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Open Innovation Choices -
What is British Enterprise doing?

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Introduction

Open innovation (OI) has become "a way of living" for many businesses. Yet the spectrum of business practices that open up the innovation process is wide. Whilst some companies may "connect" widely to external sources in order to "develop" innovations in-house, others may do very little research and acquire most of their technology from outside. Whilst some may systematically exploit their internally created intellectual properties (IP) outside the firm, others may reveal their IPs for free (e.g. open source software). Furthermore, evidence from case studies suggests that companies may mix and match different kinds of practices in pursuit of innovation. Therefore, this survey was designed to capture a fuller picture of UK companies' OI practices in recent years. As far as we know, this is one of the first comprehensive open innovation surveys in the UK. We hope that the findings of this survey not only enhance our understanding of the nature of these OI practices and their impact on business, but also inform government policymaking to help business innovation.

The survey was administered to a sample of over 12,000 UK manufacturing and business services companies with up to 999 employees between June 2010 and November 2010. The fifteen sectors covered by the survey are listed in the Appendix. This sampling frame was drawn to fill a gap in our knowledge – most research on open innovation to date has tended to focus on large established businesses in the high-technology and manufacturing sectors. We also avoided using the term "open innovation" throughout the survey instrument to prevent potential bias in the responses. Instead, our questions focused on business practices and activities (i.e. what they do). And we adopted a process view of looking at both "inbound" (i.e. taking external knowledge inside the firm) and "outbound" activities (i.e. taking internal knowledge outside the firm). The final sample achieved was 1,202 companies (a response rate of about 10%). By using weighting methods, our findings can be generalised to the UK company population. Please refer to the appendix for further details on the survey methods.

The report is structured as follows. Chapter 1 explores the three types of OI firms emerging from the data, namely traditional, hunting-cultivating and ambidextrous firms. Chapter 2 examines how and why firms carry out their inbound OI activities, as well as the impacts of these activities on business. We also report the variations of these practices across different types of firms in our sample, e.g. by size, sector and OI type. Similarly, Chapter 3 examines firms' outbound activities, related objectives and how they protect their innovation in this process. Chapter 4 draws together the key findings of the report and discusses the implications for policymakers and managers. A list of key definitions used in the report can be found on the inside of the back cover.

This survey was an open collaboration. It would not have been possible without the help and advice of our friends and colleagues at Cambridge and Imperial College. In particular, we acknowledge the contributions of Alan Hughes, Ammon Salter, Oliver Alexy, Michael Kitson, Tim Minshall, Elif Moreau-Bascavusoglu, Gerald Avison and Chas Sims to this project. We are indebted to Anna Bullock and Isobel Milner, who form the Survey and Database team at the Centre for Business Research, for their excellent management of the survey and skilful contributions to the report. We are grateful for the financial support from the sponsors of the UK Innovation Research Centre (UK~IRC). Last, but not least, we are most grateful to all the survey respondents, who kindly spared their time to fill in the questionnaire during this rather difficult economic climate.

Andy and Joanne

Chapter 1

OPEN INNOVATION TYPES: traditional, hunting-cultivating and ambidextrous

This chapter examines whether the sample companies can be clustered into groups of companies that follow similar behaviour in relation to their open innovation activities. We recognise that each firm represents a unique combination of the variety of practices that may be regarded as representing an open orientation for innovation, but argue that it may be of use to cluster the companies into similar types. By doing this it is possible to explore whether the different types are associated with firm size and sector, or whether it is the case that one type appears prevalent in all circumstances.

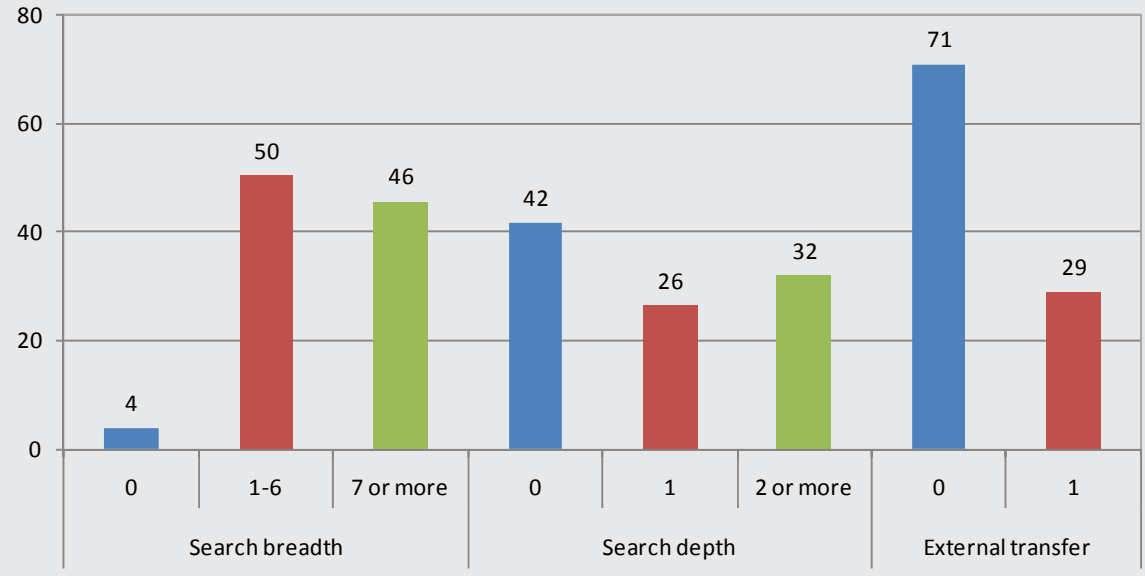
The next section describes our method for achieving this and identifies the clustering variables used. We identify three clusters and name these three OI types: traditional, hunting-cultivating and ambidextrous. With the firms clustered together into different OI types, we then examine how these clusters are distributed across firm size and sector. The following sections compare the OI types in terms of: growth performance; innovation inputs and outcomes; and their orientation, strategy and structure. Finally, the summary draws together the key findings and implications of this chapter.

1.1. Forming the clusters

Open innovation can be measured on several dimensions and the survey instrument contained a rich array of possible measures. For most of the measures a range of possible answers could be given by the respondents. Therefore, a large number of possible combinations of the measures and their scores was possible, but we wanted to cluster the firms into a few types with common OI practices. Adopting a process view of open innovation activities, we decided to cluster our companies on the basis of their search activities (hunting), their partnering activities (cultivating) and their external transfer activities (exploiting).

Exhibit 1.1.1 shows two measures of firms' searching, or hunting, activities: breadth and depth. Breadth measures the number of external sources of information used by the firm during the previous three years with a potential maximum of ten sources (these sources are listed in Exhibit 2.2.1 in chapter 2). The depth measure requires more than simple use of an information source, the firm must also regard that source to be of high importance. Again, the potential maximum is ten sources each of high importance, but the

Exhibit 1.1.1 Hunting for knowledge (breadth and depth) and external transfers: all firms (%)



Weighted: 57,420; unweighted: 1,095

maximum we found was eight sources of high importance. The statistics presented in this exhibit are for the fifteen sectors grossed up to the company population in these sectors, as described in the introduction.

The exhibit shows that whilst only 4% of the population makes no use of external sources of knowledge, this rises to 42% for the depth measure. This means that almost half of the companies do not regard any external source as having high importance to them. In terms of breadth, we can see that 46% of the sample drew from seven, or more, information sources. However, only 32% regarded two, or more, external sources as highly important.

The final measure shown in Exhibit 1.1.1 concerns the transfer of technology and knowledge from the firm to outside parties, or their exploiting activities. This is the topic of Chapter 3 and so at this point we can simply note that 29% of our firms engaged in this activity.

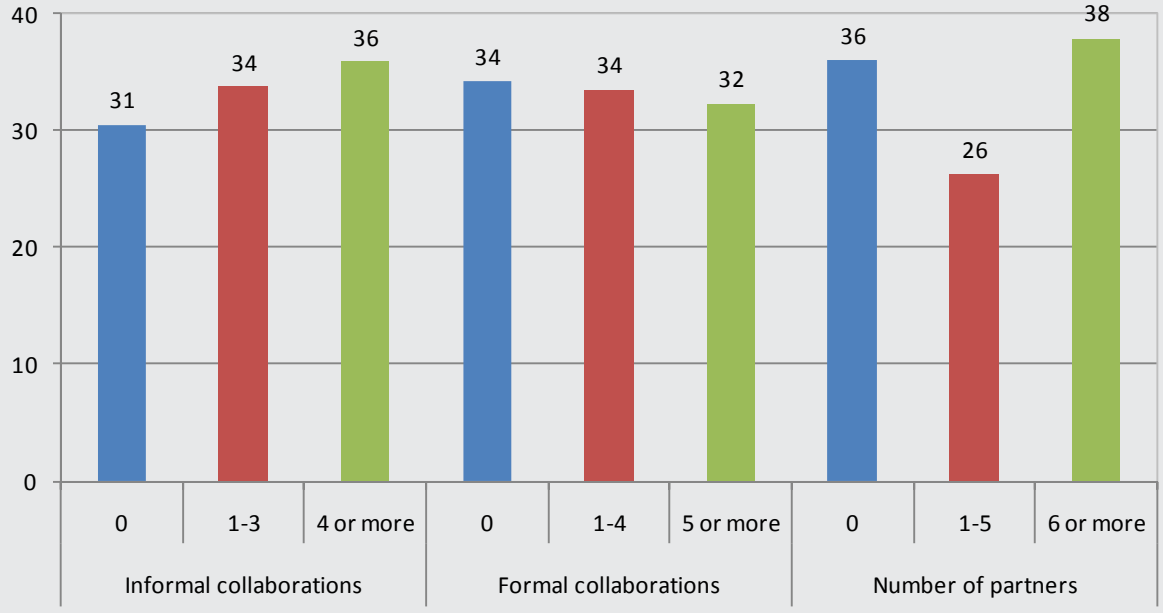
Exhibit 1.1.2 shows three measures of their partnering, or cultivating activities with others (grossed up to the company population): informal collaborative activities; formal activities; and the number of partners. In the case of informal activities the firms were asked to score five such activities on a scale from 0 for not used to 3 for used and of high importance (details of these activities are listed in Exhibit 2.3.1). The overall measure of the intensity of informal collaborative activity is formed by adding up these scores for each company giving a variable that ranged from 0 to 15. The exhibit reveals that about 30% of the sample did not engage in these informal activities at all, but about a third of the companies had a score of 4, or more.

Formal activities were measured in a similar way as informal, but the number of formal activities examined was ten and the potential range of the formal measure was 0 to 30 (details of these activities are listed in Exhibit 2.4.1). We can see that about 34% of the firms did not engage in formal collaborative activities, and about a third had a score on this measure of over 4.

The measure of the number of partners in the exhibit is drawn from a question asked about nine types of partner which yielded answers of: 0 meaning none; 1 for a single partner of that type; 2 for 2-4 partners of that type; and 3 for 5 or more partners (details of these partners are listed in Exhibit 2.5.1). The measure for the number of partners presented in Exhibit 1.1.2 is found by aggregating the answers for the nine types and could range from 0 to 27. The exhibit shows that 36% of the companies had no partners, but 38% had a score of six, or more.

To form clusters, we used three of our variables: breadth; formal collaboration; and external transfer. We assigned names to the three OI types we created: traditional; hunting-cultivating; and ambidextrous. The distribution of our respondents

Exhibit 1.1.2 Informal and formal collaboration and partners: all firms (%)



Weighted: 56,146; unweighted: 1,070

Exhibit 1.1.3 Open innovation types

		Ext transfer - No		Ext transfer - Yes	
		Formal activities		Formal activities	
		Bottom 2/3	Top 1/3	Bottom 2/3	Top 1/3
Breadth	Bottom half	336 Trad	63 H-C	64 Ambi	36 Ambi
	Top half	198 H-C	177 H-C	47 Ambi	124 Ambi

Trad	336
H-C	438
Ambi	271
All types	1,045

Trad: Traditional
H-C: Hunting-cultivating
Ambi: Ambidextrous

between these types is shown in Exhibit 1.1.3.

The traditional companies are defined as those that made no external transfers, had few formal collaborations and were in the bottom half of firms in terms of their use of external knowledge. The hunting-cultivating firms had made no external transfers, but had engaged in external sourcing of knowledge and in formal collaborations more actively. Ambidextrous firms were selected as those that had transferred knowledge and technology externally, but were found to also have engaged in hunting and cultivating, hence the choice of their name.

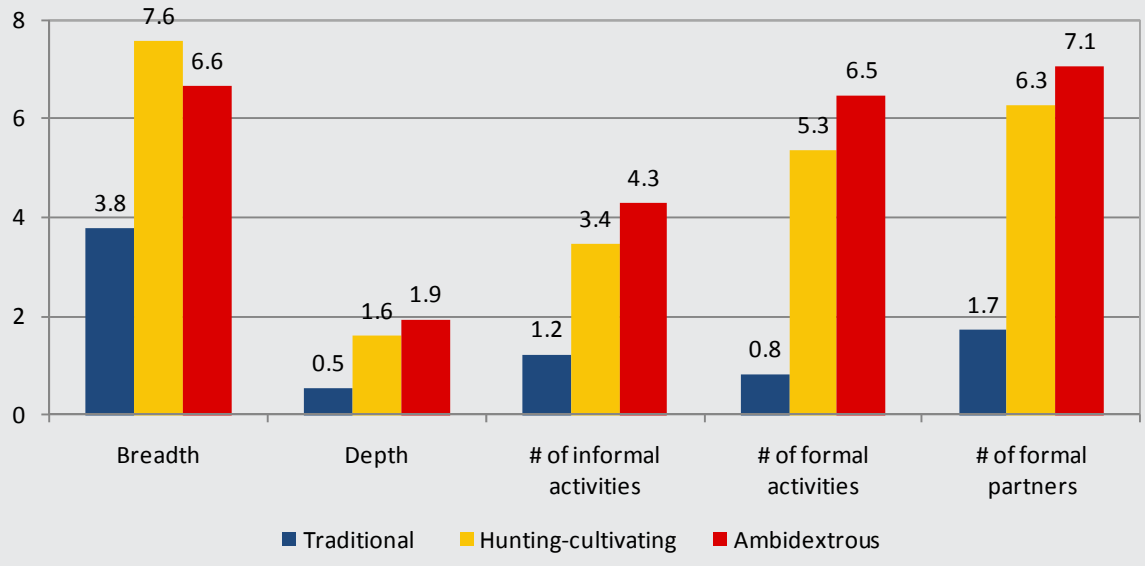
We recognise that other choices could have been made over the variables used for clustering our firms and of the particular cut-off points chosen. Such changes would have led to different sets of firms in each of the clusters. We accept this, but argue that on any reasonable definition of openness the outcomes would have been broadly similar. We experimented with statistical two-step cluster analysis to form a variety of possible clusters, some of which were close to those we have chosen. But, in the end, we decided to draw from the theoretical model and to impose our own judgement for the grouping criteria.

1.2. OI types and OI activities

The first way to examine whether these clusters of firms are meaningful is to examine how they differ from each other in terms of the six OI activity measures shown in Exhibits 1.1.1 and 1.1.2 and defined in the previous section. This is presented in Exhibit 1.2.1 and reveals a fascinating picture. It should be noted that the external transfer of knowledge and technology is not shown in the exhibit since, by definition, it takes the value of 1 for ambidextrous and 0 for the other two types.

Looking first at the traditional type of firm, we can see that its engagement with other firms and organisations is quite minimal. The breadth and depth measures of the extent and importance of external sources of information are both very low. Equally low is the traditional firm's involvement in collaboration and partnering. The hunting-cultivating type of firm is in complete contrast to this and is seeking and gathering information from a much wider range of sources and attaching more

Exhibit 1.2.1 External knowledge sourcing, collaborations and partners by OI type



Weighted: 51,465; unweighted: 1,015

importance to them. The contrast is even more striking in terms of collaboration and partnering.

In contrast to the other two OI types, ambidextrous firms do transfer knowledge and technology externally to parties outside the firm. However, it is clear that they too are involved in significant hunting and cultivating activities and this is why we term them ambidextrous. They make similar use and attach similar importance to external knowledge sources as the hunting-cultivating firms; and, if anything, are more engaged in partnering and collaboration on average.

1.3. Size and sectoral distribution of OI types

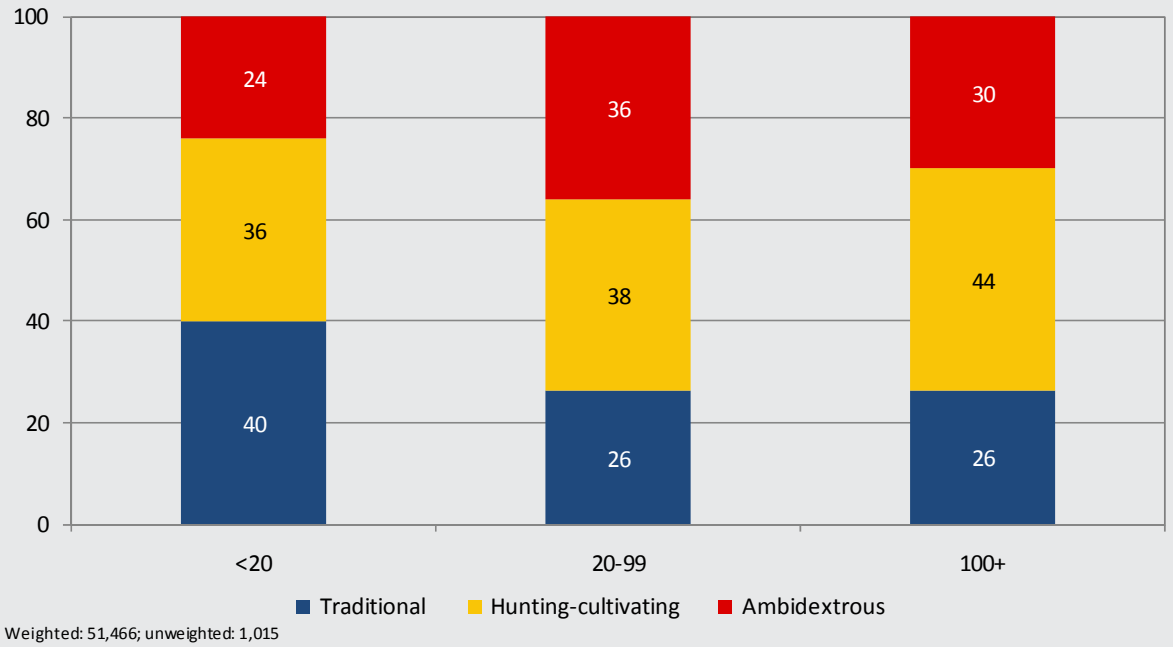
One of our key questions is whether the type of open innovation model chosen by companies is associated with their size, age, or sector; and these are addressed in this section.

Exhibit 1.3.1 shows the proportion of firms of each OI type within our size groups for the company population. It is immediately apparent that the smallest size group (<20 employees, called micro firms in this report), has the highest proportion of traditional firms, but even amongst these companies there is a significant proportion of both hunting-cultivating and ambidextrous types. The proportion of traditional firms amongst the next size category (20-99 employees, called small sized firms here) is similar to that within the largest size group in our sample (100-999 employees, called medium sized firms here); but it is the small sized firms that show the highest tendency to be ambidextrous. We conclude that within each size group firms are making different choices about their form of open innovation.

The association between OI activities and company ages is examined in Exhibit 1.3.2. The companies are divided into those started before 2002 and those started after that time. We find that older firms are more likely to be traditional and younger firms are more likely to be ambidextrous. However, the differences are small and so we can say that company age is not a major determinant of OI type.

The question of whether the form of open innovation companies adopt is influenced by their sector is examined in the next two exhibits. Exhibit 1.3.3 examines four groups: manufacturing and business services each split into high-tech and conventional sectors. Business service firms have a higher proportion of ambidextrous firms than found in manufacturing; and this is equally true for conventional and high-tech services. Rather surprisingly, we can see that it is conventional business services that exhibit higher degrees of openness, largely due to their higher hunting-cultivating proportion. Within manufacturing, there is little difference between high-tech and conventional in their proportions that are hunting-

Exhibit 1.3.1 Distribution of OI types within size groups

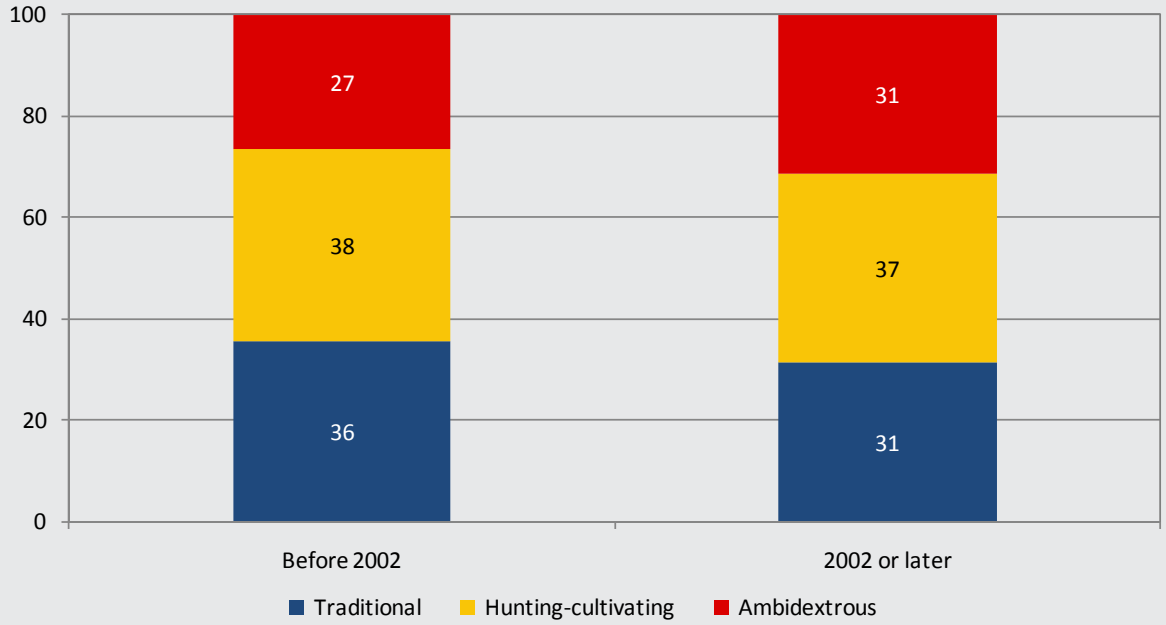


Weighted: 51,466; unweighted: 1,015

cultivating, but high-tech have a much higher proportion of ambidextrous and a lower proportion of traditional types than conventional firms in this sector.

