Identifying Innovation, Innovators and Innovative Behaviours: A Critical Assessment of the Community Innovation Survey (CIS)

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Abstract

This paper provides a critical assessment of the European Community Innovation Survey (CIS) in relation to the identification of innovation, and by extension of innovators and innovative behaviours. With innovation widely recognised as being central to competitiveness and economic growth, the CIS is an important instrument for understanding innovation and for benchmarking innovation performance between sectors and countries. The inclusion of services in the survey is particularly welcome, as little is known about innovation behaviour in services. However, that the CIS has some significant flaws, which mean the data generated should be treated with considerably more caution than has hitherto been the case. In particular, the CIS effectively conflates a wide range of activities – from technology adoption through to 'true innovation' – into a single definition of innovation. This obscures important differences in behaviour between very different types of 'innovators'. The UK response to the second CIS is used to provide an empirical grounding to these arguments. The aim of the paper is not to denigrate the CIS – the survey certainly adds to our understanding of innovation – but instead aims to provide constructive criticisms so that it can be developed to provide more useful information in the future.

1. Introduction

'Innovation is now the single most important engine of long-term competitiveness, growth and employment' – so declares a recent European Commission report (EC, 2001, p.11). Moreover, innovation is considered 'ever more important' (ibid, p.5), and:

> In today's increasingly global, increasingly knowledge-based economy, innovation – the capacity to apply new knowledge in order to improve productivity and create new products and services – assumes an unprecedented significance. … To remain competitive, today's companies need to do more than simply deliver products or services that are better or cheaper than those of their rivals. They must also add features, improve performance and reduce prices more quickly. They must be faster to launch new products. (EC, 2001, p.11)

Similar statements can be found in the policy documents of national governments, not least in the UK. Although much of this is rhetoric, it raises important questions, such as 'what is innovation?' and 'how can we measure it?' The measurement of innovation is central to providing information on innovation performance (and by extension competitive performance), where ideally this information should be comparative - to allow benchmarking - between places (regions and countries), industrial sectors, and over time. The European Community Innovation Surveys (CIS), which began in 1992, and which were repeated in 1996 and 2001, are central to this attempt to gather internationally comparable statistics. Statistics drawn from these surveys are used in both national and EC policy documents (e.g., EC 2001, DTI, 1999a&b) to make comparisons between the 'innovative performance' of countries, and of sectors within and between countries. The purpose of this paper is to provide a critical appraisal of the data provided by the CIS. This appraisal is supported by an analysis of the UK response to the second CIS (CIS-2).

It is argued that whilst these data do provide interesting insights into innovation behaviour, they should also be treated with greater caution than has hitherto been the case. In particular, comparisons between sectors and countries are problematic. There is also significant room for innovation within the survey itself, which would improve the usefulness of the information provided for both analysts of innovation and for policy makers.

The paper begins with a discussion of the measurement of innovation, especially in services, which now dominate economic activity in Europe and other advanced economies. The paper then examines the UK response to the CIS-2 and asks what we can learn from this about innovation in both manufacturing and services. The analysis includes the identification of 'innovators', the engagement of these in R&D and collaborative projects, and expenditures on innovative activities. The paper concludes with a discussion which offers suggestions about how the CIS might be improved as a tool for examining innovation.

2. Approaches to the Identification and Measurement of Innovation by Enterprises

Commercial enterprises are at the heart of what the OECD (1996) terms the 'innovation dynamo', and this paper is concerned solely with the measurement of innovation by firms. Innovation measurement is a relatively young discipline, and before the 1990s researchers and policy makers were largely dependent on indirect indicators of innovation – particularly R&D expenditures (or employment) and patent data, although some ad hoc databases of innovative outputs were compiled and analysed (e.g., Pavitt, 1984, Pavitt et al., 1989; Acs and Audretsch, 1990). The development of the OECD's Olso Manual (1992a) marked an important step towards direct measurement of innovation (Archibugi, 1988), particularly as it was constructed around a broad conceptualisation of *technological innovation* that went beyond R&D.

However, both the first edition of the Oslo Manual and the first CIS, which was based upon it, were designed solely with manufacturers in mind. This reflects the privileging of (functionally enhanced) manufactured tangibles (and the role of R&D therein) in innovation studies (Coombs, 1999), combined with the fact that almost all of our understanding of innovation and of innovation processes at the micro level has been derived from studies of manufacturing (Gallouj and Weinstein, 1997). Services, and service innovation, were omitted,[1] despite the fact that services account for roughly two-thirds of GDP and employment in Europe (Eurostat, 1999).[2]

With the exception of telecommunications and computer services, services have been widely neglected by analysts of innovation (and by economists). They are (or were) widely perceived to be unproductive, second-class or backward (Pavitt, 1984;[3] Djellal and Gallouj,

1 Except in the Netherlands.

2 'Market services' alone account for half the EU's employment (47% in 1997) and more than half of its GDP (52% in 1997).

3 In his famous taxonomy, Pavitt (1984) described private services as 'supplier dominated', effectively reflecting the widespread perception about the lack of internal innovation amongst services.

1999), especially with regard to technological innovation, which is perceived to be the main engine of economic growth, and which is the central concern of the Oslo Manual.

Gradually the shear economic significance of services, combined with their significance in employment creation, and their prominence in the 'information economy',[4] in addition to evidence of both innovation (Barras, 1986, 1990; Pavitt et al., 1989; Soete and Miozzo, 1989) and R&D in services (Young, 1996), encouraged the expansion of the Oslo Manual and CIS to embrace services. Services have, however, been accommodated by simply adapting the original version of the Manual and Survey, largely through the replacement of the word 'product' by the word 'service'. The revised Oslo Manual (OECD, 1997) and the second and third CIS (1997 and 2001 respectively) have effectively *assimilated* (Coombs and Miles, 2001) or *subordinated* (Djellal and Gallouj, 1999) services into an approach to understanding innovation which is based on studies of manufacturers, and which centres on the product – process dichotomy. This assimilation implicitly assumes that this approach is also appropriate to services and service innovation. There are those who argue this is not the case, and that innovation in services is distinct from, or at least significantly different from, that in manufacturing. In the concluding section of this paper we discuss some of the limitations of the CIS's approach to investigating services as well as the results from the survey, which provide a rare insight into innovation in services.

3. The Second Community Innovation Survey and the UK Response

The second CIS was carried out in 1997 and was based on two questionnaires: one for manufacturing; the other for services. As mentioned earlier, the services questionnaire was an adapted version of the manufacturing questionnaire and, apart from the frequent substitution of the word 'service' for the word 'product', the differences between the questionnaires were confined to the basic innovation questions and to the questions about the resources devoted to various innovation related activities.

The unit of analysis was the enterprise,[5] and the survey was postal and voluntary. Sampling excluded enterprises recorded as having fewer than 10 employees, and was confined to those primarily engaged in the activities covered by sections C to K of the 1992 Standard Industrial Classification (SIC). This includes mining and quarrying, all manufacturing and most private

[4] Miles et al. (1990) note that (at least in the US and UK) services account for at least three-quarters of all investments in information and communication technologies.

[5] Which for the UK was defined by the Office for National Statistics (ONS) as 'the smallest combination of legal units which have a certain degree of autonomy within an enterprise group' (Craggs and Jones, 1998).

services. It (primarily) excludes agriculture, fishing and forestry, as well as public services. The sampling was stratified by enterprise size and by sector; larger enterprises and those in the more 'technologically interesting' sectors were more heavily sampled. Thus 'high technology sector' enterprises (Butchart, 1987; OECD, 1992), and especially those in sectors dominated by large firms, were heavily sampled, whereas small enterprises in the 'low technology sectors' were lightly sampled (Craggs and Jones, 1998). Overall, services were sampled much less heavily than manufacturers.[6]

A total of 2,342 enterprises responded to the UK survey. Of these 1,598 (68%) responded to the manufacturers' questionnaire (a response rate of 41%), whilst 744 (32%) responded to the services' questionnaire (a response rate of 36%).[7] The CIS-2 represents the first successful national survey of innovation in the UK.[8]

Although the CIS is intended as a benchmarking exercise, the analysis that follows uses the data-set as a simple sample and makes no attempt to 'correct' the sample to make it representative of businesses in the UK. We resist making this 'correction' because, firstly, the sample size is small relative to the population. This makes a grossing up to the national pattern dubious, particularly when the survey response rate, whilst reasonable for a voluntary survey, was still less than half of those sampled. Moreover, it is quite likely that the response is biased to more innovative enterprises, or to certain types of 'innovators'.[9] Secondly, we argue innovation is an insufficiently concrete phenomenon to justify this transformation, as asking an enterprise whether or not it has innovated is not equivalent to asking a household whether or not it possesses a television or a car.[10] For these reasons we consider an analysis

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6 Only 2,045 of the 94,268 (2.2%) service enterprises with ten or more employees on the parent database were sampled, compared with 3,925 of the 61,268 (6.4%) 'manufacturers' (i.e., SIC sections C to F) with 10 or more employees on the same database. Amongst 'manufacturing proper' (SIC section D), 3,647 of the 47,862 (7.6%) possible firms were sampled.

7 The response rate varied somewhat by firm size – being highest (at 49%) amongst 'manufacturing firms' with 50-99 employees, and lowest (at 24%) amongst 'manufacturing firms' with 5,000 or more employees (according to the IDBD). Amongst the services, the response rate also tended to decline with firm size, being highest (at 47%) amongst firms with 20-49 employees, and lowest (at 30%) amongst firms with 1,000-4,999 employees.

8 The UK response to the first CIS was very poor.

9 As part of the exercise the UK Office for National Statistics (ONS) undertook a non-response analysis which asked non-respondents the main innovation questions. This apparently found no evidence of a non-response bias. Our argument is not that the non-respondents were less likely to be 'innovators' in the sense that they were less likely have introduced new products, processes or services, but rather that they may well be biased to a certain type of 'innovator' – notably 'technology adopters' rather than 'true innovator' in the terms elaborated in this paper.

10 Furthermore, such a weighting treats all enterprises equally, whether a large enterprise with thousands of employees or a small enterprise with just 10, and thus the 'correction' disregards the unequal economic significance of the enterprises in the population. Because of the sampling method, the uncorrected distribution is closer to the distribution of enterprises by economic significance.

which 'corrects' the sample to the population implies a level of authority to the results which cannot be justified. Instead, the analysis that follows should be regarded as explorative with regard to both the methodology and the results.

