[0.014]	[0.008]
Collaborations: Higher Education	-0.032	-0.006	-0.004
	[0.022]	[0.012]	[0.010]
Collaborations: Consultants	-0.014	0.001	-0.017**
	[0.022]	[0.012]	[0.008]

Dependent variable: Innovation developed mainly within the firm, in collaboration or adopted	Within Firm	Collaboration	Adoption
Collaborations: Similar Firms	0.014	0.038***	0.005
	[0.021]	[0.013]	[0.010]
Collaborations: Others	-0.028	-0.013	0.002
	[0.024]	[0.012]	[0.012]
Public support			
Local and Regional Public Support	0.050***	0.024**	0.015
	[0.019]	[0.012]	[0.010]
Central Government Public Support	0.084***	0.059***	-0.010
	[0.026]	[0.018]	[0.010]
EU Public Support	-0.038	0.018	-0.005
	[0.030]	[0.020]	[0.015]
Claimed Tax Credit	0.097***	-0.025*	-0.006
	[0.033]	[0.014]	[0.013]
Obstacles			
Obstacles: Finance	0.086***	0.029***	0.019***
	[0.010]	[0.007]	[0.005]
Obstacles: Knowledge	0.048***	0.010	0.009*
	[0.010]	[0.006]	[0.005]
Obstacles: Market	0.010	0.003	0.012***
	[0.010]	[0.007]	[0.005]
Obstacles: Other	-0.004	-0.002	-0.010**
	[0.010]	[0.006]	[0.004]
Sectoral dummy			
Manufacturing	Reference	Reference	Reference
Trade and Repair of Motorvehicles	-0.123***	-0.012	0.062***
	[0.023]	[0.018]	[0.020]
Wholesale Trade	-0.048***	0.002	0.039***
	[0.018]	[0.013]	[0.012]
Retail Trade	-0.141***	-0.029***	0.001
	[0.013]	[0.010]	[0.007]
Hotels and Restaurants	-0.133***	-0.042***	-0.026***
	[0.015]	[0.010]	[0.006]
Land Transport	-0.128***	-0.026**	-0.017**
	[0.018]	[0.013]	[0.008]

Dependent variable: Innovation developed mainly within the firm, in collaboration or adopted	Within Firm	Collaboration	Adoption
Water Transport	-0.037	-0.011	
	[0.096]	[0.065]	
Air Transport	0.077	0.058	
	[0.103]	[0.079]	
Transport and Travel Auxiliary	-0.125***	-0.002	-0.001
	[0.021]	[0.018]	[0.012]
Post and Telecommunication	-0.064**	0.002	0.012
	[0.025]	[0.019]	[0.015]
Financial Intermediation	0.037	0.025	-0.030***
	[0.041]	[0.028]	[0.012]
Insurance	0.031	0.009	-0.014
	[0.059]	[0.037]	[0.023]
Other Financial Services	-0.097***	0.014	0.016
	[0.021]	[0.018]	[0.014]
Real Estate	-0.121***	0.001	-0.005
	[0.022]	[0.018]	[0.012]
Renting of Machinery and Equipment	-0.108***	-0.004	0.02
	[0.025]	[0.020]	[0.017]
Computer and Related Activities	0.074***	-0.028**	0.002
	[0.028]	[0.013]	[0.012]
Research and Development	-0.04	0.026	0.015
	[0.033]	[0.024]	[0.020]
Other Business Services	-0.030**	0.000	-0.012**
	[0.013]	[0.009]	[0.006]
Observations	12024	12025	11982
Log Likelihood	-6067.61	-3918.45	-2488.49

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Table 9: Probability of developing innovation within the firm, in collaboration or adoption, whole sample Probit estimation, marginal effects, CIS4 by subsamples of high, medium and low innovators