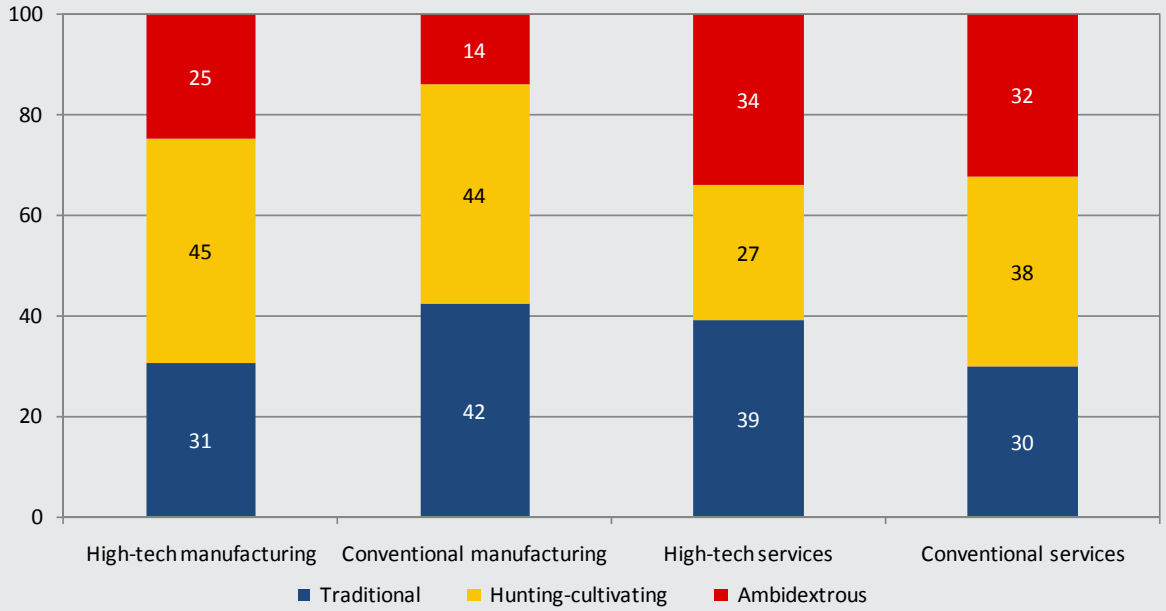
The split of companies between different OI types within the fifteen main sectors is shown in Exhibit 1.3.4. The first point to make is that sector clearly matters. For example, the highest proportion of traditional firms is 54% (non-metallic products) and the lowest proportion is 12% (research and development). For hunting-cultivating the highest is 52% (basic metals) and the lowest is 23% (computer and related activities). The largest proportion of ambidextrous firms is 50% (research and development) and the smallest is only 7% (basic metals). Further research is needed to explain these variations in patterns. The second point to make is that there is significant variety within each sector – firms in the same sector are

Exhibit 1.3.2 Distribution of OI types within company age categories



Weighted: 50,356 unweighted: 991

Exhibit 1.3.3 Distribution of OI types within sector



Weighted: 51,465; unweighted: 1,015

Exhibit 1.3.4 Distribution of OI types within industrial sectors

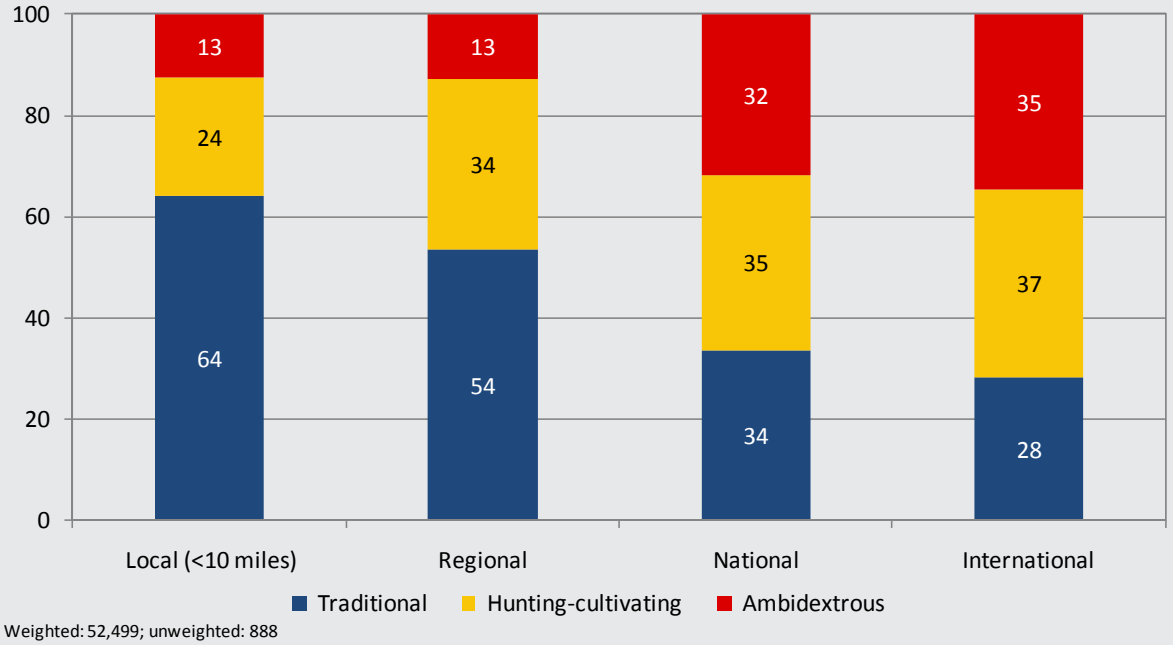
Sector	Traditional	OI type Hunting-cultivating	Ambidextrous	All types
Chemicals and chemical products	27	47	26	100
Non-metallic mineral products	54	32	14	100
Basic metals	41	52	7	100
Fabricated metal products, except machinery and equipment	46	42	11	100
Machinery and equipment not elsewhere classified	40	46	14	100
Office machinery and computers	39	36	25	100
Electrical machinery and apparatus n.e.c.	33	49	18	100
Radio, television and communication equipment and apparatus	32	39	30	100
Medical, precision and optical instruments, watches and clocks	34	44	23	100
Motor vehicles, trailers and semi-trailers	39	40	21	100
Other transport equipment	25	49	26	100
Post and telecommunications	32	43	25	100
Computer and related activities	43	23	34	100
Research and development	12	38	50	100
Other business activities	30	38	33	100
Number of companies	20,349	23,221	17,937	61,507

making different choices about how they engage in open innovation.

1.4. OI types, sales distribution and growth

The companies were asked whether their principal market was local, regional, national, or international and we can group them according to their answer to this question. The distribution of OI types within these groups is shown in Exhibit 1.4.1 and reveals a very clear pattern. Companies that principally serve a local market are, not surprisingly, more likely to be traditional. Where the principal market is national, or international, we see much higher degrees of openness and, in particular, ambidexterity. We cannot establish which is the cause and which is the effect on the basis of these results.

Exhibit 1.4.1 Distribution of OI types within principal market groupings

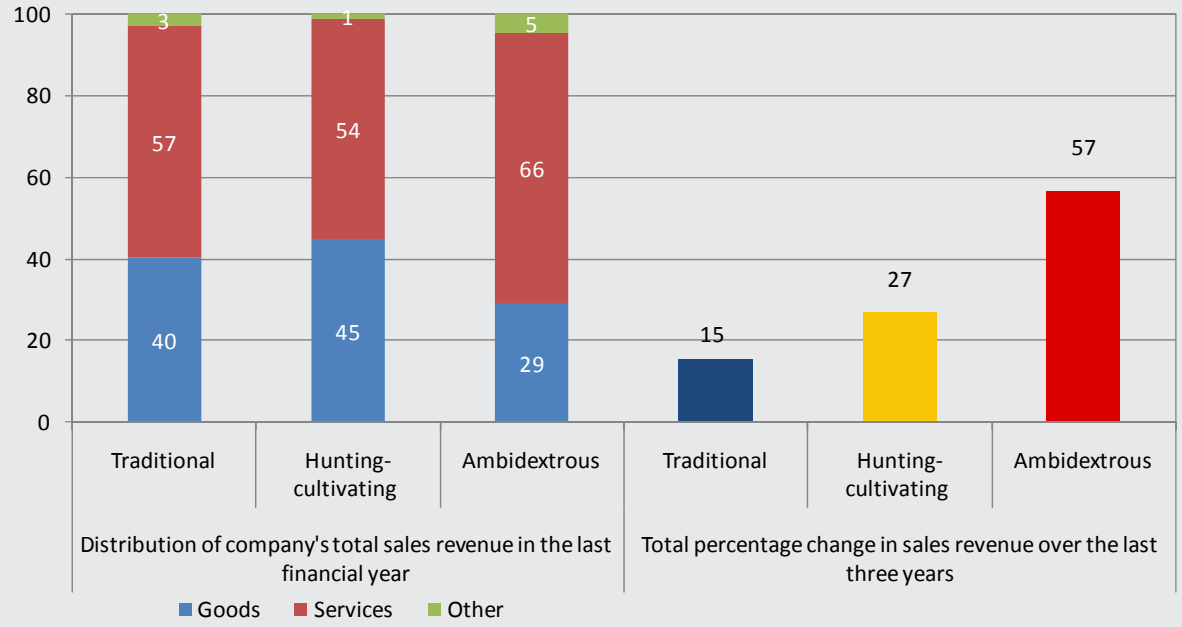


Weighted: 52,499; unweighted: 888

Two measures are reported in Exhibit 1.4.2: the proportion of sales attributable to goods, services and other; and the sales growth achieved over the previous three years. The sales distribution largely supports our sectoral conclusions reported above. Ambidextrous firms are more commonly found in business services and so we find the highest proportion of sales going to services in this OI type. The sales growth over the previous three years shows very significant differences. Hunting-cultivating firms grew significantly faster than traditional firms during the previous three years, but the ambidextrous type showed even faster growth. It is clear that openness is associated with faster sales growth.

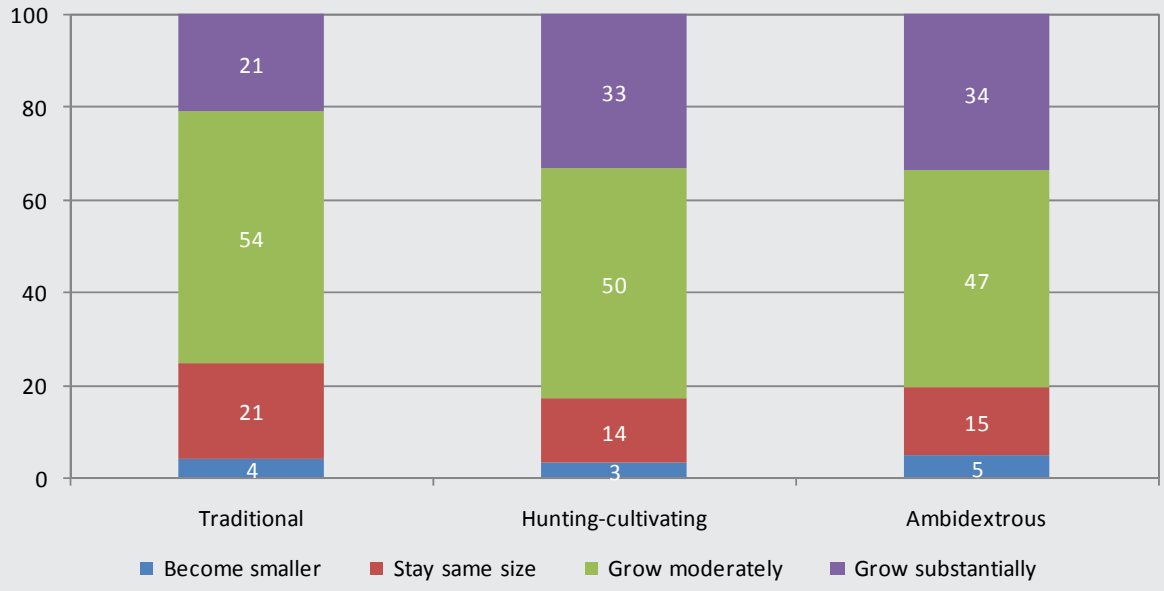
The companies were asked about their growth ambitions and their responses are analysed in Exhibit 1.4.3. It shows that traditional companies have lower growth ambitions on average than more open companies. Unlike our finding for recent growth experience presented in the

Exhibit 1.4.2 OI types by sales distribution and sales growth



Weighted: 50,899; unweighted: 712

Exhibit 1.4.3 OI types and growth ambition



Weighted: 52,340; unweighted: 888

previous exhibit, there is little difference between hunting-cultivating and ambidextrous firms in terms of their growth ambitions.

1.5. OI types and innovation

The association of open innovation with business growth is augmented in this section by examining business innovation. Exhibit 1.5.1 presents several measures of innovative activity and compares the three OI types for each measure. The first three measures are inputs to the innovation process: % of employees with a degree in science/ engineering; R&D staff as a % of employment; R&D spend as a % of sales. We can see a strong, positive relationship between each of these three measures and openness. In general, ambidextrous have higher levels than hunting-cultivating; and the latter have higher levels than traditional firms. The R&D spend measure is actually higher on average for hunting-cultivating than ambidextrous and this is interesting since the latter has been able to exploit the benefits of its knowledge and technology externally.

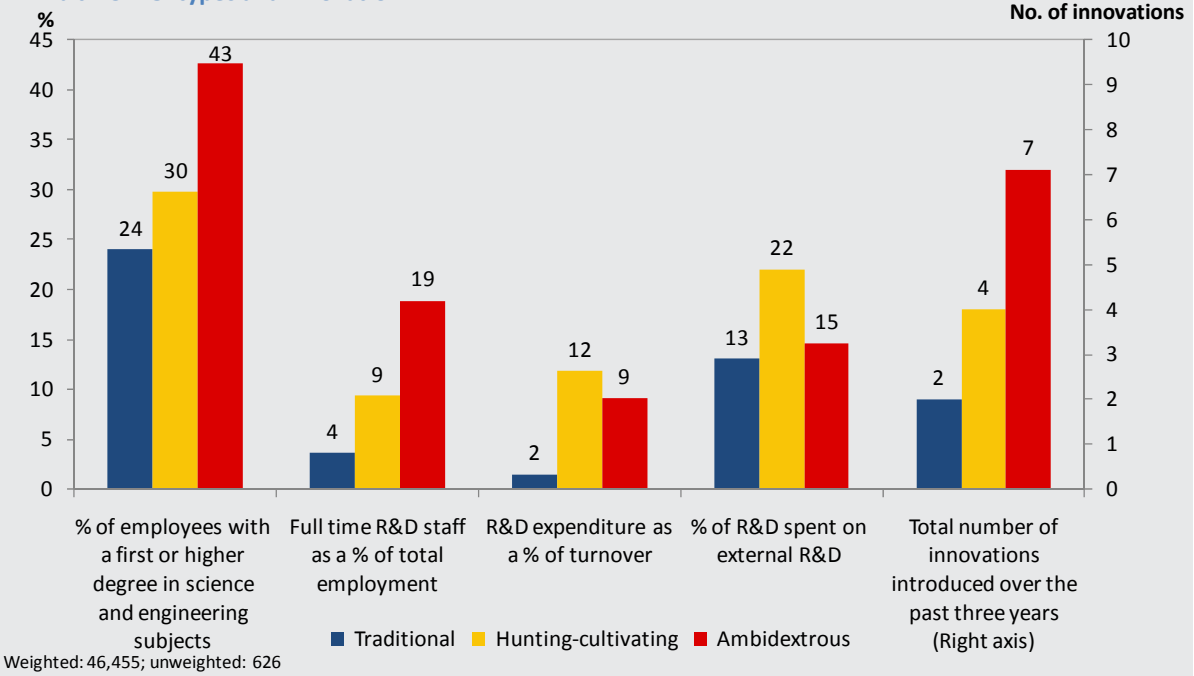
The next measure examines the proportion of R&D that is spent externally only for firms that engage in R&D. As we might expect, the hunting-cultivating firms spend a higher proportion (22%) on external R&D than the traditional firms (13%). The ambidextrous firms, who both hunt-cultivate and exploit, spend lower proportions on external R&D than the hunting-cultivating firms themselves. This will be explored further in the next two chapters.

The final measure in Exhibit 1.5.1 is an innovation output measure and shows the number of innovations the firms claimed to have made in the previous three years. It mirrors the patterns shown in the first two input measures in this exhibit. It would appear that more open firms are not only faster growing, but also likely to have carried out more innovations.

1.6. OI types and their orientation, strategy and structure

Last, but not least, we explore whether the form of open innovation chosen is associated with organisation form, business culture, or the attitudes towards openness. The first of these is examined in Exhibit 1.6.1. Businesses were asked to comment on certain statements about their business and the exhibit shows the proportion of firms that either agreed, or strongly agreed, with the statement. The questions here relate to how hierarchical, centralised and formal the company assesses itself to be. Whilst these differences between the OI types are statistically significant, they cannot be regarded as large. There appears to be no association between the type of control exerted by the chief executive and the form of openness chosen, nor is there a clear picture in relation to encouraging employees to challenge the status quo. However, there is some evidence

Exhibit 1.5.1 OI types and innovation



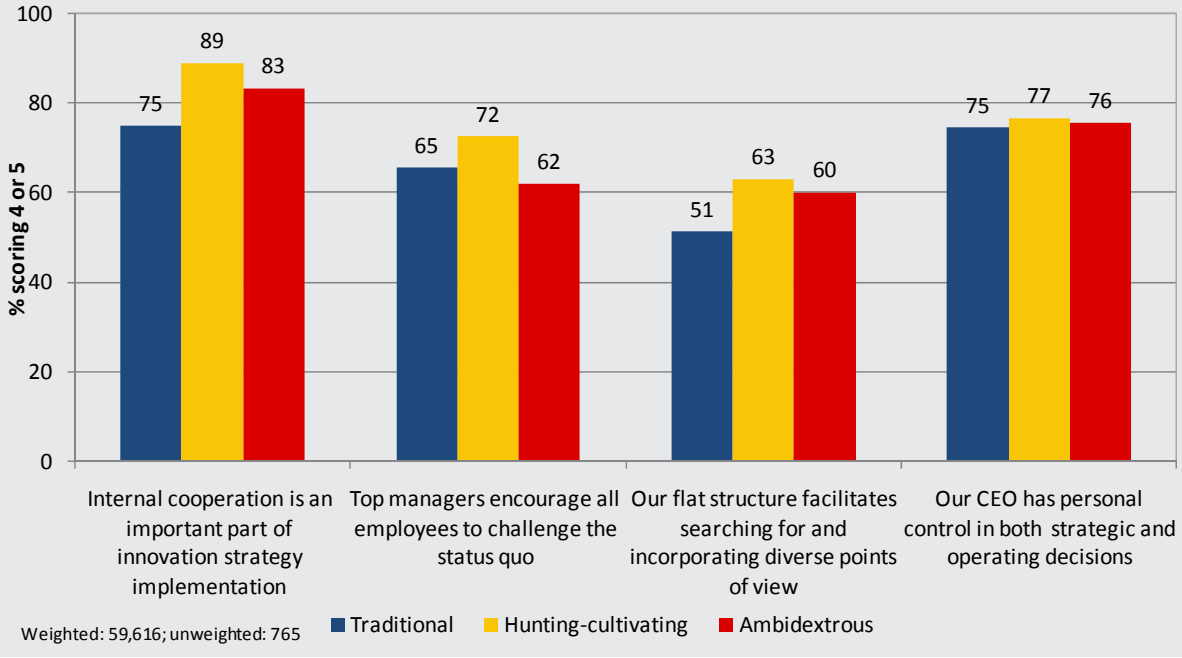
Weighted: 46,455; unweighted: 626

to suggest that more openness is associated with the flattening of hierarchies and the promotion of internal cooperation.

The first two measures in Exhibit 1.6.2 taken together suggest that more open types are more likely to see their culture as one that rewards creativity (particularly for the hunting-cultivating type), risk-taking and experimentation (particularly for the ambidextrous type). In addition, ambidextrous score themselves higher than hunting-cultivating in terms of their future orientation and having their finger on the pulse of change. The hunting-cultivating firms in turn score themselves more highly than the traditional firms in this regard.

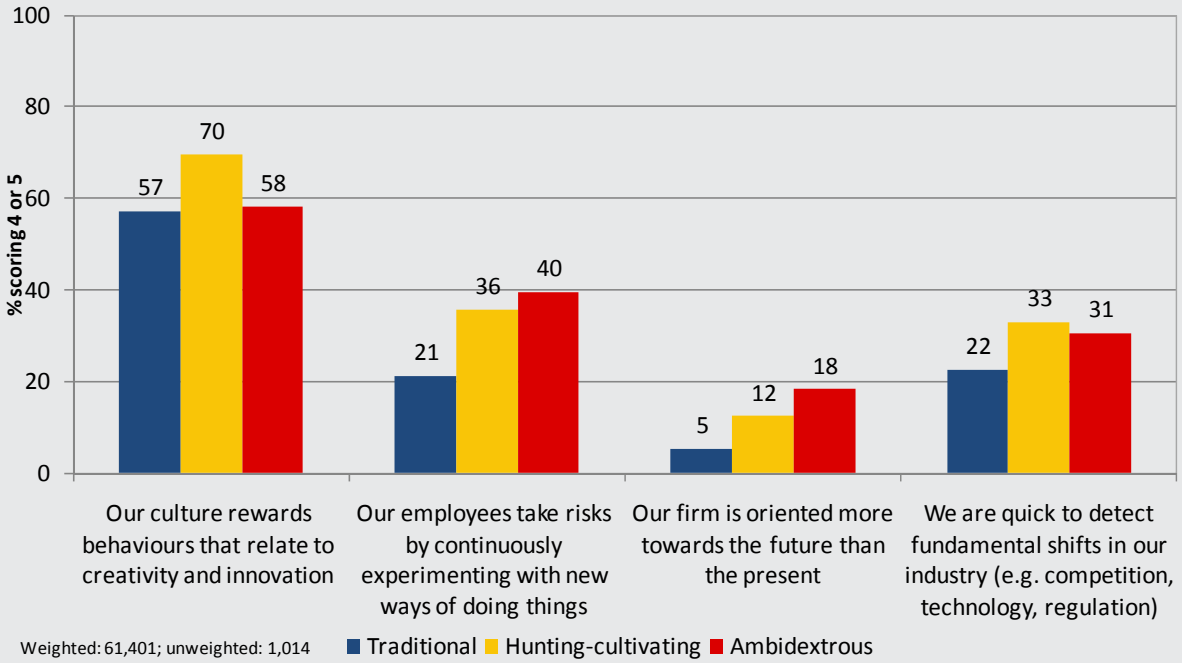
Finally, we ask the question of whether those firms whose attitudes are more oriented towards open innovation activities do indeed show this in their

Exhibit 1.6.1 Organisation form by OI type



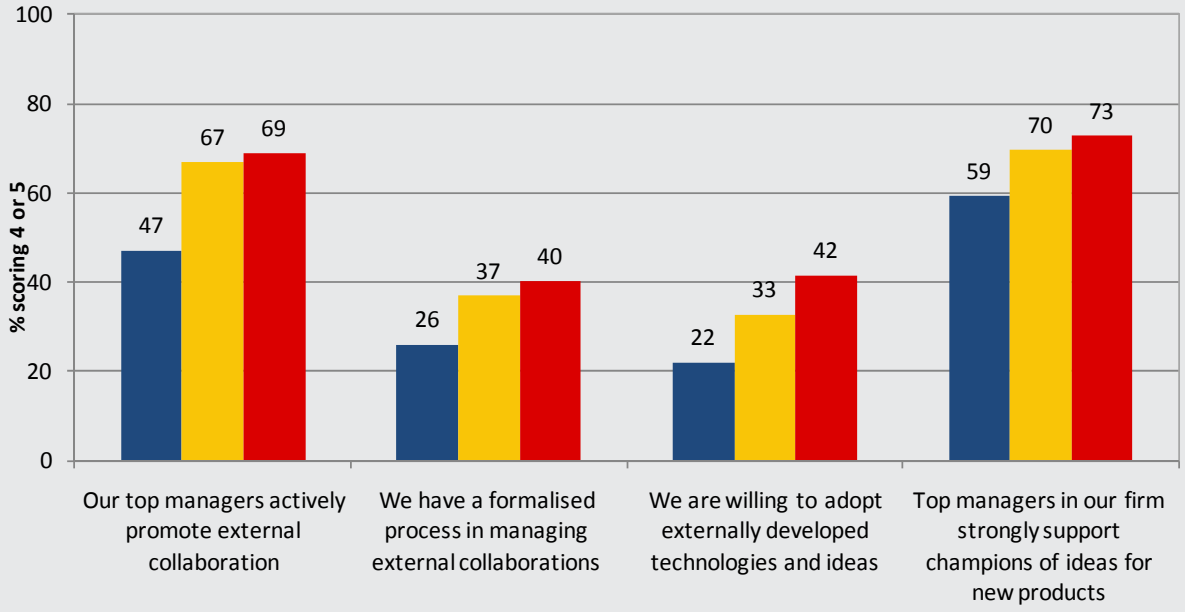
Weighted: 59,616; unweighted: 765

Exhibit 1.6.2 Business culture by OI type



Weighted: 61,401; unweighted: 1,014

Exhibit 1.6.3 Open innovation orientation by OI type



Weighted: 58,644; unweighted: 760

actions. The figures in Exhibit 1.6.3 do show that, on average, the firms 'put their money where their mouths are' in this way. More open firms are more likely to promote external collaboration and to have a formalised process for managing those activities. Greater openness is also associated with greater willingness to adopt externally developed technologies and ideas and to give greater support to those that champion those ideas. Of course, the data does not reveal whether the ideas and attitudes led to changes in practices, or whether the experience of open innovation activities changed attitudes towards it, but we suspect that it is a bit of both.

1.7. Summary

This chapter discussed the various activities that we argue can support an open orientation to innovation: seeking external knowledge (hunting); engaging in collaboration and partnerships (cultivating); and transferring knowledge and technology to others (exploiting). **Firstly**, we showed that the extent to which the practices are pursued varies dramatically across companies and for many companies the extent is very limited.

Secondly, we drew upon the measures of these open practices to cluster our companies into three forms of open innovation practice: traditional; hunting-cultivating; and ambidextrous. We showed that these OI types differed in terms of the full range of open innovation activities as we expected. This allowed us then to explore whether these groups of firms with common OI practices differed in other ways from each other.