In what follows, apart from the broad division of manufacturing and service enterprises, the responding firms are divided into seven broad 'sectors' of activity. This classification is largely based on technological intensity (or opportunity). Thus the enterprises responding to the manufacturing questionnaire were divided into four 'sectors': (1.) high technology manufacturers (HTM); (2.) medium technology manufacturers (MTM); (3.) low technology manufacturers (LTM) – all as defined by Butchart (1987) and the OECD (1992b); and (4.) 'Utilities, etc.', which includes the (electricity, water and gas) utilities and construction, mining and recycling enterprises, all of which were sampled using the manufacturing version of the survey. The responses to the services survey are also divided, into three 'sectors': (1.) high technology services (HTS) – as defined by Butchart (1987); (2.) 'Financial Services' and (3.) 'Other Services'. The latter being primarily retailers, wholesalers and transport service enterprises. This classification of services relates to the technological nature of their activities and to what is be transformed (Hill, 1977; Miles, 1996). High technology services include technology providing activities but also activities that are heavy users of new technology; financial services do not tend to provide technologies, but instead tend to be heavy users of information technologies; 'others services' are largely concerned with physical movement or storage, and are predominantly users rather than producers of technology.

Table 1

The Sample of Respondents by 'Sector'

'Sector'	SIC-92 Codes	Respondents
Manufacturing	1510 to 3663 (i.e., HTM & MTM & LTM)	1,442
Services	5010 to 7420 (i.e., HTS, Financial & Other Services)	744
High Tech Manufacturing (HTM)	2330; 2440; 3001 to 3120; 3210 to 3340; 3530	292
Medium Tech Manufacturing (MTM)	2310; 2320; 2410 to 2430; 2451 to 2524; 2740 to 2745; 2910 to 2972; 3130 to 3162; 3350; 3410; 3430 to 3520; 3540	444
Low Tech Manufacturing (LTM)	1510 to 2225; 2610 to 2734; 2750 to 2875; 3420; 3610 to 3663	706
Utilities etc.	1010 to 1430; 3710 to 4545	156
High Tech Services (HTS)	6420; 7210 to 7320; 7420	226
Financial Services	6510 to 6720	149
Other Services	5010 to 6412; 7010 to 7142	369

Other classifications could have been used (e.g., Pavitt, 1984; Soete-Miozzo, 1989), but we have used this classification because its grounding in 'technology-intensity' reflects the CIS's primary concern with technological innovation, and because OECD's classification is widely adopted in the literature. The extent to which the data can be disaggregated further is limited by the sample size, particularly amongst the service responses, and it is undoubtedly the case that each of these 'sectors' contains a variety of enterprises engaged in quite different activities, with quite different strategies, but this is true of all simple 'sectoral' classifications.

In the analysis that follows we begin by identifying 'innovating enterprises'. We will explore a variety of definitions of 'innovators'. After this, in Section 5, we shall relate these different definitions to the behaviours of the enterprises, showing how the behaviour of 'innovators' relates to the definition employed.

4. Survey Results – Part 1: Identifying 'Innovators'

We begin with the identification of (technological) innovators. The Oslo Manual and the CIS are based on the premise that (technological) innovation can be defined, and from this 'innovators' can be identified. Consequently, the manufacturers were asked, under the heading 'Product Innovation': *Between 1994-1996, has your enterprise introduced onto the market any technologically new or improved product*? A definition preceded the question:

> A technologically new product is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. A technologically improved product is an existing product whose performance has been significantly enhanced or upgraded. Technologically new or improved products includes products that were new to your enterprise, although not necessarily new to the market as a whole.

Those answering yes to this question were asked whether these products were: 'mainly developed by other enterprises or institutes'; 'by your enterprise together with other enterprises or institutes'; or 'mainly by your enterprise'.[11] We label these 'external', 'joint' and 'internal' innovators respectively. The 'product innovators' were also asked 'between 1994 and 1996, did your enterprise introduce technologically new or improved products which were also new to your enterprise's market?

[11] Multiple responses were possible.

Secondly, and separately, the manufacturing questionnaire asked about 'Process Innovation': *Between 1994-1996, has your enterprise introduced any technologically new or improved processes?* Again a definition preceded the question:

> Technological process innovation is the adoption of technologically new or significantly improved production methods, including methods of product delivery. Technologically new or improved processes include processes that were new to your enterprise, although not necessarily new to the industry as a whole.

The source of these innovations was again asked about – i.e., whether they were mainly externally, jointly or internally developed.

By contrast, the service enterprises were asked a single question: 'Between 1994-1996, has your enterprise introduced onto the market any new or significantly improved services or methods to produce or deliver services?' Again, a definition preceded the question:

> A *new or improved service* is considered to be a *technological innovation* when its characteristics and ways of use are either completely new or significantly improved or when it is performed in a significantly improved way or by using new technology. The adoption of a production or delivery method which is characterised by significantly improved performance is also a technological innovation. Such adoption may involve change in equipment and/or organisation of production and may be intended to produce or deliver new or significantly improved services which cannot be produced or delivered using existing production methods or to improve the production or delivery efficiency of existing services. (Emphasis in original)

Those answering yes to this question were asked: 'Between 1994 and 1996, did your enterprise introduce technologically new or improved services new to your enterprise and to your enterprise's market? They were also asked the equivalent of the source of innovation question asked of the manufacturers.

These questions form the basis of the means of identifying innovators, yet there are several notable features of the definitions employed. Firstly, for manufacturers 'technological innovation' is confined to changes in products and processes – service innovation by manufacturers was not asked about. Secondly each of the definitions includes the term 'significantly improved', which is highly subjective. It is quite possible, even likely, that two equally informed respondents within the same enterprise might have taken a different view as to whether or not the enterprise's products, processes or services had been 'significantly improved' over the period and therefore, potentially, whether or not the enterprise was an innovator. Thirdly, there is an emphasis on technology and technological innovation. The definitions allude to embodied technologies, but this is problematic, particularly in services where, according to Gallouj and Weinstein (1997, p. 543), the '"technologies" involved usually take the form of knowledge and skills embodied in individuals (or teams) and [where these are] implemented directly when each transaction occurs, rather than in [tangible products,] physical plant or equipment'. It is not clear whether new or improved skills should be considered technologies for the purpose of the survey. Moreover the definition of service innovation in particular is long, convoluted, and even confusing.[12] Because of this it is likely that many respondents will have answered on the basis of their intuitive understanding of innovation, rather than on the basis of the definition provided.

4.1 'Innovators' – Variously Defined

Using the responses to these (and some other questions) on the survey, 'innovators' can be identified, at various 'levels', although all of these definitions are subjective and dependent on the information provided by the respondents.

The first and most exclusive definition restricts 'innovators' to those enterprises that claimed to have introduced (between 1994 and 1996) at least one technologically new or improved product (or 'service' in the case of services) that was developed mainly by the enterprise (or jointly with other enterprises or institutes)[13] and that was not only new to the enterprise but also new to the enterprise's market. We label these (self-identified) '*new to the market innovators*' [NttM]. If properly identified, these are arguably the only true innovators, as in theory this group constitutes enterprises that have introduced new products or services that go beyond those that imitate the offerings of their competitors. However, the 'the market' was not defined and this may be problematic. For if an enterprise chose to interpret its market narrowly it is more likely to qualify as a 'new to the market innovator' than if it chose to interpret its market broadly. On the other hand, the introduction of 'new to the market innovations' may signal the strategic intent (Hamel and Prahlad, 1989) to achieve true innovation, as opposed to imitation.

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[12] For example, the definition appears to suggest the use of new technologies is sufficient for a 'new service' to qualify as a technological innovation, but it is unclear whether this should be globally new technology or just new to the firm. Moreover, as the use of changed technologies may change the nature of an existing service it is not clear whether the result should be considered a 'new service' and thus an innovation.

[13] A few respondents claimed 'new to the market innovations' but admitted these had been developed 'mainly by other enterprises or organisations'. We have categorised these enterprises as 'external innovators'.

The second 'level' expands the definition of an 'innovator' to include the other enterprises that claimed to have introduced (between 1994 and 1996) at least one technologically new or improved product, process or service that was developed internally or jointly with other enterprises or institutes. These may or may not have been 'new to the market'. We label these additional enterprises the '*other internal / joint innovators*'. With these included, the definition of an 'innovator' therefore includes enterprises that claimed to have introduced 'innovations' that were imitative of products or services already available in the market.

The third definition of 'innovators' includes all the enterprises that claimed to have introduced (between 1994 and 1996) a technologically new or improved product, process or service. Thus, beyond the internal / joint innovators defined above, this definition includes enterprises that only introduced innovations that were 'mainly developed by other enterprises or institutes'. We label these additional enterprises the '*external only innovators*'. It is questionable whether these are really 'innovators' as opposed to technology adopters. Arguably the distinction does not turn solely on the source of the technology, but also on aspects such whether the technologies adopted were bespoke, customised or standard, and whether they were used in standard or creative ways. The degree of risk taken by the innovator/adopter, and the extent of new learning required might also be considered in differentiating innovation from technology adoption. However, we unfortunately have little information about these dimensions, but overall the proportion of respondents classified as 'external only innovators' was (surprisingly) small, at just 7%.[14]

The fourth definition is of 'an enterprise with innovative activity', which follows a definition devised by Eurostat.[15] In addition to the self-identified innovators categorised above, Eurostat includes as innovators all newly established enterprises that did not explicitly deny having introduced new products, processes or services, and also those enterprises that, although they did not indicate the introduction of a new or significantly improved product, process or service between 1994 and 1996, did declared that they had undertaken unsuccessful or yet to be completed innovation projects in that period. It is questionable

[14] We suspect the survey may have under-represented the true proportion of 'external only innovators' due, on the one hand, to some enterprises failing to recognise these activities as 'innovations', and on the other to some enterprises claiming credit for the innovations (as developed internally or jointly) that were in reality largely developed by other enterprises or organisations. This relates to the question of whether the innovation was in the technology itself (which may be imported), or in the use to which the technology is put.

[15] Eurostat also has a definition of innovative enterprises, which excludes those that only had unsuccessful or yet to be completed innovation products during the 1994-96 period.

whether new enterprises and unsuccessful innovators should be included in a definition of 'innovators' – and indeed the Oslo Manual (para. 201) recommends they should not.

