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NESTA Making Innovation Flourish

Creating Innovation

Do the creative industries support innovation in the wider economy?

Hasan Bakhshi, Eric McVittie and James Simmie

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Foreword

Since the pioneering work of the Department for Culture, Media and Sport in the late 1990s, we have been aware of the size of the UK's creative industries. However, size on its own indicates only part of the economic importance of a sector.

A crucial question is to what extent it is embedded within the economy – not just an island of talent and economic power, but an intrinsic part of the entire system. NESTA is particularly interested in how creativity that runs through the thirteen 'creative industries' generates innovation elsewhere.

Until now, these questions have been difficult to answer. However, beginning in Spring 2007, NESTA embarked on a research programme designed to uncover the reality of these linkages. This research report (produced in partnership with Experian and Oxford Brookes University) examines the function of creative businesses in providing products and services to other businesses, and relates that to what we know of the innovative potential of those businesses.

Importantly, we have found that linkages with creative industries appear to support innovation. This finding has deep implications for innovation policy: no longer is it sufficient to support the creative industries alone and for their own sake – policy should encourage and embed linkages between them and the wider economy.

As always, NESTA seeks to convert research insights into practical solutions and as such, our Innovation Programmes team will be taking the messages from this report and testing them in practice. Only then will we uncover the full story behind the importance of the creative industries – and we'll be sure to report back.

As always, we welcome your input and your comments.

Jonathan Kestenbaum
CEO, NESTA

February, 2008

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

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

Executive summary

The economic importance of the creative industries

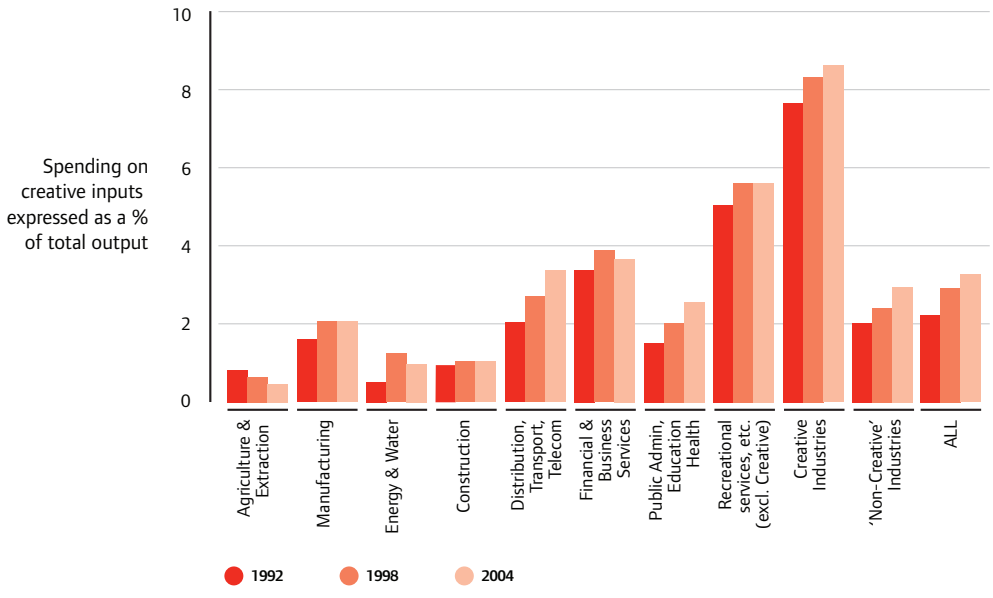
Nobody can doubt that the creative industries make important contributions to the UK's cultural and aesthetic life. Their products are central to our wellbeing: they give pleasure, they stimulate ideas and they convey meaning. Human beings need to express themselves or to experience others doing so; the quality of our lives is all the better for vibrant creative industries which enable this to happen.

Some – though not all – of these benefits are reflected in commercial value. A growing body of research has attempted to measure the contribution that the creative industries and arts make to the economy and employment (Andari et al., 2007; OECD, 2007).

There is also extensive research on the sources and impacts of types of innovation in the economy (DTI, 2006). While the innovation literature has often emphasised technical research and development activities, policymakers and academics increasingly recognise the importance of creativity and design to the process of innovation (Cox, 2005; DTI, 2005).

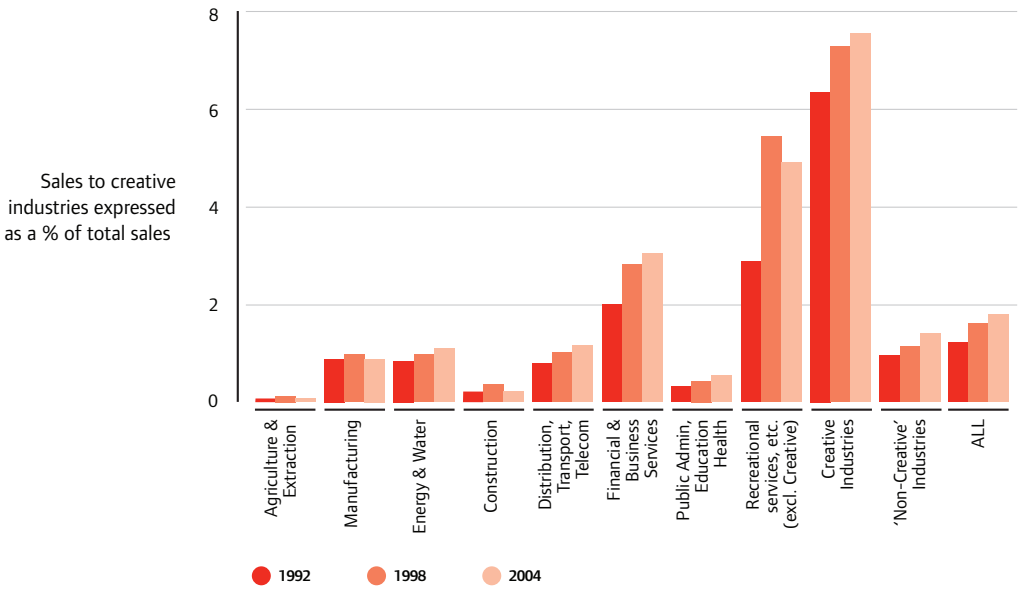
There is also a widespread belief that the 'creative economy', as a focal point for creativity, has a particularly important role to play in innovation throughout the economy (Potts, 2007). But there is little quantitative evidence for this.

Figure 1: Industry purchases of creative intermediate inputs, 1992-2004



Source: Authors based on ONS UK Input-Output Supply & Use Tables

Figure 2: Industry sales of intermediate goods to the creative industries, 1992-2004



Source: Authors based on ONS UK Input-Output Supply & Use Tables

This report presents the results of major new research into the role of the creative industries in stimulating and supporting innovation in the United Kingdom. Specifically, our research investigates and quantifies for the first time how artistic and creative activities link into the wider economy.

We do so using data from the UK's Input-Output accounts.[1] The resulting measures are then brought together with quantitative data on innovation performance from the fourth UK Community Innovation Survey (CIS4) enabling us systematically to explore the relationships between the creative industries and innovation.

Our approach aims to understand the links between the creative industries and other sectors in the wider economy; to examine which firms and industries are most 'innovative'; and to bring these together to identify the extent to which strong business-to-business (B2B) linkages to the creative industries are associated with high levels of innovative activity and performance.

B2B linkages between creative businesses and firms in other sectors

Our analysis of the Input-Output accounts suggests that purchases of creative products and sales to creative industries are important to many sectors, but that these linkages are particularly important within the creative industries themselves (Figures 1 and 2).

Figure 3 shows that for a wide range of innovation measures, industries with stronger links to the creative industries – measured here by industries which have above-median B2B spending on creative industry products expressed as a percentage of their gross output – have stronger innovation performance.

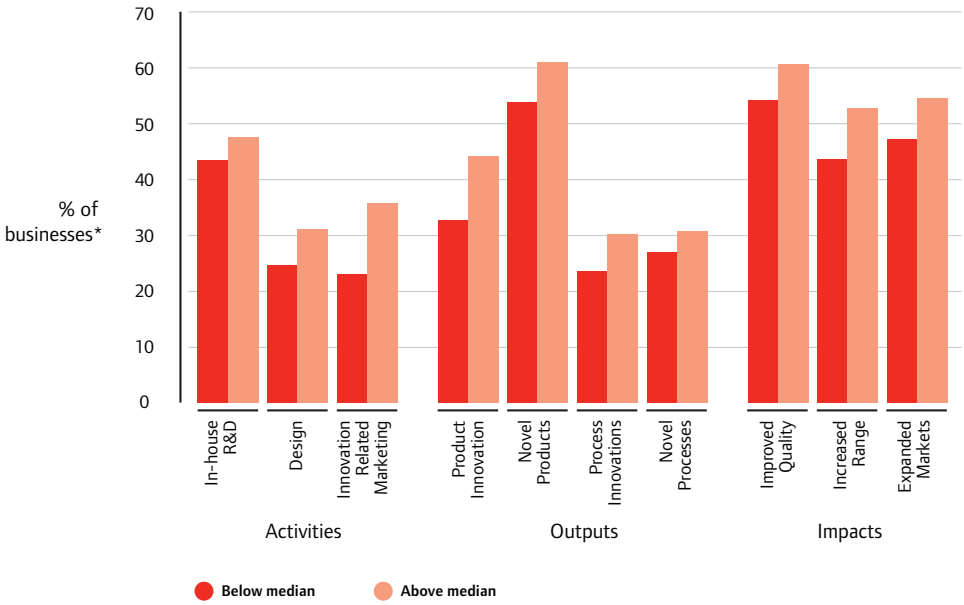
We use econometric techniques to explore more formally the relationship between firms' supply chain linkages with creative businesses and their innovation performance. Evidence that stronger linkages to the creative industries are associated with higher levels of innovation is consistent with at least two distinct effects:

- First, creative products may be direct inputs into the innovation processes of purchasing firms (good examples may be software or advertising).
- Second, supply chain linkages to the creative industries could provide a mechanism which facilitates the transfer of ideas and knowledge between creative businesses and firms in other industries.

Evidence of the second effect in particular may have direct implications for policymakers, as

1. Input-Output accounts show the relationships between all industries in the economy and all commodities that these industries produce and use. See Appendix A for a more detailed discussion.

Figure 3: Innovation performance for industries with strongest and weakest creative sector linkages (purchases of creative products)



*Claiming to have undertaken an innovation activity, introduced an innovation output or had an innovation impact

Source: Authors based on CIS4 data

it raises a possibility of market failure due to knowledge spillovers.[2]

We find evidence of a significant positive impact from creative linkages on some, but not all, dimensions of innovation behaviour. That firms with stronger B2B linkages with creative industries are more likely to introduce product innovations appears to be a particularly robust finding. Our estimates suggest that firms that spend double the average amount on creative products – 6 per cent compared with 3 per cent of their output – are 25 per cent more likely to introduce product innovations either new to their firm or to their market.

It is difficult to establish whether it is the direct effect of creative products as innovation inputs or knowledge transfer from the creative industries that is driving this result. There is some evidence that knowledge transfers associated with purchases by firms of creative products may support improvements in their product range and quality, but these findings are not conclusive.

These results raise the possibility that there are knowledge spillovers between creative businesses and other sectors, which may have important implications for policy to the extent that knowledge is under-produced in the free market.

The creative industries and innovation policy

Our results therefore support the hypothesis that supply chain linkages to the creative industries are positively related to innovation elsewhere in the economy. This suggests that the creative industries may play a more important role in the UK's ecology of innovation than has been recognised to date.

Policymakers should stress the wider benefits of creativity when promoting the contribution that design can make to business performance. Efforts to enable knowledge transfer should also support the exchange of new ideas between creative businesses and firms in other sectors of the economy.

The findings suggest that policymakers need to reconsider the frameworks on which they base creative industries and innovation policy. Creative industry support measures may be more productively targeted at stimulating innovation links between creative businesses and firms outside the creative industries. And the links also point to additional levers by which innovation policy can improve the UK's capacity for innovation.

2. Knowledge transfers become spillovers when businesses absorb, at no or little cost, new ideas and knowledge produced by creative businesses. Knowledge spillovers can occur between businesses of any type, but are arguably more likely in creative businesses, where the nature of outputs is such that much knowledge flows *tacitly* between suppliers and purchasers (as opposed to *codifiable* knowledge transfers which are easier for firms to price). Spillovers are of importance to policymakers because they imply that new ideas and knowledge may be under-produced in a free market. We discuss market failure arguments more fully in Section 2.5.

Acknowledgements

This report was written by Hasan Bakhshi (Senior Policy Analyst, NESTA), Dr Eric McVittie (Research Director, Experian) and Professor James Simmie (Oxford Brookes University).

Significant contributions were made by Albert Bravo-Biosca (NESTA) and Damian Walne (Experian). Alan Freeman (GLA Economics) and Madeleine Cullum (DCMS) made helpful suggestions.

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1. Introduction

1.1 The economic importance of the creative industries

Nobody can doubt that the creative industries contribute to the UK's cultural and aesthetic life. Their products are central to our wellbeing: they give pleasure, they stimulate ideas and they convey meaning. Human beings need to express themselves or to experience others doing so; the quality of our lives is all the better for vibrant creative industries which enable this to happen.