Thirdly, to our surprise, we found no association between the choice of OI form made by firms and firm size, or firm age. Although we did find variations across sectors, it was also clear that all three forms of OI type were represented in each sector. Therefore, we conclude that firms of the same size, age and sector are making different choices about whether, and how, to engage in open innovation. Further exploration is needed to understand why these choices are being made and their impact on firm performance.

Fourthly, we found that the degree of openness was associated with business culture and the firm's orientation towards open innovation activities.

Fifthly, and perhaps most importantly, we found that open innovation was associated with superior growth performance and higher innovative activity. This is important in view of the growing emphasis on open innovation policies by both firms and governments. It is not possible at this stage to identify the transmission mechanisms at work, or to be sure of the direction of causation.

Chapter 2

INBOUND OI ACTIVITIES: into the funnel

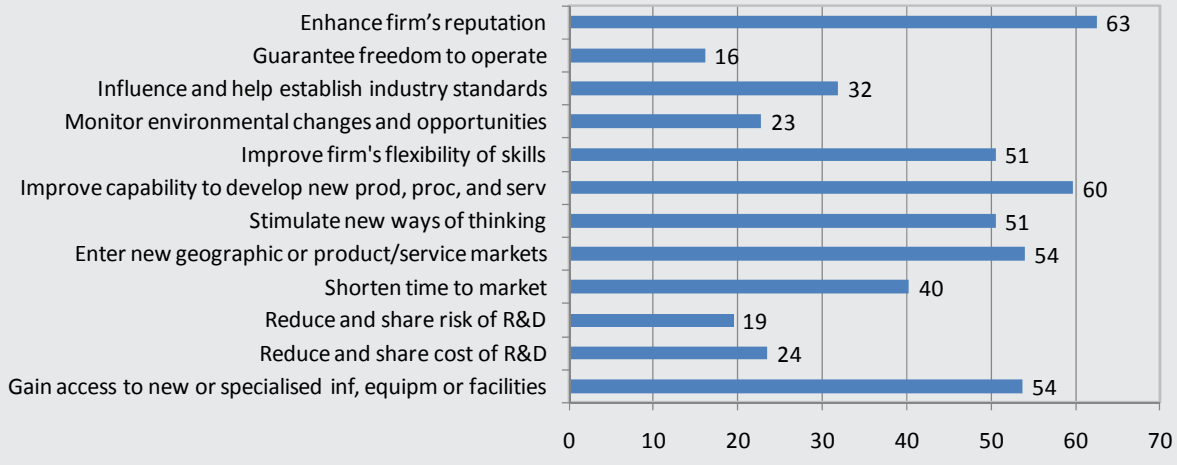
This chapter examines the 'inbound' open innovation activities of our sample companies. The survey did not specifically ask about open innovation, but instead included questions about those activities we associate with inbound innovation. These questions examined the companies' activities in sourcing information and knowledge as well as partnering and collaboration. The chapter begins by exploring their objectives before turning to their inbound activities (what they do and the importance they assign to them) and how these activities have changed over the last three years. It then turns to the companies' ability to carry out inbound activities and the constraints they face. Finally, the chapter shows their assessment of the outcomes of these activities and draws together the key findings and implications of this part of the survey.

2.1. Objectives

The companies were asked about their objectives in carrying out these "inbound" open innovation activities. In particular, they were offered twelve possible reasons for engaging in informal and/or formal activities with external parties to accelerate innovation; and they were also given the opportunity to write in other objectives (23 did so and the disparate answers they provided are not reported here). The question was asked only of those companies which had engaged in inbound activities and these respondents were asked to answer yes, or no, for each of the objectives (and were allowed to indicate multiple objectives). The findings for our whole population of companies is shown in Exhibit 2.1.1, indicating the percentage of active firms that said yes to that particular objective. For example, if we first look at the bottom row, it shows that 54% indicated that gaining access to new, or specialised, information, equipment and facilities was a reason for engaging with external parties in their innovation activities. Interestingly, the most common objective (63% of these companies) was enhancing the firm's reputation; and so we find that signalling is an important aspect of engaging in open innovation.

This is followed by improving the capability to deliver new products and processes (60%); entering new markets (54%, the same as that for gaining access to resources); to stimulate new ways of thinking (51%); to improve skills flexibility (51%); and to shorten the time to market (40%). Much lower proportions sought to reduce the risk (19%) or cost (24%) of R&D; and only 16% indicated these activities as a route to guaranteeing freedom to operate. Overall, reputation signalling, capability building and gaining access to knowledge and resources were the key objectives.

Exhibit 2.1.1 Purpose of collaboration: all firms (%)



Weighted: 47,977; unweighted: 805

Exhibit 2.1.2 Purpose of collaboration by size group

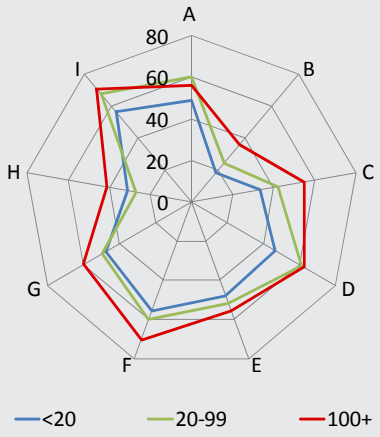


Exhibit 2.1.3 Purpose of collaboration by sector

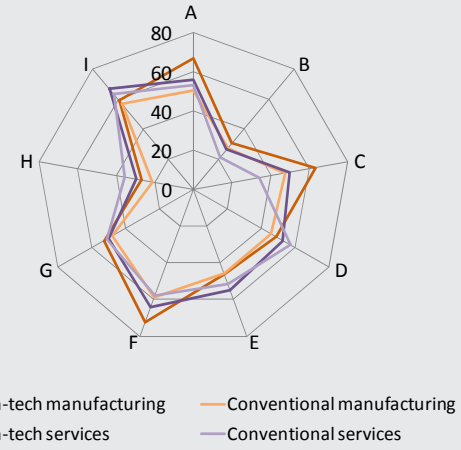
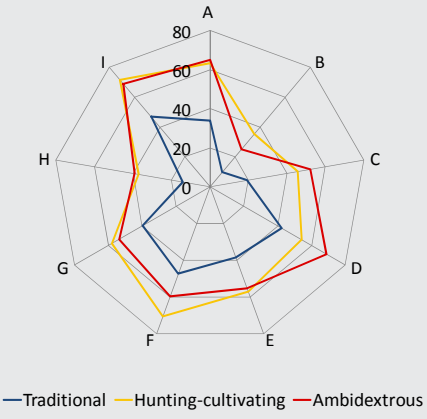


Exhibit 2.1.4 Purpose of collaboration by OI type



A= Gain access to new or specialised inf, equipm or facilities
B= Reduce and share cost of R&D
C= Shorten time to market
D= Enter new geographic or product/service markets
E= Stimulate new ways of thinking
F= Improve capability to develop new prod, proc, and serv
G= Improve firm's flexibility of skills
H= Influence and help establish industry standards
I= Enhance firm's reputation

Radar charts, Exhibits 2.1.2-4, are presented to show how these objectives differ in their absolute and relative importance across various types of company. Exhibit 2.1.2 shows the nine most important objectives by our three size categories. The micro companies show lower proportions than the other two size categories and this suggests that their motives are more focused (and perhaps that their activities are less widespread). On the other hand, the medium sized firms are more likely to give improving skills and capabilities; shortening the time to market and reducing the cost of R&D; and influencing standard-setting as objectives. The small size class generally comes somewhere between the other two (except in the case of influencing standards); but the objectives of accessing resources, entering new markets and enhancing reputation are as common in this size group as found for medium sized firms.

Exhibit 2.1.3 shows that variations across the four sector categories are not substantial, apart from the observation that higher proportions of high-tech manufacturing firms expressed a wider range of objectives than their conventional counterparts. While enhancing the firm's reputation is the most common objective for both high-tech and conventional services firms; improving capabilities and gaining access to resources are common objectives for both high-tech services and manufacturing firms. Shortening time to market is also considered as a common objective by high-tech manufacturing firms.

Exhibit 2.1.4 shows a strong contrast between traditional and more "open" firms – the former seems to have more limited or focused motives than the latter, which again may be related to the extent of inbound activities they carried out. The other two OI types show broadly similar objectives but hunting-cultivating firms more commonly indicate improving capabilities and reducing the cost of R&D. Ambidextrous firms are more likely to seek entering new markets and shortening time to market from inbound activities.

2.2. Sourcing information and knowledge

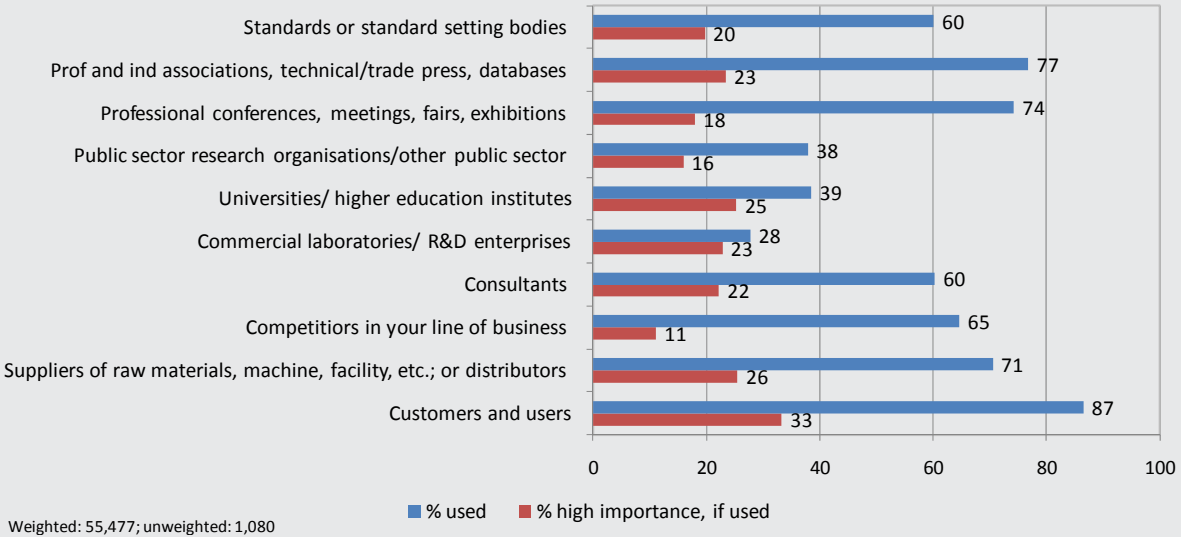
Searching for external information and knowledge is one of the most common features of open innovation. So companies were asked about whether particular sources of outside information and knowledge were used to accelerate innovation, and to what extent they were considered important. A total of fifteen external

sources were listed in the questionnaire, and here they are further grouped into ten sources under three broad categories: from other firms and markets — including customers and users, suppliers, distributors, competitors and consultants; from university and research centres — including commercial laboratories/R&D enterprises, universities/higher education institutes, public sector research organisations/other public sectors; and from public information sources — including professional conferences/ meetings/ fairs/ exhibitions, professional and industry associations/technical and trade press/computer databases, and technical, industry or service standards/standard setting bodies.

Exhibit 2.2.1 shows the findings for the whole population of UK companies, each source has two bars with the upper one indicating the percentage of firms that used a particular external information source, and the lower one showing the percentage of those who have used it that considers it to be of high importance for innovation. For example, if we first look at the bottom pair of bars, they show that 87% of firms indicated that they sourced information and knowledge from customers and users, which was the most frequently used external source; and the lower bar indicates that 33% of the firms that had used this source consider it highly important for innovation. Looking first across the frequency of usage of all external sources, customers and users are followed by professional and industry associations, technical/trade press, computer databases (77%), and professional conferences (74%), suppliers (71%), competitors (65%), consultants (60%) and technical standards etc. (60%). In general, it shows that firms frequently source information and knowledge from other firms and markets as well as public information sources in their inbound activities, although relatively low proportions of the firms using these sources assign high importance to them. At the same time, although university and research centres are among the least utilised sources, of those who have used them, relatively high proportions of firms consider them highly important. For instance, of those 39% of firms that used universities/HEIs in sourcing information, 25% consider it highly important. In comparison, while 71% of firms sourced information from suppliers, only 26% of them consider it to be of high importance. This also places universities/HEIs as the third most important source following customers and suppliers, suggesting that its relatively low usage is unlikely to be due to dissatisfaction with the outcome.

Exhibit 2.2.2 presents the percentage of usage of the three size groups. It shows that the pattern of sourcing external information and knowledge does not vary substantially across the size categories, and the frequency of usage among all sources is only slightly lower in most cases for micro firms compared with larger firms. This may reflect the challenge facing smaller firms — although constrained by their limited resources, smaller firms may have greater needs for sourcing knowledge extensively to accelerate innovation than larger firms. However, micro firms seem unable to access the research base and consultants.

Exhibit 2.2.1 External sources of information: all firms (%)



Weighted: 55,477; unweighted: 1,080

Exhibit 2.2.2 External sources of information by size group

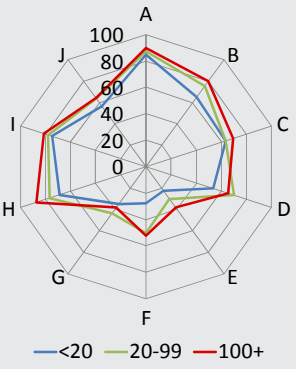


Exhibit 2.2.3 External sources of information by sector

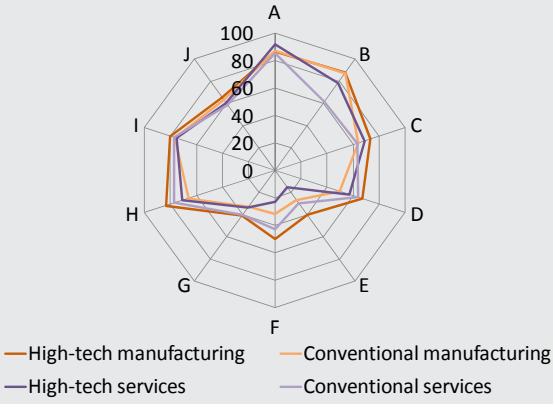
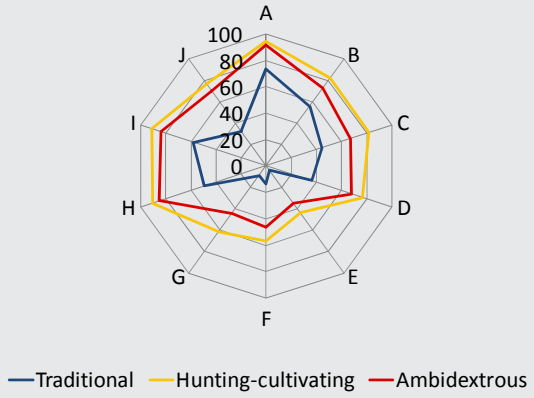


Exhibit 2.2.4 External sources of information by OI type



A= Customers and users
B= Suppliers of raw materials, machine, facility, etc.; or distributors
C= Competitiors in your line of business
D= Consultants
E= Commercial laboratories/ R&D enterprises
F= Universities/ higher education institutes
G= Public sector research organisations/other public sector
H= Professional conferences, meetings, fairs, exhibitions
I= Prof and ind associations, technical/trade press, databases
J= Standards or standard setting bodies

Across the three size groups, customers and users are the most frequently used external sources (above 85%), followed by professional associations/press/databases for micro firms (75%) and small sized firms (78%), and professional conferences/fairs etc. for medium sized firms (87%). Suppliers are another frequently used source among firms (65% for micro firms, 75% for the small sized firms and 80% for the medium sized firms). It also appears that, small sized firms have the highest level of usage of consultants (70%), including both business and technology and design consultants, in comparison with other size groups.

Exhibit 2.2.3 shows that the sourcing pattern across sectors is again rather similar, with some gentle variations. Both high-tech and conventional manufacturing firms are most likely to use suppliers to source information externally among other external sources, 88% and 87% respectively, whereas high-tech and conventional services firms are most likely to use customers and users, 92% and 85% respectively. Also, firms in the high-tech sectors have higher frequency in utilising customers, suppliers and competitors than those in conventional sectors. When it comes to use of university and research centres, the high-tech services firms are the least frequent users whereas high-tech manufacturing firms are the most frequent ones.

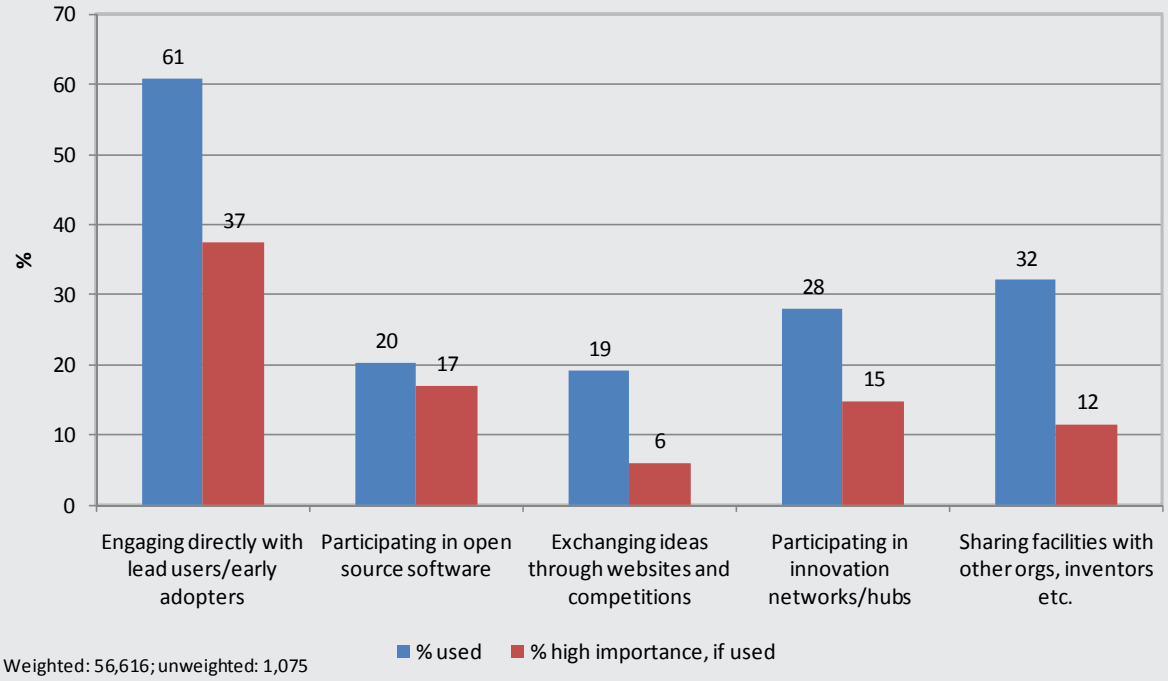
Exhibit 2.2.4 shows clearly that, our hunting-cultivating firms are the most frequent users of all ten external sources, whereas our traditional firms are the least active in sourcing. This is not surprising considering our clustering criteria. The hunting-cultivating and ambidextrous firms show a similar pattern of usage.

2.3. Informal collaborations

Companies were asked three related questions regarding their partnering activities in the last three years: 1) have they engaged in a particular form of informal and formal activities with external parties to accelerate innovation?; 2) if yes, how important is this particular form of activity?; and 3) has the use of this form changed during this period? Companies were also given the opportunity to write in if other forms had been adopted. We separate informal and formal activities in this question as the choice of governance in partnering is an important aspect of firms' open innovation strategy. We report the findings of informal activities first.

Exhibits 2.3.1-4 present the findings with regard to the first two questions above. Exhibit 2.3.1 shows

Exhibit 2.3.1 Engagement in informal activities to accelerate innovation: all firms (%)



Weighted: 56,616; unweighted: 1,075

the percentage of firms that had engaged in a particular form of informal collaboration in inbound activities and the percentage of those firms who had used this form that consider it of high importance. For instance, the highest column in the exhibit shows that, the most frequently used informal activity among all companies is engaging directly with lead users and early adopters (61%); and relatively speaking, rather high proportions of those firms (37%) consider this activity of high importance. All other informal activities were much less frequently used, including sharing facilities with other organisations, inventors, researchers etc. (32%) and participating in or setting up innovation networks/hubs with other firms (28%). The least frequently used activities were exchanging ideas through submission websites and competitions (19%) and participating in open source software development (20%). Apart from engaging directly with lead users and early adopters, the users of these informal collaborations rate them as important in less than one fifth of the cases.

Radar charts 2.3.2-4 show that different crosscuts follow the above trend in general with smaller firms showing lower usage proportions. Across size cuts (Exhibit 2.3.2), whilst engaging directly with lead users and early adopters were the most frequent informal activities adopted by all size groups, small sized firms used this form most frequently (75%). Higher proportions of medium sized firms had engaged in open source software development (36%), setting up innovation networks/hubs (35%) and exchanging ideas through submission websites and competitions (35%). This is not surprising, as high levels of resources and commitment are often required to enact and manage these activities.

Exhibit 2.3.2 Engagement in informal activities to accelerate innovation by size group

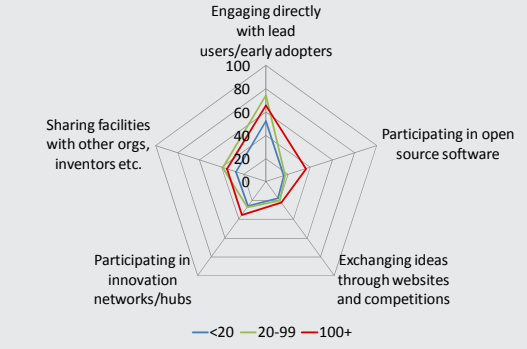


Exhibit 2.3.3 Engagement in informal activities to accelerate innovation by sector

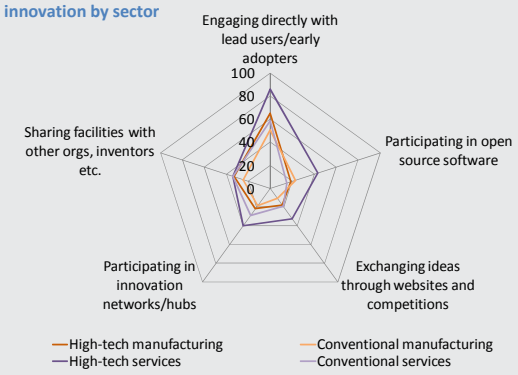
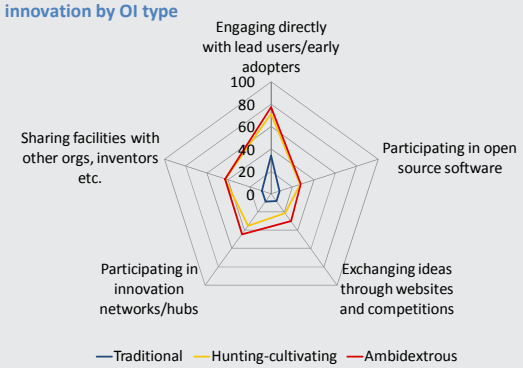


Exhibit 2.3.4 Engagement in informal activities to accelerate innovation by OI type



Across our four sector cuts, shown in Exhibit 2.3.3, while high-tech firms were more likely to engage in informal activities than conventional firms, much higher proportions of high-tech services firms had engaged in all forms of informal activities than the other three sector groups with the exception of sharing facilities with other organisations.

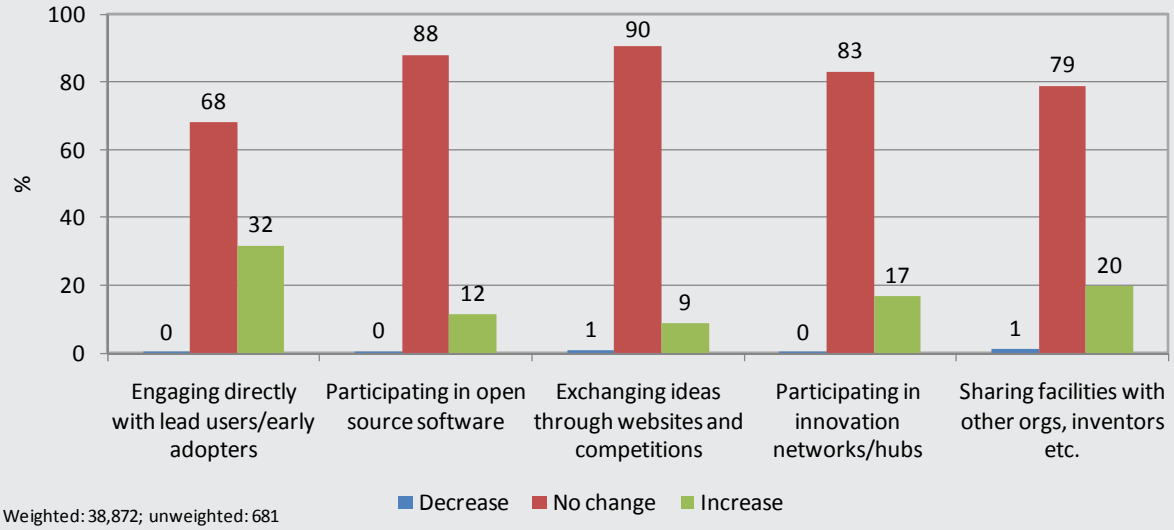
Exhibit 2.3.4 shows that, our ambidextrous firms were the most frequent users of all five forms of informal activities, whereas our traditional firms were the least active in such informal collaborations. Hunting-cultivating firms exhibit the same pattern of usage as ambidextrous firms but with a somewhat lower level of usage, other than in the case of open source software.