Dependent variable: Innovation developed mainly within the firm, in collaboration or adopted	Innovation developed within the firm			Innovation developed in collaboration			Innovation adopted		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
Firms' characteristics									
Age	0.020	-0.037	-0.002	-0.033	0.000	-0.007	0.000	0.009	0.016**
	[0.060]	[0.026]	[0.015]	[0.042]	[0.017]	[0.011]	[0.000]	[0.007]	[0.007]
Size (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Size squared (employees)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ownership Structure	-0.023	0.020	0.033***	-0.008	0.026*	0.017**	0.000	-0.010	0.001
	[0.047]	[0.021]	[0.012]	[0.032]	[0.014]	[0.009]	[0.000]	[0.006]	[0.007]
Exporter	0.060	0.049**	0.075***	0.027	-0.015	0.016*	0.000	0.004	-0.006
	[0.049]	[0.023]	[0.015]	[0.033]	[0.014]	[0.010]	[0.000]	[0.007]	[0.007]
Human capital									
Fraction Employees with Science Degree	0.211***	0.090*	0.228***	-0.050	0.009	0.039	0.000	0.002	0.003
	[0.080]	[0.050]	[0.058]	[0.055]	[0.033]	[0.040]	[0.000]	[0.015]	[0.037]
Fraction Employees with Other Degree	-0.108	-0.011	0.049	0.038	0.037	0.019	0.000	-0.009	0.021
	[0.095]	[0.040]	[0.035]	[0.063]	[0.026]	[0.024]	[0.000]	[0.013]	[0.020]
Innovation expenditures									
Internal R&D Expenditure p.e.	0.004**	0.023***	0.007***	0.001	-0.001	-0.002	0.000	-0.004	0.000
	[0.002]	[0.006]	[0.002]	[0.001]	[0.002]	[0.002]	[0.000]	[0.004]	[0.002]
Acquisition of External R&D p.e.	-0.004	0.000	0.001	-0.001	0.000	0.003	0.000	0.000	-0.002
	[0.003]	[0.002]	[0.003]	[0.003]	[0.001]	[0.002]	[0.000]	[0.001]	[0.003]
Equipment and ICT Expenditure p.e.	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001**
	[0.003]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
Training Expenditure p.e.	0.003	-0.001	0.001	0.016	-0.002	-0.001	0.000	0.000	-0.009*
	[0.019]	[0.002]	[0.001]	[0.010]	[0.005]	[0.002]	[0.000]	[0.000]	[0.005]
Design Expenditure p.e.	0.002	0.074***	-0.002	0.003	-0.006	-0.001	0.000	-0.003	-0.027
	[0.005]	[0.027]	[0.003]	[0.003]	[0.011]	[0.001]	[0.000]	[0.008]	[0.017]
Market Expenditure p.e.	0.016	0.001	0.000	0.008	0.000	0.000*	0.000	-0.001	-0.001
	[0.011]	[0.002]	[0.000]	[0.005]	[0.001]	[0.000]	[0.000]	[0.002]	[0.002]