Some – though not all – of these benefits are reflected in commercial value. A growing body of research has attempted to measure the contribution of the creative industries and arts to the economy and employment (Andari et al., 2007; OECD, 2007).

There is extensive research on the sources and impacts of different types of innovation in the economy (DTI, 2006). While the innovation literature has often emphasised technical research and development activities, policymakers and academics increasingly recognise the importance of creativity and design to the process of innovation (Cox, 2005; DTI, 2005).

There is also a widespread belief that the 'creative economy', as a focal point for creativity, has a particularly important role to play in innovation throughout the economy (Potts, 2007). But there is little quantitative evidence for this assumption.

This report presents the results of major new research into the role of the creative industries in stimulating and supporting innovation in the United Kingdom. Specifically, our research investigates and quantifies for the first time how artistic and creative activities link into the wider economy.

We do so using data from the UK's Input-Output accounts.[3] The resulting measures are then brought together with quantitative data on innovation performance from the fourth UK Community Innovation Survey (CIS4) enabling us systematically to explore the relationships between the creative industries and innovation.

Our approach aims to understand the links between the creative industries and other sectors in the wider economy; to examine which firms and industries are most 'innovative'; and to bring these together to identify the extent to which strong business-to-business (B2B) linkages to the creative industries are associated with high levels of innovative activity and performance.

1.2 B2B linkages between creative businesses and firms in other sectors

Our analysis of the Input-Output accounts suggests that many sectors purchase significant amounts of creative products and services and sell significant amounts of their own products and services to creative industries.

Such trade is particularly important within the creative industries themselves. CIS4 suggests that creative businesses are more innovative than many other sectors of the economy. The CIS data also suggest that supply chains are important sources of innovation for UK businesses. This is again particularly true in the creative industries.

We use econometric techniques to explore the extent to which firms that do a lot of business with creative industries are more innovative.

3. Input-Output accounts show the relationships between all the industries in the economy and all the commodities that these industries produce and use. See Appendix A for a more detailed discussion.

The evidence is consistent with at least two distinct effects. First, creative products directly impact on the innovation processes of firms that buy those products (good examples may be software and advertising). Second, supply chain linkages to the creative industries could facilitate the transfer of ideas and knowledge between creative businesses and firms in other industries.

Evidence of the second effect in particular may have direct implications for policymakers, as it raises a possibility of market failure due to knowledge spillovers.[4]

We find evidence that linkages to creative industries often – but not always – correspond with more innovative behaviour. There is less systematic evidence of knowledge transfer between the creative industries and firms in other sectors, though there is some evidence that knowledge transfers that occur when firms purchase creative products support improvements in the range and quality of their product range.

Our results thus support the hypothesis that supply chain linkages to the creative industries are associated with more innovation elsewhere in the economy. This suggests that the creative industries may play a more important role in the UK's ecology of innovation than has previously been recognised.

Policymakers should stress the benefits of wider forms of creativity when promoting the contributions that design can make to business performance. Efforts to enable knowledge transfer should also support the exchange of new ideas between creative businesses and firms in other sectors.

The findings suggest that policymakers may need to reconsider the frameworks on which they base their policies for both the creative industries and innovation.

With creative industries policy, support measures may be more productively targeted at stimulating innovation links between creative businesses and firms outside the creative industries. With innovation policy, the linkages highlight additional levers through which policy can help the UK to become more open to innovation.

4. Knowledge transfers become spillovers when businesses absorb new ideas and knowledge produced by creative businesses, at little or no cost. Knowledge spillovers can occur between businesses of any type, but are arguably more likely in creative businesses, where the nature of outputs is such that knowledge flows tacitly between suppliers and purchasers (as opposed to codifiable knowledge transfers which are easier for firms to price). Spillovers are of importance to policymakers because they imply that new ideas and knowledge may be under-produced in a free market. We discuss market failure arguments more fully in Section 2.5.
5. This approach underlies 'idea-based' models of economic growth first associated with Romer (1986, 1990), Aghion and Howitt (1992) and Grossman and Helpman (1991).
6. Recent empirical work suggests that technological improvements in the form of ICT can explain only around half of overall productivity growth in the US economy during recent years (Oliner and Sichel, 2000; Jorgenson and Stiroh, 2000), implying that other types of innovation are responsible for a similar share of overall growth. In the UK, Bakhshi and Larsen (2005) estimate that 20-30 per cent of labour productivity growth over the longer run is explained by technological progress in ICT.

2. Creativity, linkages and innovation

2.1 Innovation plays a central role in the growth process

Most economists regard innovation as the principal determinant of long-run economic performance and prosperity, as well as a key influence on the functioning and performance of individual firms and markets.

As Baumol (2000) points out, the centrality of innovation in the growth process reflects two factors. First, innovation is a 'good' with special features which mean that its benefits are likely to be dispersed throughout the economy. And second, the fact that the stock of knowledge underlying technologies and processes accumulates over time.

The growing recognition of innovation as the root of economic prosperity has made policymakers increasingly keen to understand the process of innovation and what drives it.

The research literature has tended to emphasise scientific technical research and development (R&D) activities as the principal component of innovation activity and the key driver of product and process innovation.

Within this tradition, research has focused on large manufacturing firms. For the most part, it has applied a narrow technological concept of innovation which emphasises the role of formal R&D and the generation of new technological artefacts and patents (Tether et al., 2001; NESTA, 2006).

Economists have generally viewed innovation as the output of "a process that uses R&D resources and existing ideas as inputs" (Bottazzi and Peri, 2007). New ideas are produced by people working in R&D – scientists and engineers – who use their creativity and knowledge to develop new ideas, and subsequently new technologies and products.[5]

Whilst undoubtedly important, technical R&D cannot explain the whole growth process within advanced economies, since service activities increasingly dominate economic life.[6] Understanding innovation within these economies requires a broader conception of its nature and determinants.

Tether (2003) argues that analysts have insufficiently researched the role of innovation and technological change in services but that

services are increasingly appreciated as having a diverse range of innovation activities.

Similarly, Miles (2004) argues that the growth of services as the dominant part of the UK economy means that innovation in services must not be ignored. He notes that innovation in services extends beyond the services sectors to affect service functions in all parts of the economy.

Malbera (2004) considers that: (i) the features and sources of knowledge differ from sector to sector; (ii) different knowledge and learning processes are essential for understanding each sector and how they innovate; (iii) science and development activities have grown in importance across sectors; and (iv) the boundaries between knowledge in different sectors change over time.

2.2 Measuring innovation can be challenging

We need appropriate and accurate measures of innovation to identify its role within the economy. However, the measurement of innovation faces two major difficulties.

The first is one of definition. The focus on technological rather than service innovations reflects the fact that the former have been easier to define and measure. Until we have clearer definitions of innovation in services and the creative industries it will remain impossible to measure them accurately (Green, Miles and Rutter, 2007).

The second difficulty is the continuous nature of the innovation process. Innovative firms aquire new knowledge all the time and change products and processes as a result; it is more difficult to measure a dynamic process than a static activity. A related problem is the difficulty in distinguishing between products and processes, because production and consumption often takes place simultaneously in many services activities.[7]

Nevertheless, some attempts have been made to measure innovation in the service sectors (de Jong et al., 2003; Howells and Tether, 2004; Miles, 2004).

Howells and Tether (2004) classify services into four main types for analytical purposes:

- Those dealing mainly with goods (such as transport and logistics);
- Those dealing with processing information (such as call centres);
- Knowledge-creating services (such as product design); and
- Services dealing with people (such as health care).

Concerns with concepts of innovation which extend beyond the traditional technical R&D focus have also led standard definitions and measures of innovation to be revised. The Oslo Manual, for example, now identifies the immediate drivers of innovation as "all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations" (OECD, 2005: 47).

The Oslo Manual framework is based on insights derived from theories of business innovation together with those that view innovation from a complex systems perspective (Kline and Rosenberg, 1986; Lundvall, 1992). As a result, four measurement requirements are identified. These are:

- Innovation in the firm;
- Linkages with other firms and public research institutions;
- The institutional framework in which firms operate; and
- The role of demand.

The first two – innovation in the firm and linkages with other firms – suggest two main options for firms that wish to change their products or processes. They can either invest in new knowledge development in-house, or they can adopt other firms' innovations once they have put them on the market.

2.3 Creativity is fundamental to the innovation process

There has also been a growing appreciation of the importance of creativity (broadly defined) to the process of innovation. Ideas and creativity, defined as the ability imaginatively to invent in a so-called chain link model of innovation,[8] are a particular focus of Lundvall's (1992) work. Lundvall argues that there are complex national systems of innovation where interactive learning is the key driver.

The role of new ideas and knowledge requiring creativity is explored by Cooke and Schwartz

7. NESTA (2008) forthcoming provides an overview of service sector innovation based on the fourth Community Innovation Survey (CIS4).
8. The influential 'chain link' model of commercial innovation (Kline and Rosenberg, 1986) sees innovation as a learning process in which knowledge is constantly developing and being modified in an iterative series of feedback loops. According to this view, innovation takes place within a complex system of interactions between research, the knowledge base, invention, design, production, distribution and marketing, and existing or potential markets.

(2007 a, b) who collate contributions on the theme of the role of creativity in technology, culture and entrepreneurship. The Cox Review (Cox, 2005) considered the importance of design on business innovation.

All this has prompted interest in the particular role of the 'creative economy' within the innovation process. Terms such as the 'creative sector', 'creative industries' and 'creative economy' are increasingly employed to describe a wide range of activities that involve the commercial exploitation of creative and artistic inputs.

There have been extensive debates on the most appropriate way to define and measure the creative economy. These are discussed in detail in sources such as Caves (2000), DCMS (2004), Hesmondhalgh (2007) and Higgs et al. (2008). In particular, providing an operational definition for the concept of the creative industries has proved difficult; the OECD (2007) provides an authoritative guide to these definitions.

Such difficulties are not surprising given rapid technological change. The convergence of ICT and new types of 'content' has led to new industries and products which defy existing classifications. The relationship between creativity as a generic phenomenon and the creative industries *per se* nevertheless remains controversial.[9]

The UK's Creative Industries Taskforce brought the term 'creative industries' into wider use in 1998 when it defined the 'creative industries' as:

"Activities which have their origin in individual creativity, skill and talent, and which have the potential for wealth creation through the generation and exploitation of intellectual property." (DCMS, 1998).

The Taskforce template was used to define thirteen 'creative industries': Advertising; Architecture; Arts & Antiques Market; Crafts; Design; Designer Fashion; Film; Music; Performing Arts; Publishing; Software and computer services; Computer Games (Interactive Leisure Software); and Radio & TV.

This has formed the basis for measurement of the creative industries in the UK by the Department for Culture, Media and Sport (DCMS), and has informed many approaches to measuring the creative economy including in New Zealand (New Zealand Institute of Economic Research, 2002), Australia (Department of Communications, Information Technology and the Arts, 2003) and Singapore (Heng et al., 2003).

On the basis of this industry approach, the UK has been shown to have the largest creative sector in the European Union and probably the largest in the world as a proportion of GDP (Andari et al., 2007). With over 7 per cent of economic value added and over one million employees, it is comparable in size to the UK's financial services industry.

Some have argued that the importance of 'creativity' to innovation implies a special role for the 'creative economy', the focus for creative activities:

"Creativity and innovation are overlapping concepts. In the main, creativity is about the origination of new ideas – either new ways of looking at existing problems, or of seeing new opportunities, while innovation is about the successful exploitation of new ideas. It is the process that carries them through to new products and services or even new ways of doing business. Increasingly, both are important across the spectrum of economic activity. The creative industries can be conceived as a pioneer sector of the economy, trailblazing approaches, and fostering an attitude towards creativity and innovation from which the rest of the economy and society can benefit. This critically depends on whether 'effective' transmission mechanisms are in place." (Andari et al., 2007).

Until recently, however, relatively little attention has been given to innovation in the creative industries, beyond a broad presumption that it is likely to play an important role in determining economic performance, particularly in the case of sectors based on new digital technologies.[10]

So, creative industries are widely seen as part of an avant-garde of innovation-intensive, high-growth information services (Handke, 2006); as a key source of new ideas and their commercialisation (Barras, 1990); or as an area where 'R&D is the main activity, while production is secondary' (Lash and Urry, 1994).

Yet, there have been few comprehensive attempts to study the creative industries on the basis of economic theories of innovation.[11] This neglect probably reflects the particular problems which the creative industries pose for the analysis of innovation:

9. These issues are discussed by, among others, Higgs and Cunningham (2007) and Pratt (2000).
10. Droust (2005) points to 'the perpetual innovation and development dynamic' that flows from digital innovation into – and between – other key economic sectors and industries. Cunningham et al. (2004) provide a descriptive analysis of the innovation system within Australia's creative industries, focusing on the digital content industries.
11. Stoneman (2007) is an exception.

"The conventional thinking about innovation doesn't capture what actually happens in the creative industries … The problem is two-way. People who talk about innovation tend to ignore what happens in the creative industries; and the creative industries tend to downplay the benefits of innovation." (Howkins, 2002).

In other sectors of the economy, extensive research has attempted to uncover the principal determinants of innovation performance. Innovation – at least within areas of private economic activity – is often explicitly driven by the profit motive, and particularly the possibility of earning profits by being the first mover or one of the leaders in a new market. But a range of other factors may influence the incentives for an individual firm to pursue innovation, and their capacity to do so.