The respondents were asked to assess whether their informal collaboration activities had increased, remained the same, or decreased over the last three years; and our findings are summarised in the next two exhibits.

The first of these, Exhibit 2.3.5, reveals that whilst the majority of firms had not changed their informal activities, 32% of them had increased their activities in engaging directly with lead users and early adopters, nearly no firm had decreased this type of activity. Sharing facilities with others increased as an activity for one-fifth of the firms, but there was less change in activities for the other types of informal engagement.

Exhibit 2.3.6 shows the variations in the net change pattern (% of those showing an increase in activity minus % showing a decrease) by size, sector and OI type cuts. Across size groups, firms of all sizes had increased their activities. This seems to reflect the emergence of novel open innovation practices among firms of all sizes in recent years. The net increases are found to be lower for the micro firms and the medium sized firms have higher net increases for open source

Exhibit 2.3.5 Change in engagement in informal activities to accelerate innovation: all firms (%)



Weighted: 38,872; unweighted: 681

Exhibit 2.3.6 Net change in engagement in informal activities to accelerate innovation by size group, sector and OI type (%)

	Engaging directly with lead users/early adopters	Participating in open source software	Exchanging ideas through websites and competitions	Participating in innovation networks/hubs	Sharing facilities with other orgs, inventors etc.
Employment					
<20	25	9	7	16	14
20-99	40	9	12	16	26
100+	35	20	5	19	19
Sector					
High-tech manufacturing	30	12	5	14	11
Conventional manufacturing	25	8	4	13	12
High-tech services	36	18	8	15	12
Conventional services	33	10	9	18	23
OI type					
Traditional	21	9	4	7	9
Hunting-cultivating	32	12	3	17	15
Ambidextrous	35	12	13	26	28

software and participating in networks. On the other hand, small firms show the largest net increase for engaging with lead users, sharing facilities and exchanging ideas.

A higher proportion of services firms had increased their engagement in informal activities than manufacturing firms. If we look at the four sector categories, we can see that conventional services firms have the highest net increase in sharing facilities with other organisations, inventors, researchers etc. (23%), as well as for participating in or setting up innovation networks/hubs with other firms (18%). High-tech services firms have the highest net increase for engaging directly with lead users and early adopters (36%), and for participating in open source software development (18%).

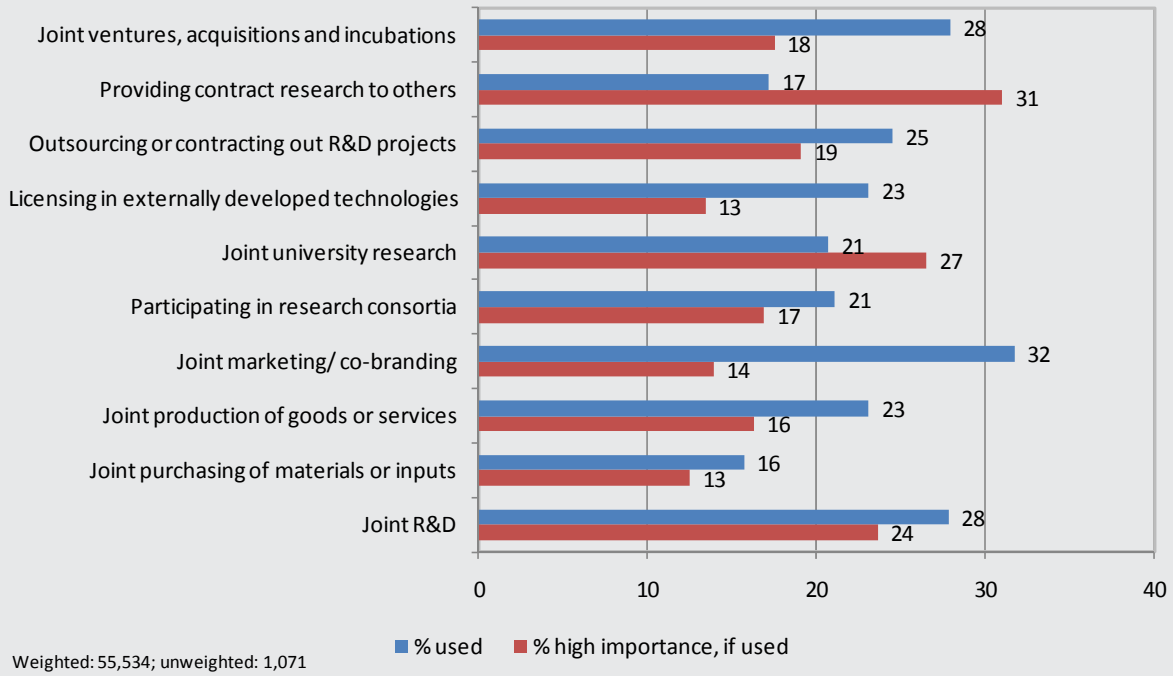
Our analysis across our OI types follows the general trend — all types of firms have shown higher net increases in direct engagement with lead users and early adopters compared with other informal activities. In general, higher average net increases are found for more open firms than traditional firms. The net increase over the previous three years is greatest for ambidextrous firms, but their net increase is matched by hunting-cultivating firms for open source software development and engagement with lead users.

2.4. Formal collaborations

The companies were also asked about the level of, and change in their, use of ten types of formal collaboration. Generally speaking, firms used formal activities much less frequently than sourcing. Among the population of firms, the most frequently used formal collaboration form to accelerate innovation appears to be joint marketing/co-branding, as indicated by the longest row in Exhibit 2.4.1. While 32% of firms have used this form, only 14% of those firms consider this activity to be of high importance. Other frequently used formal activities include: joint R&D (28%); joint ventures, acquisitions and incubations (28%); outsourcing and contracting out R&D projects (25%); licensing in externally developed technologies (23%); joint production of goods and services (23%); participating in research consortia (21%); and joint university research (21%). The least frequently used types of formal collaboration are: providing contract research to others (17%); and joint purchasing of materials or inputs (16%). It is interesting to note that, although providing contract research and joint university research are not the most widely used formal activities, higher proportions of those who have used them consider them to be highly important (31% and 27% respectively). Joint R&D is also considered important for those who have used this form (24%). This feature echoes our earlier findings about the importance attached to these areas in terms of firms' sourcing activities.

Exhibit 2.4.2 shows the percentage use of formal activities across the three size classes. Whilst joint marketing/co-branding was the most widely used formal activity for both small sized (39%) and micro firms (28%), joint R&D was the most frequently used form for medium sized firms

Exhibit 2.4.1 Engagement in formal activities to accelerate innovation: all firms (%)



Weighted: 55,534; unweighted: 1,071

(46%). This seems to suggest that smaller firms tend to engage in downstream collaborations along their value chain activities, whereas larger businesses are more frequently involved in both upstream and downstream collaborations. The exhibit shows that larger firms also carry out all types of formal collaboration activities more frequently than smaller firms with the exception of joint marketing.

Looking across the four sectors, we can see that high-tech firms use formal collaborations more frequently than conventional firms, whereas joint marketing/co-branding is most frequently used by services firms and joint R&D by manufacturing firms. Exhibit 2.4.3 shows the pattern of variation across the four sector categories. For high-tech manufacturing firms, the most frequently used forms are joint R&D (42%) and outsourcing and contracting out R&D projects (42%), whereas the least used one is joint purchasing of materials or inputs (17%). For high-tech services firms, licensing in externally developed technologies is the most frequently used form (42%), and the least used ones are joint purchasing of materials or inputs (17%) and joint university research (19%). Among conventional firms, joint R&D is the most frequently used form for conventional manufacturing firms (32%), and joint ventures, acquisitions and incubations is the most frequently used one for conventional services firms (29%).

Exhibit 2.4.4 clearly shows that, not surprisingly, more open firms use all forms of formal

Exhibit 2.4.2 Engagement in formal activities to accelerate innovation by size group

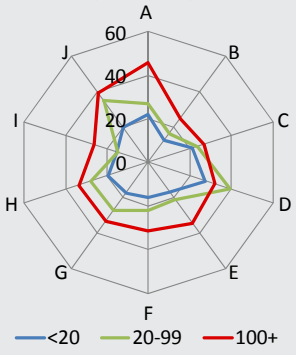


Exhibit 2.4.3 Engagement in formal activities to accelerate innovation by sector

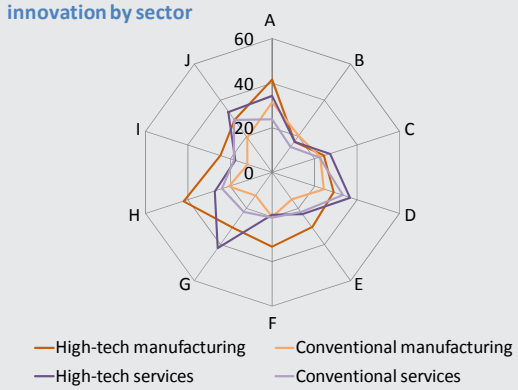
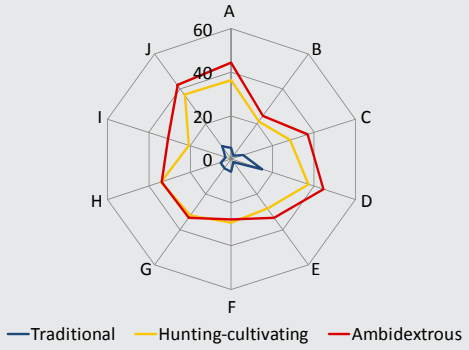


Exhibit 2.4.4 Engagement in formal activities to accelerate innovation by OI type



A= Joint R&D
B= Joint purchasing of materials or inputs
C= Joint production of goods or services
D= Joint marketing/co-branding
E= Participating in research consortia
F= Joint university research
G= Licensing in externally developed technologies
H= Outsourcing or contracting out R&D projects
I= Providing contract research to others
J= Joint ventures, acquisitions and incubations

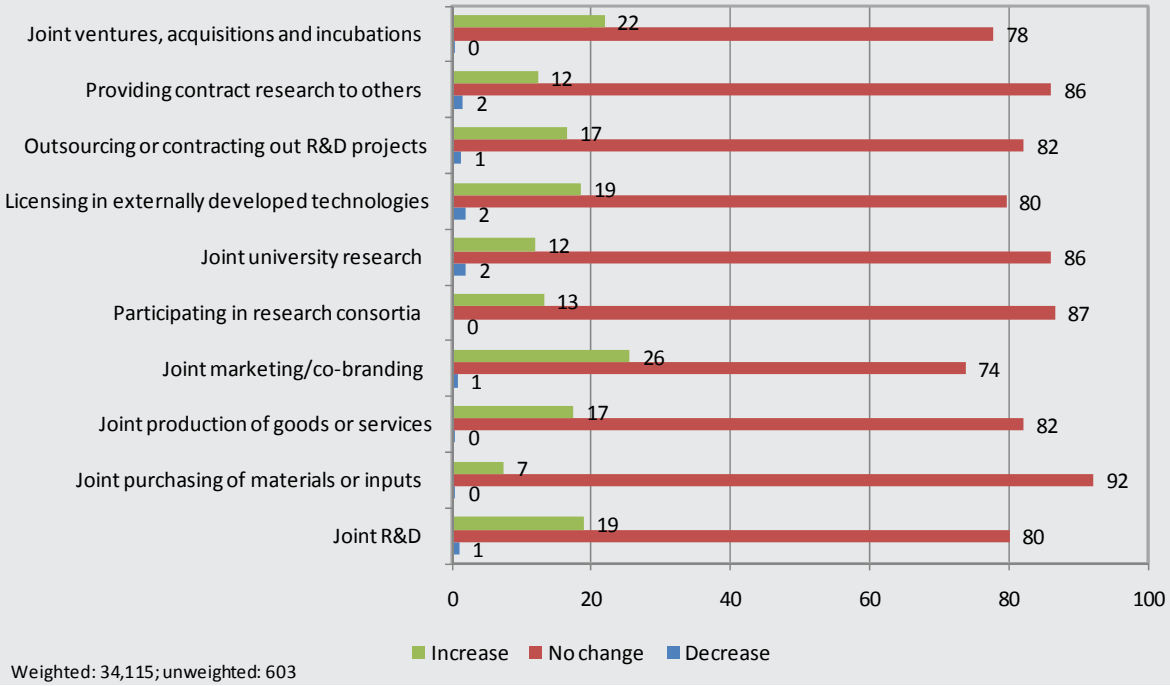
collaborations more frequently than our traditional firms. It also reveals that a higher proportion of the ambidextrous firms use all of these formal collaborations than our hunting-cultivating firms, with the exception of joint university research.

Exhibit 2.4.5 shows the change in these formal collaborations over the previous three years. Similar to informal activities, we find that the majority of the firms had not changed their formal collaboration activities over the last three years, and nearly no firm had decreased such activities. Among all of these activities, a relatively high proportion of firms had increased their formal engagement in joint marketing/co-branding (26%), joint ventures, acquisitions and incubations (22%), and joint R&D (19%).

Across the three size categories, Exhibit 2.4.6 shows that micro firms have made fewer changes among most formal activities than the other two size groups. We also note that, high proportions of small sized firms have increased their activities in: licensing in externally developed technologies (30%); joint production of goods and services (26%); joint marketing/co-branding (31%); joint ventures, acquisitions and incubations (31%); and joint R&D (25%). Medium sized firms have the higher percentage use only for: joint R&D (27%); research consortia (21%); and university research (16%), so these activities are clearly not the preserve of larger firms.

Exhibit 2.4.6 shows that, whilst conventional firms have been catching up in formal activities compared with high-tech firms over the last three years, it is conventional services firms that predominantly drive this trend in all forms of

Exhibit 2.4.5 Change in engagement in formal activities to accelerate innovation: all firms (%)



Weighted: 34,115; unweighted: 603

Exhibit 2.4.6 Net change in engagement in formal activities to accelerate innovation by size group, sector and OI type (%)

	Joint R&D	Joint purchasing of materials	Joint production of goods or services	Joint marketing/ co-branding	Participating in research consortia	Joint university research	Licensing in externally developed technologies	Outsourcing or contracting out R&D projects	Providing contract research to others	Joint ventures, acquisitions and incubations
Employment										
<20	10	8	14	19	7	11	5	12	10	14
20-99	25	6	26	31	18	5	30	20	16	31
100+	27	7	11	28	21	16	27	17	4	26
Sector										
High-tech manufacturing	26	7	12	16	15	16	16	18	7	16
Conventional manufacturing	24	8	14	19	10	8	7	12	6	14
High-tech services	13	6	16	17	8	7	13	8	7	19
Conventional services	17	7	19	29	15	11	20	18	13	25
OI type										
Traditional	4	0	8	23	2	4	7	9	1	11
Hunting-cultivating	19	9	15	20	14	17	18	19	12	25
Ambidextrous	27	9	26	28	18	7	22	15	17	25

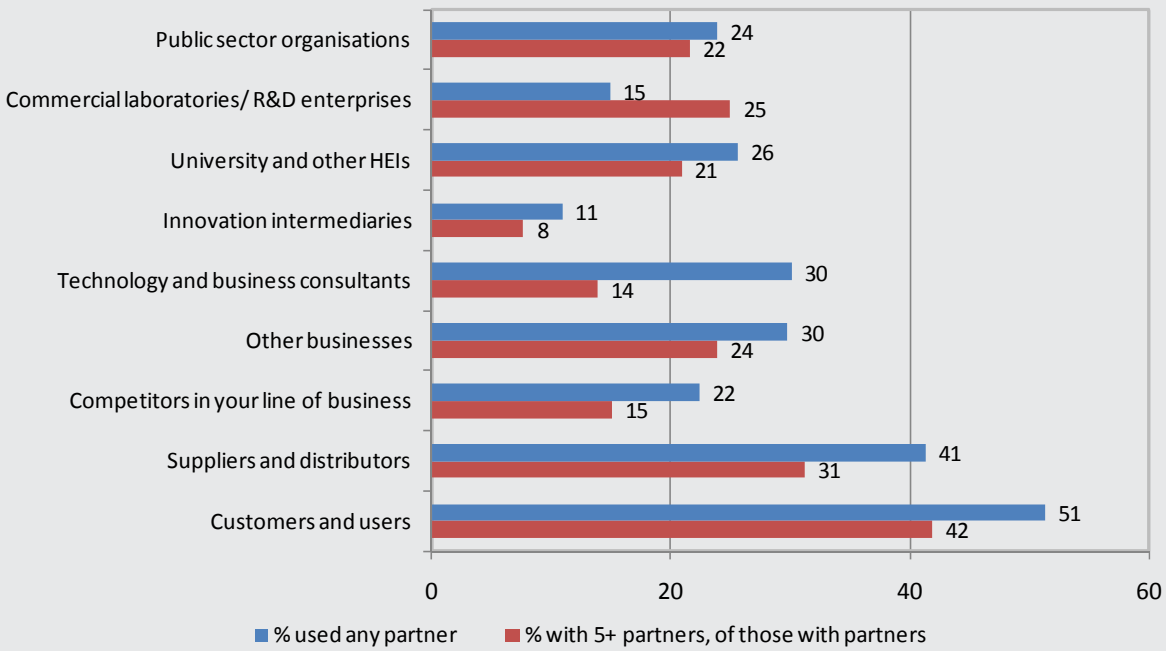
activities except joint R&D, joint university research, and joint purchasing of materials or inputs.

Exhibit 2.4.6 also shows that, our traditional firms not only have a low level of activity in this area but also are the least active in increasing their formal activities, except for joint marketing/co-branding. And higher proportions of ambidextrous firms have increased their formal activities in all forms except outsourcing or contracting out R&D projects and joint university research, than the hunting-cultivating firms. This may account for the similar levels of usage of these types of collaboration that we showed above.

2.5. Partners of formal collaborations

To further explore formal collaboration activities, we asked companies about the number and type of external partners that the company had engaged with in the last three years (the firms could indicate 0, 1, 2-4, or 5+ partners of each type). In addition, the firms were asked whether their activities with these types of partner had decreased, not changed, or increased over the previous three years. Exhibit 2.5.1 indicates the

Exhibit 2.5.1 Use of partners of formal collaboration: all firms (%)



Weighted: 54,882; unweighted: 1,052

Exhibit 2.5.2 Use of partners of formal collaboration by size group

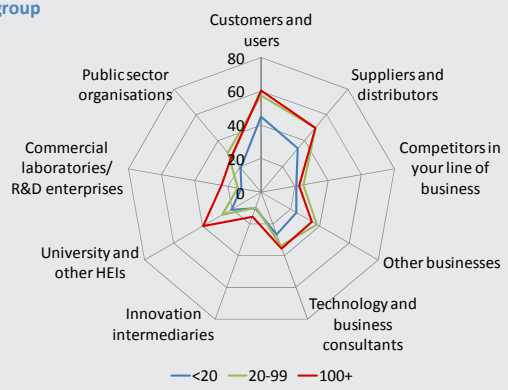


Exhibit 2.5.3 Use of partners of formal collaboration by sector

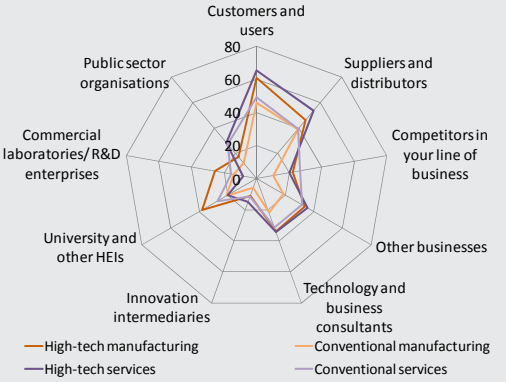
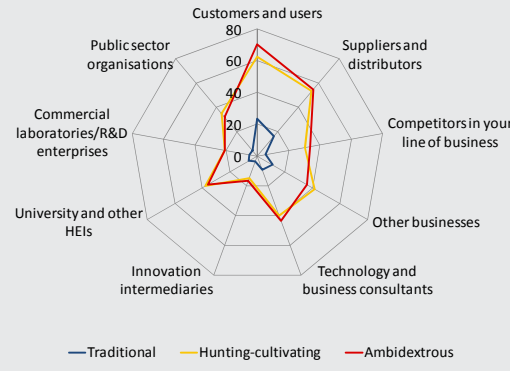


Exhibit 2.5.4 Use of partners of formal collaboration by OI type



percentage of firms that had engaged in formal collaborations with a particular type of partner and, for those that have that type of partner, the percentage who had engaged with more than 5 partners. For example, the bottom two rows show that the most likely partners of formal collaborations among all firms are customers and users (51%) and 42% of those firms have more than 5 partners. Other popular partners include suppliers and distributors (41%), other businesses (30%) and technology and business consultants (30%). 26% of firms collaborate with university and other HEIs, and 24% with public sector organisations, and 22% with competitors. Whilst only 15% of firms collaborate with commercial labs/R&D enterprises, a high proportion of them had more than 5 partners (25%). The least likely partner seems to be innovation intermediaries (11%).

Exhibit 2.5.2 shows that, in general, small and medium sized firms are more likely to collaborate with various types of partners than micro firms, except with innovation intermediaries. Customers and users are the most likely partners for all three types - micro firms (45%), small sized firms (58%) and medium sized firms (60%), followed by suppliers and distributors. Medium sized firms are more likely to have partners drawn from the research base than smaller firms.

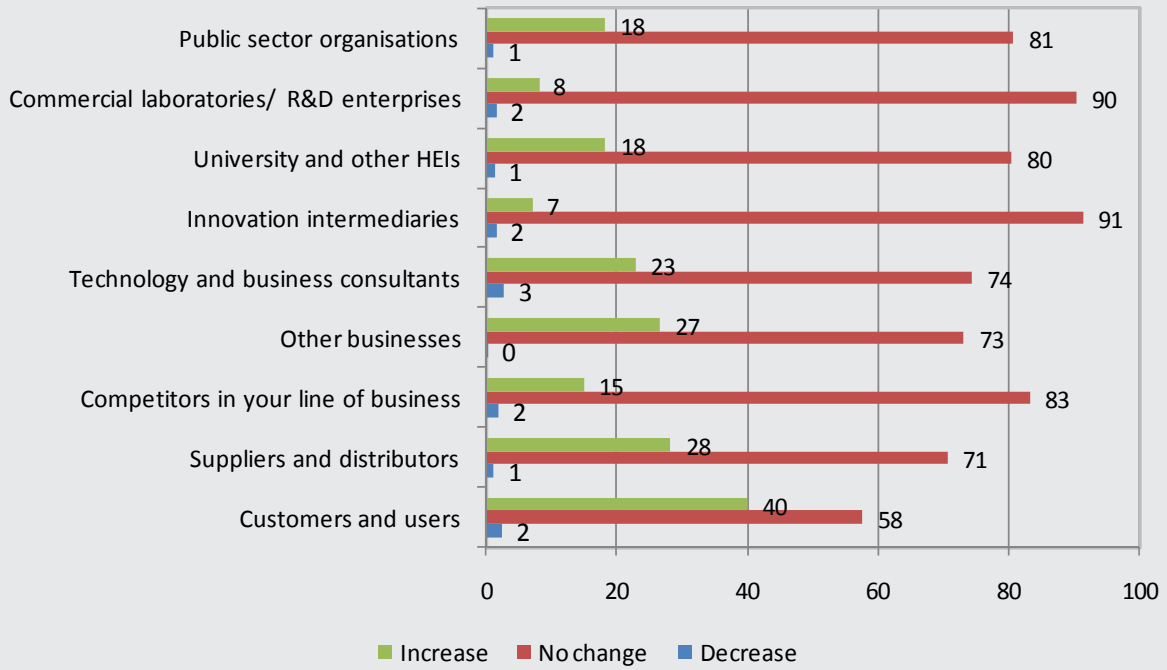
Exhibit 2.5.3 shows that conventional manufacturing firms tend to partner less widely and frequently than other firms. High-tech services firms tend to engage relatively more than the other groups with customers and suppliers and distributors. High-tech manufacturing firms show the highest proportion with partners drawn from the science base.