The final and most generous definition of an 'innovator' is one devised by the UK government's Department of Trade and Industry (DTI). In addition to Eurostat's 'enterprises with innovative activities' the DTI included those respondents that (although they did not introduce a product, process or service innovation between 1994 and 1996, nor had any innovation projects within that period) did claim to have had product, process or service innovation projects in the last ten years or, failing that, claimed to have had plans to innovate in the next five years. Arguably this is an excessively generous definition of an 'innovator', and, in contrast to the other definitions it is interesting primarily for the enterprises that it excludes rather than includes. For it is striking that a quarter of the responding enterprises fell into this category, including one in eight of those in high technology manufacturing and one in four of those in high technology services.

Table 2

'Innovators' - Variously Defined and as a Proportion of the Respondents

'Sector'	Definition 1	Definition 2	Definition 3	Definition 4	Definition 5
Manufacturers	23%	48%	56%	68%	78%
Service Enterprises	23%	36%	41%	54%	71%
HTM	31%	62%	69%	79%	88%
MTM	30%	57%	63%	74%	83%
LTM	15%	37%	47%	59%	71%
Utilities etc.	8%	23%	29%	50%	60%
HTS	31%	45%	49%	58%	75%
Financial Services	32%	52%	57%	66%	82%
Other Services	15%	24%	29%	46%	65%

Definition 1 : 'New to the Market' Internal or Joint Innovators – see text for details.

Definition 2 : All Self-Identified Internal or Joint Innovators – see text for details.

Definition 3 : All Self-Identified Innovators, including External Only Innovators – see text for details.

Definition 4 : Eurostat's 'enterprises with innovative activities' – see text for details.

Definition 5 : The DTI's definition of innovators – see text for details.

Figure 1:
'Innovators' - Variously defined and by Enterprise Size

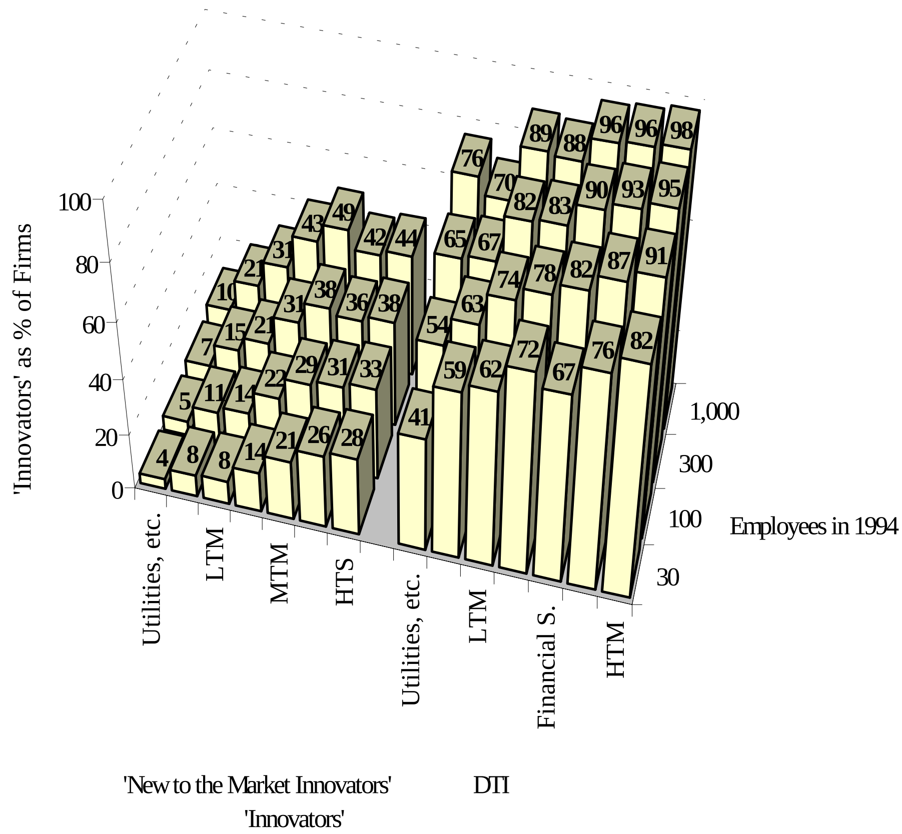

Table 2 reports the proportion of 'innovators' under each of these definitions amongst the manufacturers and service enterprises, and also within each of the 'seven sectors'. Further analysis shows the proportion of innovators increases with enterprise size for all of the definitions of 'innovator' outlined above, although in general the effect of size was less amongst the service enterprises (see Appendix Table A). Enterprises in the higher technology sectors were also more likely to be identified as innovators. Figure 1 shows the estimated probability that an enterprise, in each of the seven sectors and with 30, 100, 300 or 1,000 employees in 1994 (i.e., at the start of the period of analysis), was identified as an innovator, according to both the narrowest ('new to the market') and broadest (DTI) definitions. These estimations are derived from logistic regressions (see appendix Table A).[16] This increase with size in the likelihood that a firm is identified as an innovator is explainable

[16] This involves the estimation of the linear equation *Z* (which is composed of a constant and coefficients on the independent variables in the normal fashion), but the dependent variable takes a binary form (0,1) – in this case Non-Innovator = 0; Innovator = 1. The estimation is probability of the event under investigation

on the basis that larger firms tend to have more lines of business (and greater resources) and therefore greater opportunity to innovate than smaller firms.[17]

4.2 Innovation and Technology Adoption

The existence of a sizeable proportion of respondents, particularly in the high technology sectors, that do not qualify as an 'innovator' even under the DTI's generous definition raises questions about the adequacy of the survey instrument to identify innovative activity. It may not be impossible for (a high technology manufacturing) firm to exist for ten years and to expect to exist for another five years without introducing any 'new or (significantly) improved' products or processes, but it would be extremely surprising if this were truly the case for a large proportion of these firms, especially if innovation is really the key to competitiveness.[18]

Interestingly, the UK's CIS-2 surveys also asked the enterprises whether they had introduced (between 1994 and 1996) any of a series of new technologies and managerial practices. Under any of the five definitions outlined above the majority of 'innovators' claimed to have introduced at least one of: electronic data interchange; the use of e-mail; and/or the use of the Internet. That is, they were 'technology adopters'. Similarly, a majority were 'practice adopters', having introduced one or more of the following organisational or managerial practices: just in time (or a similar planning system); investors in people; a quality management system or standard (such as ISO 9000); and/or the benchmarking of the enterprise's performance against that of other firms. But it is especially notable that a third of the enterprises that did not qualify as 'innovators' even under the DTI's definition were identified as 'technology adopters', and a similar proportion were 'practice adopters'. Half the DTI's 'non-innovators' had introduced at least one of the listed new technologies or new practices. This shows that many of these 'non-innovators' were not entirely dead to change, yet they resisted identifying the themselves as innovators, or as being engaged in any innovation activity. This conjunction raises questions about the relationship between the adoption of new technologies (and practices) and (technological) innovation.

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will occur. Thus: $\Pr(Innov) = \hat{I}_i = 1/(1+e)^{-Z_i}$. The probabilities provided in Figure 1 are derived from the estimated linear equations (Z) which are reported in Appendix Table A.

17 This does not mean that the share of turnover due to innovation is necessarily higher amongst larger firms. It suggests there is likely to be greater variance in this share amongst small as compared with large firms.

18 There is a possibility that some respondents recognised that by denying their firm had innovated they could complete the questionnaire whilst skipping a significant portion of it. We do not, however, know the extent of this activity, although it is unlikely to account for most of the 'non-innovators'.

Innovation certainly implies more than the adoption of new technologies or practices. Innovation implies a degree of disruption, a degree of uncertainty or risk taking and/or significant learning on the part of the innovator. In this sense the enterprises that claimed to have adopted technologies but not to have innovated may well be correctly classified, for the mere adoption of a technology is not sufficient to qualify as innovation. Indeed, according to the European Commission's Green Paper on Innovation (EC, 1995 – as quoted in the Oslo Manual, para 61):

> The innovative firm … has a number of characteristic features which can be grouped into two major categories of skills:
>
> - strategic skills: long term view; ability to identify and even anticipate market trends; willingness and ability to collect, process, and assimilate technological and economic information;
> - organisational skills: taste for and mastery of risk; internal co-operation between the various operational departments, and external co-operation with public research, consultancies, customers and suppliers; involvement of the whole firm in the process of change, and investment in human resources'

Not only does this imply more than the adoption of new technologies, it implies more than the introduction of (technologically) new or improved products, processes or services. Consequently, it is reasonable to ask whether the introduction of new products, processes or services, even if new to the enterprise's market, is sufficient to justify the label '(technological) innovation', but it is particularly unclear whether the label 'innovator' is justified when the enterprise is 'innovating' through the adoption of acquired technologies. Two examples should help clarify the argument.

1. A bus company introduces low access busses that allow easier access for passengers in wheelchairs.[19]
2. A delivery company begins using mobile phones and/or computer mapping software to reroute drivers throughout the day so that instead of returning to base they can move between delivery points in a more efficient way.

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[19] Consider also a bus company which introduces a less polluting bus – is this innovation? Perhaps it depends on whether the bus was introduced on the company's own initiative (especially if it pressured the bus manufacturer to produce such busses and/or had a role in their design) or whether it was forced to change by new regulations.

Are either of these technological innovation? Arguably, even though both have resulted in an objectively enhanced service, neither constitutes *technological innovation* by these firms, particularly if the adopted technologies were standard rather than purpose built or significantly customised, and especially if their adoption did not involve significant learning. Arguably the second is an organisational innovation, albeit one facilitated by new technologies.[20]

The broader point is that (technological) innovation is difficult to reduce to a black and white categorisation. Yet both the Oslo Manual and the CIS are constructed on this premise, asking direct and simple questions (although based on complex definitions) so as to dichotomise innovating and non-innovating firms. The data is then used to make statements such as: 'Overall, 52% of all [UK] enterprises were innovators' (Craggs and Jones, 1998, p. 51), and 'Over half of all European manufacturing enterprises (51%) and 40% of those in the service sector are technological innovators' (European Commission, 2001, p. 14).[21] These statements are problematic because they conflate a variety of activities (from technology adoption through to 'true innovation') into 'technological innovation'. These difficulties are compounded when the data are used to make comparisons between countries and sectors.