2.4 The incentives to innovate are determined by a number of factors

Incentives to innovate are fashioned by market structure. The incentives for individual firms to devote resources to innovation will depend on factors such as the degree of competition and the existence of barriers to entry, which will influence the ability of firms to make profits from successful innovations, to 'steal' profits from their competitors, and the period over which such profits can be sustained.

Another important consideration will be the extent to which firms can prevent the transfer of relevant knowledge about their innovations – such as new products and processes – to their competitors.

If competitors can quickly and cheaply gain access to any new knowledge, then there will be little incentive for firms to incur the expenses associated with innovation. Knowledge transfers can be restricted through formal instruments – such as patents and copyright – or through less formal means like trade secrecy.

The nature of innovative activities in any given industry will depend on its 'technological regime'. This will include 'technological opportunities' for innovation; the ability of firms to protect innovations from imitation by others ('appropriability'); the extent to which successive innovations build upon each other ('cumulativeness'); and the nature of the knowledge base underlying those innovations.[12]

2.5 When knowledge transfers become knowledge spillovers

Concerns about the protection of new knowledge lead naturally to a focus on knowledge externalities or 'spillovers'.

Spillovers imply that one firm's productivity and innovation performance depend not only on its own attempts to innovate (and associated resources) but also on the pool of knowledge produced by other firms.

This implies that innovations (or the knowledge they generate) have the characteristics of 'public goods' which may require public support to ensure sufficient investment, since they will be under-provided in a free market. The role of knowledge spillovers has been a particular focus for research on innovation processes for some years.[13]

Knowledge may be transferred between firms in a number of ways. These various knowledge transfer mechanisms are not mutually exclusive. All may occur in the case of any given firm or industry; there may also be other mechanisms.

However, not all forms of knowledge transfer involve knowledge *spillovers*. Spillovers arise only when new knowledge produced within one firm is used by another *without the latter bearing the costs of the innovation process* (Grossman and Helpman, 1991).

Firms may obtain information simply by observing and copying or adapting others' innovations. To a large extent, knowledge flows of this type may go unrecorded, although patent citations will provide a partial record of technical and scientific innovations by one firm building on knowledge generated by others.

Knowledge will also flow between firms as workers move jobs over the course of their careers. Research into knowledge transfers through worker mobility has been particularly focused on foreign direct investment (FDI).[14] This type of knowledge transfer may be particularly important for the creative industries, since creative labour markets are especially fluid with workers having unusually high levels of mobility (Benhamou, 2003).

A range of contractual relationships between firms may also encourage the transfer of knowledge between them. Some formal relationships – such as joint ventures and other forms of collaboration on R&D, and technology licensing agreements – may be directly aimed at supporting innovation. Caves (2000) argues

12. See Breschi, Malerba and Orsenigo (2000) for a discussion of technological regimes. The notion of a technological regime dates back to the works of Nelson and Winter (1982) and Winter (1984). Various authors (inter alia Gort and Klepper, 1982; Malerba and Orsenigo, 1993; Audretsch, 1995) present empirical evidence that these factors are the most important determinants of the dynamics of market structure and innovation.
13. Indeed Marshall (1920) discusses the importance of interactions between firms as sources of spillovers, and identifies the principal mechanisms involved. Later theoretical work on knowledge spillovers within microeconomics (including Nordhaus, 1962 and Arrow, 1962) and subsequent developments within the macroeconomic literature on economic growth (Romer, 1986; Grossman and Helpman, 1990) have stimulated an extensive empirical literature focused on the extent of knowledge spillovers, particularly those associated with foreign direct investment (FDI), and their implications for productivity and growth. Sena (2004) provides a recent survey.
14. See, for example, Fosfuri et al., 2001; Glass and Saggi, 2002; and Gorg and Strobl, 2005.

that collaboration on innovation is common within the creative industries, where the creation of new creative products often occurs in flexible networks and temporary, project-based cooperation.

Other formal links, such as buyer-seller (supply chain) relationships are not primarily concerned with innovation, but may nevertheless allow either or both parties access to knowledge which supports their innovation efforts.

Informal links between firms are likely vastly to outnumber formal links (Powell et al., 1996). "For the hundreds of formal ties among firms that act as information conduits, thousands of informal relationships exist among scientists, engineers, developers, managers, and other personnel through which information flows" (Uzzi and Lancaster, 2003).

Formal and informal links are often mutually supporting. Thus, Gulati (1995) and Lazerson (1995) show that informal ties often form the basis for the development of contractual relationships between firms. Similarly, initially formal links may, over time, develop into informal personal relationships between individual members of staff (Roy et al., 2004).

A principal focus of our research is on knowledge transfers through supply chain linkages with the creative industries.

Knowledge may be 'embodied' in B2B transactions between firms, such as the supply of intermediate goods and services for use in another firm's production processes (Griliches, 1992; Nadiri, 1993; Wolff and Nadiri, 1993).

In this case, one creative firm or industry's innovative activity may affect the technology and capacity to innovate of both customers of the creative industries ('forward linkage' effects) and suppliers to the creative industries ('backward linkage' effects).

Embodied knowledge transfers through supply chain relationships will only be spillovers insofar as they are not reflected in the prices at which the B2B transactions take place. If markets are competitive, the firm receiving the knowledge transfer from creative businesses will be charged for the benefits they enjoy (Griliches, 1992).

Arguably, however, the market environment facing supplying industries may mean that prices do not fully reflect the value of improved products to purchasers. In addition, the intangible nature of information products – it is often more difficult for sellers of such products to fully convince buyers of the quality of their offer – means that it is unlikely that firms will be fully rewarded for the knowledge they share.[15]

Roy et al. (2004) provide a detailed discussion of the ways in which supply chain relationships in particular may contribute to innovation. Supply chain relationships give rise to a variety of interactions between buyers and sellers that support exchanges of information and the generation of new knowledge.

The knowledge exchanged may relate to: buyers' specific requirements (Hallen et al., 1991); clarification of design issues and usage patterns to pre-empt problems arising in the use of intermediate goods and services (Clark and Fujimoto, 1990; Leonard-Barton, 1995); and ongoing detailed technical discussions, sometimes leading to 'creative abrasion' when problems are highlighted, stimulating the search for solutions (Leonard-Barton, 1993; 1995).

Interactions between buyers and sellers may range from impersonal and 'arms length' (and possible one-off) contacts, to stronger and enduring personal relationships in which informal discussions result in routine knowledge-sharing.[16] Buyers and sellers are likely to have both shared (overlapping) and specific knowledge, providing a fruitful basis for the exchange of ideas (Burt, 1987; 1992). Roy et al. (2004) therefore propose that the greater the extent of buyer-seller interactions (in terms of their frequency, duration and quality), the greater their contribution to both incremental and radical innovations by both buyers and sellers.

Another implication of these arguments is that supply chain relationships may stimulate broader communications between businesses. The knowledge transfers associated with these communications may involve knowledge spillovers, even if the 'embodied' knowledge transfers do not.

Roy et al. (2004) also point to a number of other factors which will influence the link between supply chain interactions and innovation. These include features of the buyer-seller relationship which either or both parties can control – particularly 'commitment' and 'trust'.

15. The study of such information problems, and their implications for public policy, has been a major feature of research in economics since the 1970s. Stiglitz (2003) provides a useful review.

16. The social network literature refers to the 'relational embeddedness' of interactions between firms, by which is meant the strength and quality of social attachments (Granovetter, 1973; Gulati, 1998; Uzzi, 1996, 1997).

Gundlach et al. (1995) argue that commitment is particularly important in supporting innovation within business networks. Commitment involves making efforts and devoting resources to maintaining the relationship (Morgan and Hunt, 1994). Commitment by both buyers and sellers ('symmetric' commitment) supports two-way communication (Anderson and Weitz, 1992), and is likely to strengthen the impact of buyer-seller interactions on the generation of innovations.

Successful communication also depends on trust, which usually takes time to build and is therefore a feature of enduring relationships. The degree of trust between partners determines the extent to which organisations are willing and able to interact, and the character of those interactions (Athaide et al., 1996; Dodgson, 1993; Gambetta, 1988; Gulati, 1995; Joshi and Stump, 1999; Morgan and Hunt, 1994; Sako, 1992). High levels of trust increase the capacity of supply chain interactions to stimulate innovations.

Roy et al. (2004) suggest that the importance of supply chain relationships to innovation is also likely to depend on factors which are outside the control of buyers and sellers.

Supply chain interactions will be more important when relevant knowledge is 'tacit' rather than explicit.[17]

In addition, supply chain interactions are more likely to support *incremental* innovations when demand for the final product (at the end point of the supply chain) is stable. This is because stable demand conditions will be conducive to lasting supply chain relationships, increasing commitment and trust, building shared knowledge and allowing ongoing attention to product improvements. In contrast, supply chain interactions are more likely to support *radical* innovations when end-product demand is unstable.

Finally, if either buyer or seller are more strongly linked into other knowledge networks then this will tend to increase the impact of supply chain interactions on innovation.

Arguably, a great deal of the knowledge generated within the creative industries is likely to be tacit in nature. The discussion above would then imply that supply chain interactions may be important to knowledge transfer between the creative industries and the rest of the economy.

And uncertain demand for creative products may imply that strong supply chain relationships to creative sectors may by especially important in driving radical innovations among their suppliers. Vogel (2003) argues that creative products often have short life cycles and demand conditions are often highly uncertain (Handke, 2006), while Peterson and Berger (1971, 1975) point to recurrent periods of radical technological change affecting some creative industries such as the music industry.

The principle that supply chain linkages are important for innovation is well established (Christensen et al., 1999; de Bresson et al., 1997; Dumont and Meeusen, 2000). However, very few empirical studies analyse supply chain linkages as a source of spillovers.[18]

The potential role of backward supply chains linkages has been especially neglected, despite strong theoretical justification.[19] Those studies which have investigated 'embodied' knowledge spillovers have typically made use of input-output techniques, which provide an ideal framework for measuring the extent of these supply chain linkages and assessing their importance to innovation.[20] However, none focus on supply chain linkages to creative businesses.

2.6 Imitation requires knowledge

The previous discussion should make clear that the extent of knowledge transfers (including spillovers) will depend not just on the generation of new knowledge – innovation – and on the strength of transfer mechanisms, but also on the ability of firms to exploit innovation from outside sources.

Understanding and imitating innovations may itself require specialist knowledge. The types of knowledge required will depend on the nature of the initial innovation. So, high levels of technical expertise may be required successfully to imitate a technical product innovation.

The capacity to imitate others' innovations is generally referred to as 'absorptive capacity' (Cohen and Levinthal, 1990). A business's absorptive capacity reflects its knowledge resources, particularly the skills of its workforce.

Firms with greater knowledge resources, or with resources more closely geared to innovation activities in other parts of the economy with which they have contact, are more likely to adopt others' innovations to their own benefit.

17. Tacit knowledge is knowledge that is difficult to codify and communicate, but which can be transmitted through training, ongoing personal interactions and experience (Polanyi, 1966).
18. See Blomstrom et al. (2000). The main exceptions focus on spillovers from foreign direct investment (FDI). Blalock (2001) reports evidence of spillover effects from supply chain linkages to FDI using firm-level data for Indonesia, and Schoors and van der Tol (2001) also finds evidence of spillovers using firm-level data for Hungary. Javorcik (2004) provides a useful overview of the research in this area. Her own study provides support for spillovers through backward supply chain linkages (to suppliers of intermediate goods to FDI companies) in the case of Lithuanian firms.
19. See Rodriguez-Clare (1996), Markusen and Venables (1999).
20. Input-output methods have been widely used to construct measures of the strength of supply chain linkages between different parts of the economy. Javorcik (2004) provides a recent example of their use in firm-level analysis of links to the FDI sector, while Papaconstantinou et al. (1996) use input-output methods to examine cross-country technology spillovers embodied in supply chain transactions.

Some innovations within the creative industries require high levels of specialist creative expertise. Intuitively, therefore, businesses with larger numbers of creative specialists may find it easier to absorb new ideas and knowledge transfers from transacting with creative businesses.[21]

2.7 Summary

The process of innovation requires a variety of resources – artistic, creative, technical, scientific, entrepreneurial and managerial. Forward supply chain linkages from the creative industries may support innovation in the wider economy by directly supplying artistic and creative inputs to the innovation process, and by embodying transfers of knowledge and new ideas from creative technologies.

Firms may of course access creative talent by directly employing creative people. Patterns of artistic and creative employment are often complex, with individual artists working for a variety of different commercial and non-commercial organisations, spreading knowledge among them. But firms can also buy in creative inputs from other suppliers – 'outsourcing' artistic and creative activities as they would do with other services (Pearce, 1999).

Backward linkages to the creative industries may also support innovation in the wider economy, since purchases by creative businesses may stimulate innovation in their suppliers. There is a substantial economics literature on the importance of backward supply linkages to innovation among suppliers to some leading sectors of the economy, and to multinational companies – a high level of innovation in the purchaser requires suppliers to be innovative in order to improve and develop key inputs. The artistic and creative sectors may be especially demanding customers in this regard.

Both the direct contributions by creative inputs to business innovation and the extent of knowledge spillovers from creative industries depend not only on the extent of innovation activity within leading firms, but also on the 'absorptive capacity' of other firms to capture and exploit the resulting improvements in knowledge. So, while innovation by leading firms determines the potential flow of knowledge to other parts of the economy, the efforts of receiving firms and industries will determine the extent to which those innovations are adopted and developed elsewhere.