Exhibit 2.5.4 shows a strong contrast between more open firms (ambidextrous firms and hunting-cultivating firms) and traditional firms. The former collaborate much more extensively than the latter and the pattern of partner usage is very similar for these two OI types. Once again, the most frequently chosen partners for all types are customers and users, and suppliers and distributors.

Exhibit 2.5.5 shows that, whilst the majority of firms had not changed their partnering activities during the previous three years, certain types of partner had seen a significant increase in their use. In particular, the largest increases in engagement were with: customers and users (40%); suppliers and distributors (28%); other businesses (27%); and technology and business consultants (23%). Again a very low proportion of firms had decreased their formal partnering.

Exhibit 2.5.6 shows the net change (% increase minus % decrease) of firms' use of formal collaboration with various types of partners. Micro firms generally had the smallest increase in the use of these types of partners. Across all of the different size categories the largest average increase was in their engagement in formal collaboration with customers and users, followed

Exhibit 2.5.5 Change in use of partners of formal collaboration: all firms (%)



Weighted: 38,501; unweighted: 689

by suppliers and distributors and other businesses. The medium sized firms were also more likely to increase formal partnering with university and other HEIs, but small firms showed higher increases than medium sized firms in a number of areas.

The exhibit also shows that, across our four sector categories, once again, customers and users and suppliers and distributors are among the most likely types of partners in terms of the increase in firms' collaboration activities. High-tech and conventional firms showed similar increases in these partnering activities over the previous three years. Indeed, the conventional services firms had the highest increase in collaboration activities with: other businesses (34%); technology and business consultants (22%); competitors (17%); and public sector organisations (22%). Both conventional services firms (19%) and high-tech manufacturing firms (24%) had increased collaboration with university and other HEIs.

Exhibit 2.5.6 presents an interesting picture for our OI types. Our traditional firms had a low level of use of partners and lower increases in their use over the previous three years. The increase in partnering activity by the ambidextrous firms

Exhibit 2.5.6 Net change in use of partners of formal collaboration by size group, sector and OI type (%)

	Customers and users	Suppliers and distributors	Competitors in your line of business	Other businesses	Technology and business consultants	Innovation intermediaries	University and other HEIs	Commercial laboratories/ R&D enterprises	Public sector organisations
Employment									
<20	29	20	11	18	12	6	13	8	10
20-99	43	37	16	38	29	4	16	6	27
100+	50	30	14	29	26	7	29	3	20
Sector									
High-tech manufacturing	41	34	10	19	14	8	24	10	9
Conventional manufacturing	35	29	3	10	15	4	15	7	6
High-tech services	38	24	12	18	19	10	8	2	13
Conventional services	38	27	17	34	22	5	19	7	22
OI type									
Traditional	30	21	5	18	7	5	3	5	7
Hunting-cultivating	46	26	12	22	26	1	21	3	22
Ambidextrous	33	31	21	37	21	12	24	12	21

appears to be right across the value chain and was generally higher than for hunting-cultivating firms. However, the latter showed higher average increases of partnering activities with customers and users (46%).

2.6. Abilities and constraints

Abilities

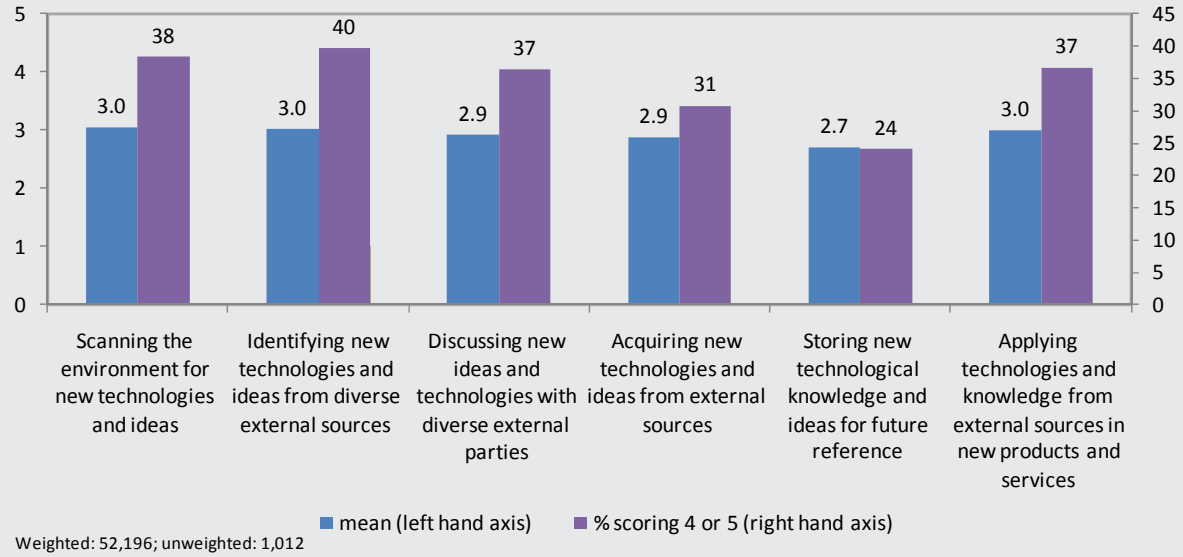
We asked respondents to assess their firms' ability to utilise external knowledge and technology in inbound OI practices along six different procedural aspects: scanning the environment for new technologies and ideas; identifying new technologies and ideas from diverse external sources; discussing new ideas with diverse external parties; acquiring new technologies and ideas from external sources; storing new knowledge and ideas for future reference; and applying technologies and ideas from external sources in new products and services. As shown in the left-hand columns in Exhibit 2.6.1, on average, firms considered their ability to carry out inbound activities to be about average (1 was assigned to a low ability and 5 to a high ability). The right-hand column of each set shows the proportion of firms that scored 4 or 5, indicating a high ability in this area. Between 36% and 40% of firms regarded themselves as having good or excellent inbound-related abilities in scanning the environment, identifying new ideas and technologies, discussing them with external parties and applying them to new products and services. Lower proportions scored themselves highly in terms of acquiring these technologies and ideas (31%) and in storing them for future use (24%). Clearly, identification of possibilities and getting hold of them are seen differently.

Exhibit 2.6.2 shows our respondents' assessments of their abilities for different types of firm. It suggests that small sized firms are most confident in their abilities of identifying, discussing and acquiring new technologies and ideas from external sources, compared with the other two size categories. And micro firms seem to lead in the case of applying and storing new technologies and ideas. This pattern may indicate that medium sized firms are more conservative in assessing and scoring their abilities.

The exhibit shows a strong contrast between high-tech services and conventional manufacturing firms. On the one hand, much higher proportions of high-tech services firms indicated that they have superior abilities in engaging in inbound activities to the other three groups in all aspects, with the exception of discussing new ideas and technologies with diverse external partners. On the other hand, much lower proportions of conventional manufacturing firms indicated that they have superior abilities in engaging in inbound activities to the others. In general, we find that services firms and high-tech firms are more open for innovation.

Exhibit 2.6.2 shows a clear order among the three OI groups. Ambidextrous firms considered themselves as having superior abilities in managing inbound activities to hunting-cultivating firms; and the latter scored themselves more highly than traditional.

Exhibit 2.6.1 Ability to utilise external knowledge and technology: all firms



Weighted: 52,196; unweighted: 1,012

Exhibit 2.6.2 Ability to utilise external knowledge and technology by size group, sector and OI type (%)

	Scanning the environment for new technologies	Identifying new technologies and ideas	Discussing new ideas and technologies with diverse external parties	Acquiring new technologies and ideas from external sources	Storing new technological knowledge and ideas for future reference	Applying technologies and knowledge from external sources in new products and services
Employment						
<20	37	36	34	31	27	39
20-99	40	48	42	36	22	37
100+	39	36	35	21	20	30
Sector						
High-tech manufacturing	42	45	31	30	24	38
Conventional manufacturing	23	31	23	24	19	29
High-tech services	53	47	36	38	34	54
Conventional services	40	41	42	32	24	36
OI type						
Traditional	26	26	20	24	16	27
Hunting-cultivating	40	44	37	28	23	37
Ambidextrous	52	51	55	44	36	47

Constraints

Exhibit 2.6.3 presents the firms' views about the extent to which particular factors have limited their firm's ability to make maximum use of knowledge and technology brought into the firm over the previous three years (on a scale of 1 = insignificant to 5 = crucial constraint). Firms tend to consider all the listed constraints as slightly significant, as indicated by the mean scores (around 2 out of 5) in the upper row (of each type). The lower row in the same exhibit shows the percentage of firms that consider a particular factor as a significant, or crucial, limitation. Generally speaking, firms tend to consider time constraints (30%) and lack of financial resources (27%) as the two most significant and crucial constraints; whereas partners located too far away geographically (3%) and internal cultural issues (e.g. Not invented here syndrome) (4%) appear to be the least concerns for our respondents.

Exhibit 2.6.4 shows the percentage of firms indicating that they face a significant, or crucial, constraint across the three size groups (N.B. the least significant constraints are removed from this exhibit for clarity). We find a similar pattern across all size categories with two interesting variations — cultural differences between partners and lack

Exhibit 2.6.3 Factors limiting the ability to utilise external knowledge and technology: all firms

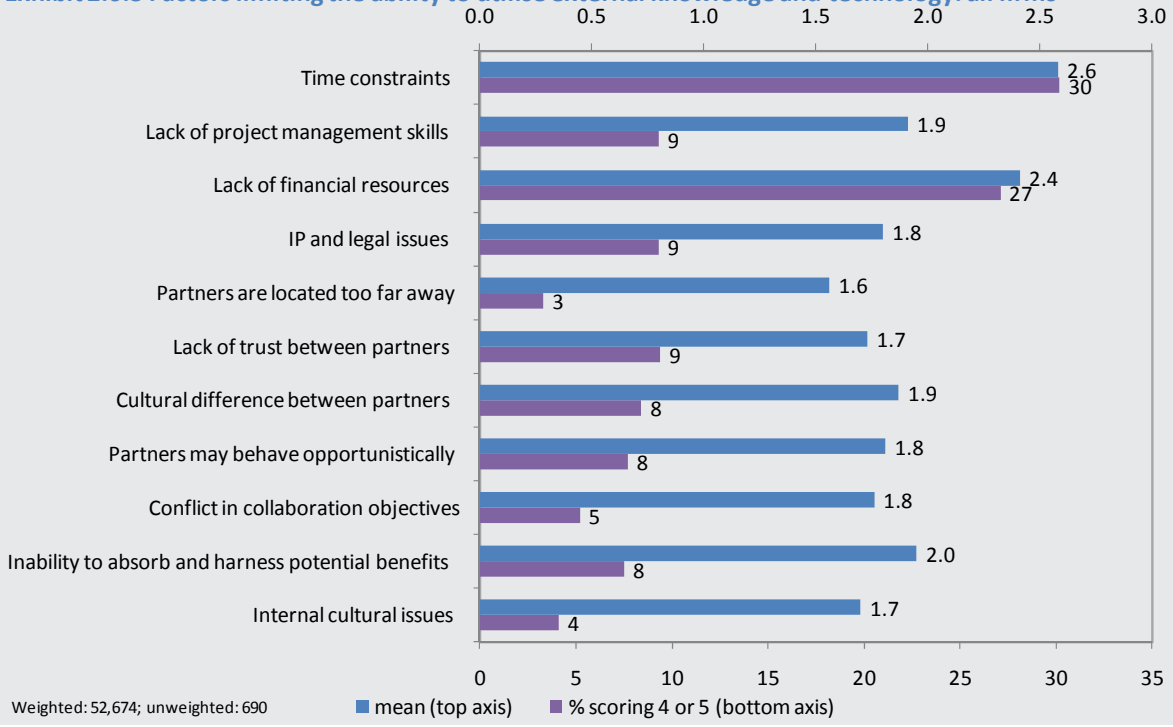


Exhibit 2.6.4 Factors limiting the ability to utilise external knowledge and technology by size group, sector and OI type (%)

	Inability to absorb and harness potential benefits	Conflict in collaboration objectives	Partners may behave opportunistically	Cultural difference between partners	Lack of trust between partners	IP and legal issues	Lack of financial resources	Lack of project management skills	Time constraints
Employment									
<20	6	4	8	8	9	9	28	10	30
20-99	7	5	8	3	6	8	29	9	31
100+	11	9	7	20	18	13	22	7	30
Sector									
High-tech manufacturing	8	11	10	9	7	12	22	17	31
Conventional manufacturing	3	4	8	6	7	10	20	10	23
High-tech services	4	4	10	9	7	13	23	3	23
Conventional services	10	5	7	9	11	8	31	10	34
OI type									
Traditional	4	1	6	4	8	9	17	8	23
Hunting-cultivating	12	7	12	10	12	9	25	12	26
Ambidextrous	8	7	5	13	7	11	35	9	45

of trust between partners are more likely to be crucial limitations for medium sized and, to a lesser extent, micro firms than for small sized firms. This might reflect the difficulties encountered by micro and medium sized firms in collaborating with each other. IP and legal issues are more likely to be considered as a major constraint in the case of medium sized firms.

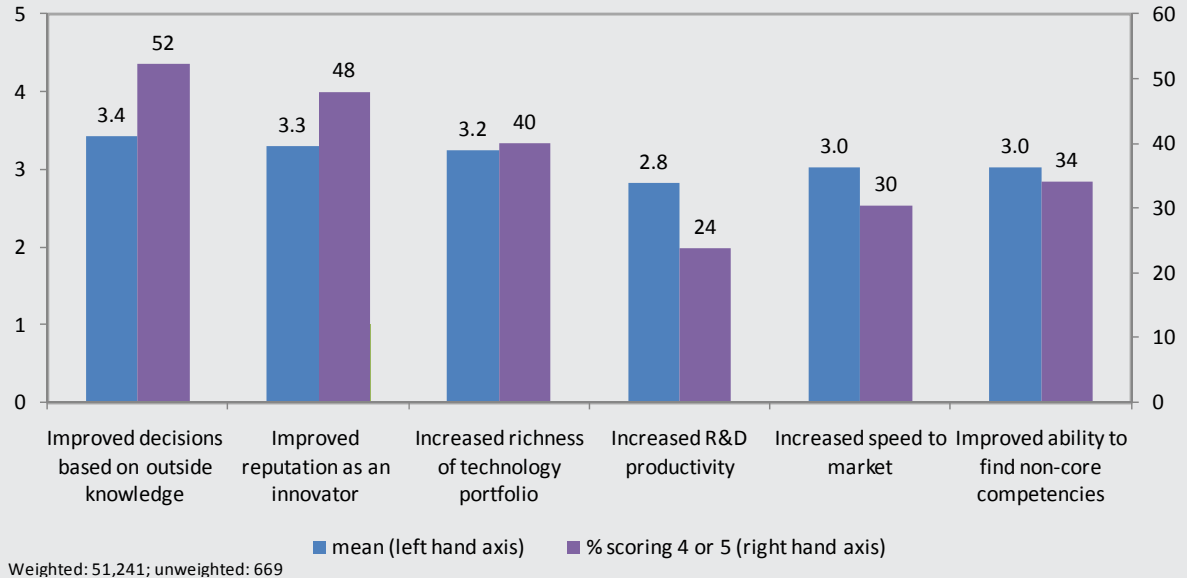
Analysis across sectors shows again that time constraints and lack of financial resources were the most crucial constraints for all types of firms, with conventional services firms indicating the highest level of frequency. Lack of project management skills and conflict in collaborative objectives between partners were also major concerns for high-tech manufacturing firms, compared with the other groups. Lack of financial resources and time constraints were greatest for conventional services.

While the variations across our OI types shown in Exhibit 2.6.4 follow the general pattern, ambidextrous firms are much more likely to voice concerns over lack of financial resources (35%) and time constraints (45%) than the other OI types.

2.7. Outcomes

Companies were also asked to assess the impact of inbound activities in relation to company performance in six different areas (they were asked to comment on the statement that these aspects of innovation performance had improved as a consequence on a scale from 1 = strongly disagree to 5 = strongly agree). Exhibit 2.7.1

Exhibit 2.7.1 Impact of inbound activities: all firms



Weighted: 51,241; unweighted: 669

shows, in the left-hand column the mean score for each performance effect and, in the right-hand column, the proportion of firms that scored a significant impact from these inbound activities (scoring 4 or 5). The average scores of around three in the left-hand columns suggest that there is not much confidence on average that these inbound activities have led to improved innovation performance. If we consider the right-hand columns that represent the percentages of firms indicating positive effects we find that the highest are improved decisions based on knowledge gained from outside (52%), and improved reputation as an innovator in the marketplace (48%); and the least satisfactory outcome seems to be increased R&D productivity — only 24% of firms considered that they had done well in this area.

Exhibit 2.7.2 Impact of inbound activities by size group

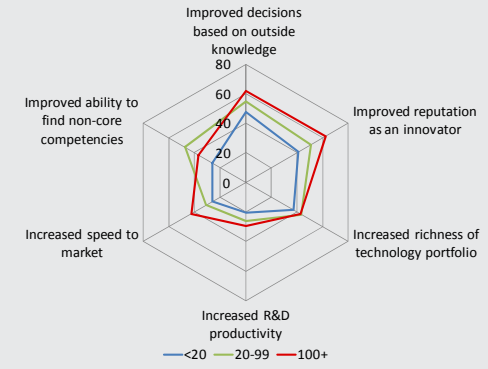


Exhibit 2.7.3 Impact of inbound activities by sector

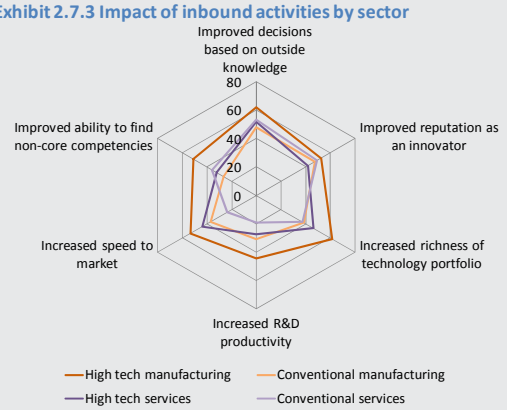
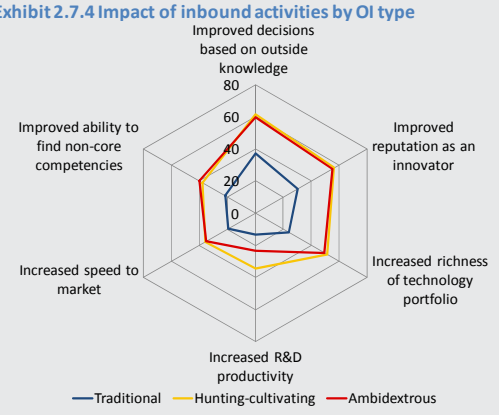


Exhibit 2.7.4 Impact of inbound activities by OI type



We can see in Exhibit 2.7.2 that, in comparison with micro firms, small and medium sized firms seem to gain more from carrying out inbound activities, but this might be expected since they are more active in this area. It is also worth noting that small firms gain more in improved ability to find non-core competencies than medium sized firms.

It is not surprising to see, in Exhibit 2.7.3, that inbound activities seem to benefit high-tech manufacturing firms the most in comparison with the other three sector categories even though we have found the services sector to be as open innovation active. Exhibit 2.7.4 examines the success of inbound activities for aspects of innovative performance for our three OI types. It shows a similar pattern for each and suggests that traditional firms benefit the least in comparison with more OI active firms.

2.8. Summary

In this section of our survey, we set out to gain a more detailed and fuller picture of UK firms' inbound activities in four different aspects — sourcing, informal and formal collaboration and their partners. We note that, **firstly**, in general, firms used sourcing activities much more frequently than informal and formal collaborations; the only exception was engaging directly with lead users and early adopters.

Secondly, firms searched widely among a wide range of external sources, including other firms and markets, public information sources, as well as university and other research organisations. Among them, customers and users are by far the most frequently used external sources by all firms. We also note that, while search breadth matters, the proportion of firms that considered these sources highly important (i.e. search depth) is not strikingly high, with the exception of customers and users. Interestingly, while firms used university and research organisations less frequently to source information and knowledge, those who did considered this a highly important source. This pattern seems to continue in firms' collaboration activities. Among informal collaboration activities, firms recorded the highest frequency in engaging directly with lead users and early adopters. Among formal collaborations, joint marketing and co-branding, presumably with some

of those customers and users, is the most frequently used form. Further, joint university research is again considered a highly important form of collaboration by those who have done so.

Thirdly, when looking across different size, sector and OI type cuts, generally speaking, larger firms had engaged more extensively in inbound activities sourcing than micro firms, in terms of frequency of usage of various types of partners and change in inbound activities in the last three years. The same can be said for the more open firms, ambidextrous and hunting-cultivating firms, vis-à-vis traditional firms. At the same time, variations across sectors differ depending on particular forms of inbound activities, suggesting that there is no one optimal form of "openness" across sectors. Furthermore, most firms that were engaged in formal collaborations reported that they had not changed their collaboration and partnering activities over the last three years. This seems to suggest that despite the growing emphasis on open innovation during this period, the increase in activity has been modest.

Fourthly, we also probe into firms' abilities and constraints in carrying out these inbound activities. We find that more firms considered that they had superior abilities in identifying new technologies and ideas from external sources than in acquiring and storing ideas. However, the variations among different kinds of abilities are not substantial. With regard to constraints, the most common ones were time constraints and lack of financial resources and the pattern persists across different cuts.

Last, but not least, when we compare firms' objectives in conducting inbound open innovation activities with how satisfactory they consider the impact of such activities, we find a mixed picture. The good news is, while 63% of firms set out to enhance the firm's reputation, the most common motive, 48% agree or strongly agree that these activities have improved their reputation as an innovator in the marketplace. On the other hand, while firms identified improving capabilities to develop new products, processes and services as the second most common objective, relatively lower proportions of firms indicate that they have increased R&D productivity and speed to market. Further analysis is required to probe into the missing link between motives and outcomes.

Chapter 3

OUTBOUND OI ACTIVITIES AND PROTECTIONS: managing the "leaky" funnel

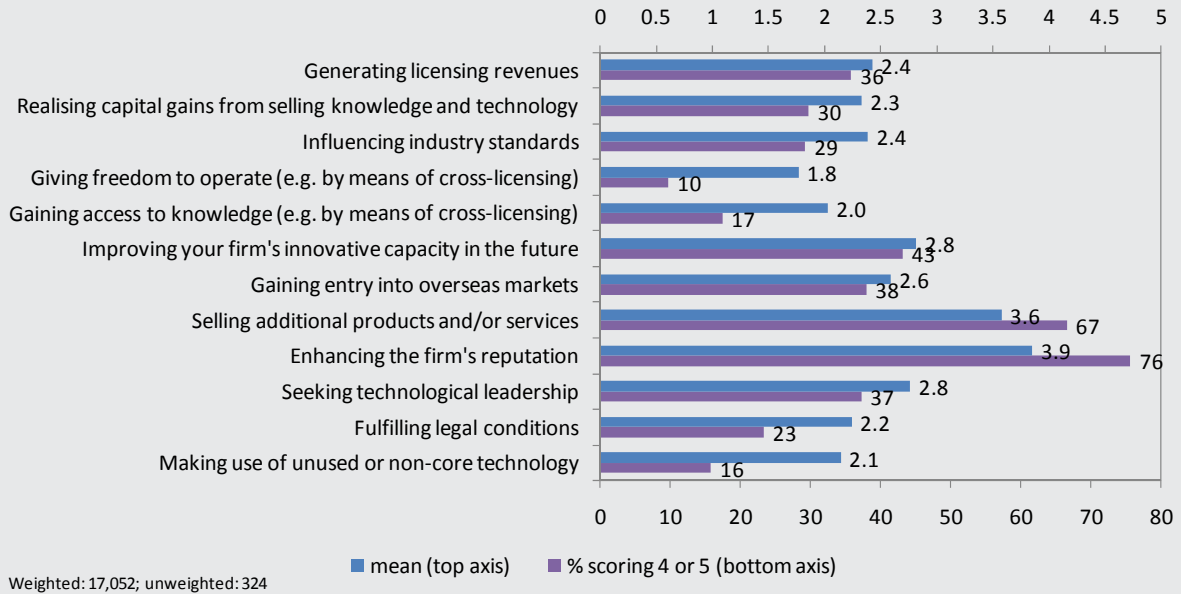
Companies principally design their innovation activities to enhance the products and services they offer and to increase the market traction of their offerings; but they may also enhance their performance by exporting the fruits of their innovation activities. This chapter examines these 'outbound' open innovation activities of our sample companies, i.e. taking internally owned knowledge and technology outside the company to accelerate innovation and create value. After exploring companies' motives, the chapter looks at the forms and revenue sources of these external transfer activities over the last three years. It then turns to companies' methods of protecting their innovation activities, their patenting activities and rationale behind them, as well as the problems and constraints they face in protecting their innovation. Finally, the chapter draws together the key findings and implications of this part of the survey.