For although the aim of the CIS is to provide comparable statistics (between countries and sectors), there are doubts as to whether the findings are comparable. Are services really less likely to be (technological) innovators than manufacturers? – perhaps they are merely less likely to recognise themselves as innovators. Statements about the proportion of innovators also say nothing about the intensity of innovation activities, which tend to be unevenly distributed amongst firms, and groups of firms.[22] Meanwhile, the threshold of what is considered an 'innovation' may vary between sectors and countries. A small change may not qualify as an innovation in a sector where change is routine or continuous, but may be considered an innovation where change is rare.

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[20] These cases were cited as 'technological innovations' on the CIS-2 – the second is given as an example of technological innovation in services in both the Oslo Manual and on the CIS-2 questionnaire.

[21] First 'Key Finding', Statistics on Innovation in Europe, 2000 edition, EC – Building and Innovative Economy in Europe, p.14.

[22] Amongst one group the great majority may engage in at least a low level of innovation activity, but few may engage in a high level. Amongst a second group innovation may be more skewed, such that although a smaller proportion achieves at least the low level of innovation, a greater proportion achieves the high level. The point is the proportion of 'innovators' alone can mislead as to the extent of innovation amongst a group of firms.

4.3 Towards a More Tiered Approach to Identifying Innovators and Technology Adopters

One of the reasons why it is important not to conflate a variety of activities, from technology adoption through to 'true innovation', is that achieving 'true innovation' may require very different capabilities and resources, and may have a very different impact on the firm. Yet, if we define innovation at a low level the population of 'innovators' will tend to be dominated by low-level innovators, and the differences in the behaviours of different types of innovators will be obscured. In the next section of the paper we use the UK CIS-2 data to demonstrate how different types of 'innovators' behaved differently, and thus illustrate how the definition of innovation used impacts on the revealed characteristics of 'innovators'.

5. Survey Results – Part 2: The Variable Characteristics of Innovators

In the previous section we argued that the CIS conflates different types of behaviour - from true innovation to technological adoption - into a single definition of 'innovation'. We now use the evidence from the UK CIS-2 to illustrate how the different types of 'innovators' behaved differently in terms of their engagement in R&D, employment of qualified scientists and engineers, participation in external collaborative arrangements for innovation, and the extent and structure of their expenditures on innovation. We do this on the basis of the different definitions of 'innovators' outlined earlier in the paper.

5.1 Variation in the Activities of 'Innovators'

We begin by examining whether or not the different types of 'innovators' engaged in R&D (at all, and on a continuous basis), employed qualified scientists and engineers (QSEs), and participated in co-operative arrangements for innovation with other firms or institutions.[23] All of these features are related to, though not necessary for, technological innovation. For each of these we undertook logistic regressions (one for the manufacturing survey responses, another for the service respondents), which were confined to those enterprises that were defined as innovators by the DTI's definition and where the dependent variable was the presence or absence of these attributes. The independent variables were: the size of the firm (in the form of log of employment); sector dummies; and dummies for each of the different types of innovator. The results are shown in Table 3.[24]

[23] Innovation co-operation is defined as: 'active participation in joint R&D and other technology projects with other organisations. It does not necessarily imply that both partners derive immediate commercial benefit from the venture. Pure contracting out work, where there is no active participation is not regarded a co-operation.'

[24] Logistic regressions were also run for each individual sector. These found similar pattern to the pooled regressions.

Table 3

Engagement in Innovation Related Activities by Different Types of 'Innovators'

Logistic Regressions:	Model 1	Model 2	Model 3	Model 4
Dependent Variables:	Engagement in R&D	Continuous R&D	Employment of QSEs	External Collaborations
Manufacturing Survey:				
(Constant)	-0.42	-2.95***	-2.19***	-2.68***
Ln(Employment)	0.33***	0.54***	0.54***	0.37***
HTM	0.44**	0.60***	1.25***	0.52***
MTM	0.48***	0.35**	1.31***	0.39**
Utilities etc.	-0.47*	-0.52*	0.17	0.57**
New to the Market Innovator	1.14***	0.92***	0.44**	0.70***
External Only Innovator	-1.72***	-1.56***	-1.24***	-0.43*
Only a Eurostat Innovators	-1.44***	-1.47***	-0.90***	-0.62***
Only a DTI Innovator	-1.20***	-1.54***	-0.62***	-1.72***
Observations (N.)	1,202	1,202	1,222	1,201
-2 LL	1,146.2	1,208.6	1,234.0	1,332.2
Model χ^2 (degrees of freedom)	326.3*** (8)	430.1*** (8)	338.6*** (8)	231.0*** (8)
Nagelkerke R^2	0.34	0.40	0.33	0.24
Services Survey:				
(Constant)	-2.30***	-3.72***	-2.01***	-2.37***
Ln(Employment)	0.24***	0.19***	0.21***	0.21***
HTS	1.55***	2.00***	2.06***	1.18***
Financial Services	0.28	0.62*	-0.78***	-0.06
New to the Market Innovator	1.36***	1.54***	0.60**	0.91***
External Only Innovator	-0.32	-0.48	-0.03	-0.22
Only a Eurostat Innovators	-0.54 [12%]	-0.17	-0.30	-0.40
Only a DTI Innovator	-0.95***	-1.03**	-0.41	-0.66*
Observations (N.)	517	517	531	513
-2 LL	545.0	417.6	576.7	558.0
Model χ^2 (degrees of freedom)	160.8*** (7)	140.2*** (7)	145.7***	89.4*** (7)
Nagelkerke R^2	0.36	0.36	0.32	0.22

* significant at 10%; ** significant at 5%; *** significant at 1%

This found that, after controlling for enterprise size and sector,[25] the type of 'innovator' had an influence on whether or not the enterprise engaged in these various activities. In particular, amongst both the manufacturing and service respondents and compared with the

[25] The coefficients for which were as expected, i.e., there were positive coefficients on size, and the more technology oriented sector firms were more likely to engage in these activities (after controlling for size) than were those in the less technology oriented sectors.

'other internal / joint innovators', the 'new to the market innovators' were more likely to engage in R&D (at all and on a continuous basis),[26] were more likely to employ qualified scientists and engineers, and were more likely to engage in collaborative arrangements for innovation with external partners. Amongst the manufacturing respondents, the 'external only innovators' - together with those that were only identified by Eurostat as 'enterprises with innovative activities', or as 'innovators' by the DTI's definition - were less likely than the 'other internal / joint innovators' to engage in these activities. Amongst the service respondents, these three types of innovators were also less likely to engage in these activities than were the 'other internal / joint innovators', although few of these results were statistically significant.

In general these results show that the type of innovation introduced by the firms relates to the type of activities engaged in, and in particular shows the 'new to the market innovations' – the closest we can get to 'true innovators' – were, after controlling for size and sector, more likely to engage in R&D, employ qualified scientists and engineers, and have collaborative arrangements for innovation than were the enterprises that introduced 'imitative innovations' or those that 'innovated' on the basis of adopted technologies developed by others. Especially amongst the manufacturers these 'technology adopters' were significantly less likely to engage in these activities than were the 'imitative innovators'. This supports our argument that the CIS provides more interesting information about innovative behaviours when the analysis goes beyond a simple dichotomisation of 'innovators' and 'non-innovators'.

5.2 The Extent of Expenditures on Innovation Related Activities'

We now turn to the data on extent to which the 'innovators' committed financial resources to innovation. In this section the analysis is confined to the self-identified innovators, which is the third definition outlined in Section 4.1.

The survey asked the firms to state the expenditures they had made in 1996 on seven innovation-related activities. These were: in-house R&D; the acquisition of R&D services; the acquisition of machinery and equipment; the acquisition of other external technologies

[26] R&D was defined as: 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications. Design, construction and testing a prototype is often the most important phase of development work. Software development is included as long as it involves making a scientific or technological advance. R&D can be carried out within the enterprise, or can be acquired from external R&D services.'

(including software);[27] preparations for the introduction of innovations; training directly linked to innovation; and expenditures on the market introduction of innovations. Later we will analyse how the proportional allocation of these expenditures also varied with the type of innovation introduced (and by the sector of the innovators), but we begin by assessing the total amounts committed to these activities by the enterprises on a per employee basis. The data are assessed on a per employee basis to provide a simple control for enterprise size.

Overall, amongst the manufacturing respondents that provided innovation expenditure data for 1996 (Figure 2), the median declared expenditure was £2,990 per employee (Figure 3). Amongst the service enterprises the corresponding figure was £2,180. However, amongst both the manufacturers and service respondents there was wide variation in the declared innovation expenditures. The respondent at the 75th percentile of the manufacturing sample had a declared expenditure of £7,540 per employee, 2.5 times that of the median firm, and over six times that of the respondent at the 25th percentile in that distribution (£1,180). It was therefore not uncommon for one manufacturer to declare an expenditure on innovation activities (for 1996) that, on a per employee basis, was ten times that of another manufacturer. Similar variation was found amongst the responses from the service sector. Amongst these the enterprise at the 75th percentile in the distribution (£5,090) declared expenditures 2.3 times (on a per employee basis) that of the median respondent, and over eight times that of the enterprise at the 25th percentile (£570).

This variation in innovation expenditures exists for a variety of reasons. Firstly the data refer to the single year, 1996, rather than the whole period, or to a 'typical year' within the period. It is perfectly possible that an enterprise could have had an atypically high or low innovation expenditure in 1996 compared with the 1994-1996 period as a whole. This is particularly likely to be the case amongst small firms, and especially amongst those that 'innovated' largely through the acquisition of externally developed technologies, as expenditures on external technologies can be lumpy, and therefore vary widely from one year to the next.

Secondly, the interpretation of what counts as innovation related expenditures may vary between firms. For instance, the survey asks about expenditures on 'training directly linked to technological innovation' and for expenditures on 'preparations' to introduce innovations. All of the expenditure categories, but perhaps these especially, are subject to considerable

[27] '… includes the acquisition of packaged software, patents, non-patented inventions, licences, know-how, trademarks, drawing plans and consultancy services (excluding R&D) relating the implementation of technological innovations, plus the acquisition of packaged software that is not classified elsewhere.

interpretation, and it is likely that some respondents will have included expenditures on activities that others will have overlooked.