3. Quantifying the extent of creative linkages

3.1 Quantifying the size of creative linkages

If we are to explore how the creative industries influence innovation in the wider economy, we must first identify – and, ideally, measure – the links between creative industries and other economic activities. As we have seen, several types of linkage are important to innovation, both directly and because they facilitate knowledge spillovers.

This study focuses on supply chain linkages – specifically business-to-business transactions in so-called 'intermediate' goods and services – as providing one potentially important means by which the creative sector may support innovative activities elsewhere.[22]

We use input-output methods – which provide detailed information on the supply and use of goods and services within an economy – to measure the strength of supply chain linkages from different sectors of the UK economy to the creative industries (see Appendix A for a more detailed discussion). Input-output methods tell us which industries buy which goods and in what amounts, allowing us to identify and measure the pattern of supply chain linkages between industries across the economy as a whole.

By analysing the UK's Input-Output accounts on a consistent basis for every year between 1992 and 2004 for which the Supply and Use Tables are published, we construct measures of the value of 'creative' goods and services purchased by each UK industry and the value of goods and services sold by each UK industry to the creative industries. We call the former 'forward linkages' to the creative industries and the latter 'backward linkages'.

These measures are based on an industry- and product-based definition of the creative industries. We get this by mapping the ONS classification of input-output sectors containing creative activities (ONS, 2006) to the ONS 'functional' creative sectors.[23]

This approach provides a close approximation to the DCMS's definition of the creative industries, given the classification constraints in the input-output data.

Our basic measure of the strength of linkages with purchasers is the share of spending on creative products expressed as a percentage of total gross output for a given industry (forward

21. For recent reviews of the literature on absorptive capacity seen van den Bosch et al. (2003) and Zahra and George (2002). Recent empirical studies of absorptive capacity include Frenz et al. (2004), Griffith et al. (2001) and Stock et al. (2001).
22. Business-to-business (B2B) transactions in investment goods may also be important in transferring knowledge between firms. It is not, however, possible to measure the importance of these transactions using published input-output data for the UK.
23. The ONS Input-Output analysis of the creative industries uses a specially constructed set of nine 'creative industry' groupings (Fashion/Clothing; Software; Architecture; Publishing; Advertising; the Arts; Radio & TV; Distribution; and Film), which ONS refers to as 'creative functional headings' or 'creative functions'. These are intended to approximate the definition of creative industries provided by the DCMS Creative Industries Mapping Document (DCMS, 2001). Our use of these 'functional headings' and the adjustment to exclude 'non-creative' activities are described in McVittie (2007). We have adjusted our data, so far as possible, to exclude 'non-creative' activities within these functional sectors.

linkages).[24] Similarly, the strength of linkages with suppliers is measured by the share of purchases by the creative sector in total sales by that industry (backward linkages).[25]

The lack of industry detail in UK input-output data for the creative industries means that we sometimes have to use supply chain information based on wider input-output groups, rather than their 'creative' components alone. The accuracy of our estimates will reflect the extent to which supply chain patterns for creative products are common with other industries with which they are grouped.

The extent of supply chain linkages to the creative sector – both in terms of purchases and sales – is also likely to vary between different firms. Our industry-based measures will miss these variations, making it more difficult to pinpoint the relationships between creative businesses and firms in other parts of the economy.

3.2 Forward linkages

Figure 4 shows that B2B sales are important for the creative industries (Frontier Economics, 2006; Freeman, 2007; Andari et al., 2007). In particular, almost 60 per cent of overall demand for creative products within the UK comes from purchases by businesses as intermediate inputs. This is a higher share than for all products, and is similar to that for financial and business services, which include a broad range of B2B products.

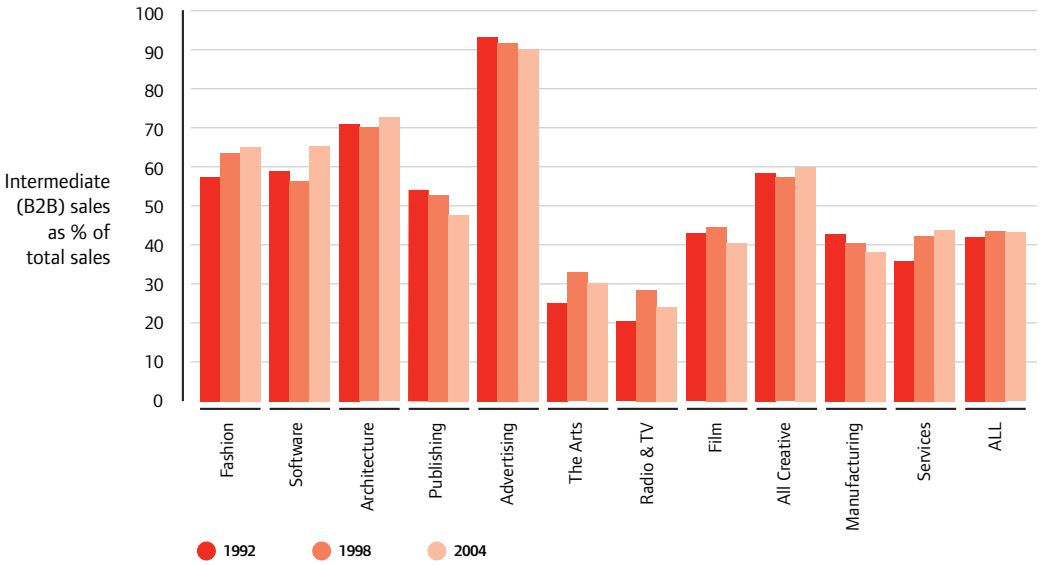
This finding suggests that the creative industries are strongly integrated into the wider economy through their supply chains, and that these may provide an important source of interactions with other sectors. There is significant variation in the importance of business-to-business demand across different parts of the creative industries. Figure 4 shows that B2B demand for creative products is particularly important for Advertising, Architecture, Software and Fashion products.

Industries' purchases of creative products are one way that the creative industries may contribute to innovation in other parts of the economy. As noted in Section 2, this can occur in at least two ways: (a) the creative industries may directly assist the innovation processes of other sectors – such as through software sales and advertising services; and (b) market transactions may facilitate knowledge transfers between creative businesses and those businesses which purchase creative products.

Industry purchases of creative products accounted for around 6 per cent of intermediate purchases by UK industries in total during 2004 and around 3 per cent when

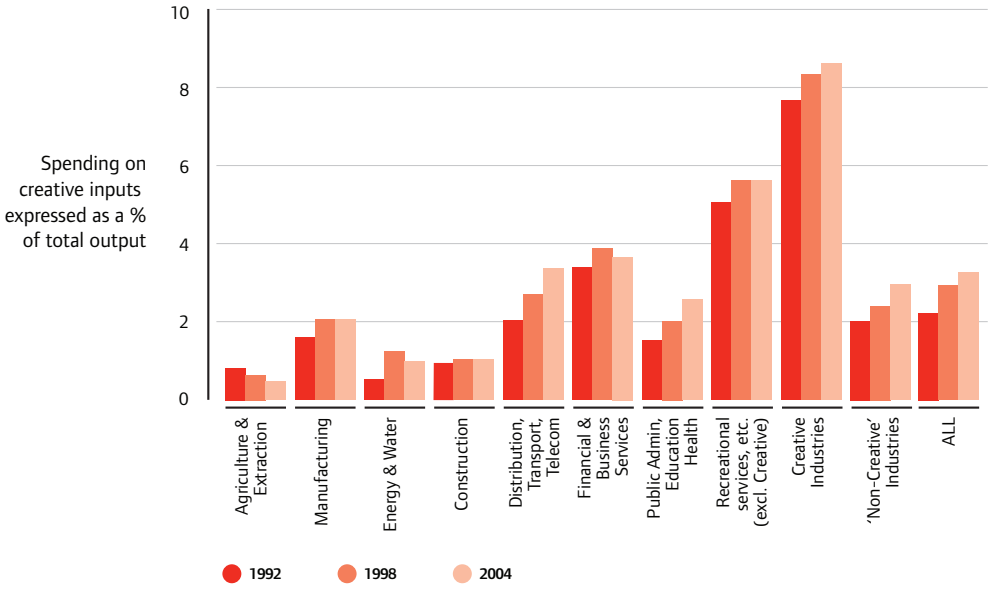
24. Gross output is made up of the value of intermediate purchases (purchases of goods and services as inputs to other production processes) plus value added in that sector. The ratio of creative product purchases to gross output therefore measures the importance of creative inputs to production.
25. This measures the importance of purchases by the creative sector in total demand for each industry's output.

Figure 4: Importance of business-to-business sales for the creative industries, 1992-2004



Source: Authors based on ONS UK Input-Output Supply and Use Tables

Figure 5: Industry purchases of creative intermediate inputs, 1992-2004



Source: Authors based on ONS UK Input-Output Supply and Use Tables

26. French Ministry of Culture (2005), Higgs and Cunningham (2007) and Higgs et al. (2008).
27. See Appendix B for a more detailed discussion of CIS4.

expressed as a percentage of total industry gross output (Figure 5).

Purchases of creative products are particularly important between the creative industries themselves. Creative product purchases are equivalent to over 8 per cent of total gross output and account for 19 per cent of intermediate purchases by the creative industries.

Forward supply chain linkages appear to be stronger between the creative industries and a number of services sectors, with somewhat weaker links to manufacturing and the other production sectors.

3.3 Backward linkages

Purchases by the creative industries of intermediate goods and services produced in other industries (backward linkages from the creative sector) provide another potential means for the creative industries to support innovation in the wider economy. Creative firms may share knowledge – either deliberately or as an unintended consequence of the relationships involved – with their own suppliers, or they may require more innovative products themselves.

Figure 6 plots creative industry purchases for broad product groups as a share of total demand for those products. Overall, creative industry intermediate input demands contribute around 1.6 per cent of total product demand within the UK, but 7.4 per cent of demand for creative products.

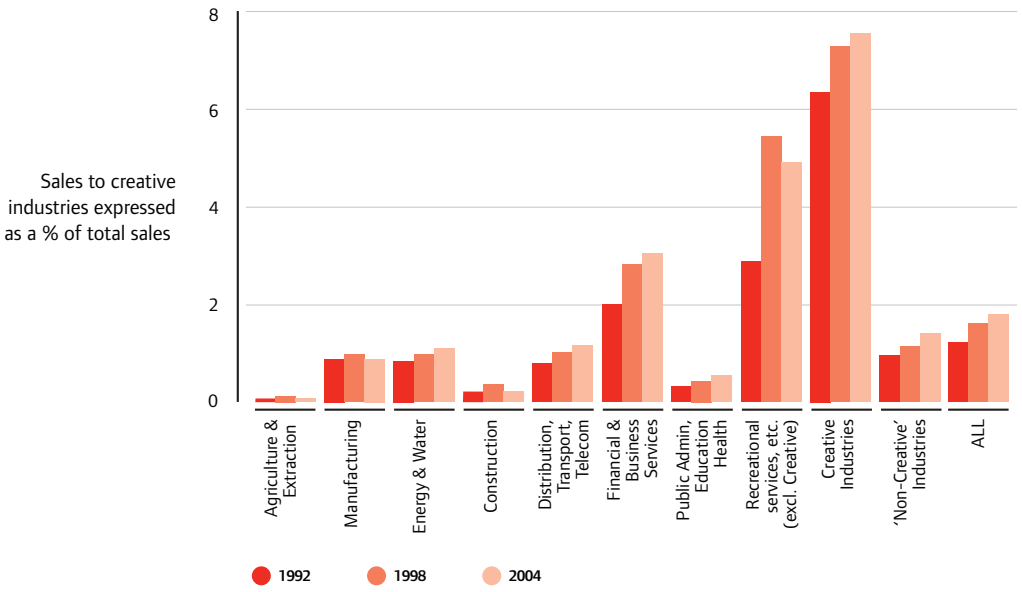
The above measures of creative linkages are defined at the industry level, in that they reflect sales and purchases between each industry and a specific set of industries characterised as 'creative' based on the ONS and DCMS definitions.

It has been widely argued, however, that industry-based definitions alone understate the size and importance of the creative economy.[26] A complete assessment of creative activities requires the employment of creative workers outside of the narrowly-defined creative industries to be considered. The DCMS estimates that around 1.9 million creative workers were employed across the UK economy during 2006, around 1.1 million of whom worked within the creative industries (DCMS, 2007).

4. Quantifying the extent of innovative industries

Our analysis is largely based on the innovation activities and performance of individual firms, using data from the latest UK Community Innovation Survey (CIS4).[27] This allows us to exploit the range of information within the CIS4 on other influences on innovation performance already identified by researchers,

Figure 6: Industry sales of intermediate goods to the creative industries, 1992-2004



Source: Authors based on ONS UK Input-Output Supply and Use Tables

and to control for these in exploring the role of linkages to the creative industries. Doing so requires advanced econometric methods.

Before considering this analysis, it is useful to discuss informally the pattern of innovation in the UK at the industry level. We therefore construct a range of measures of innovation for UK industries by aggregating firm-level data from the CIS.[28] We can think of the innovation measures as encompassing three distinct stages of the innovation process:[29]

1. **Innovation activities:** firms' deliberate attempts to generate new knowledge and innovations through their own research and development, acquisition of R&D and knowledge from other firms, design activities, equipment purchases, training and marketing activities.