3.1. Objectives

Companies were given twelve possible objectives for carrying out outbound activities, and they were asked to rate the relative importance for each of them, ranging from "not at all important" (scored 1) to "extremely important" (scored 5). It should be noted that the question was answered only by those firms that had carried out external transfer in the last three years. Exhibit 3.1.1 presents, for each possible motive, the mean score among all firms (the upper row) and the percentage of those which rated it very or extremely important (the lower row). The mean score for most objectives is around the middle (2.5), with enhancing reputation (3.9) and selling additional products and services (3.6) being the most important objectives, and "giving freedom to operate" the least important (1.8). Interestingly, firms were most motivated by enhancing reputation in carrying out both inbound and outbound open innovation activities.

Radar chart 3.1.2 shows the variations by size. Generally speaking, a higher proportion of larger firms sought to achieve more of the objectives than smaller firms with a few exceptions. Small sized firms were more motivated to sell additional products and services and generate licensing revenues than medium and micro firms. Also, medium sized firms were least concerned with influencing industry standards, an objective micro firms considered more important than the other two size groups.

Exhibit 3.1.1 Objectives of external knowledge and technology transfer: all firms with outbound transfer



Weighted: 17,052; unweighted: 324

Exhibit 3.1.2 Importance of objectives of external knowledge and technology transfer by size group

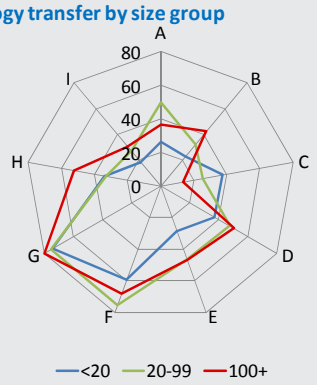
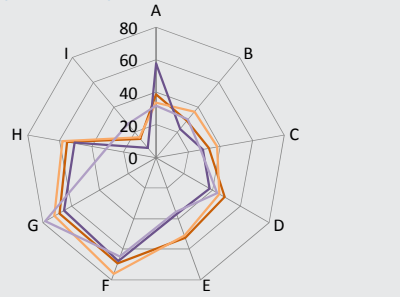


Exhibit 3.1.3 Importance of objectives of external knowledge and technology transfer by sector



A= Generating licensing revenues
B= Realising capital gains from selling knowledge and technology
C= Influencing industry standards
D= Improving your firm's innovative capacity in the future
E= Gaining entry into overseas markets
F= Selling additional products and/or services
G= Enhancing the firm's reputation
H= Seeking technological leadership
I= Fulfilling legal conditions

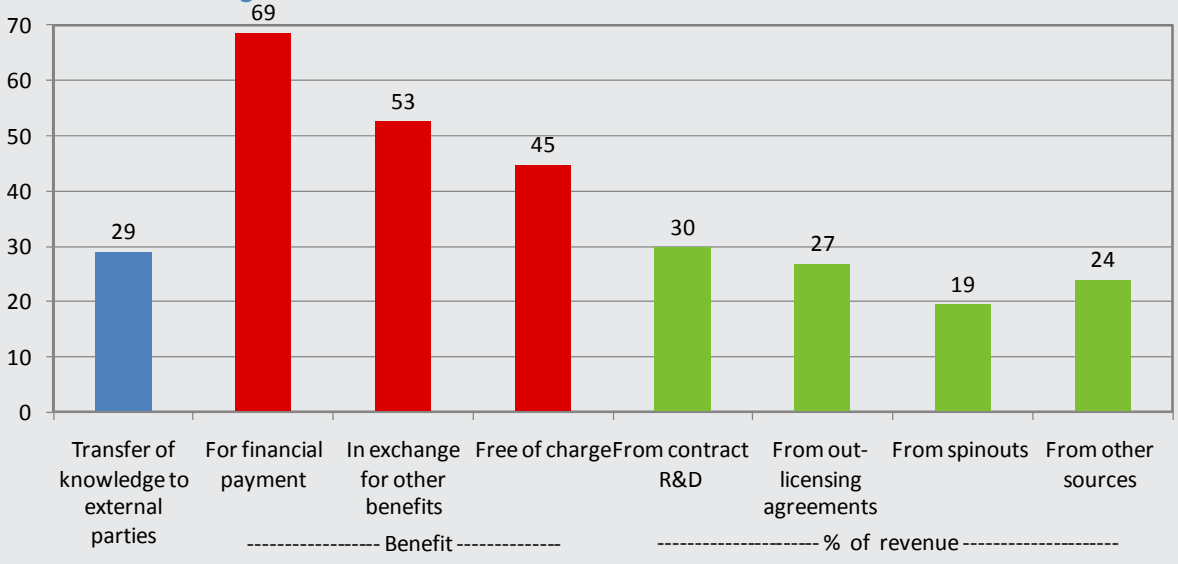
Exhibit 3.1.3 shows that the pattern is rather similar across our four sector groups with two interesting spikes – higher proportions of conventional services firms were motivated to enhance reputation, and higher proportions of high-tech services firms sought to generate licensing revenues, compared with other types of firms.

3.2. Activities and outcomes

To explore companies' outbound practices and outcomes, the survey asked companies three questions sequentially. First, companies were asked about whether they had transferred their knowledge or technology to external parties over the last three years. If yes, then they were asked whether the transfer was made for financial payment, in exchange for other benefits, or free of charge. The three forms are not mutually exclusive since more than one type of transfer may have been made by the same firm. Thirdly, those which had transferred externally, were asked to indicate how much revenue or income they had received from the following sources: out-licensing agreements, contract R&D, spinouts, and other revenue sources in the last financial year.

A summary of the findings is presented in Exhibit 3.2.1. From the left hand side, the first column indicates that 29% of firms in our population had carried out outbound activities over the last three years. This relatively low figure echoes the view in the literature that outbound OI activities are less common than inbound activities, but it also shows

Exhibit 3.2.1 Proportion of firms engaged in outbound transfers, the benefits they receive and the sources of financial gain



Weighted: 57,420; unweighted: 1,095

Exhibit 3.2.2 Proportion of firms engaged in outbound transfers, the benefits they receive and the sources of financial gain by size group, sector and type of innovator

	Employment			Sector				Type of innovator	
	< 20	20-99	100+	High-tech manufacturing	Conventional manufacturing	High-tech services	Conventional services	Non-novel	Novel
Transfer of knowledge to external parties	26	35	29	26	13	33	33	25	34
Benefit									
For financial payment	69	70	66	64	39	73	72	70	68
In exchange for other benefits	50	50	65	58	65	51	51	43	61
Free of charge	45	53	29	42	45	44	45	39	40
% of revenue									
From contract R&D	18	51	26	57	32	42	24	34	28
From out-licensing agreements	24	25	39	23	25	27	27	13	34
From spinouts	30	1	23	9	24	13	22	24	17
From other sources	29	23	12	11	19	18	27	28	22

that a significant minority are engaged in these activities.

The next three columns indicate that, of this 29% of firms, 69% of them had done it for financial payment, 53% in exchange for other benefits, and 45% free of charge. This supports our earlier finding that financial reward is not the sole objective for outbound activities. It also suggests that multiple forms of external transfers were adopted by companies.

For those that had charged financial payments in the outbound activities, the last four columns present the percentage distribution of external transfer revenue. It indicates that slightly more than a quarter of the "outbound" revenue came both from contract R&D (30%) and out-licensing agreements (27%); and revenues from spinouts and other sources account for slightly less, 19% and 24% respectively. In addition, 22 companies wrote in other sources of revenue and these were mainly associated with revenue such as consultancy income.

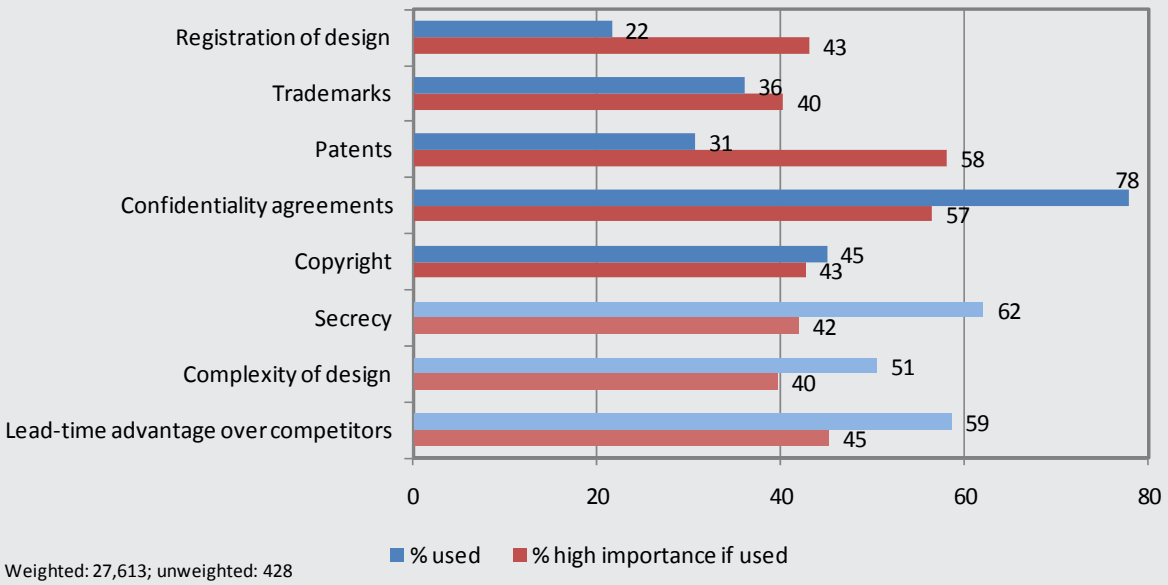
Exhibit 3.2.2 shows how the pattern of external transfer varies by size, sector and novel/non-novel innovators. Across size groups, we find an interesting "middle" syndrome, i.e. small sized firms were more active in transferring knowledge and technology externally than the other two groups. Further, smaller firms (i.e. micro and small sized firms) transferred knowledge for free more frequently than larger firms (i.e. medium sized firms). This raises the issue of whether this is intentional strategising by smaller firms or due to their weak bargaining power.

Looking at the distribution of revenue from external transfer, small sized firms gained over half of the revenue from contract R&D (51%), a quarter from out-licensing agreements (25%), and virtually no revenue from spinouts (1%). This seems to be at odds with one of their objectives – smaller sized firms were more motivated to achieve licensing revenues than other types. Out-licensing revenue accounted the most for medium sized firms (39%), and spinouts accounted the most for micro firms (30%). It seems that different size groups favour specific revenue sources.

Across our four sector groups, conventional manufacturing firms stood out as the least likely candidates to transfer knowledge externally. When they did, they exchanged for other benefits rather than for financial payments. This supports our earlier finding that conventional manufacturing firms were the most motivated to enhance their reputation and seek technology leadership of all types. In terms of the distribution of external transfer revenue sources, high-tech firms gained more from contract R&D than conventional firms. While high-tech manufacturing firms gained the least from spinout incomes, conventional manufacturing firms generated the highest proportion from this source of all types. This finding is somewhat counter-intuitive, which may relate to the extent and effectiveness of innovation protection methods used by high-tech manufacturing firms.

Only ambidextrous firms are engaged in external transfers and so only this OI type is included in Exhibit 3.2.1. So for our third crosscut of the data here we distinguish between novel innovators (those who have introduced an innovation new to their market) and other firms. Exhibit 3.2.2 reveals that there is no substantial difference in the frequency of external transfer between novel and non-novel innovators, (novel innovators led by a narrow margin), although the former transferred more often in exchange for other benefits than the latter. Again, we find that these practices match their objectives (though not included in this

Exhibit 3.3.1 Methods of innovation protection: all firms with outbound transfer



Weighted: 27,613; unweighted: 428

report). Much higher proportions of novel innovators were driven by strategic objectives such as influencing industry standards, improving the firm's innovative capacity, gaining entry into overseas markets and seeking technological leadership. Across all revenue sources, out-licensing agreements accounted more for novel innovators than for non-novel innovators.

3.3. Methods of protection

In order to appropriate value from their innovative products and services, companies need to use legal and/or strategic methods to protect their innovations. The survey asked which methods companies had used in recent years and how important they were (on a scale of 1-3 for low, medium and high importance). Legal methods include registration of design, trademarks, patents, confidentiality agreements and copyright; strategic methods include secrecy, complexity of design and lead-time advantage over competitors.

Exhibit 3.3.1 shows that, of all methods, confidentiality agreements were the most widely used method among the population of our companies (78%), followed by two strategic methods - secrecy (62%) and lead-time (59%). More than half of the companies used various strategic methods, and around 40% of them considered these methods highly important (scored 3 out of 3). In comparison, although legal methods were less widely used apart from confidentiality agreements, those which used these methods often considered them highly important. For instance, while only 31% of firms used patents, 58% of them regarded it crucial in order to protect their innovation. Among those 45% of companies that used copyright, 43% considered it highly important. This may reflect not only the effectiveness of the intellectual property regime, but also the availability of certain legal protection methods for products and services.

Exhibit 3.3.2 shows that larger firms are clearly more active in protecting their innovations than smaller firms – the former used both legal and strategic methods more frequently than the latter. This raises the issue of whether this is due to smaller firms' lack of resources, awareness or other constraints.

Across the four sector groups (Exhibit 3.3.3), high-tech manufacturing firms used all protection methods more frequently than other firms except for copyright, which was most frequently used by high-tech services. In general, high-tech firms used both strategic and legal methods more extensively than conventional firms except patents and registration of design, of which conventional manufacturing firms were frequent users. This may be associated with our earlier finding that high-tech manufacturing firms gained the least income from spinouts, whilst conventional manufacturing firms generated the highest proportion from this source.

Looking at the pattern across OI types (Exhibit 3.3.4), ambidextrous firms used various

Exhibit 3.3.2 Use of innovation protection methods by size group

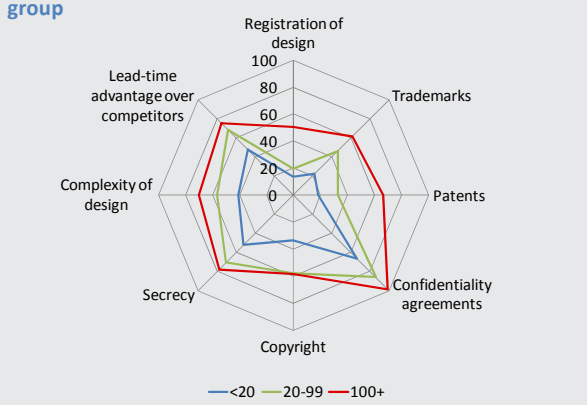


Exhibit 3.3.4 Use of innovation protection methods by OI type

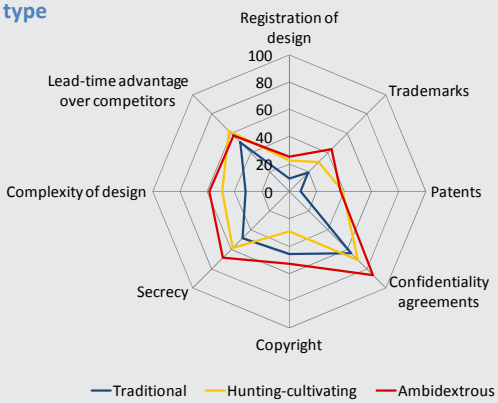
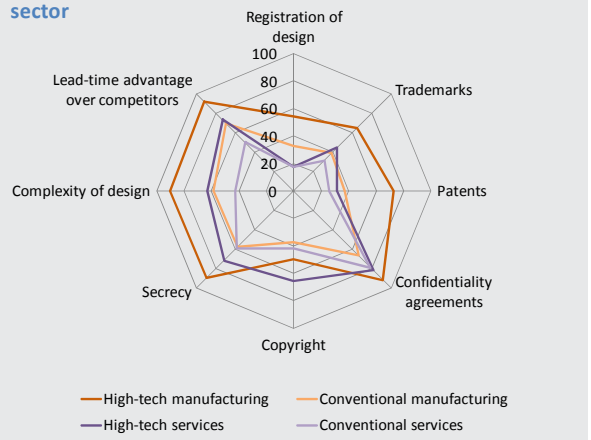


Exhibit 3.3.3 Use of innovation protection methods by sector



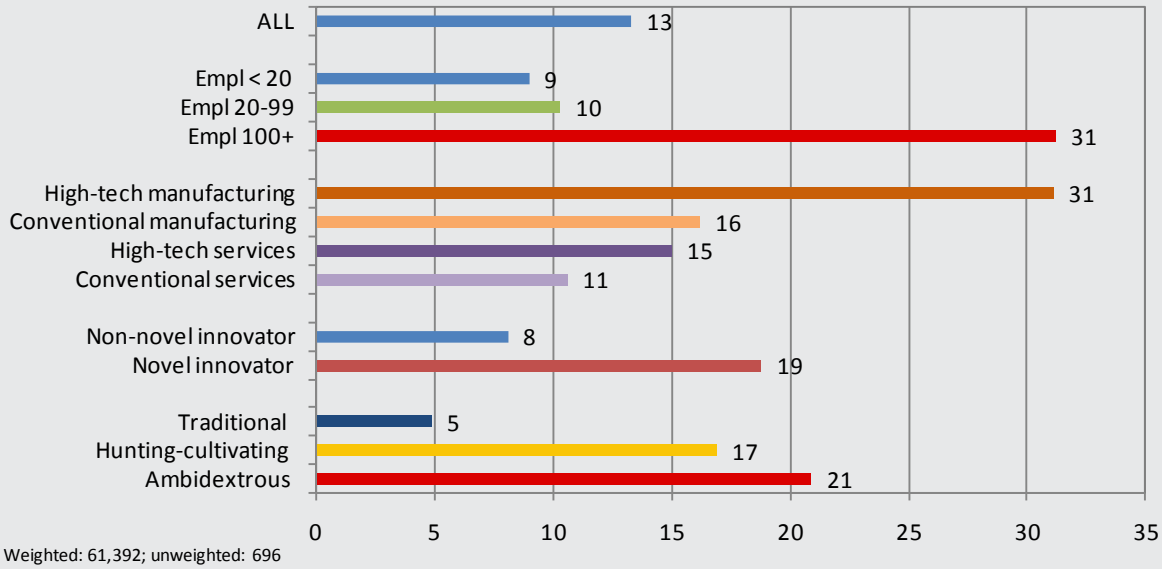
protections more frequently and more extensively than other types with the exception of lead-time advantage. This is to be expected since ambidextrous firms are the only type to transfer knowledge and technology externally. Traditional firms were the least frequent users of all protection methods except copyright. This may reflect that high-tech services firms account for a larger proportion of our traditional firms than hunting-cultivating firms.

3.4. Patents

Number of patents

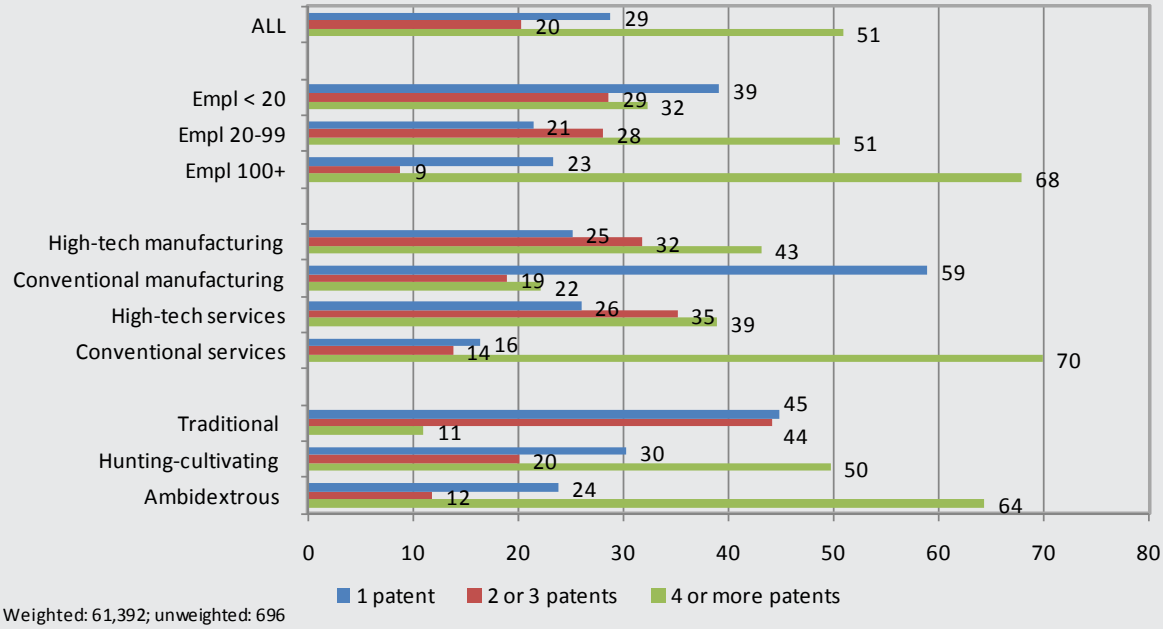
Considering patents as one of the most important methods of protection, the survey also asked companies how many patents they had been granted in the last three years. Exhibit 3.4.1 shows the percentage of firms that had patented among the population of our companies as well as

Exhibit 3.4.1 Percentage of firms that had taken out patents in the last 3 years: all, size group, sector, innovator and OI type



Weighted: 61,392; unweighted: 696

Exhibit 3.4.2 Number of patents taken out by those that had patented in the last 3 years: all, size group, sector and OI type



Weighted: 61,392; unweighted: 696

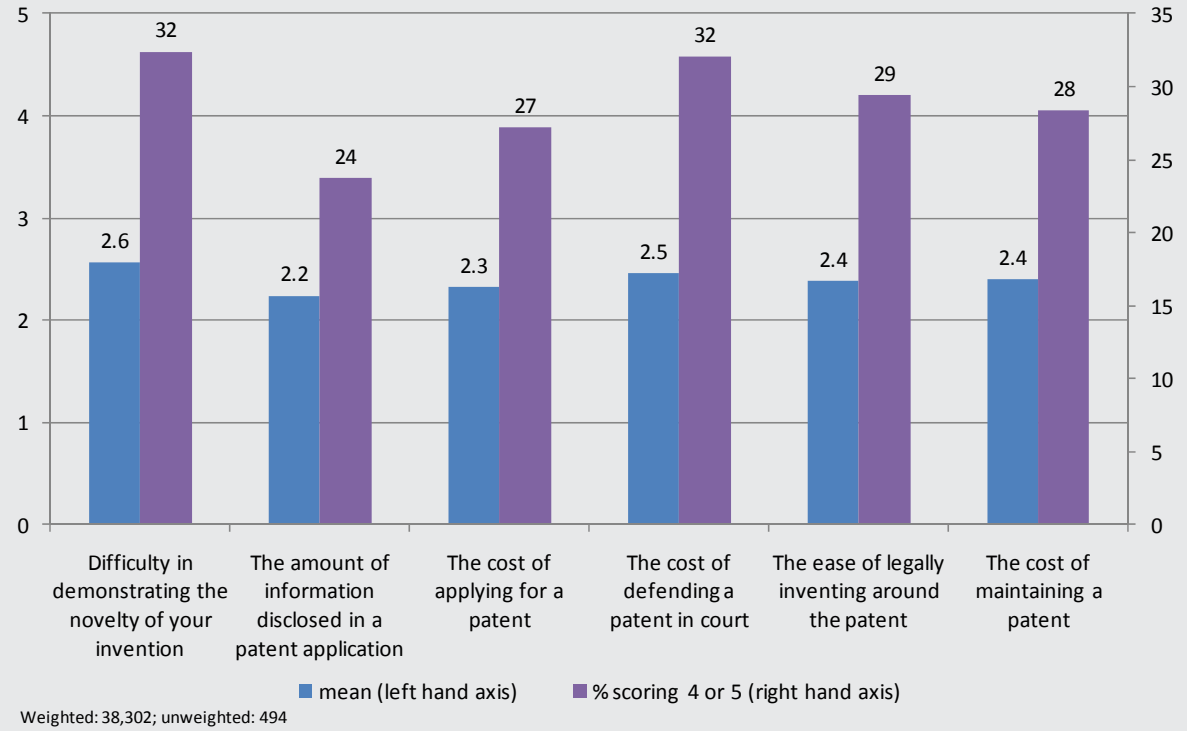
among different types of firms. Looking at Exhibit 3.4.1 from the top, the first row indicates that among all companies, only 13% had been granted patents in the last three years. The next cluster of rows indicates that a much higher proportion of medium sized firms had been granted patents (31%) than micro and small sized firms – nearly three times – although the difference between the latter two was rather small (9% and 10% respectively). Across our four sector groups, high-tech manufacturing firms were the clear "winners" (31%), followed by conventional manufacturing (16%), high-tech services (15%) and conventional services (11%). This supports the general trend that high-tech firms are more likely to seek IP protection than their conventional counterparts; it also reflects the issue that patents as a legal protection method are less often available to service products in comparison with manufacturing products. Now, if we look at the cluster of rows at the bottom, it shows that more open firms had been granted patents much more frequently than traditional firms. It is interesting to note that, despite the fact that our hunting-cultivating firms do not transfer knowledge externally, they were nearly as active as ambidextrous firms in patenting.