Dependent variable: Innovation developed mainly within the firm, in collaboration or adopted	Innovation developed within the firm			Innovation developed in collaboration			Innovation adopted		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
Wider innovation									
New Corporate Strategy	-0.025	-0.027	0.056***	0.025	0.036*	0.017	0.000	0.007	0.026**
	[0.057]	[0.026]	[0.019]	[0.039]	[0.019]	[0.012]	[0.000]	[0.009]	[0.012]
New Management Techniques	0.083	0.029	0.052***	-0.012	0.024	0.016	0.000	0.000	0.018*
	[0.056]	[0.025]	[0.018]	[0.037]	[0.017]	[0.012]	[0.000]	[0.007]	[0.010]
New Organisational Structure	0.128**	0.120***	-0.019	-0.029	-0.017	0.008	0.000	-0.006	-0.015*
	[0.054]	[0.026]	[0.015]	[0.037]	[0.016]	[0.011]	[0.000]	[0.007]	[0.008]
New Marketing Strategies	0.193***	0.107***	0.116***	-0.061*	0.049***	0.052***	0.000	0.016	0.020**
	[0.051]	[0.026]	[0.018]	[0.036]	[0.018]	[0.013]	[0.000]	[0.010]	[0.010]
Open innovation									
Collaborations: Suppliers	-0.221***	0.103*	0.067*	0.198***	0.103**	0.083***	0.000	0.048*	0.074**
	[0.083]	[0.056]	[0.036]	[0.066]	[0.043]	[0.029]	[0.000]	[0.029]	[0.030]
Collaborations: Customers	0.233***	0.047	-0.020	-0.025	-0.012	0.046*	0.000	-0.004	-0.021*
	[0.071]	[0.053]	[0.029]	[0.047]	[0.027]	[0.026]	[0.000]	[0.012]	[0.012]
Collaborations: Higher Education	-0.201**	0.028	-0.041	0.079	0.036	-0.025	0.000	0.010	-0.004
	[0.097]	[0.059]	[0.032]	[0.067]	[0.039]	[0.017]	[0.000]	[0.020]	[0.020]
Collaborations: Consultants	0.094	-0.086**	0.014	-0.072*	0.017	0.002	0.000	-0.016*	-0.014
	[0.088]	[0.043]	[0.033]	[0.042]	[0.031]	[0.019]	[0.000]	[0.009]	[0.014]
Collaborations: Similar Firms	-0.051	0.059	0.043	0.076	0.075**	0.019	0.000	-0.010	-0.005
	[0.076]	[0.049]	[0.034]	[0.052]	[0.037]	[0.021]	[0.000]	[0.011]	[0.016]
Collaborations: Others	-0.063	-0.068	0.000	0.082	-0.034	-0.008	0.000	0.011	0.020
	[0.103]	[0.051]	[0.036]	[0.072]	[0.026]	[0.019]	[0.000]	[0.021]	[0.025]
Public support									
Local and Regional Public Support	0.194***	0.038	0.041	-0.051	0.069*	0.012	0.000	-0.017*	0.023
	[0.069]	[0.051]	[0.033]	[0.043]	[0.039]	[0.021]	[0.000]	[0.009]	[0.020]
Central Government Public Support	-0.063	0.099	-0.029	0.056	0.045	0.117***	0.000	0.014	-0.012
	[0.112]	[0.071]	[0.035]	[0.079]	[0.047]	[0.044]	[0.001]	[0.025]	[0.018]
EU Public Support	-0.003	0.027	-0.019	-0.034	-0.018	-0.007	0.000	0.011	0.006
	[0.111]	[0.093]	[0.051]	[0.055]	[0.045]	[0.034]	[0.000]	[0.032]	[0.033]
Claimed Tax Credit	0.168*	-0.026	0.166**	-0.055	-0.046	-0.033	0.067	-0.004	0.012
	[0.099]	[0.085]	[0.080]	[0.061]	[0.035]	[0.020]	[0.340]	[0.021]	[0.036]

Dependent variable: Innovation developed mainly within the firm, in collaboration or adopted	Innovation developed within the firm			Innovation developed in collaboration			Innovation adopted		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
Obstacles									
Obstacles: Finance	0.091	0.091***	0.074***	-0.003	0.050***	0.036***	0.000	0.010	0.018**
	[0.055]	[0.023]	[0.014]	[0.038]	[0.015]	[0.010]	[0.000]	[0.007]	[0.008]
Obstacles: Knowledge	0.041	0.093***	0.016	0.018	-0.034**	0.034***	0.000	0.010	0.012
	[0.048]	[0.023]	[0.014]	[0.033]	[0.014]	[0.011]	[0.000]	[0.008]	[0.008]
Obstacles: Market	0.089*	0.044*	0.002	-0.048	0.025	-0.019**	0.000	0.000	0.023***
	[0.051]	[0.023]	[0.014]	[0.035]	[0.016]	[0.009]	[0.000]	[0.007]	[0.009]
Obstacles: Other	-0.219***	-0.050**	0.020	0.106**	-0.004	-0.019**	0.000	0.000	-0.013*
	[0.056]	[0.021]	[0.014]	[0.043]	[0.014]	[0.008]	[0.000]	[0.006]	[0.007]
Observations	584	2504	4469	584	2504	4469	584	2504	4469
Log Likelihood	-319.46	-1308.13	-1835.61	-228.99	-851.93	-1183.52	-112.67	-447.2	-956.03

Standard errors in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

NESTA Making Innovation Flourish

NESTA

1 Plough Place
London EC4A 1DE
research@nesta.org.uk

www.nesta.org.uk

Published: May 2008
TSS/10