2. **Innovation outputs:** the results of firms' innovation efforts in the form of new (and novel) products and process, and of wider innovations in organisational structure, corporate strategy, management methods, and marketing.

3. **Innovation impacts:** the impacts of firms' innovation activities and outputs on aspects of business performance, including improvements to the range and quality of products, increases in market share or penetration of new markets, improved flexibility of production, and reduced production costs.

Our prior is that purchases of creative products should be more strongly related to certain types of business innovation activity than others recorded by the CIS (internal R&D, design and marketing activities); to certain innovation outputs (product innovations, rather than process innovations); and to certain types of innovation impact (expanded diversity of products and improvements in product quality, rather than reduced cost and increased flexibility). This is why we focus on these aspects of innovation performance in our results.

4.1 Innovation activities

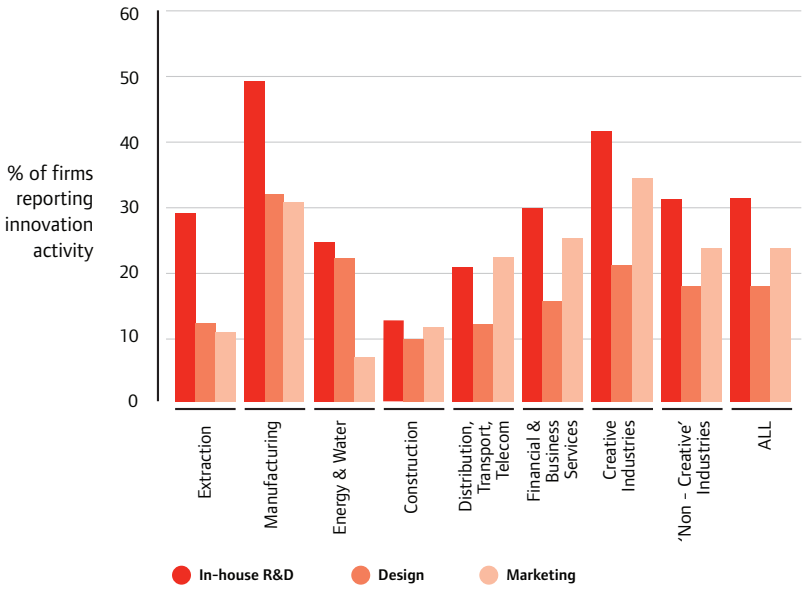
Figure 7 shows that around 32 per cent of firms covered by CIS4 report that they have engaged in some form of in-house R&D between 2002 and 2004; around 18 per cent in design activities; and over 25 per cent in marketing.

Some industries are more engaged in innovation than others. Manufacturing is the most likely to report innovation activity, with almost 50 per cent of firms reporting in-house R&D, and over 30 per cent reporting use of either design or innovation in marketing activities. Over 30 per cent of financial and business services firms reported using in-house R&D.

On the whole, the creative industries report higher innovation than 'non-creative' industries.

28. Industries are defined based on the input-output industry groups used for the creative linkage measures.
29. This characterisation is based on the structural model of innovation introduced by Crepon et al., (1998) and subsequently adopted by Griffith et al. (2006), Janz et al. (2003) and others.

Figure 7: Innovation activities by broad industry group, 2002-2004



Source: Authors based on CIS4 data

Over 40 per cent of firms in creative industries report use of in-house R&D; over 20 per cent report use of design inputs and almost 35 per cent innovations in marketing; each of these is higher than their 'non-creative' counterparts.[30]

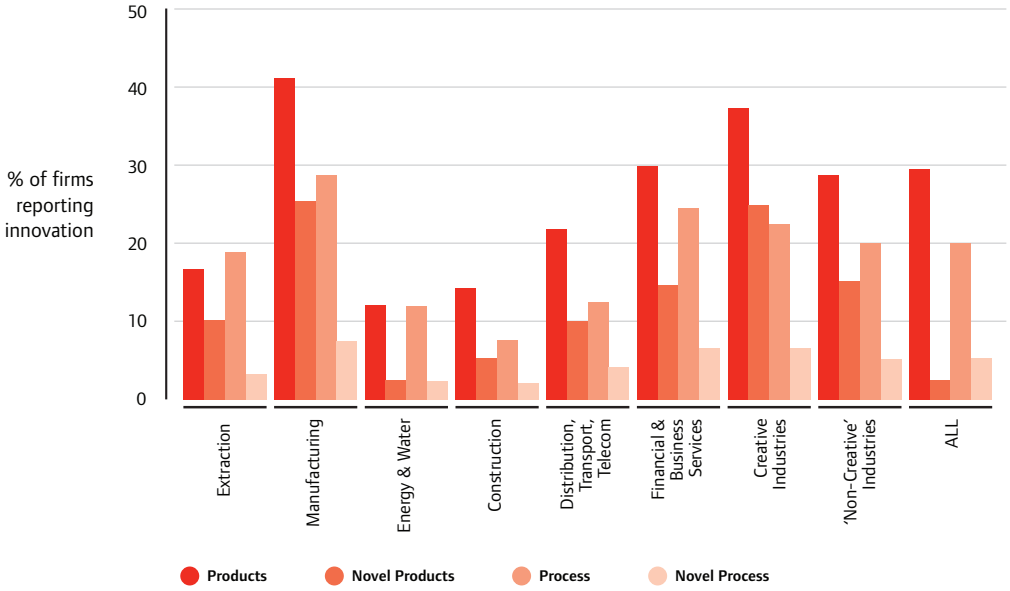
30. Wilkinson (2007) also notes that the CIS4 shows higher levels of innovation among firms in the creative industries than in other sectors in the UK.

4.2 Innovation outputs

Figure 8 shows that innovation activities are reflected in reported innovation outputs too. Almost 30 per cent of firms claim to have introduced some form of product innovation in the previous three years. Of these, only a small fraction characterise these as new to market (or 'novel', as distinct from products that are new to the firm). Fewer firms, around 20 per cent, report that they have introduced process innovations.

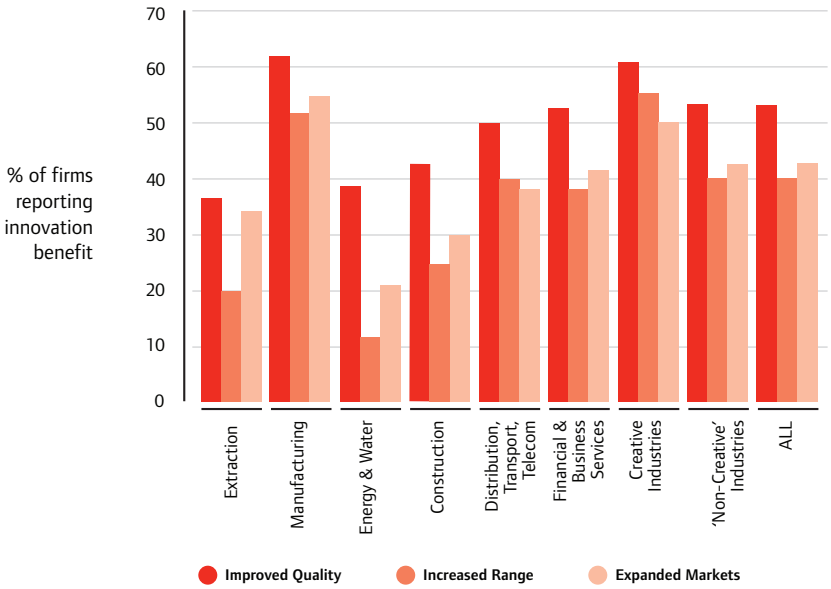
Manufacturing firms claim to be particularly innovative, with over 40 per cent having introduced product innovations and around 28 per cent process innovations. High rates of product and process innovation are also reported by financial and business services

Figure 8: Innovation outputs by broad industry group, 2002-2004



Source: Authors based on CIS4 data

Figure 9: Innovation impacts by broad industry group, 2002-2004



Source: Authors based on CIS4 data

firms, with nearly 30 per cent reporting product innovation and 25 per cent process innovation.

Again, the creative industries have much higher rates of product innovation than their 'non-creative' counterparts, but the gap is perhaps narrower for process innovation. One implication might be that creative businesses play a greater role in stimulating product, as opposed to process, innovation in other businesses (and that is indeed what our analysis finds).

4.3 Innovation impacts

The survey responses on innovation impacts tell a broadly similar story to innovation activities and outputs (Figure 9). Almost 55 per cent of firms report that the quality of their product or service has improved in the previous three years, over 40 per cent report an increased range and almost 45 per cent some expansion in the size of their markets. The manufacturing sector again reports the highest impacts from innovation, though the creative industries are not far behind.

Some industries which report fewer innovation activities or outputs than manufacturing also appear to have experienced significant impacts from innovation. Financial and business services firms frequently report high rates of improved quality and expanded market size; large numbers of Distribution, Transport, Telecom businesses report impacts in the form of an increased product range.

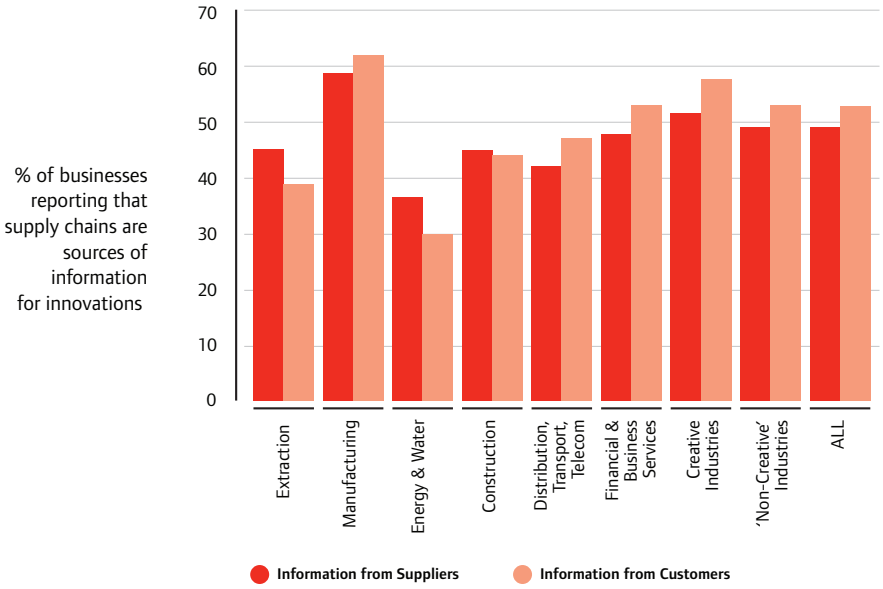
A main component of our hypothesis is based around the idea that firms acquire valuable information for innovation through their contacts with suppliers and customers. There is some evidence on the importance of supply chains as sources of information for innovation from CIS4 itself (Figure 10).

These data suggest that supply chain linkages are an important source of information for innovation. This applies across all areas of economic activity, but particularly in manufacturing where almost 60 per cent of businesses report that information from suppliers is important to their innovation. Information from customers is even more significant, with around 62 per cent of manufacturing firms reporting that such information is important to their innovation.

Information inflows also appear to be important for innovation by creative businesses. More than 50 per cent report that information from suppliers is important for their innovation, and almost 60 per cent say the same about information from customers. These are higher shares than for most services industries, and for the economy as a whole.

CIS4 suggests that firms are less likely actively to cooperate with suppliers or customers on innovation than they are to acquire information from them (Figure 11). Even so, around 10 per cent of firms report cooperating with customers on innovation activities, and slightly more (over 11 per cent) report cooperating

Figure 10: Supply chains as sources of information for innovation



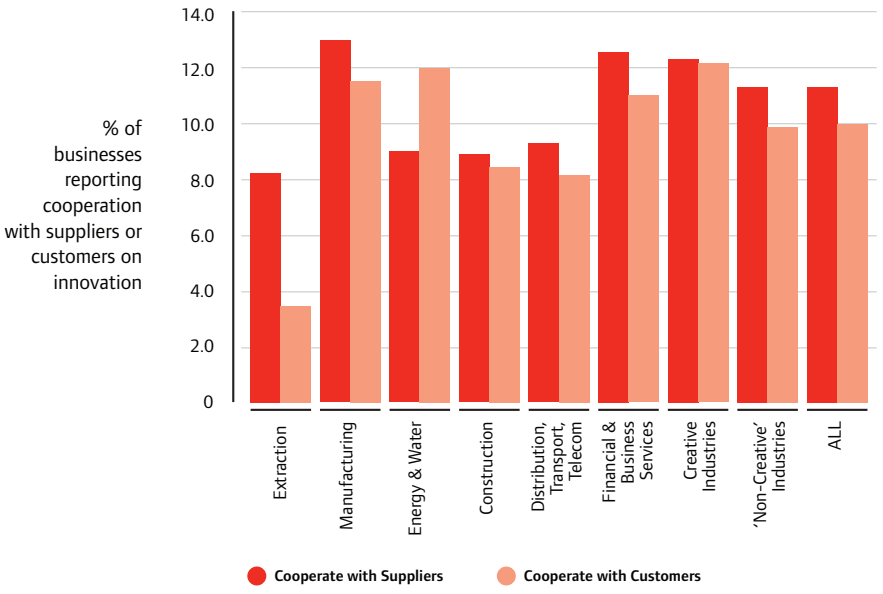
Source: Authors based on CIS4 data

with their suppliers. As with information flows, such cooperation appears to be particularly important for creative businesses. (This may have implications for innovation in other sectors with supply chain linkages to the creative industries).