Exhibit 3.4.2 presents the distribution of number of patents among those which had patented. Looking from the top, the first three rows show that, over the last three years, 29% of firms had one patent, 20% of firms had two or three patents, and 51% of firms had been granted more than three patents. And if we look at the next cluster of rows, the general trend is that as firm size grows, they tend to have more patents, which is not surprising. Looking across the sector categories, the high-tech manufacturing and high-tech services firms which had taken out patents in the past three years shared a rather similar pattern in both the level and the progression of patenting activity. And there is an interesting contrast between conventional manufacturing and services firms – whilst the majority of conventional manufacturing had only one patent in the last three years (59%), 70% of conventional services firms had more than three patents. Further analysis may be required to probe into this somewhat surprising patenting behaviour. The bottom cluster of rows indicates that more open firms had more patents, suggesting that "openness" seems to go hand in hand with "protection".

Reasons for not patenting

To explore the rationale behind companies' patenting strategy, the survey asked the respondents to evaluate the relative importance of six possible reasons for not patenting their most recent invention (scored 1 if an "insignificant issue" and scored 5 if a "crucial issue"). A summary of the findings is presented in Exhibit 3.4.3. The left-hand column in each twin bar shows the mean score for each possible reason, indicating that on

Exhibit 3.4.3 Reasons for not using patents: all firms



Weighted: 38,302; unweighted: 494

average firms considered these to be moderately significant reasons for not patenting, which is to be expected. The right-hand column shows the percentage of firms that rated a particular issue significant or crucial for deciding not to patent. We find that between 24% and 32% of our firms considered these to be issues of major concern for patenting – 32% rated difficulty in demonstrating the novelty of your invention and the cost of defending a patent in court as major issues, and 24% rated the amount of information disclosed in a patent application a major issue. Other issues that could be a major reason for not patenting include the ease of legally inventing around the patent (29%), the cost of maintaining a patent (28%), and the cost of applying for a patent (27%).

Exhibits 3.4.4-6 show the varying patterns, across size, sector and our OI types, of the percentage of those firms that considered a particular issue a significant reason for not patenting. Exhibit 3.4.4 shows that micro firms most frequently regarded five of the six issues most important barriers to patenting. The one exception was the difficulty in demonstrating the novelty of your invention which was a major concern for medium sized firms. Interestingly, it is small sized firms that least frequently considered these to be major issues in formulating their patenting strategy.

While the pattern across sectors follows the general trend (Exhibit 3.4.5), it shows that high-tech manufacturing firms were more concerned with all these issues than other firms. This is followed by conventional manufacturing firms except in the case of difficulty in demonstrating the novelty of the invention, where high-tech services firms expressed their concerns more frequently. And conventional services firms least frequently rated these issues as major concerns except for the cost of applying for a patent. In general, this finding relates to the extent and nature of patenting activities among firms in different sectors.

Exhibit 3.4.4 Importance of reason for not patenting by size group

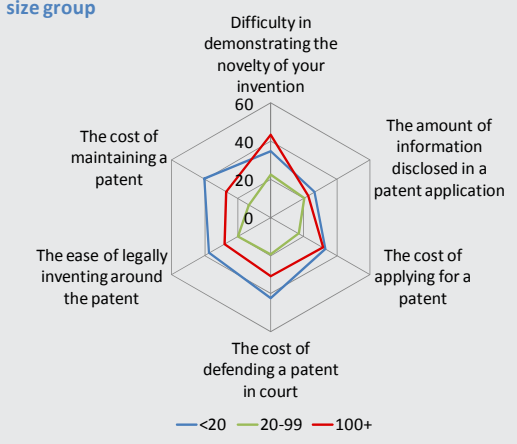


Exhibit 3.4.5 Importance of reason for not patenting by sector

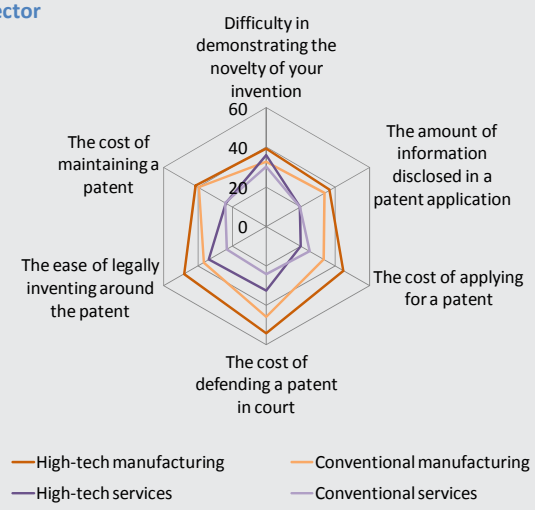


Exhibit 3.4.6 Importance of reason for not patenting by OI type

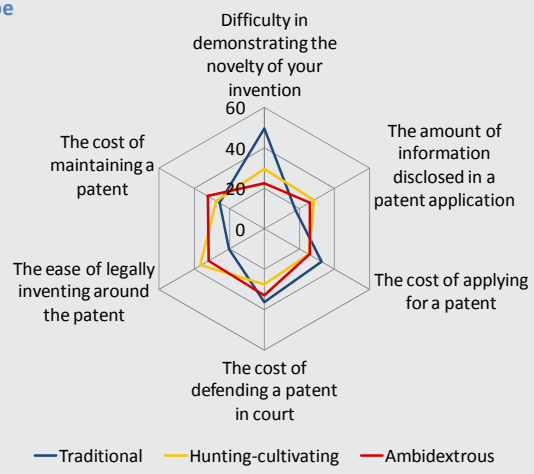
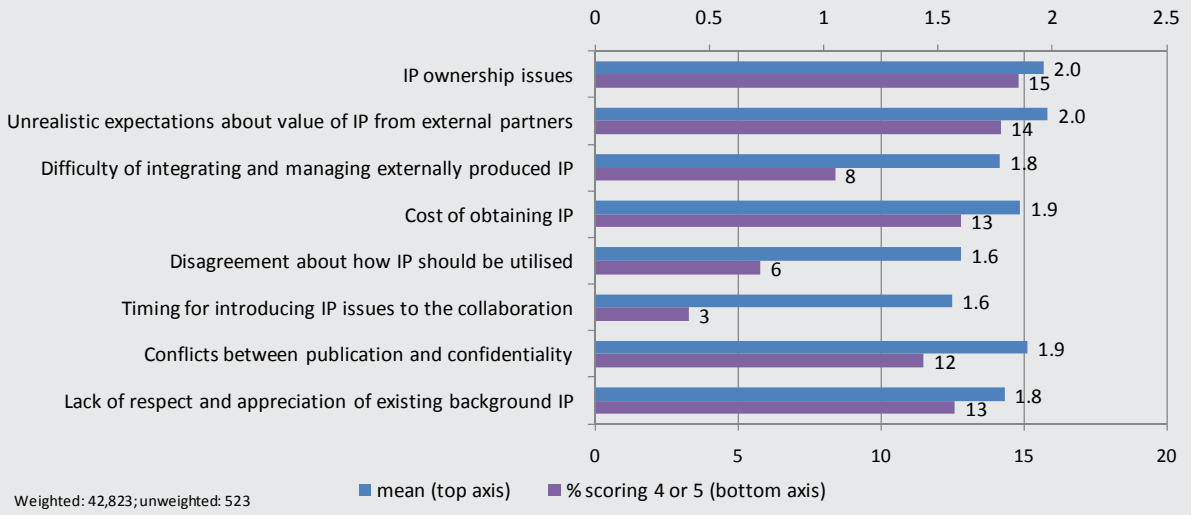


Exhibit 3.4.6 shows that, across our OI types, traditional firms were more concerned about three issues than more open firms: nearly half of them considered difficulty in demonstrating the novelty of your invention a major concern, and 36% and 33% worried about the cost of defending a patent in court and the cost of applying for a patent respectively. Hunting-cultivating firms were more concerned with the ease of legally inventing around the patent and the amount of information disclosed in the patent application than other firms, while ambidextrous firms were more concerned about the cost of maintaining a patent. Together with our earlier finding that more open firms tend to have more patents, this seems to suggest that there is a learning effect in formulating and executing patenting strategy.

3.5. Intellectual property (IP) related issues in protecting innovation

The survey also asked companies about the IP-related problems they may have during their external collaboration and commercialisation activities. Eight potential problems were offered and companies were asked to rate the relative importance for each of them on a 1 to 5 scale (1 as insignificant and 5 as crucial). Exhibit 3.5.1 shows a summary of the findings: the upper row of each twin bar indicates the mean score for a potential problem, and the lower row indicates the percentage of companies that regarded a particular problem a major issue (scored 4 or 5). The mean score is around 2, suggesting that on average firms considered all eight issues between insignificant and moderately significant. And in general, a relatively low proportion of firms considered these issues to be major problems in protecting innovation: around 15% of firms considered IP ownership and 14% unrealistic

Exhibit 3.5.1 IP-related problems with external collaboration and commercialisation: all firms



Weighted: 42,823; unweighted: 523

Exhibit 3.5.2 Importance of IP-related problems with external collaboration and commercialisation by size group

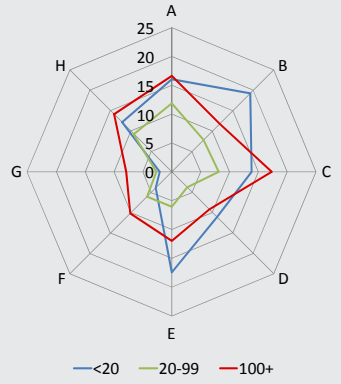


Exhibit 3.5.3 Importance of IP-related problems with external collaboration and commercialisation by sector

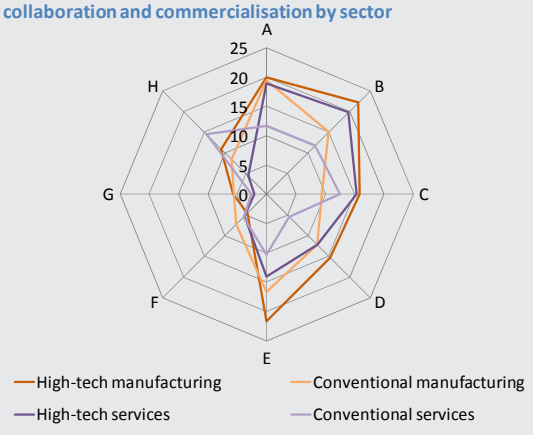
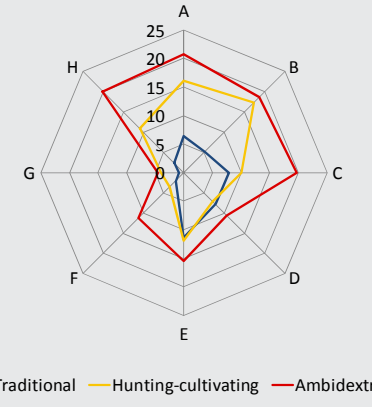


Exhibit 3.5.4 Importance of IP-related problems with external collaboration and commercialisation by OI type



A= IP ownership issues
B= Unrealistic expectations about value of IP from external partners
C= Lack of respect and appreciation of existing background IP
D= Difficulty of integrating and managing externally produced IP
E= Cost of obtaining IP
F= Disagreement about how IP should be utilised
G= Timing for introducing IP issues to the collaboration
H= Conflicts between publication and confidentiality

expectations about value of IP from external partners to be major issues, 13% considered cost of obtaining IP and lack of respect and appreciation of existing background IP, 12% considered conflicts between publication and confidentiality, 8% considered difficulty of integrating and managing externally produced IP, 6% considered disagreement about how IP should be utilised, and the least frequently considered major issue was timing for introducing IP issues to the collaboration (3%).

Exhibit 3.5.2 shows that, while all size groups followed the general trend, much lower proportions of small sized firms were concerned with IP related problems than the other two types except in two areas: disagreement about how IP should be utilised and timing for introduction of IP issues. Not surprisingly, micro firms were more concerned about the cost and valuation discrepancy of IP than other firms, whereas medium sized firms most often voiced concerns about lack of respect and appreciation of existing background IP.

Exhibit 3.5.3 shows that, across sector groups, high proportions of high-tech manufacturing firms regarded all these as major constraints except for two issues – conflicts between publication and confidentiality and disagreement about how IP should be utilised. The former was most often considered a major constraint by conventional services firms, while the latter by conventional manufacturing firms.

Exhibit 3.5.4 reveals that the more open the companies, the more frequently they considered these IP-related issues as major constraints in their external collaboration and commercialisation activities, with the exception of difficulty of integrating and managing externally produced IP. This seems to suggest that IP-related problems are intractable in OI activities (i.e. experience does not seem to lessen the impact of these constraints in the company's view).

3.6. Summary

Whilst overall outbound OI activities were less common than inbound activities among all firms, our survey reveals some interesting features.

Firstly, we find that enhancing reputation was the most frequently cited motive for not only inbound (Chapter 2), but also outbound activities. Detailed analysis of the forms of external transfer further supports the view that financial reward is not the sole objective for outbound activities (i.e. firms transferred externally for both financial and non-financial benefits).

Secondly, different kinds of revenue sources were favoured by different size groups: medium sized firms gained the highest proportion of external transfer revenue from out-licensing, small sized firms from R&D contracts, and micro firms from spinouts.

Thirdly, to protect their innovations, confidentiality agreements were the most widely used and most highly regarded method by firms. At the same time, while other legal methods were less frequently used, they were considered highly important for those firms that had used them. This may reflect not only the effectiveness of the intellectual property regime, but also the availability of certain legal protection methods for products and services. As a result, perhaps, strategic methods such as secrecy and lead-time advantage were also frequently used by all firms.

Fourthly, looking at the barriers to protecting their innovation, those with fewer recent patents (e.g. micro and traditional firms) as well as those with more patents (e.g. high-tech manufacturing firms) than their counterparts, were concerned with a wide range of issues when deciding whether to patent their inventions. At the same time, those more OI active firms (e.g. medium sized, high-tech manufacturing and more open companies) were more concerned with most IP-related issues in external collaboration activities than their counterparts. This seems to suggest that firms face various types of constraints in effectively protecting their innovation, and experience may not reduce the impact of these constraints.

Fifthly, there seems to be an interesting "middle" syndrome – while small sized firms were more active in transferring knowledge and technology externally than the other two size groups, they were much less concerned with IP-related problems in external collaboration and commercialisation. This calls into question whether small sized firms were most effective in external transfer.

At the same time, comparing smaller and larger firms, we find that while the former transferred knowledge externally more frequently for free than larger firms, the latter were more conscious of using protection methods than smaller firms. This reflects the tension between smaller and larger firms in appropriating value from an open innovation strategy.

Sixthly, high-tech firms, in particular high-tech manufacturing firms, sought both legal and strategic protection more frequently and extensively than their conventional counterparts, suggesting a strong awareness of the "leaky funnel" among high-tech firms in general and high-tech manufacturing firms in particular. It not only reflects the issue that certain legal forms such as patents are often not available to service products in comparison with manufacturing products; but also offers a possible explanation to our somewhat counter-intuitive finding that high-tech manufacturing firms gained the least from spinout income, whilst conventional manufacturing firms generated the highest proportion from this source.

Last, but not least, more open firms used protection methods more frequently and more widely than traditional firms in general, suggesting "openness" may go hand in hand with "protection". It is interesting to note that, although our hunting-cultivating firms did not transfer knowledge externally, they were nearly as active as ambidextrous firms in patenting.

Chapter 4

CONCLUSIONS

Earlier chapters have examined the characteristics of three types of OI firms (Chapter 1); and the inbound activities (Chapter 2) and outbound activities (Chapter 3) of our survey companies. This chapter draws together the key findings and discusses their implications for both policy makers and management.

The survey covered UK companies in fifteen sectors within manufacturing and business services with between 5 and 999 employees; and achieved 1,202 responses, a 10% response rate.

4.1. Open innovation choices: commonalities and variations

We highlight our key findings in terms of the commonalities of open innovation practices across all firms. This is followed by a summary of the variations across our size (micro, small and medium sized), sector (high-tech and conventional manufacturing, high-tech and conventional business services) and OI types (traditional, hunting-cultivating and ambidextrous).

Commonalities across all firms

- In general, firms used sourcing activities much more frequently than informal and formal collaborations, with the exception of engaging directly with lead users and early adopters. We also note that while firms searched widely among a wide range of external sources, customers and users were by far the most frequently used external sources by all firms. At the same time, the proportion of firms that considered these sources highly important is not strikingly high (except customers and users). Interestingly, while firms used university and research organisations less frequently to source information and knowledge, those who did considered this a highly important source. This pattern seems to continue in firms' collaboration activities.

- In the last three years, although most firms that were engaged in formal collaborations reported that they had not changed their collaboration and partnering activities, we find this activity to be on the increase.

- While more firms considered that they had superior abilities in identifying new technologies and ideas from external sources than in acquiring and storing ideas, the variations among different kinds of abilities are not substantial. And the most common constraints in carrying out inbound activities were time constraints and lack of financial resources.

- Comparing firms' objectives in conducting inbound open innovation activities with how satisfactory they consider the impact of such activities, 63% of firms set out to enhance the firm's reputation, the most common motive, while 48% agreed or strongly agreed that these activities had improved their reputation as an innovator in the marketplace. On the other hand, while firms identified improving capabilities to develop new products, processes and services as the second most common objective, relatively lower proportions of firms indicated that they had increased R&D productivity and speed to market. Further analysis is required to probe into the missing link between motives and outcomes.

- Enhancing reputation was the most frequently cited motive for not only inbound, but also for outbound activities. Detailed analysis of the forms of external transfer further supports the view that financial reward is not the sole objective for outbound activities (i.e. firms transferred externally for both financial and non-financial benefits).

- To protect their innovations, confidentiality agreements were the most widely used and most highly regarded method by firms. At the same time, while other legal methods (e.g. patents) were less frequently used, they were considered highly important for those firms that had used them. This may reflect not only the effectiveness of the intellectual property regime, but also the availability of certain legal protection methods for different products and services. As a result, perhaps, strategic methods such as secrecy and lead-time

advantage were also frequently used by all firms.

Across size groups

- In carrying out inbound activities, smaller firms were not only more focused in setting their objectives, but also engaged in less widespread activities than larger firms. We also find that, larger firms tend to appropriate more value out of these inbound activities in comparison with smaller firms according to their self-evaluations.

- Interestingly, among those who had increased their inbound activities in the last three years, it is the small sized group that was the most active in increasing their inbound activities.

- For those who carried out outbound activities, while reputation enhancing was the most common objective for all size groups, small sized firms were more motivated to sell additional products and services and generate licensing revenues than the other two groups. And micro firms considered influencing industry standards as more important than the other two groups.

- Interestingly, again it is the small sized group that was the most active in outbound activities among all three size groups. At the same time, different kinds of revenue sources were favoured by different size groups: medium sized firms gained the highest proportion of external transfer revenue from out-licensing (39%), small sized firms from R&D contracts (51%), and micro firms from spinouts (30%).

- Further, smaller firms (i.e. micro and small sized firms) transferred knowledge externally more frequently for free than medium sized firms. At the same time, we find that larger firms used both legal and strategic protection methods more frequently than smaller firms. Looking at the barriers to protecting their innovation, micro firms, with fewer recent patents than their counterparts, were also more concerned than larger firms with a wide range of issues when deciding whether to patent their inventions. This reflects the tension between smaller and larger firms in appropriating value from open innovation strategies.

- At the same time, both micro and medium sized firms were more concerned with most IP-related issues in external collaboration activities than small sized firms. While micro firms were most concerned about IP valuation from external parties and cost of obtaining IP, medium sized firms were most concerned about lack of respect and appreciation of existing background IP. This seems to suggest that firms face various types of constraints in effectively protecting their innovations, and experience may not reduce the impact of these constraints. This also calls into question whether small sized firms were the most effective in external transfer, since while they were the most active in transferring knowledge and technology externally of all types, they were the least concerned with patenting barriers and IP-related problems in external collaboration and commercialisation.

Across sector groups

- Among our four sector cuts, high-tech manufacturing firms sought to achieve the widest range of objectives in carrying out inbound activities. They were also most satisfied with the outcomes achieved.

- High-tech firms, both manufacturing and business services, were more active in engaging in inbound activities (e.g. sourcing, informal and formal collaborations and partnering) than their conventional counterparts.

- Among those who had increased their informal and formal collaborations in the last three years, it is the conventional manufacturing firms that were the most active.

- Further, while higher proportions of services firms rated their abilities in carrying out inbound activities as superior in comparison with manufacturing firms, they were also more concerned about various issues limiting their abilities to use external knowledge and technology.

- For those who carried out outbound activities, while manufacturing firms sought to achieve a wider range of objectives than services firms (except generating licensing revenue, where high-tech services firms led), services firms were more active in carrying out these activities. We also find that manufacturing

firms tend to gain revenue from contract R&D and spinouts, whereas services firms tend to gain from out-licensing.

- Conventional firms were more likely to transfer externally for free than high-tech firms. At the same time, high-tech firms, in particular those in manufacturing, sought both legal and strategic protection more frequently and extensively than their conventional counterparts. Not only had manufacturing firms applied for more patents in recent years, but also were they more concerned about innovation protection issues. This suggests a strong awareness of the "leaky funnel" among high-tech firms in general and high-tech manufacturing firms in particular.

Across OI types

- Various activities can support open innovation strategy: seeking external knowledge (hunting); engaging in collaboration and partnerships (cultivating); and transferring knowledge and technology to others (exploiting). As shown above, the extent to which these practices are pursued varies dramatically across companies and for many companies the extent is very limited.

- We drew upon these measures of open practices to cluster our companies into three forms of open innovation practice: traditional; hunting-cultivating; and ambidextrous.

- We find no association between the choice of OI form made by firms and firm size, or firm age. Although we find variations across sectors, it is also clear that all three forms of OI type are represented in each sector. Therefore, we conclude that firms of the same size, age and sector are making different choices about whether, and how, to engage in open innovation.

- Hunting-cultivating and ambidextrous firms are both active users of external sources of knowledge and show a similar pattern of use of the various sources – they both hunt more than traditional firms.

- In terms of both informal and formal collaboration their use increases as we move from traditional to hunting-cultivating and ambidextrous. The latter, more open, types show a similar pattern of collaboration, except that ambidextrous firms are more likely to collaborate with universities and HEIs.

- The more open types were more concerned about constraints on utilising external knowledge and technology. In particular, ambidextrous firms were most concerned about financial and time constraints. However, they were more confident than the other OI types about their ability to identify, absorb and apply external knowledge than the hunting-cultivating and traditional types. We also find that the degree of openness is associated with business culture and the firm's orientation towards open innovation activities.

- Open innovation is strongly associated with innovative activity, with hunting-cultivating and ambidextrous firms both showing much higher levels of activity than traditional firms. They showed this in terms of achieved innovations, number of patents and in the use of protection methods. This suggests that openness may go hand in hand with protection.