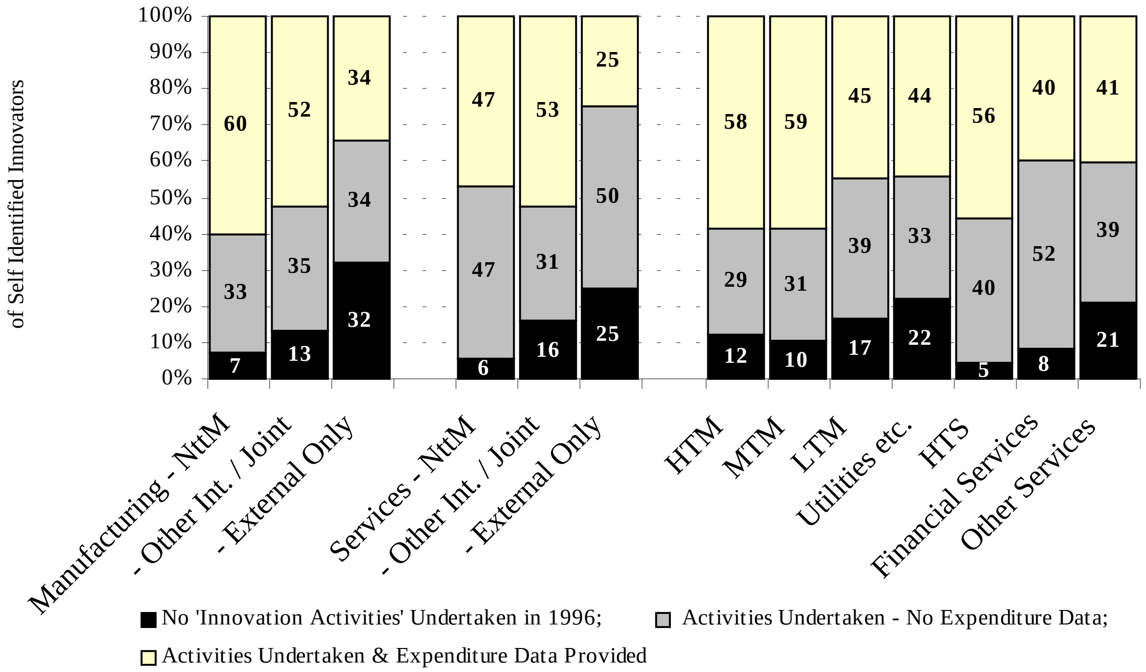
Thirdly, there will be genuine differences in the extent to which enterprises engage in innovation and, by extension, the extent to which they commit resources to innovation. We would, for example, expect that enterprises in high technology activities devote more resources to innovation than is common amongst enterprises in low technology activities. We would also expect the enterprises that introduced higher level innovations to have higher expenditures on innovation than those that introduced lower level innovations.

Overall, the data support these expectations. For amongst the manufactures the median (per employee) expenditure on innovation – amongst those that provided this data - increased from the low (£1,800), through the medium (£2,770) to the high technology manufacturers (£5,280). And amongst the high and medium technology manufacturers the 'new to the market' innovators tended to spend more on innovation (per employee) than the 'other internal / joint innovators', which in turn tended to outspend the 'external only innovators'. However, amongst the low technology manufacturers the median expenditure of the 'external only innovators' exceeded that of the 'internal / joint innovators', including the 'new to the market innovators'. This is a surprising result, which may be partially explained by the fact that a quarter of the 'external only innovators' amongst low technology manufacturers declared no innovation expenditures in 1996 (and were therefore excluded from the analysis), thus boosting the average, which may be boosted further if expenditures on acquired technologies tend to be lumpy. Nonetheless, the relatively high expenditures of the 'external only innovators' in low technology manufacturing is worthy of note and further investigation.

Amongst the service sector respondents similar patterns were found, although more service firms failed to provide this data (Figure 2). This suggests services have more difficultly in estimating these expenditures, perhaps because it is more difficult to decide in services whether or not expenditures relate to innovation (particularly given the expenditure items asked about) and/or because they monitor their commitment of resources to innovation less closely. Of those that did provide innovation expenditure data the median expenditure (per employee) was higher amongst the 'high technology services' (£4,360) than amongst the financial services (£2,040), with 'other services' trailing some way behind (£570). And within each of these 'sectors' the 'new to the market innovators' tended to spend more on innovation than the 'other internal / joint innovators'. Amongst services there is little data on innovation expenditures by the 'external only innovators' (Figure 2), but what there is suggests these spent less per employee on innovation than the internal / joint innovators.

Beyond this, it appears there is at least as much variation in the declared expenditures on innovation (per employee) amongst services as amongst the manufacturers (Figure 3). This variation may reflect the reality, but it may also reflect considerable uncertainty, or ambiguity, over what qualifies as innovation-related activities within services. Should, for example, computer programming be considered innovation related activities, and if so should they be included under research and development expenditures?[28] Because of the variation in these data we urge caution in their interpretation. In particular, it is questionable whether exact comparisons of innovative intensity can be made between sectors (and still less between enterprises).

Figure 2:
Engagement in Innovation Activities and
Provision of Innovation Expenditure Data for 1996



[28] As part of another study investigating R&D activities amongst UK information technology companies, we contacted IT service companies. One large company responded they did not conduct R&D - 'many thousands [of employees] are working on development but on client contracts rather than internal investment'. Because there was no centralised activity, this company denied it undertook internal R&D – others might see it differently.

Figure 3:
Expenditures per Employee on 'Innovation Activities' in 1996
(amongst those providing this data)

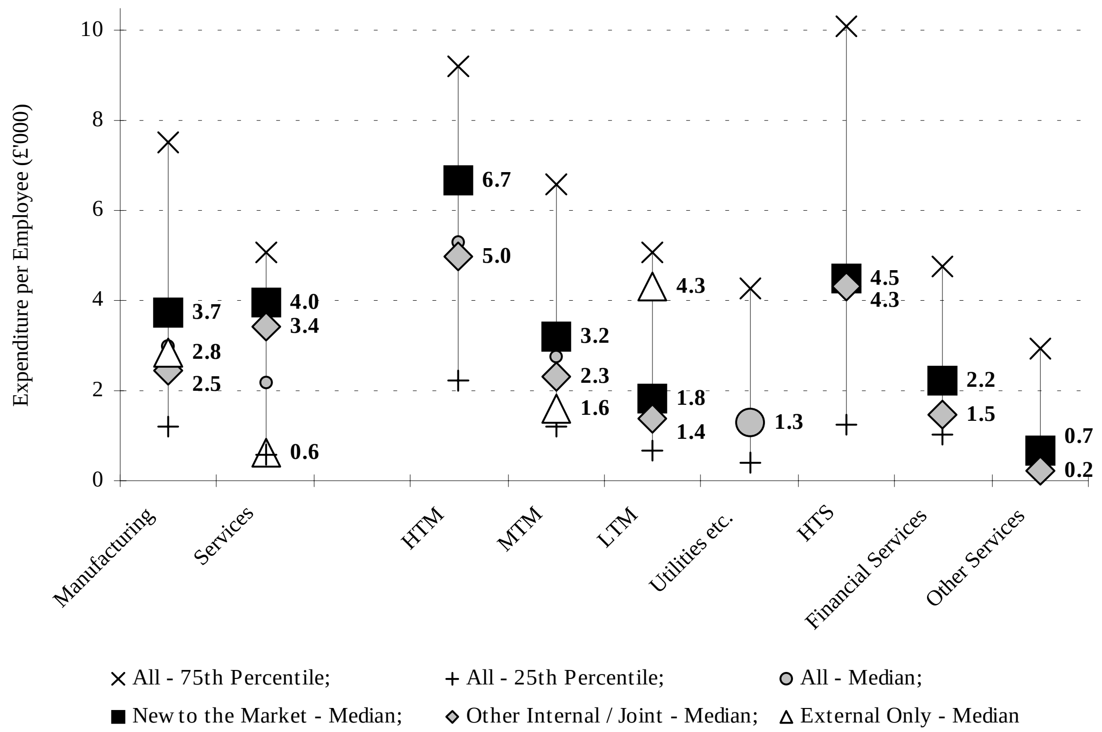
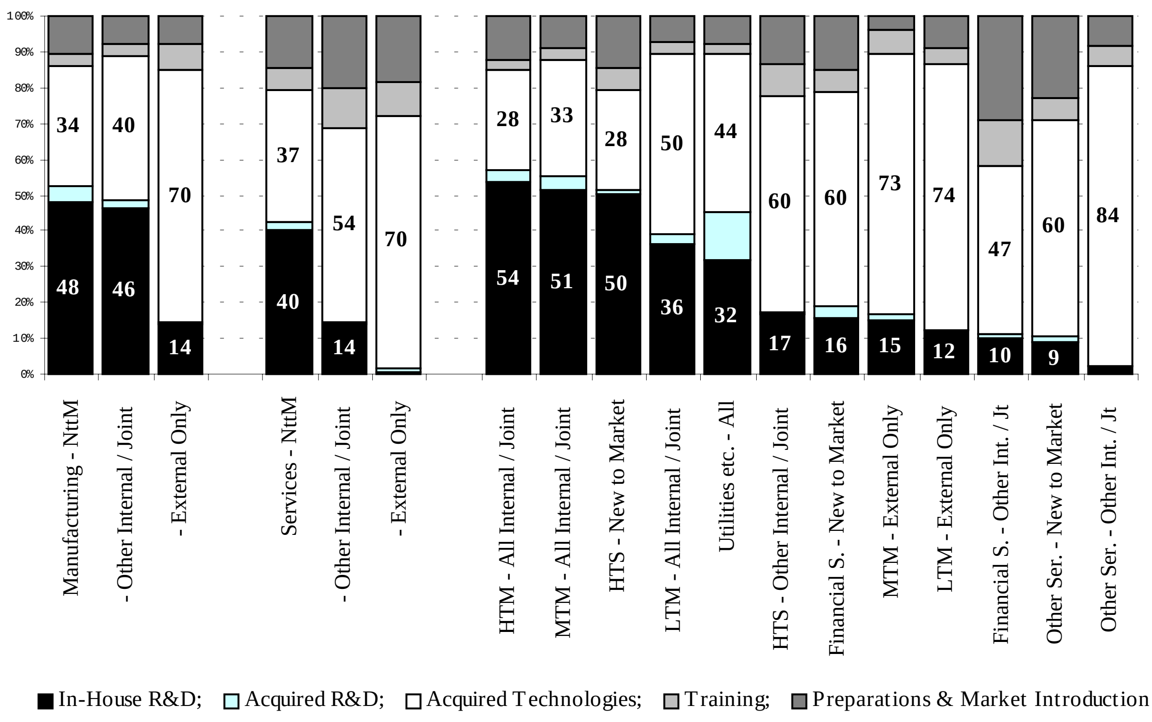


Figure 4:
Innovation Expenditures Distributions by Sector & Type of Innovator



5.3 The Structure of Expenditures on Innovation Related Activities'

Having commented on the total innovation expenditures reported by the respondents, we now turn to the breakdown of these expenditures into various activities. Because of the scope for interpretation as to what constitutes innovation expenditures, we restrict the analysis to comparisons of the average distribution of innovation costs by sector and by type of 'innovator'.