Several published research studies using previous versions of the Community Innovation Survey have found that acquisition of information and cooperation with suppliers and customers help to explain the innovation patterns of firms in the UK.[31] We replicate such findings using CIS4 data, and then investigate also whether supply chain linkages with creative industries help to explain innovation by businesses in other sectors.

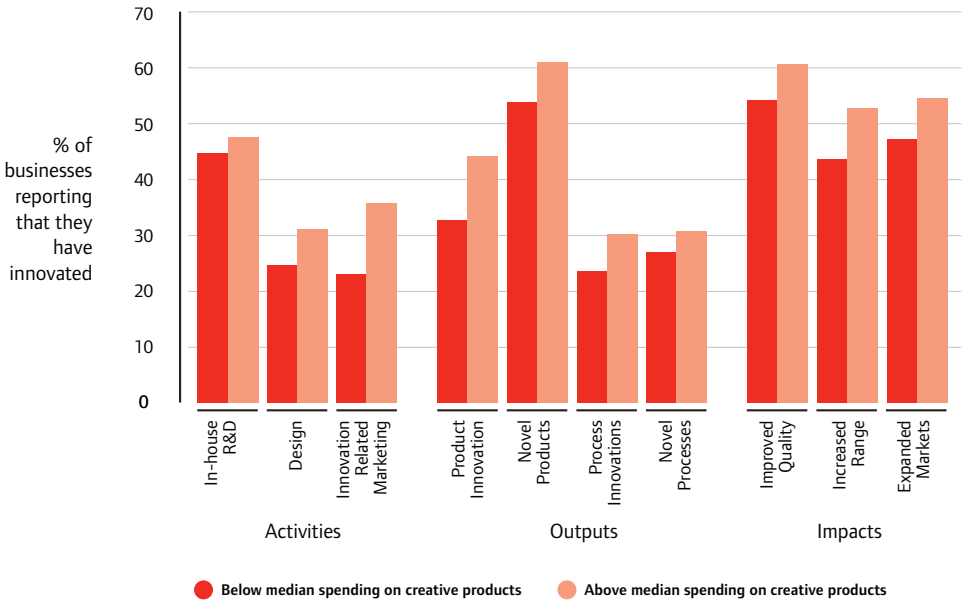
31. Neely and Hii (1998) provide a review of the earlier literature. More recent studies using CIS3 include Janz et al. (2003), Loof and Heshmati (2000) and Griffith et al. (2006).

Figure 11: Cooperation with suppliers and customers on innovation



Source: Authors based on CIS4 data

Figure 12: Innovation performance for industries with strongest and weakest creative linkages (purchases of creative products)



Source: Authors based on CIS4 data

5. Creative linkages and innovation: patterns in the data

Our hypothesis is that firms' purchases of creative inputs and sales to the creative industries allow them to access new resources, ideas and knowledge which support innovation in their own businesses. We shall now consider whether our measures of creative industry linkages in the UK support this hypothesis.

5.1 Descriptive analysis

As a precursor to the more formal econometric analysis, we compare the innovation performance of those industries with strong supply chain linkages to the creative industries with the performance of industries with weaker links. Figure 12 divides industries in the UK (excluding the creative industries) into two halves on the basis of their purchases of creative products expressed as a percentage of their gross output (forward linkages to the creative industries).[32]

On all the innovation measures, industries with stronger links to the creative industries have stronger innovation performance. So, industries which purchase a greater proportion of creative products have a higher proportion of firms claiming to have engaged in in-house R&D, design and innovative marketing. They also have higher proportions of firms reporting product and process innovations.

Finally, firms in those industries with stronger links to the creative industries are more likely to report that they have improved the quality of their products, increased their product range, expanded into new markets or increased their share in existing markets as a result of innovation.

These patterns are consistent with a link between purchases of creative inputs and innovation performance – though on the basis of this descriptive analysis alone we cannot know its statistical significance.

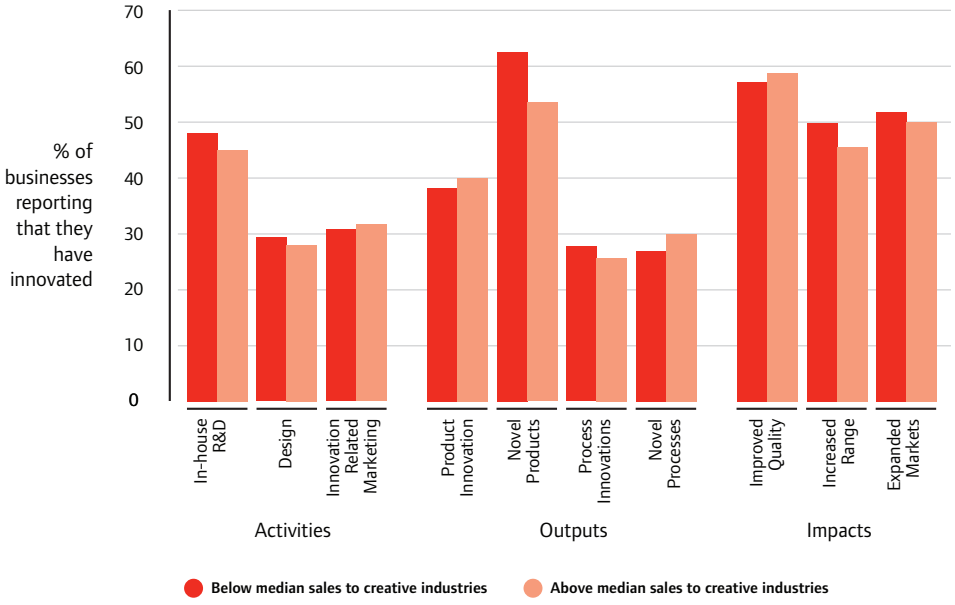
Figure 13 presents a similar analysis for sales to the creative industries (backward linkages). There appears to be no clear tendency for industries with significant sales to the creative industries to be more innovative.

5.2 Statistical analysis

More formal statistical measures are unclear on the relationships between industries' creative purchases and sales to creative industries and their innovation performance. Correlation analysis, for example, generally shows no systematic statistically significant positive relationship between our measures of creative industry supply chain linkages and aspects of innovation performance.[33]

32. The creative industries themselves are excluded since we are primarily interested in the role of creative activities in supporting innovations elsewhere in the economy.
33. Detailed correlation matrices are provided in Appendix C.

Figure 13: Innovation performance of industries with strongest and weakest creative linkages (sales to creative industries)



Source: Authors based on CIS4 data

This should not be surprising. Even if important for innovation, creative industry linkages are likely to be only one among many influences on the innovation performance of individual firms and industries; we should not expect to find strong simple ('unconditional') relationships between creative linkages and innovation. Exploring the nature of such relationships requires more sophisticated and rigorous econometric methods, which would allow us to control for the influence of other determinants. The results of such an analysis are reported in Section 6.

6. Creative linkages and innovation: econometric analysis

This section presents and discusses the results of an econometric analysis of creative linkages and innovation performance using firm-level data from CIS4. We provide a brief and informal outline of our methods to help non-specialist readers to interpret the results.[34]

6.1 Specification of the model

The fourth UK Community Innovation Survey (CIS4) provides a range of information on innovation behaviour and performance on individual businesses in the UK together with data on business characteristics widely regarded as important determinants of innovation. The firm-level data cover over 16,000 firms across most economic sectors, although firms with fewer than ten employees are excluded, as are some important service industries.

Our methodology seeks to explain differences in the innovation performance of individual firms based on standard 'control' variables and measures of linkages to the creative industries.[35] This approach attempts to measure how creative suppliers or purchases contribute to innovation, once other key influences on a firm's innovation performance have been discounted.

Our main variables are summarised in Table 1.[36] The first set of variables relates to various measures of innovation. Table 1 divides the innovation measures into innovation activities, innovation outputs and innovation impacts.

Our analysis focuses on three types of innovation activity reported within CIS4:

- In-house R&D;
- Design activities; and
- Innovation-related marketing activities.

These are arguably the most likely to be influenced by purchases of creative intermediate inputs.[37] We also concentrate on three types of innovation output:

34. The method used uses binary choice (probit) regressions. Technical details of this methodology are given in Appendix E.
35. By 'standard' we mean variables that are typically included in econometric models of innovation in the academic literature. See, for example, Kleinknecht and Mohnen (2002).
36. Further details and descriptive statistics are presented in Appendix D.
37. Other innovation activities reported in the CIS4 are external R&D, knowledge acquisition, equipment purchases and innovation-related training.

- Product innovations (introduction of new or significantly improved goods or services);
- Novel product innovations (where the new good or service is also new to the market); and
- Process innovations (introduction of new or significantly improved processes).[38]

Finally, we consider three ways in which innovation can impact on a firm:

- Improvements in product quality;
- Increases in product range; and
- Expansion into new markets or increased market share in existing markets.

In each case, we build econometric models to account for why firms engaged in that type of innovation during the period covered by CIS4 (2002-2004).

In our models we attempt to isolate the impact of linkages to the creative industries on each of these nine innovation measures. The measures are derived using input-output techniques which, as described in Section 3, estimate the value of purchases of creative products and sales to creative sectors for each of 119 input-output industry groups, as well as the share of creative purchases and sales in total gross output and demand.

Each firm in the CIS4 dataset is allocated to an input-output industry on the basis of its detailed (5-digit) standard industrial classification (SIC). Firms are assumed to have the same pattern of supply chain linkages as the input-output industry of which they are a part.[39]

Since we are interested in the role of the creative industries in supporting innovation elsewhere in the economy, firms in the creative industries themselves are excluded from the econometric analysis.

The other variables listed in Table 1 are intended to account for a broad range of other influences on a firm's innovation performance used in the published literature (see the discussion in Section 2). That innovation may be related to firm size, for example, with larger firms more likely to engage in innovation activities and to generate new innovation outputs, is a common finding in empirical studies of innovation. We also control for various other characteristics which we might expect to influence innovation.[40]

Two broad groups of control variable merit particular mention. First, we include a full set of industry 'dummy' variables indicating to which industry the firm belongs.[41] These variables are included because innovation performance is likely to vary structurally across industries, and this is unlikely to be fully captured by the available data.

For example, industries will have different technological regimes that fundamentally influence the opportunities and incentives for firms to engage in innovative activities, and their success in generating innovation outputs and impacts.[42] Differences in innovation processes and outcomes across industries may also lead firms to report their innovative behaviours in different ways.[43]

The industry dummy variables within our regression analysis provide a simple, albeit imperfect, way of controlling for these differences to focus on the determinants of innovation at the firm level, and particularly the role of linkages to the creative industries, across all sectors.[44] (Even though we make great efforts to control for the impact of these determinants, we cannot rule out linkage variables 'capturing' some industry effects unrelated to creative linkages).

We also include regional variables, defined for the UK Government Office regions to allow for the possibility of systematic geographical variations in innovation performance.[45]

The second important group of control variables are our proxies for potential supply chain knowledge transfers between businesses (not just those involving creative businesses).

These are intended to measure the extent to which firms acquire information for innovation from suppliers and customers, and the extent of cooperation on innovation with suppliers and customers.

These variables are often included in econometric models of innovation; they allow us to explore the importance of these knowledge transfer mechanisms at the general level. We further investigate the possibility that knowledge transfers are particularly strong when creative industries are involved in the supply chain.[46]

38. CIS4 also records other types of innovation outputs: novel processes and four types of 'wider innovation' – corporate strategy innovations, organisational structure innovations, marketing innovations, and the introduction of 'advanced management' techniques.
39. This assumption is necessary because we have no data on supply chain linkages at the level of the firm to match the innovation measures which we have at firm level in the CIS4 sample. The use of estimates of creative linkages at the industry level raises two technical issues for the regression analysis. First, heterogeneity among firms within the same industry implies that supply chain linkages to the creative sector will be imperfectly measured (in other words, subject to measurement error) for individual firms. This limits the information content in our dataset and results in less precise estimates of the influence of linkages to the creative sector on innovation. It may also lead to 'downward biased' estimates of these linkage effects, although without further data it is not possible to establish this. Second, the estimated 'standard errors' from the regression analysis (which predict the precision of the regression estimates of linkage effects) need to be adjusted to take account of the use of industry-level data within a firm-level analysis – in technical language, this means that the standard errors need to be cluster-adjusted (Moulton, 1990; Wooldridge, 2002, 2003).
40. Our set of control variables corresponds to that used in several recent studies of innovation using the previous Community Innovation Survey (CIS3), including, Griffith et al. (2006).
41. Dummy variables are simple binary variables which take the value of 1 in specific cases and zero otherwise. They are useful ways of controlling for the specific impact that individual businesses of a particular type have on the overall results.
42. See the discussion of technology regimes in Section 2.
43. Cambridge-MIT (2008) forthcoming and Green, Miles and Rutter (2007).
44. The industry dummies are defined at the 2-digit SIC level. In technical language, this approach ensures that the industry dummies are not collinear with the creative linkage variables, since the 2-digit SIC industries do not directly correspond to the input-output industry groups.
45. There is extensive research