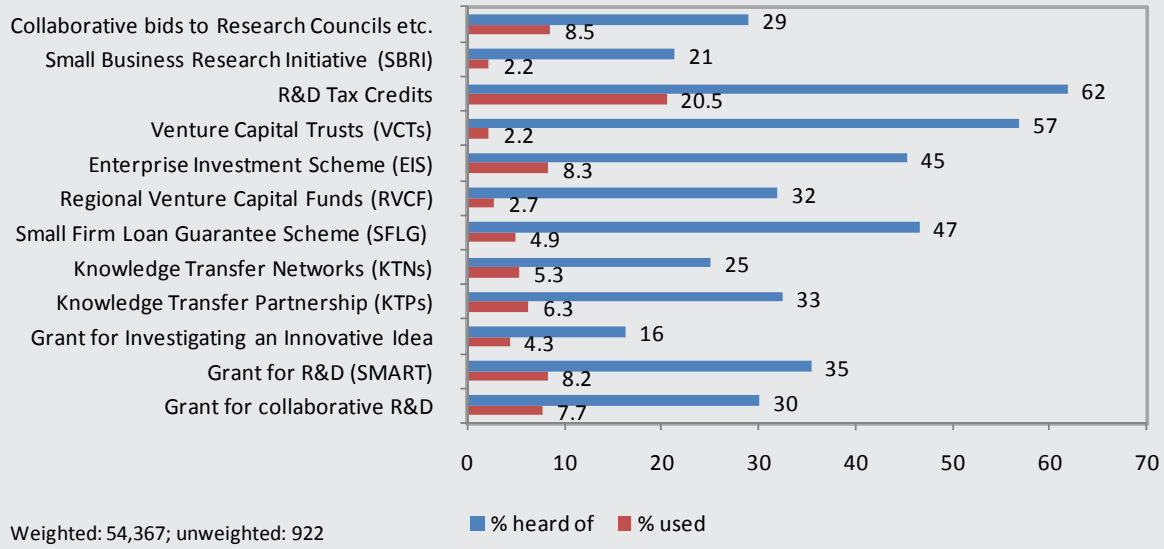
- Perhaps most importantly, we find that open innovation is also associated with superior growth performance. This is important in view of the growing emphasis on open innovation policies by both firms and governments. It is not possible at this stage to identify the transmission mechanisms at work, or to be sure of the direction of causation.

4.2. Innovation policy

Government policies play a key role in the innovation ecosystem, addressing market failure and promoting innovation. Before turning to the implications of our findings for innovation policy, we first examine the importance of existing policies to our survey companies. Our survey included questions about the awareness, usage (in the previous three years) and effectiveness of various UK innovation policy measures.

The awareness and usage of various policy measures is shown for the whole sample in Exhibit 4.2.1. The awareness of the policies varies from 62% for R&D tax credits down to 16% for grants for investigating an innovative idea. The only other measures with about half of the businesses aware of them were: venture capital trusts (VCT, 57%); small firm loan guarantees (SFLG, 47%); and the enterprise investment scheme (EIS, 45%).

Exhibit 4.2.1 Innovation policies - awareness & usage



Weighted: 54,367; unweighted: 922

R&D tax credits are by far the most commonly used – by 21% of companies in these industries. No other measure was used by more than 10% of the companies, but the most frequently used were: the EIS (8%); collaborative bids to Research Councils (9%); grants for R&D (8%); and grants for collaborative R&D (8%). There is not much evidence here that the adoption of open innovation policies has had anything to do with these policy measures.

It is apparent that there is no simple relationship between the awareness and the usage of policies. For example, the VCT was known about by 57%, but used by only 2%; whereas the grant for investigating an innovative idea was known about by only 16%, yet used by 4%. This does suggest that certain policies with high usage to awareness ratios, but low awareness levels, should perhaps be given greater publicity.

Exhibit 4.2.2 shows the differential uptake of the nine most commonly used measures across the size groups. As might be expected, micro firms were infrequent users of each measure. Small firms were proportionately more frequent users of R&D grants and tax credits. Medium sized firms were more frequent users of the collaborative policy measures such as KTNs, KTPs, collaborative research bids and grants for collaborative R&D. This suggests that more internal resources are needed to take advantage of these policy measures.

The uptake of policy measures across the four sectors is shown in Exhibit 4.2.3. This chart is dominated by the high uptake of R&D tax credits by high-tech firms in both manufacturing and business services. High-tech firms are also more likely to engage in collaborative research bids. KTNs and KTPs are most commonly used by

Exhibit 4.2.2 Innovation policy usage by size group

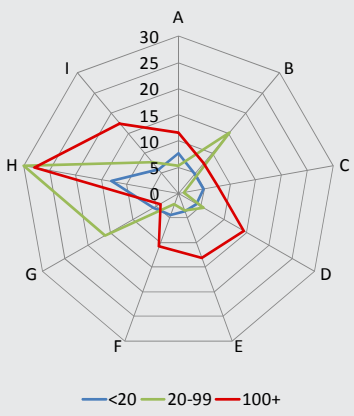


Exhibit 4.2.3 Innovation policy usage by sector

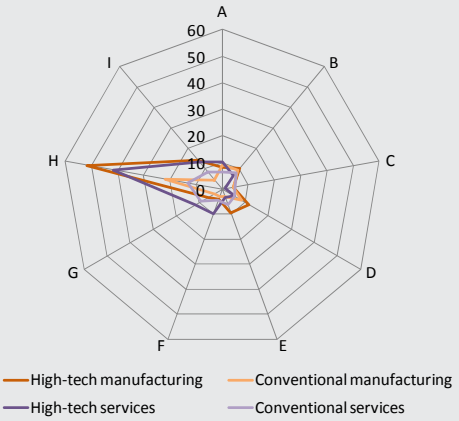
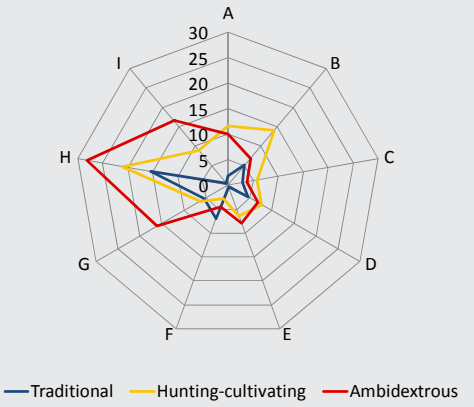


Exhibit 4.2.4 Innovation policy usage by OI type



A= Grant for collaborative R&D
B= Grant for R&D (SMART)
C= Grant for Investigating an Innovative Idea
D= Knowledge Transfer Partnership (KTPs)
E= Knowledge Transfer Networks (KTNs)
F= Small Firm Loan Guarantee Scheme (SFLG)
G= Enterprise Investment Scheme (EIS)
H= R&D Tax Credits
I= Collaborative bids to Research Councils etc.

high-tech firms in the manufacturing sectors.

Exhibit 4.2.4 shows the uptake of these policy measures by the three OI types. In general, the lowest users were traditional firms, followed by hunting-cultivating and then ambidextrous, but this is not always the case. Although ambidextrous firms showed higher proportionate use of collaborative bids, R&D tax credits and the EIS, hunting-cultivating firms matched them in their usage of grants for collaborative R&D, KTNs and KTPs. In addition, hunting-cultivating firms were ahead in their use of grants for R&D.

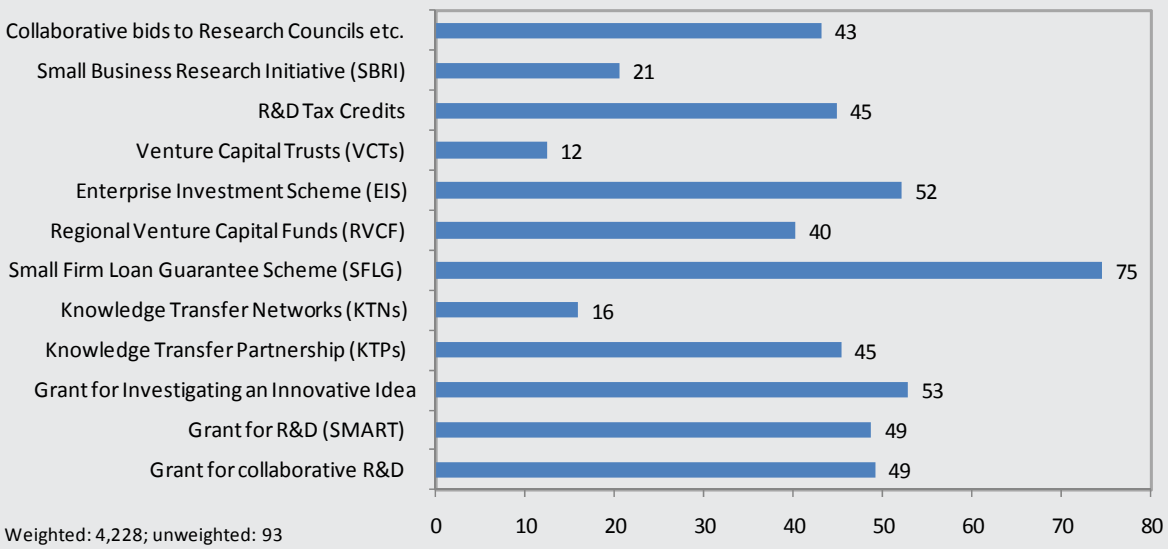
Companies that had used a particular measure were asked to assess its impact on their business on a scale from 1 = no impact to 5 = crucial impact. Exhibit 4.2.5 shows the proportion of these policy users that scored the scheme as important, or crucial. The picture that emerges is encouraging showing that 40% or more scored the measure as having an important, or crucial, impact for all but three of the schemes. The lowest approval ratings amongst users were for the SBRI (21%), KTNs (16%) and VCTs (12%).

Exhibit 4.2.6 shows significant differences in approval ratings across size categories. In general, medium sized firms gave low approval ratings and micro firms gave higher ratings, but this was not always the case. It is clear that firm size matters in the firms' assessment of policy effectiveness.

The sectoral pattern, shown in Exhibit 4.2.7 is more uniform, but there are some differences. Regional venture capital funds were most popular amongst high-tech business services. Conventional manufacturing firms had the highest regard for grants for R&D and for an innovative idea, but lowest for collaborative research bids. However, the sample sizes here are quite small.

Finally, we report, in Exhibit 4.2.8, on the effectiveness of innovation policy measures as judged by our OI types. Traditional firms gave a high approval rating for the SFLG scheme and the grant for R&D. Hunting-cultivating firms were the most common users of and gave the highest approval rating to the grant for an innovative idea.

Exhibit 4.2.5 Impact of innovation policies, % of users indicating important or crucial impact



Weighted: 4,228; unweighted: 93

Exhibit 4.2.6 Policy impact by size group

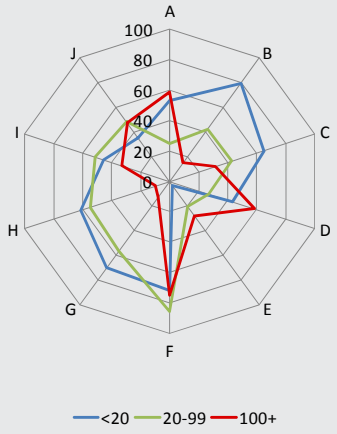


Exhibit 4.2.7 Policy impact by sector

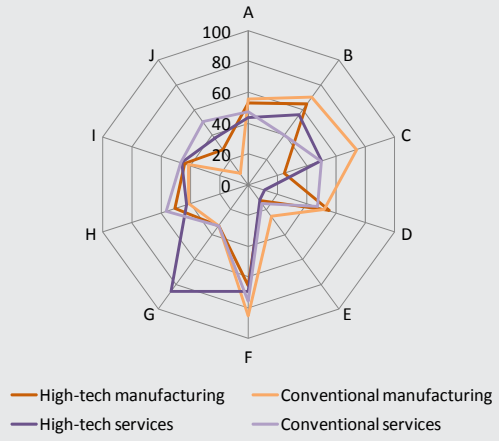
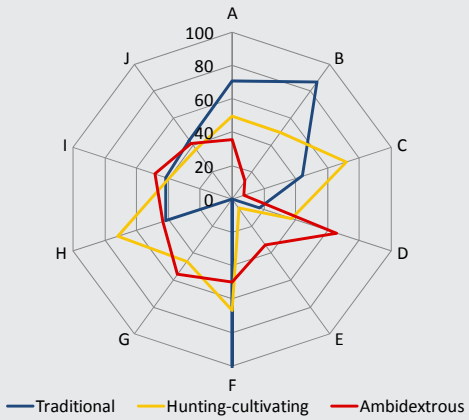


Exhibit 4.2.8 Policy impact by OI type



A= Grant for collaborative R&D
B= Grant for R&D (SMART)
C= Grant for Investigating an Innovative Idea
D= Knowledge Transfer Partnership (KTPs)
E= Knowledge Transfer Networks (KTNs)
F= Small Firm Loan Guarantee Scheme (SFLG)
G= Regional Venture Capital Funds (RVCF)
H= Enterprise Investment Scheme (EIS)
I= R&D Tax Credits
J= Collaborative bids to Research Councils etc.

They also gave high approval ratings to the EIS and the SFLG scheme. Ambidextrous firms gave lower approval ratings to the grant for R&D and the grant for collaborative R&D. They were also the most approving of the KTPs and KTNs (although a much lower rating than for KTPs).

Policy implications

- Policy measures are well-received in general when they are taken up.
- There is some work to be done in raising policy awareness and in making sure policies are reaching those for whom they are intended.
- We find that certain types of financial support policies work better for certain groups of firms, suggesting this should be taken into account in the design and marketing of these policies.
- OI policy design needs to be tailored to inbound and outbound activities separately.
- Firms cannot be treated as homogeneous. In promoting network and collaborations, policy makers need to address different types of groups (size, sector, OI type) differently.
- Special attention is needed in training and guidance to facilitate large firm – SME collaborations, helping both to maximize potential value through collaboration.

4.3. Concluding remarks

This report aims to portray a full picture of OI practices among UK firms. Taking all the above together, our findings point to some key issues:

- Open innovation practices, both inbound and outbound, are associated with superior growth and innovation performance.
- Inbound and outbound processes differ in their practices and capability requirements; and need to be examined separately as well as combined.
- Whilst there is much commonality of OI practices among our sample firms, it is firms' choices that drive what practices they use and how they use them to open up their innovation process. There is no one optimal form of "openness" for all firms.

- There is a tension between smaller and larger firms in appropriating value from carrying out open innovation practices.

- Manufacturing and business services firms differ in their use of OI practices, and further studies are required to understand the reasons for this.

- There is a strong awareness of the "leaky funnel" among high-tech firms in general and high-tech manufacturing firms in particular.

- A variety of innovation polices are needed to match the variety of firms' needs in open innovation.

Management implications

Readers are reminded that further analysis is required to probe into the causal relationships among drivers, practices and business performance. The data collected from this survey requires further analysis of why firms make particular choices in their form of open innovation. These choices also need to be examined in relation to performance outcomes before confident advice can be offered to businesses. However, we offer below some tentative conclusions for management:

- Companies need to avoid jumping onto the bandwagon of "open innovation". Managers need to formulate OI strategies in accordance with their firms' resources and strategic needs, as well as taking into account the external environment (e.g. competition within the sector, IP regimes, innovation market etc.).

- Open innovation practices can be manifested in many forms, in both inbound and outbound processes. Managers should consider the full spectrum of OI practices.

- Collaborations require effective management. Not only do managers need to build capabilities in absorbing external knowledge and technology in pursuit of innovation, but also learn how to appropriate value from these collaborations.

- Managers need to be strategic in exploiting government policies.

Appendix

SURVEY METHODS AND OUTCOME

Between June and November 2010 five waves of questionnaires were sent out by post and posted online to over 12,000 UK companies. A final sample of 1,202 companies was achieved which represents a 10% response rate. This appendix describes: the sampling frame; questionnaire design and piloting; the survey process and responses; non-response analysis; and the weighting methods used to gross the findings up to the company population.

A1. Sampling frame

The sample was drawn from the FAME database of companies. This was stratified by size and sector within the manufacturing and business services sectors using companies with between 5 and 999 employees. The sampling proportions in terms of sector were 65% in manufacturing and 35% in business services drawn from fifteen sectors (see A3 below). Two additional samples were also drawn for the survey from the pharmaceutical and clean energy sectors. Larger businesses and smaller sectors were over-sampled relative to their proportions in the company population. Where possible, companies with employment data available on FAME were selected over those who only had estimates of their employment size, but otherwise businesses were selected randomly within the size and sector cells. The total number of companies surveyed was over 12,000.

A2. Survey instrument

Our Open Innovation (OI) survey focused on three research questions: 1) how do patterns of OI practices vary across sectors and sizes?; 2) what are the drivers for and barriers to using OI practices at the firm level?; and 3) what are the impacts of OI practices on firms' innovation outputs?

We took the decision early on to not use the term "open innovation" throughout the questionnaire, due both to various definitions and ambiguities surrounding this term and to minimise the risk of respondents giving the answers that they felt should be given. Rather, the survey instrument focused on firms' activities and practices in their innovation processes (i.e. OI as managerial practices).

When examining firms' OI practices, we look at both "inbound" (i.e. seeking to take external knowledge and technology inside the company to accelerate innovation and create value), and "outbound" activities (i.e. seeking to take internally owned knowledge and technology outside the company to accelerate innovation and create value). We also examine OI activities in different forms as suggested by the extant research, including sourcing, informal and formal collaboration, and their partners. Further, to add a dynamic view, we also ask about whether firms have changed their OI practices in the last three years. To explore the determinants of OI usage and their effects, apart from traditional questions such as the barriers to and objectives of innovation, we also include questions on managerial behaviour (e.g. innovation orientation), and firm core competence (e.g. absorptive capacity), organisational form and IP management issues.

The questionnaire design draws upon three main sources: 1) existing innovation and OI surveys; 2) existing scales and items from prior academic research; and 3) potential new scales from the existing qualitative research. We also attended open innovation conferences and seminars to collect information and feedback on our preliminary design with practitioners. Throughout the design stage from October 2009 to May 2010, we held monthly or bi-monthly meetings with our advisory group, comprising a team of ten OI experts from both academia and business, to discuss and revise our questionnaire.

The final version of the questionnaire was 12 pages long and had four sections:

- The company and its competitive situation covering sales, growth, competition and accounting data;
- Innovation and R&D activities, covering types of innovation, objectives of and barriers to innovation and R&D;

- Collaboration and Innovation, which included questions on sources of information, ability to use external knowledge, engagement in activities with external parties and awareness and use of policy schemes;
- External transfer of knowledge and technology, looking at revenues received from technology/knowledge exploitation, innovation protection methods and IP related collaboration/commercialisation problems.

A3. Survey process and outcome

Before running the full scale survey, we performed ten pilot tests. The aim was to check whether the respondents understood the questions clearly. The pilot tests were carried out in various company size groups, ranging from start-ups, SMEs to large listed companies; as well as in different sectors, including both high-technology and conventional services firms. Most tests were carried out through telephone or face to face interviews (after first sending the questionnaire for completion) so that we could probe into the respondents' understanding of each question. Others were completed via email or post, others were returned with notes explaining whether the questionnaire was clear; if not, which question and why it may be unclear.

The first wave was sent out in mid-June, reminders were sent to those who had not responded two weeks later (Exhibit A3.1). Wave 3 went out in mid-September with a follow up mailing after two weeks and the final wave was sent in mid-November. For waves 1 to 3, the standard 12 page version of the questionnaire was sent. For wave 4, a shorter 6 page version was sent and in the final wave, two versions of the questionnaire were used, a 2 and 3 page version. Half of the remaining sample received the 2 page and half the 3 page version. The version of questionnaire sent was allocated randomly. The returns from each of these waves are given in Exhibit A3.1 below.

The division of the responses across the fifteen sectors and between the main sample, pharmaceuticals and clean energy is shown in Exhibit A3.2. It is these sectors that are used to gross our sample up to the company population (see A5 below). The 39 respondents outside these sectors came partly from the clean energy and pharmaceutical samples, but in 6 cases resulted from the company's own identification of sector being different from that on FAME.

Exhibit A3.1 Mailing dates and responses

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	All
Date sent	15/06	28/06	14/09	29/09	17/11	
Questionnaire version	Long	Long	Long	Short 6 page	Short 2 or 3 page	
Number of responses	223	416	132	246	185	1,202

Exhibit A3.2 Sectoral distribution of OI survey responses by sample type

Sector	Main	Pharma-ceutical	Clean energy	All
Chemicals and chemical products	83	35	0	118
Non-metallic mineral products	26	0	0	26
Basic metals	41	0	0	41
Fabricated metal products, except machinery and equipment	125	4	1	130
Machinery and equipment not elsewhere classified	76	3	1	80
Office machinery and computers	24	0	0	24
Electrical machinery and apparatus n.e.c.	109	1	0	110
Radio, television and communication equipment and apparatus	37	0	0	37
Medical, precision and optical instruments, watches and clocks	90	8	0	98
Motor vehicles, trailers and semi-trailers	26	0	1	27
Other transport equipment	28	0	1	29
Post and telecommunications	39	0	0	39
Computer and related activities	106	5	0	111
Research and development	60	29	4	93
Other business activities	101	65	34	200
All 15 sectors	*971*	*150*	*42*	*1,163*
Other sectors	6	14	19	39
Number of responses	977	164	61	1,202

Exhibit A4.1 Response analysis by sector

	High-tech manufacturing		Conventional manufacturing		High-tech business services		Conventional business services		All	
	N	%	N	%	N	%	N	%	N	%
Response	239	19.9	515	42.8	241	20.0	207	17.2	1,202	100.0
No response	2,084	18.8	4,856	43.7	2,524	22.7	1,640	14.8	11,104	100.0
All	2,323	18.9	5,371	43.6	2,765	22.5	1,847	15.0	12,306	100.0

A4. Non-response analysis

Information from the FAME database was used to make comparisons between respondents and non-respondents. For this analysis we have used data on employment size, turnover and year of formation of the company. The companies have been grouped into four sectors: high-tech manufacturing, conventional manufacturing, high-tech business services and conventional business services and the number of respondents and non-respondents is shown in Exhibit A4.1.

An analysis of non-response has been carried out in several ways, but a brief summary by sector is presented here. Comparisons of year of formation show that the median values within the four sectors are very similar between respondents and non-respondents and there are no significant differences. In terms of employment size, within high-tech manufacturing, responding companies were larger, 88 as opposed to 77 employees; but whilst this is statistically significant, the difference is quite small. In the other sector groups there were no significant differences in employment. Comparing turnover, the only significant difference was for conventional business services where respondents had a significantly smaller turnover than non-respondents. In general, there is no evidence for significant non-response bias in terms of company age, or size.

A5. Grossing up to company population

The sample drawn from FAME was stratified by both size and sector in such a manner as to give a reasonable number of responses in each cell. However, the achieved sample is not necessarily representative of the company population distribution in FAME. This is due both to different response rates in different size/sector combinations and due to our choice to over-sample amongst larger companies and smaller sectors. The relationship between the company population and the responses received are summarised in Exhibit A5.1 for the fifteen sectors. The results presented in this report are for the company population and this is achieved by giving each observation a weight that is calculated by the ratio of the company population in that size-sector cell (fifteen sectors, three size classes) to the number of responses in that cell.

Exhibit A5.1 Comparison of the sample with the company population

	Number of employees			
	<20	20-99	100+	All
Manufacturing				
Population	7,927	4,144	2,711	14,782
Sample	199	216	163	722
Business services				
Population	25,632	12,909	8,075	46,616
Sample	216	148	77	441
All				
Population	33,559	17,053	10,786	61,398
Sample	415	508	240	1,163

Definitions

Types of Business

Micro	-	Businesses with less than 20 employees in 2010
Small	-	Businesses with between 20 and 99 employees in 2010.
Medium	-	Businesses with between 100 and 999 employees in 2010.
Newer	-	Businesses formed in 2002 or later.
Older	-	Businesses formed in 2001 or earlier.
Manufacturing	-	Manufacturing industries (SIC (2003) principally industry headings: 24, 26-35).
Business services	-	Advertising, Management, Technical and Professional consultancy and Telecoms services (SIC (2003) principally industry headings: 64.20, 72.10-72.60, 73.10-73.20, 74.12-74.30).
High-tech manufacturing	-	High-tech manufacturing sectors as defined by Butchart[1] (1987).
Conventional manufacturing	-	Remaining manufacturing sectors.
High-tech business services	-	High-tech business services sectors as defined by Butchart[1] (1987).
Conventional business services	-	Remaining business services sectors.
Traditional OI type	-	Low external sourcing, few formal collaborations, no external transfer.
Hunting-cultivating OI type	-	Active external sourcing and formal collaborations, no external transfer.
Ambidextrous OI type	-	Active external sourcing and formal collaborations and external transfer.

Survey period	-	June - November 2010
Response rate	-	10%

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[1]Butchart, R.L. (1987) 'A New Definition of the High Technology Industries', *Economic Trends,* Number 400, February.

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