Amongst the manufactures that introduced internally of jointly developed innovations, internal R&D accounted for, on average, over 45% of total innovation expenditures (in 1996)(Figure 4). This proportion was slightly higher amongst the 'new to the market innovators', but far lower, at just 14% amongst the 'external only innovators'.[29] Instead, the innovation expenditures of these were dominated by acquired technologies, which (on average and excluding acquired R&D services) accounted for 70% of their total innovation expenditures. Contrast this with the 'new to the market innovators', for which acquired technologies accounted for only about a third of total innovation expenditures. The balance of R&D against acquired technologies tended to vary with the technological intensity of the sectors, with R&D being more important in the high-tech sectors and acquired technologies dominating in the low-tech sectors. Also of note is that amongst the manufacturing respondents acquired R&D services, training (directly linked to innovation), preparations, and the market introduction of innovations tended to account for relatively small shares of total innovation expenditures.[30]

Overall amongst the service sector respondents the significance of R&D in total innovation expenditures was less and the significance of acquired technologies was greater. However, amongst the 'new to the market' service innovators internal R&D accounted for a substantial 40% of total innovation expenditures (on average). The corresponding proportion amongst the 'other internal / joint innovators' was less than half of that, whilst almost nothing was spent (on average) by the 'external only innovators' whose expenditures were dominated by acquired technologies. Also notable is the share of innovation expenditures spent on training, preparations and the market introduction of innovations. This was around 30% amongst the 'other internal / joint innovators' and the 'external only innovators'

[29] Many of the 'external innovators' did not conduct R&D at all, and this average is inflated by the minority that did, for which internal R&D could constitute a significant share of their innovation costs.

[30] The mean share of expenditure on these activities was greatest, at around 20% of total costs, amongst the 'new to the market innovators' in the high technology manufacturing activities.

Further analysis by 'sector' and type of 'innovator' reveals that, within services, only amongst the high technology 'new to the market innovators' did in-house R&D account for as large a proportion of total innovation expenditures as was common in manufacturing. Indeed, the average expenditure profile of these enterprises is very similar to that of the corresponding high technology manufacturers. Meanwhile amongst the high technology services that introduced 'other internal / joint innovations' R&D accounted for less than a fifth of total innovation expenditures, whilst 60% was spent on acquired technologies. Amongst the financial and 'other services' that introduced 'internal / joint innovations', including 'new to the market innovations', R&D tended to account for a small share of total innovation expenditures, whilst acquired technologies dominate. This suggests a relatively low importance of R&D (or of what is recognised as R&D) for innovation in services, particularly beyond those enterprises in high technology service activities developing 'new to the market innovations'. Notably, significant shares of total expenditure are allocated to the rather vague category of 'preparations'.[31] This might reflect a desire on the part of the respondents to indicate expenditures on internal innovation activities that they were not comfortable classifying as R&D.

Overall the innovation expenditure data highlight the significance of investments, particularly amongst technology adopters and imitators, but also amongst 'true innovators', especially in the service sectors. This is notable, because investments are often neglected in studies of innovation (Evangelista, 1999). However, the importance of investments raises questions about the nature of the acquired technologies, such as whether they were bespoke, customised or just standard, and whether they were used wholly as intended by the manufacturer or in creative and unintended ways. This is a return to the earlier discussion about the difference between technological adoption and innovation. Apart from some evidence on training (directly related to innovation) the CIS unfortunately provides very little insight into these questions.

Training is of course not always necessary for learning, and it is quite possible that (standard) technologies were used creatively without training, but overall the adoption of technologies with little or no training suggests the acquired technologies were easily absorbed into the enterprises. It is striking, therefore, that relatively little was spent by the enterprises on training directly linked to innovation. Amongst the manufacturers, more than half (of those

[31] Defined for services as: 'activities aimed at defining procedures, specifications and operational features (including final tests) necessary for the introduction of innovation.'

that declared innovation expenditures for 1996) indicated they spent nothing on training linked to innovation, and only a quarter spent more than £100 per employee (only 7% spent more than £500 per employee). Alternatively examined, only 6% of the enterprises declared expenditures on training that exceeded a third of their expenditures on acquired technologies. Amongst services, two thirds (of those that declared innovation expenditures for 1996) reported expenditures on training (directly linked to innovation) and half of these spent more than £100 per employee on training, but only 15% spent more than £500, and only 15% indicated their spending on training exceeded a third of their expenditures on acquired technologies.

These patterns suggest relatively little training accompanied the introduction of the acquired technologies, which in turn suggests that most of the enterprises that 'innovated' through the acquisition of externally developed technologies absorbed these technologies with ease. Unfortunately, we have no information as to whether the adopted technologies were used in creative or standard ways, which would help determine whether the firms were active or passive technology adopters, but these results do suggest these firms were predominantly technology adopters, rather than innovators.

6. Discussion

Having discussed the survey and some of the evidence it provides, we end the paper with a discussion which is framed around three issues. The first is an appraisal of the contribution and limitations of the CIS as a tool for understanding innovation behaviour. The second is a commentary on the revealed patterns of innovation in services, which have until now been widely overlooked by analysts of innovation. The third is a discussion of the 'missing dimension' in the survey, that is the relationship between innovation and performance.

6.1 The Contribution and Limitations of the Community Innovation Survey

Any assessment of the contribution and limitations of the CIS should begin by recognising that this survey represents an important step towards gaining a fuller understanding of innovation and of innovation processes. Prior to these surveys, European policy makers and analysts of innovation had little data other than that on R&D expenditures or employment, on patenting, and the occasional, ad hoc, survey of innovations (Pavitt, 1984; Pavitt et al., 1989; Kleinknecht et al., 1993). Each of these indicators has important limitations, and arguably the concentration on R&D and patents encouraged the excessive privileging in our conceptualisation of innovation of new disembodied scientific and technological knowledge, to the neglect of investments (Evangelista, 1999) and the use of technologies, and of innovation through design and new combinations of existing technologies. The OECD's Oslo Manual (OECD, 1992a; OECD, 1997) and the CIS therefore make an important contribution, operationalising a wider concept of (technological) innovation and providing the first systematic attempts to understand this at the level of the firm.

These data have facilitated a wider understanding of innovation and of innovation processes, and broad patterns can be discerned between different sectors – for example, and as expected, the role of R&D clearly tends to be greater amongst enterprises in the high technology sectors whereas investments are of greater significance in the low technology sectors. But beyond this the CIS is significant in revealing variety within and between sectors. It is unfortunate that it is difficult to discern how much of this variety is due to differences in interpretation of the innovation questions and how much reflects genuine differences between firms. Certainly, variety in behaviour is to be expected, particularly from an evolutionary economic perspective. In the analysis in this paper some significant differences were found between the behaviour of the 'new to the market innovators' - which are the closest we can get to identifying 'true innovators', the essentially imitating 'other internal / joint innovators', and the (probably) largely technology adopting 'external only innovators'.

Yet despite its merits, the CIS can be frustrating to deal with, because the survey has some important limitations, which could be reduced to increase significantly the usefulness of these data, not only to innovation analysts but to policymakers. Below we discuss three areas in which the CIS's approach to identifying innovations and innovators could be improved.

The first limitation is that the CIS is effectively built on an attempt to dichotomise innovation behaviour into innovators or non-innovators. If the product-process duality is used then four categories can be derived: product and process innovators; product-only innovators; process-only innovators; and non-innovators. The problem with this is what is included as innovation clearly turns on the definition employed, and we argue the definitions used by the CIS effectively conflates technology adoption and innovation. We have shown using the UK response to the CIS-2 that the behaviour of different types of 'innovators' can be quite different. Deriving headline findings from all 'innovators', such as X% of innovators conduct R&D and Y% enter into collaborative arrangements with external partners can therefore be misleading. Both of these behaviours appear to be significantly more common amongst 'high level' innovators. We therefore propose the development of a more tiered approach to identifying 'innovators' which differentiates between innovation and technology adoption. For example, a five-tiered categorisation might be developed, including:

1. *'True innovators'*. These are enterprises for which (technological) innovation is at the core of their activities. Such enterprises should have many of the strategic and organisational 'skills' outlined in the above (European Commission) definition of an 'innovative firm'.

2. *Imitators*. These firms *develop technologies* for their own new products, processes and services, but they are essentially imitators rather than true innovators.

3. *Active Technology Adopters.* Rather than develop technologies internally, these enterprises use technologies developed by others, but they do so in creative rather than standard ways. Thus they are creative users but not producers of new technologies.

4. *Passive Technology Adopters*. These enterprises also use technologies developed by others, but in standard rather than in novel or creative ways.

5 *Non-Innovators and Non-Technology Adopters*.

A categorisation such as this clearly requires further development before it can be operationalised,[32] but the aim is to gain more knowledge about the variety of innovative behaviours. The significance of this is that it allows the survey's data to be used for purposes beyond (a rather dubious) benchmarking, to permit a fuller investigation into the diversity and uneven distribution of innovative activity, which presently remains under-explored.