Table 1: Innovation and creative linkage measures and control variables

Variable	Description	Source
Dependent Variables - Innovation measures		
Innovation activities		
In-house R&D	Enterprise engaged in in-house R&D during 2002-4 (1 = Yes, 0 = No)	CIS4 Question 13
Design	Enterprise devoted resources to design during 2002-4 (1 = Yes, 0 = No)CIS4	Question 13
Innovation-related marketing	Enterprise engaged in marketing related to innovative products during 2002-4 (1 = Yes, 0 = No)	CIS4 Question 13
Innovation outputs		
Product innovation	Introduced new or significancly improved product (good or service) during 2002-4 (1 = Yes, 2 = No)	CIS4 Question 5
Novel products	Introduced new to market product innovation during 2002-4 (1 = Yes, 0 = No)	CIS4 Question 7
Process innovations	Introduced new or significantly improved process during 2002-4	CIS4 Question 9
Innovation impacts		
Improved quality	Improved product quality (1 = 'Medium' or 'High' importance)	CIS4 Question 12
Increased range	Increased product range (1 = 'Medium' or 'High' importance)	CIS4 Question 12
Expanded markets	Entered new markets or expanded market share (1 = 'Medium' or 'High' importance)	CIS4 Question 12
Explanatory Variables - Creative linkage measures		
Purchases of creative products	Purchases of creative products as % of total output for input-output industry group (total or by product)	UK Input-Output Accounts 2002-4
Sales to creative sectors	Purchases by creative sector as % of total demand for input-output industry/product group (total and by industry/product)	UK Input-Output Accounts 2002-4
Creative employment	Employment of 'creative' occupations as % of total employment by input-output industry group	Labour Force Survey and UK Input-Output Accounts 2002-4
Explanatory Variables - Control variables		
Firm size	(Log of) business turnover (total sales) in 2004	CIS
Industry	'Dummy' (0,1) variables for 2-digit SIC industry groups	CIS
Location	'Dummy' variables for UK Government Office regions based on CIS4 postcodes	CIS
Business type and age	'Dummy' variables recording whether the business is part of a larger enterprise group, and whether it was established after 1 Jan 2000	CIS Questions 1 & 4
Employee qualifications	% of employees with degrees in Science & Engineering subjects; % of employees with degrees in other subjects	CIS Question 26

Variable	Description	Source
Product market area	'Dummy' variables recording whether the business's main market area is local, EU or global	CIS Question 2
IP protection methods	Set of variables recording extent to which firm employs range of methods to protect its intellectual property (patents, copyright, etc.) (3 = 'High' importance, 2 = 'medium', 1 = 'low', 0 = 'none')	CIS Question 21
Barriers to innovation	Set of variables recording stated importance of a range of barriers to innovation (3 = 'High' importance, 2 = 'medium', 1 = 'low', 0 = 'none')	CIS Question 19
Public support	'Dummy' variables recording whether business receives public support for innovation from local, national or EU sources (1 = Yes, 0 = No)	CIS Question 22
Innovation activities	'Dummy' variables recording engagement in range of innovation activities as control variable within innovation output and impact models (1 = Yes, 0 = No)	CIS Question 13
Cooperation	'Dummy' variables recording whether the business cooperates with suppliers or customers as part of its innovation activities (1 = Yes, 0 = No)	CIS Question 18
Information sources	'Dummy' variables recording whether suppliers or customers serve as important sources of information for the business's innovation activities (1 = 'Medium' or 'High')	CIS Question 16

6.2 Results of the econometric analysis

Table 2 summarises the results from our regression analysis. They suggest a statistically significant positive impact from creative linkages on some of the innovation measures.[47]

Firms in industries where purchases of creative products (forward linkages) are important within production are more likely to engage in design activities; more likely successfully to introduce new and novel products; and more likely to enjoy an expansion in their product range as a result of their innovation activities. Firms in industries where sales to creative businesses (backward linkages) are important are more likely to implement product innovations, and are more likely to see an increase in their product range as a result of their innovation.

The 'marginal effects' in Table 2 illustrate the extent to which changes in creative linkages increase the probability of innovation. They imply, for example, that if the 'average' firm spends twice the amount it does on creative products – 6 per cent as opposed to 3 per cent of total gross output[48] – the probability of that firm engaging in design innovation activities is around three percentage points higher (22 per cent compared with 19 per cent), the probability of the firm introducing a product innovation is seven percentage points higher (36 per cent compared with 29 per cent), and the probability of a novel product innovation is four percentage points higher (20 per cent compared with 16 per cent).

By comparison, access to innovation support from national government is associated with the average firm's probability of introducing a product innovation being around eight percentage points higher. The creative linkage impacts are therefore similar in magnitude to those of key policy variables.

The results in Table 2 are based on regressions which do not include innovation activities in the set of explanatory variables. To test the robustness of our results, we also run the regressions including the innovation activity measures in our conditioning set. Doing so provides an indication of the effects of linkages to the creative industries given firms' levels of innovation activities (which can loosely be interpreted as their innovation 'effort').

The results – reported in detail in Appendix E, Table 21 – show significant, but weaker, positive effects from purchases of creative products for both new and novel products. This suggests that even allowing for their existing innovative activities, firms in industries that buy more creative products are more likely to see product innovations. The impact of sales to

evidence that geographical location is an important determinant of innovation – e.g. Audretsch and Feldman (1996); Simmie (2002). We also experiment with alternative geographical variables linked to city-rural status. Alternative specifications have no significant impact on the regression results.

46. In technical terms we do this by including constructed variables in our econometric model which interact the input-output based creative linkage measures with the information acquisition and cooperation values taken from CIS4.
47. See Tables 17, 20 and 26 in Appendix E for more detailed results.
48. This is an increase of around one standard deviation.
49. The creative employment

Table 2: Summary of creative linkage effects on innovation measures[1]

	Purchases of creative products		Sales to creative industries	
	Marginal effect [2]	Significance [3]	Marginal effect [2]	Significance [3]
Innovation activities				
In-house R&D	0.328	.	0.802	.
Design	1.086	**	-0.322	.
Innovation-related marketing	-0.143	.	0.157	.
Innovation outputs				
Product innovation	2.376	***	0.933	***
Novel products	1.383	***	0.009	.
Process innovations	0.856	.	0.586	.
Innovation impacts				
Improved quality	0.780	.	-0.139	.
Increased range	0.866	*	1.753	*
Expanded markets	1.140	.	1.672	

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support.

2. The marginal effect shows the impact of a unit increase in each variable on the probability of observing each type of innovation behaviour while holding other influences on innovation behaviour constant.

3. * = statistically significant at the 10% level or less; ** = 5% or less; *** = 1% or less. Based on robust (cluster-adjusted) standard errors.

Source: Authors based on CIS4 and UK input-output data

creative industries on new product innovation is also still positive and statistically significant.

A similar analysis of innovation *impacts*, however, shows that quality is the only significant positive impact in the case of sales to the creative industries after controlling for patterns of innovation activity (Appendix E, Table 27).

This suggests that greater purchases of creative products significantly increase the probability that a firm will improve the quality of its products as a result of its innovation activities, even after allowing for the firm's level of innovation 'effort'.

In our econometric analysis we also explore the possibility that direct employment of creative occupations may be associated with higher levels of innovation.[49] The econometric analysis provides no direct link between creative employment and the innovation performance of businesses.[50] We also examine the possibility, associated with the idea of absorptive capacity, that creative linkages may have a stronger impact on innovation in firms with higher levels of direct creative employment, than in those with lower levels of creative employment.[51] But, the evidence is inconclusive.

The results in Table 2 suggest that stronger B2B linkages to the creative sector may in some cases support higher levels of business innovation. This raises the question of which *types* of creative linkage (with which particular creative industries) are most important for innovation performance.

Unfortunately, it is very difficult to attribute the impact of the linkages to individual creative industries. There are two reasons for this. First, there are strong correlations between some creative linkage measures (see Appendix C, Tables 13 and 14), making it hard statistically to extract the effect of a linkage with one

measure we use is the share of employment of creative occupations in total employment for the industry of which the firm is a part.

50. The results are presented in Tables 18, 22 and 29 in Appendix E.

51. This is done by introducing into the model 'interaction' variables derived by multiplying the creative linkage variables by the creative employment variable. See Tables 18, 22 and 29 in Appendix E.

52. See Tables 19, 24, 25 and

Table 3: Innovation effects of supply chain linkages to individual creative[1, 2]

	Creative linkage variables included together				Creative linkage variables included separately			
	Design activities	Product innovations	Novel product	Increased range	Design activities	Product innovations	Novel product	Increased range
Purchases of creative products								
Fashion	.	++	.	.	--	+++	---	+++
Software	.	.	.	-	+++	+++	+++	.
Architecture	.	-	.	.	+++	+++	+++	+++
Publishing	.	++	.	.	.	.	.	.
Advertising	++	++	++	+++	++	++	++	++
The Arts	.	-	.	.	--	.	.	.
Radio & TV	.	++	.	.	--	.	.	.
Film	.	.	.	.	.	.	.	---
Sales to creative industries								
Fashion	.	.	.	---	.	++	.	--
Software	.	.	.	.	.	+++	.	+++
Architecture	.	+	.	.	.	+++	.	---
Publishing	.	.	.	.	.	.	.	.
Advertising	.	.	.	.	.	+++	.	---
The Arts	.	+	.	.	.	+++	.	.
Radio & TV	.	.	.	.	.	+++	.	.
Film	.	.	.	.	.	.	.	.

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support.

2. Shows the sign and the significance level for each variable: +/++/+++ and 10%/5%/1%

Source: Authors based on CIS4 and UK input-output data

28 in Appendix E for more detailed results.

53. Some panel data – covering

industry from that with another. Second, some individual creative linkage measures (e.g. purchases of Radio & TV and Film products) show little variation across businesses and are zero for a large proportion of firms. This lack of variation makes it difficult precisely to estimate the impact of linkages to those sectors.

With these qualifications in mind, Table 3 summarises our attempt to separate out the impacts of linkages with different creative industries on business innovation.[52] It presents only those innovation measures for which we obtain statistically significant positive results for linkages to the creative industries at the aggregate level.

Table 3 reports a number of significant positive relationships for product innovation in particular (when all variables are entered separately or together in one model). The statistical problems outlined above imply, however, that any conclusions should be treated with a great deal of caution.

The results discussed so far give some support to the general hypothesis that supply chain linkages to the creative sector are positively

Table 4: Knowledge transfer mechanisms, creative linkages and innovation performance

	Product innovations		Novel products		Increased product range		Improved product quality	
	Marginal effect [2]	Signif. [3]	Marginal effect [2]	Signif. [3]	Marginal effect [2]	Signif. [3]	Marginal effect [2]	Signif. [3]
Explanatory variables								
Cooperation with suppliers	0.107	***	0.028	*	0.026	.	0.046	.
Cooperation with customers	0.120	***	0.048	***	0.075	**	0.173	.
Interaction effects								
Purchases of creative products x cooperation with suppliers	-0.296	.	0.068	.	0.469	.	1.045	.
Sales to creative industries x cooperation with customers	0.906	.	0.327	.	-0.163	.	0.779	.
Explanatory variables								
Information from suppliers	0.034	***	0.004	**	0.140	***	0.168	***
Information from customers	0.095	***	0.036	***	0.208	***	0.242	***
Interaction effects								
Purchases of creative products x info from suppliers	-0.078	.	0.156	.	0.403	*	1.038	***
Sales to creative industries x info from customers	0.366	.	0.120	.	0.087	.	-0.057	.

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities

2. The marginal effect shows the impact of a unit increase in each variable on the probability of observing each type of innovation behaviour while holding other influences on innovation behaviour constant.

3. * = statistically significant at the 10 per cent level or less; ** = 5 per cent or less; *** = 1 per cent or less. Based on robust (cluster-adjusted) standard errors.

Source: Authors based on ONS UK input-output data

related to innovation elsewhere in the economy.

They do not, however, allow us to establish the direction of this relationship. Creative linkages may drive innovation in other sectors. However, it is equally possible that firms require creative inputs to support their innovation, and that the primary determinants of innovation lie elsewhere.

To investigate these issues further would require data with a time series dimension, but these are not currently available in a form adequate to our needs.[53]

Nor do the results presented so far on their own provide any evidence about the precise *mechanisms* by which creative linkages influence innovation.

Our principal hypothesis has two elements: first, that creative products – such as advertising or design – are important resource inputs into the innovation decisions of businesses in non-creative sectors; second, that supply chain transactions with creative businesses are associated with knowledge transfers, possibly spillovers, from those creative businesses to other sectors of the economy. The results we have reported so far do not allow us to discriminate between these two possibilities.

the same firms over time – can be obtained by combining CIS3 and CIS4 data. However, these cover only a small sample of firms and a very short time period. Since measured linkages to the creative sector change only slowly over time, the data do not provide a sufficient basis for examining the causality between creative linkages and innovation performance.

54. One proviso to our results is

To provide more direct evidence on the role of knowledge transfers, we examine the impact of two types of knowledge transmission mechanism considered in the CIS4, which are particularly relevant to supply chain transactions: specifically knowledge acquisition from suppliers and customers; and cooperation with suppliers and customers.

The results in Table 4 focus on innovation output and impact measures. Consistent with the findings of previous published research, cooperation with suppliers and customers and the importance of information from suppliers and customers are generally significant determinants of innovation performance.

We go further and explore whether these effects are stronger in firms with stronger linkages to the creative sector. We do this by 'interacting' the creative linkage measures with the transmission mechanism variables.