The second difficulty follows directly from the first, and is the fact that the CIS data is plagued by subjectivity and interpretive flexibility. This is important, because one of the core purposes of the CIS is to provide statistics on innovation that are comparable between sectors and countries. Although the Oslo Manual (OECD, 1997, para. 36) warns that the 'proportion of [innovating firms] threatens to become a "magic number" comparable to the percentage of GDP devoted to R&D. It is a figure that requires some care in presentation and interpretation' a recent European Commission report declares – drawing directly on the CIS-2 data: 'Over half of all European manufacturing enterprises (51%) are technological innovators, but this proportion varies widely between countries – from around 70% in Ireland, Denmark and Germany to around 30% in Belgium, Spain and Portugal. In almost every Member State, there are fewer innovators in the service sector than in manufacturing

[32] It may be necessary to add further aspects, for example on organisational innovation. We do not pretend this is a fully developed proposal.

industry – just 40% across the EU as a whole' (EC, 2001, p. 15). But these findings are questionable. Are Belgian manufacturers really less likely to innovate than Irish manufacturers,[33] and are services really less likely to innovate than manufacturers? Are they instead merely less likely to recognise themselves as innovators, and particularly as technological innovators?

Future versions of the survey should seek to reduce the scope for interpretive flexibility, particularly because innovation is now massively in vogue amongst industrial and economic policymakers, and politicians are forever exhorting firms to innovate.[34] In recent months the term 'innovation' has appeared 10 times per day on average in the articles of the Financial Times and its website FT.COM. The point is that not only has the word 'innovation' entered into general language, but it has also become (or is in danger of becoming) what the Americans call a 'motherhood-applepie concept' – something that is universally accepted as good. Consequently asking firms whether they have innovated may not generate accurate responses. Instead, it may be better to use a more neutral language – such as a 'survey of technological and organisational change' – to effectively ask about innovation without using the term directly.

The third difficulty relates to those above and is the concentration on 'technological product and process' innovation. Both these restrictions – to 'technological innovation' and to product and process innovation[35] – are problematic. If we consider that innovation is central to the competitiveness of firms, industries and countries, can we be certain that it is 'technological product and process innovation' within this that really matters. Organisational and strategic innovation is overlooked,[36] as is the opening of new markets (market innovation), unless this is based on new or significantly changed products, whilst new forms of delivery or customer interfacing (such as e-commerce) are either considered processes or are overlooked.[37] Yet these dimensions of innovation can be crucial to firms' competitiveness.

For example, without denying the significance of (innovation in) product quality and process efficiency, it is important to recognise that for car companies innovation does not end at the

[33] Comparisons between countries are problematic as the understanding of (technological) innovation may well be different in different cultures or languages.

[34] To illustrate, a search of the UK government's web site (open.gov.uk) in May 2001 generated almost 16,000 hits for the term 'innovation' and over 12,500 for the term 'innovative'.

[35] Service innovation in the second CIS is effectively a conflation of product and process innovation.

[36] According to the Oslo Manual (OECD, 1997, para 120) this is because: 'organisational innovation is highly firm-specific, making it still more difficult to summarise in aggregate, sector or economy-wide statistics.'

factory gate. Jaques Nasser, Chief Executive of Ford, perhaps the most iconic of manufacturers, has stated: 'We do not see ourselves as a car company only, but the leading consumer company for providing automotive products *and services*' (emphasis added).[38] To effect this strategy Ford has been buying service firms such as Kwik-Fit, and has become a major provider of financial services. Ford is far from alone in this strategy, which Howells (2001) terms 'service encapsulation'. The wider point is that services as well as products and processes are increasingly central to the competitiveness of manufacturers. Indeed, arguably the growing significance of services reflects the fact that in many areas of manufacturing the remaining competitors have all reached such a high level of product quality (in terms of functionality, ergonomics, etc.) that competition (and value added) has shifted from products to associated services. Quality products are necessary but not sufficient for competitiveness. This points to the significance of innovating in services, both in the introduction of new services and refining the provision of existing services, but amongst manufacturers such innovation is missed by the CIS.

The focus on technological innovation is also problematic, for 'technology' is variously understood – does it, for example, include skills?[39] Respondents that take a broad view of technology are more likely to identify their enterprise as an innovator than those that take a narrow view of technology. But arguably both the Oslo Manual and the CIS are confused as to what they mean by 'technological innovation'. On the one hand they include the development of technologically new or enhanced products or processes, but on the other they include the adoption and use of new technologies even if used wholly as intended by the producer. Take the 'use of cellular phones to reroute (delivery) drivers throughout the day' which is given as an example of technological innovation in services in both the Oslo Manual and the CIS questionnaire. Arguably this is not a 'technological innovation', but an organisational or work process innovation facilitated by the use of new technologies. The point is, how central should the technology be to 'technological innovation'?

Innovation – 'a complex, diversified activity with many interacting components' (Oslo Manual, para. 93)[40] - is not easy to define, and the concept is variously understood. But because of this that asking a firm whether it has introduced a (technologically) new or

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[37] Notably, Figure 3 in the Oslo Manual distinguishes the 'delivery process' from the 'production process'

[38] Financial Times, 4th and 8th of August, 1999.

[39] The UK CIS-2 states that 'Technology can be defined as a complex set of knowledge, capabilities, routines competencies, equipment and technical solutions necessary to manufacture a product' (or 'to produce and deliver a service'). This suggests skills are included in the definition.

significantly improved product, process or service is not equivalent to asking a household whether it possesses a television or microwave oven. Moreover, it is also doubtful whether the mere introduction of a (technologically) new or enhanced product, process or service is sufficient to qualify the firm as an 'innovator'. The 'characteristic features' of innovators, in terms of strategic and organisational skills, outlined in the European Commission's Green Paper on Innovation (EC, 1995) implies much more than this.

6.2 Innovation in Services – Into the Unknown

The extension of the CIS to cover services is particularly welcome as services dominate employment and value added in advanced economies, yet almost all of our understanding of (technological) innovation is derived from studies of manufacturing. Previous indicators such as R&D expenditures and patents are of little relevance to many services, and the original version of the Oslo Manual was also confined to manufacturing.

However, the second CIS surveyed services using a questionnaire adapted from that used for manufacturing. As noted above, this effectively represents a 'subordination' (Djellal and Gallouj, 1999) or 'assimilation' (Coombs and Miles, 2001) of service into a framework derived from studies of manufacturers. Some commentators argue this is inappropriate, and that patterns of innovation are markedly different in services. These *demarcation* (Coombs and Miles, 2001) or *autonomy* (Djellal and Gallouj, 1999) approaches highlight especially the (supposed) peculiarities of services, and of innovation in services. Most prominent amongst these peculiarities are: the intangibility (and/or information-intensity) of the 'service product' such that, unlike manufactured products, these often lack an autonomous physical existence independent of their producer or user (Gallouj and Weinstein, 1997);[41] the intensity of the user-producer interactions in the production-delivery of the service, such that the service might even be co-produced by the producer and user acting together;[42] the tight inter-relationship between the 'service product', the process of provision, and the organisation of provision, such that changes to one tend to impact on the others to a much greater extent than is generally the case in manufacturing – it is therefore difficult to separate product and

[40] Moreover 'When firms innovate, they are engaging in a complex set of activities with multiple outcomes, some of which, moreover, can reshape the boundaries and nature of the firm itself' (ibid).

[41] This in turn means services can be difficult to store, transport, or replicate precisely, and there may be many customer-specific variations, making it difficult to distinguish between variation and innovation.

[42] These features mean it is often difficult to determine whether the service provider of the user is the author of the innovation.

process innovation;[43] and finally the heavy 'human element' in service production-delivery, particularly in client interface operations. Miles (1996) argues that much of innovation in services is about reducing this need for close interactions in the production and consumption of services. The introduction of Internet banking can be seen as an example of this.

All of these features mean the framework build around 'technological-product-process innovation' amongst manufacturers may not be very successful for services (in addition to overlooking important service-oriented elements of innovation amongst manufacturers). Yet, like many manufacturers, many services (e.g., transportation, banking and insurance) depend heavily for innovation on acquired equipment 'technologies'. What is most likely to be overlooked by the CIS is other forms of innovation – such as customer interface innovation and innovations which are at the interface of technology and work organisation. Telephone call centres are a good example. The significance of these for disrupting traditional services is exemplified by the transformation of the UK insurance market since the introduction of Direct Line in 1985 (Channon, 1966).

Consequently, many of the criticisms outlined above – about conflating technology adoption and innovation, privileging technology, and maintaining a product-process focus – apply at least as much to innovation in services as they do for manufacturing, but rightly or wrongly the second CIS used essentially the same framework for manufacturing and services. Although this has weaknesses, the survey does provide some valuable insights into innovation processes in services, and in the remainder of this section we accentuate the positive.

The first thing note is that many services recognise themselves as having innovated, although, controlling for enterprise size, services tended to be less likely to claim to have introduced new services or methods to produce or deliver services than manufacturers were to claim to have introduced new products or processes. Within services, the high technology services were more likely to claim to have innovated, although these were closely followed by financial services, with 'other services' lagging some way behind.

The data also suggests that innovation processes within services tend to differ from (that perceived to be) the norm amongst manufactures. Especially with the high technology services excluded, the conduct of R&D, or at least the recognition of the conduct of R&D, and the employment of qualified scientists and engineers, was relatively rare compared with

[43] Gallouj and Weinstein (1997) note that in services the term 'product' frequently denotes a process', such as a

manufacturers. This said, it is perhaps surprising how many service firms, especially beyond those in the high technology sectors (claimed to be) engaged in R&D, even if this was not necessarily undertaken on a continuous basis or in formal R&D departments.

From the assessment of innovation expenditures, it would appear that acquired technologies are particularly prominent amongst services (particularly beyond those in the high technology sectors developing new to the market innovations). This appears to support the widespread assumption that services depend heavily on externally developed technologies for their innovation activities. However, this may have something to do with the way the questions were structured, as these placed an emphasis on embodied technologies. Moreover the larger share of innovation expenditures attributed to 'preparations' amongst services, as compared with manufacturers, hints at their undertaking internal activities that, for one reason or another, were not classified as R&D. Meanwhile amongst the high technology services, and especially amongst those that introduced 'new to the market innovations' the significance of R&D within innovation costs was comparable with that of high technology manufacturers. This shows that there was significant diversity in innovative behaviours across services, but also that there was not a 'great divide' between the patterns found for services and those for manufacturing, particularly amongst the high technology firms. This may indicate a convergence of services and manufacturing (Miles, 1996), at least in high tech activities.

Finally, service firms appear more likely to engage in training (linked directly to innovation) than manufacturers, but rarely were their expenditures on training high, either on a per employee basis or relative to their investments in acquired technologies. This suggests that the majority of the service firms absorbed the technologies acquired with relative ease, at least in terms of the new learning required.

6.3 Innovation and Commercial Performance – the Missing Dimension

We began this paper by remarking on how central 'innovation' has become to competitiveness and employment creation in the minds of national and European policymakers. It is remarkable, therefore, that the CIS contains very little information on the impact of innovations on the firms that introduced them, despite the Oslo Manual's recognition that: 'Perhaps the most important indicators (and the most difficult and controversial ones) describe the influence of innovation on the performance of the firm' (OECD, 1997, para. 218). The aims of innovation are asked about, but we have no

set of procedures and protocols, or an 'act'.

information as to how successful the firms were in achieving these aims. The survey also asks the proportion of turnover (in 1996) that is due to ‘technologically new and improved products (services) introduced between 1994 and 1996’ (and the proportion of turnover due to ‘unchanged or marginally modified products (services)’. These data are problematic, for innovations introduced in (late) 1996 are likely to have had little impact on sales in that year, yet we are not able to separate out the income from early innovations (say those of 1994) to assess the impact of these on sales by 1996.

Table 4

The Impact of Technological Product / Service Innovation on Sales of Established Firms

‘Sector’	Definition 1 Median %	Definition 2 Median %	Definition 3 Median %	Definition 3 25th percentile	Definition 3 75th percentile
Manufacturing	8% [97%]	5%	25% [99%]	10%	50%
Services	10% [66%]	5%	30% [70%]	15%	70%
HT Manufacturing	10% [97%]	10%	35% [100%]	19%	60%
MT Manufacturing	6% [99%]	5%	20% [99%]	10%	50%
LT Manufacturing	8% [94%]	5%	20% [99%]	10%	40%
Utilities etc.	13% [100%]	1%	17% [100%]	2%	31%
High Tech Services	20% [85%]	10%	40% [86%]	20%	75%
Financial Services	10% [41%]	5%	30% [61%]	12%	70%
Other Services	8% [63%]	3%	17% [63%]	10%	40%

Definition 1 : % of sales due to new to the market products / services amongst new to the market innovators. The figure in the square brackets is the proportion of these innovators that provided this information.

Definition 2 : % of sales due to <u>new</u> products / services amongst self declared product or service innovators

Definition 3 : % of sales due to <u>new or improved</u> products / services amongst self declared product or service innovators. The figure in the square brackets is the proportion of these innovators that provided this information.

Note, excluded from this analysis are any firms which were established in 1994-96, or merged or had a significant divestment in that period. Manufacturers that only introduced process innovations are also excluded.

These problems notwithstanding, the evidence does suggests (product or service) ‘innovation’ tends to have a less significant impact on sales than policy rhetoric might suggest. Of the ‘new to the market innovators’ that provided an answer, the median manufacturer declared only 8% of its turnover in 1996 was due to new to the market innovations introduced between 1994 and 1996 (Table 4). Amongst services the equivalent figure was 10%. Amongst all the ‘self identified innovators’ the median manufacturer and service enterprises both claimed just 5% of their turnover in 1996 was derived from <u>new</u> (to the firm or market) products (or services) introduced between 1994 and 1996. When ‘improved products (or services)’ are included, the median manufacturer claimed a quarter of its sales in 1996 were from innovative products introduced between 1994 and 1996, whilst the median service innovator claimed 30% of its 1996 sales were due to 'innovative services' introduced in that period. There was, however, wide variation in this proportion amongst both manufacturers and service enterprises.[44] For example, a quarter of the manufacturers claimed no more than 10% of their turnover was due to innovative products, whilst another quarter claimed at least half was due to these.

Beyond this we have little information on the impact of the innovations on the firms. Data is available on turnover and employment for 1994 and 1996 – i.e., the years at the beginning and the end of the period of inquiry – but such data is not available for the years after the introduction of the innovations. This is an important omission, as without such data we cannot test the impact of the (product, process and service) innovations on the firms that introduced them. Such testing is important for the framework represented by the CIS. For if direct and/or indirect data were available on the impact of the innovations, and if this found innovation had no significant impact on sales, employment, and/or on turnover per employee (a crude measure of productivity), we would have to think again. It would be important to establish whether the lack of impact was due to mis-measurement – perhaps in confining innovation to 'technological product (service) and process innovation' - or have we overlooked the dimensions of innovation that really matter - or perhaps it is because we have conflated too many different activities into 'innovation' (such as technological adoption, imitation and true innovation).

In conclusion, the CIS is an important step forward towards providing fuller evidence of the extent and significance of innovation in the economy, but there is considerable room for improvement with the existing survey, and the data derived from the CIS should be interpreted with greater caution than has hitherto been the case, particularly in policy documents.

[44] Note that especially amongst (financial and 'other') services a significant proportion of the 'innovators' were not able to answer the question. It should be recognised that these data are also subject to mis-measurement and differences in interpretation, perhaps especially in services. Consider the example of the bus company that introduced low access busses for disabled access. Arguably the true impact on turnover of these busses is the additional revenue from the disabled passengers and those who accompany them, not all the revenue earned by these busses, but it is certainly possible that the second (much larger) proportion might be given in response to this question.

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Appendix Table A
Logistical Regressions Identifying Innovators According to the Various Definitions

	Definition 1	Definition 2	Definition 3	Definition 4	Definition 5
Manufacturing Survey:[#]					
(Constant)	-3.925***	-2.762***	-2.046***	-1.343***	-1.005***
HTM – dummy	2.183***	1.479***	1.156***	0.784	0.291
MTM – dummy	1.389**	1.286***	0.273	0.187	0.095
Utilities etc. – dummy	-0.392	-0.447	-1.740***	-0.684	-0.872
Ln(Employment in 1994)	0.451***	0.483***	0.427***	0.372***	0.444***
HTM x Ln(Employment in 94)	-0.244	-0.088	-0.049	0.056	0.207
MTM x Ln(Employment in 94)	-0.090	-0.080	0.109	0.141	0.166
Utilities x Ln(Employment 94)	-0.143	-0.078	0.168	0.015	-0.004
Observations (N.)	1,342	1,342	1,342	1,342	1342
-2 LL	1,278.3	1,622.5	1,615.1	1,544.3	1269.8
Model χ^2 (degrees of freedom)	140.3 (7)	233.4 (7)	231.5 (7)	185.0 (7)	195.1
Nagelkerke R^2	0.152	0.213	0.212	0.178	0.204
Services Survey:[##]					
(Constant)	-3.600***	-2.639***	-2.217***	-0.645**	-0.075
HTS – dummy	1.958***	1.520***	1.447***	0.005	-0.002
Financial Services – dummy	0.367	-1.511*	-0.767	-2.091***	-1.535*
Ln(Employment in 1994)	0.333***	0.283***	0.263***	0.099*	0.135**
HTS x Ln(Employment in 94)	-0.130	-0.052	-0.082	0.143	0.158
Financial S. x Ln(Emp't in 94)	0.091	0.490***	0.361***	0.569***	0.541***
Observations (N.)	634	634	634	634	634
-2 LL	624.3	718.9	766.2	811.2	704.9
Model χ^2 (degrees of freedom)	67.1	116.1	96.9	62.7	53.4
Nagelkerke R^2	0.151	0.229	0.191	0.126	0.116

* significant at 10%; ** significant at 5%; *** significant at 1%

[#] LTM acts as the base sector; [##] Other Services act as the base sector.

Definition 1 : 'New to the Market' Internal or Joint Innovators – see text for details.

Definition 2 : All Self-Identified Internal or Joint Innovators – see text for details.

Definition 3 : All Self-Identified Innovators, including External Only Innovators – see text.

Definition 4 : Eurostat's 'enterprises with innovative activities' – see text for details.

Definition 5 : The DTI's definition of innovators – see text for details.

Appendix Table B

Regressions Relating Employment, Turnover and Turnover per Employee in 1996 with that in 1996 and Innovation in the 1994 – 1996 Period

Dependent Variable:		Ln (Employment in 1996)	Ln (Turnover in 1996)	Ln (Turnover per Employee in 96)
(Constant)		0.226***	0.513***	1.036***
Ln(Employment in 1994)		0.964***	-	-
Ln(Turnover in 1994)		-	0.961***	-
Ln(Turnover per Employee in 1994)		-	-	0.776***
Utilities – dummy		-0.020	-0.034	0.097**
HTM – dummy		0.011	0.048	0.049
MTM – dummy		-0.004	0.040	0.064**
LTM – <u>base category</u>		-	-	-
HTS – dummy		0.060**	0.057	-0.025
Financial Services – dummy		0.017	0.081 (13%)	0.204***
Other Services – dummy		0.073***	0.110***	0.061*
High Turnover from Innovation – dummy (1)	(+)	-0.009	-0.004	0.013
Medium Turnover from Innov. – dummy (2)	(+)	0.070**	0.097**	0.017
No / Low Turnover from Innov. – <u>base</u> (3)		-	-	-
New to the Market Innovator – dummy	(+)	0.020	-0.012	-0.008
Other Internal / Joint Innovators – <u>base</u>		-	-	-
External Only Innovator – dummy	(-)	-0.028	-0.025	-0.027
Only Eurostat Ents. with Innov. Activity – d.	(-)	-0.028	-0.064	-0.077 (12%)
Only a DTI Innovator – dummy	(-)	-0.015	-0.045	-0.045
Not Even a DTI Innovator – dummy	(-)	-0.018	-0.068*	-0.104***
Observations (N.)		1,788	1,788	1,788
F-Statistic		3,891.7	2,059.3	311.0
Adjusted R^2		0.972	0.948	0.744

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: (1) – identified enterprises which were in the top 25% <u>for their sector</u> in terms of the proportion of turnover due to innovation (i.e., new or improved products / services); (2) – identified enterprises which were around the median (between the 25th and 75th percentile) <u>for their sector</u> in terms of the proportion of turnover due to innovation (i.e., new or improved products / services). (3) The enterprises that did not provide this information, or which did were in the bottom 25% <u>for their sector</u>.

The symbols (i.e., (+) / (-)) next to some variables indicate the expected signs

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