So, for example, we explore the potential role of knowledge transfers related to forward creative linkages by including interaction variables constructed by multiplying creative purchases with the extent of reported cooperation between a firm and its suppliers on innovation, and with the extent to which a firm claims to have obtained innovation-related information from its suppliers.

In general, we find no evidence that such knowledge transfer effects are a significant determinant of innovation. We do, however, obtain statistically significant results from purchases of creative products (forward creative linkages) interacted with information acquired from suppliers for two of the innovation impact variables: improvements in product range and product quality.

This is consistent with the possibility that knowledge transfers from creative businesses to firms purchasing creative products may support innovations leading to improvements in the range and quality of products offered.

7. Policy implications and conclusions

This research for the first time brings together knowledge of the production structures relating the creative industries to the wider economy with current understandings of the determinants of innovation.

Specifically, we construct measures of the strength of supply chain linkages to the creative industries and explore – using a range of informal and more formal techniques – their relationship to measures of innovation reported in the fourth UK Community Innovation Survey (CIS4).

By doing so, we can investigate a range of innovation activities, outputs and impacts, controlling for a variety of other determinants of innovation to test our central hypothesis – namely, that firms' purchases of creative inputs and sales to the creative sector allow them to access key resources and knowledge which support their innovation activities.

Our analysis of the Input-Output accounts suggests that business-to-business (B2B) purchases of creative products and sales to creative businesses are important to many sectors of the economy (and that these linkages are particularly important between creative industries themselves).

Measures of innovation from the CIS show that innovation is more likely in the creative industries than in many other sectors. The CIS also shows the importance of supply chains as sources of innovation, again particularly so in the creative industries, and that such supply chain linkages are positively related to innovation.

We undertake an econometric analysis to explore the relationships between creative linkages and innovation performance. Our results suggest a significant positive impact from creative linkages for some, but not all, of the key innovation measures.

Firms in industries where purchases of creative products (forward linkages) are important in production are more likely to engage in design activities; to introduce new products (both new to the firm and new to market); and to expand their product range as a result of their innovation activities. Firms in industries where sales to the creative sector (backward linkages) are important are also more likely to introduce new products to the firm and to increase their product range.[54]

To provide more direct evidence on the potential role of knowledge transfers and spillovers embodied in B2B transactions, we also examine the impact of two types of knowledge transmission mechanism contained within the CIS4 which are particularly relevant to supply chain transactions: knowledge

that, while powerful, they do not allow us to establish the direction of the relationship between creative linkages and innovation. While our results are consistent with our key hypothesis – that creative businesses stimulate innovation elsewhere in the economy – it is equally possible that businesses which are innovative for unrelated reasons have a greater tendency to purchase creative inputs. Unpicking this further is a priority for future research, although the data limitations in the Community Innovation Survey suggest that a different research methodology will be needed.

acquisition from suppliers and customers, and cooperation with suppliers and customers.

By interacting these measures with our creative linkage variables we can test the hypothesis that knowledge transfers embodied in supply chain transactions between firms in 'non-creative' industries and creative businesses support innovation in these sectors.

In general, we cannot conclude that knowledge transfer effects from creative businesses are a significant determinant of innovation. There is some evidence, however, that businesses which are more cooperative with suppliers and customers in the creative industries are likely to enjoy greater returns in terms of improved product range and quality.

Our results support the general hypothesis that supply chain linkages to the creative sector are positively related to innovation elsewhere in the economy.

DTI (2005) stresses three broad ways in which the public sector can enable industries to be more creative – the correction of market failures, through ensuring the right framework conditions are in place for business, and enhancing the supply of creativity skills through the education system.

Our results only raise the possibility that there may be knowledge spillovers from the creative industries to other sectors which lead to market failures, though further research is needed to establish if this finding is robust, and if the knowledge transfer benefits are in fact fully reflected in market prices (in which case there are no spillovers or market failures).

More conclusively, the results support the view that businesses can enhance their innovation performance – particularly product innovation – through purchasing creative products. Our estimates suggest that if the typical firm in the UK spends double what it does on creative products – around 6 per cent as opposed to 3 per cent of its gross output – the likelihood that the firm introduces a product innovation either new to the firm or to its market is around 25 per cent higher.[55]

While the policy implications of direct improvements in innovation from the use of creative inputs are less immediate than in the case of spillovers, policymakers should at a minimum stress the benefits of wider creative inputs when promoting the contributions that design can make to business performance.

Networks are likely to be particularly important for the spread of new ideas from creative businesses, as a good deal of knowledge is tacit. It is widely accepted that in situations where there is coordination failure – i.e. the benefits of knowledge sharing are enjoyed by many firms, but the fixed costs of spreading it are borne by a few – the public sector may have a role in encouraging knowledge transfer networks. Our results suggest that such initiatives must take care to recognise the importance of knowledge sharing between creative businesses and firms in 'non-creative' industries too.

Taken together, our results suggest that policymakers should reconsider the analytical frameworks on which they base policy. The creative industries may play a significantly bigger role in the UK's innovation system than has been hitherto recognised.

55. Interestingly, our use of Input-Output data means that linkages to the design sector are not included in our study. This means that our results cannot be explained by the design sector. See DTI (2005) and Haskel et al. (2005) for evidence that design inputs can enhance business performance.

Appendix A: Measuring supply chain linkages using the Input-Output Tables

Input-Output accounts describe the structure of an economy by providing detailed estimates of the value of all transactions of goods and services among industries – and between industries and final consumers (firms, households, governments and exports) – within a single year.

In the UK, Input-Output accounts are produced by the Office for National Statistics (ONS) in two main sets of tables:

1. **Annual Input-Output Supply and Use Tables (SUTs)**: The Supply and Use tables divide the whole economy into 123 industries and 123 products. The tables show the links between the components of industry inputs and outputs and product supply and demand. The Supply and Use tables are produced each year.

2. **Input-Output Analytical Tables**: The Analytical Tables use data from the Supply and Use tables and also from other sources. These tables are produced for 123 'industries and products' or as symmetric tables of 'products by products'. The Analytical Tables have been produced roughly every five years, although the most recent UK tables are for 1995.

The age and infrequency of the UK Analytical Tables makes them unsuitable for the current study, which instead relies on the Input-Output Supply and Use Tables.

The primary source of information on supply chain linkages is the Input-Output Use Table (Figure 14). The table estimates the values of the various uses of each product. The industry part of the Table describes the process of production by industries. It provides detailed estimates of each industry's purchases of each type of good or service ('intermediate consumption').

The Use Table also estimates the incomes generated by each industry in the form of employee compensation, profits/'mixed incomes' (payments to the self-employed) and taxes (less subsidies) on production. Incomes and taxes make up industry Gross Value Added (GVA). Total industry output is the sum of intermediate consumption and GVA. The final demand part of the Use Table shows the use of goods and services by households, firms (for investment), government bodies and exports.

Defining the creative industries

The standard ONS Input-Output accounts do not contain separate 'creative' industries or products. Instead, the ONS provides an analysis of the creative sector by identifying as creative all or part of several of the 123 industry and product groups, and then mapping activity in these industries to 'functional headings' broadly corresponding to the DCMS creative industries.

The ONS defines creative and 'non-creative' parts of input-output sector groups by analysing economic activity within relevant 4-digit Standard Industrial Classification (SIC) industries.

Table 5 below shows the mapping from input-output groups through these industries to creative 'functional headings'. For example, input-output industry and product group 121 'Recreational, cultural and sporting activities' includes all of SIC 92. Only parts of SIC 92 (and

Figure 14: The Input-Output Use Table

	Domestic Industries	Sub-total	Final Demand				Total
Products	Intermediate Demand by industry and product at purchasers' prices	Total intermediate demand by product	Households	Government	Investment	Exports	Total demand for products
Sub-Total	*Total intermediate consumption*						
Value Added	Taxes (less subsidies) on production	Taxes					
	Compensation of Employees	CoE					
	Gross operating surplus/ mixed income	GOS					
Sub-Total	*Gross Value Added by Industry*	GVA					
Totals	*Total output by industry (inputs)*	Output					

of input-output group 121), corresponding to the 4-digit SIC groups are regarded as 'creative' industries. Other SIC 92 sectors (92.5 Libraries, archives, museums and other cultural activities; 92.6 Sporting Activities; and 92.71 Gambling and betting activities) are excluded from the creative industries under this definition.

Our analysis is based on the ONS input-output definitions of the creative industries. This allows us to build on the ONS's analysis to derive measures of linkages between the creative sector and the wider economy.

The ONS publishes estimates of gross output and gross value added by creative industries, and supply and demand for creative products. We use these estimates as the basis for deriving a full set of Supply and Use tables incorporating the creative functional headings as separate industry groups.

This involves splitting 'creative' and 'non-creative' elements of the input-output industry groups ('printing & publishing', 'recreational services', etc.) and then mapping these groups to the creative 'functional' headings ('publishing', 'film', 'the arts', etc.) by assigning proportions of each industry group to 'functional' groups.

This process of re-aggregating the data results in Input-Output Supply and Use Tables for 119 industry groups including the creative industries. The final estimates are checked to ensure consistency with the published ONS estimates.

The basic assumption underlying this process is that the input-output structure of demand and supply (by product and industry) for 'creative' industries is the same as that for the larger input-output group to which it belongs. So, for example, the pattern of intermediate purchases for the creative part of 'Architectural activities and technical consultancy' is assumed to be identical to that for the sector as a whole. Clearly this assumption is likely to be unrealistic in some cases, but insufficient data are available to inform further adjustments.

Particular technical problems arise with the 'Distribution' function (which includes arts and antiques activities within retail distribution). The combined Use matrix within the Supply and Use Tables is in 'purchasers' prices which include 'distributors' trading margins'.

This means that the value of retail distribution purchases are attributed to the products supplied rather than to the retail sector itself. It is therefore not possible accurately to identify the various input-output linkage measures for this sector, so it has been omitted from our analysis.

The ONS's classification of the 'creative' industries (from their input-output analysis) differs substantially from that used by DCMS. The ONS industries contain all of the relevant 4-digit SIC groups, while the DCMS industries include only the proportion of those groups which is regarded as 'creative' – defined as "activities which have their origin in individual creativity, skill and talent, and which have the potential for wealth creation through the

generation and exploitation of intellectual property".

The differences between the ONS and DCMS approaches can result in large differences in their estimates of economic activity in parts of the creative industries and for the sector as a whole. Since our research is not primarily concerned with measuring the size of the creative industries *per se*, these differences are not crucial for our analysis however.

The inclusion of large elements of 'non-creative' activity within some parts of the ONS 'creative functional headings' does, however, tend to distort our analysis. For example, it gives too much weight to clothing industries and products within other industries' supply chains.

This is why we also adjust the ONS input-output analysis to ensure a closer match with the DCMS's definition of the creative industries.

We do this by scaling the ONS creative industries and functional headings to more closely correspond to the DCMS measures (Table 6 and Figure 14).

This process attributes only part of the relevant input-output sectors to the 'creative functional headings', based on the DCMS's shares of creative activity in wider industries. Our aim in doing so is to improve measures of linkages between the creative sector and the wider economy, rather than to produce an alternative set of 'economic contribution' measures. All of the results in the paper are presented for these scaled input-output creative 'functional headings'.

Creative employment

Estimates of employment of creative occupations by input-output sectors (including the adjusted 'creative functional headings') are based on data from the ONS's Labour Force Survey/Annual Population Survey for 2001-2004. The data are compiled at the 4-digit level for both SIC industries and SOC occupations, and creative occupations are defined as in DCMS (2007).

Table 5: Definition of the creative industries in ONS input-output analysis

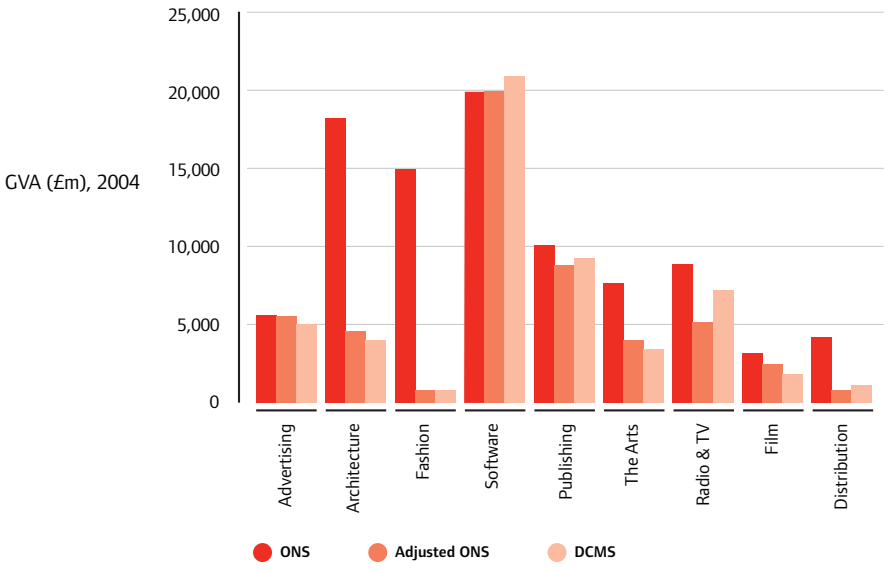
Input-Output Group	SIC (2003)	SIC Industry Description	ONS 'Functional' Heading
27 (part)	17.71	Manufacture of knitted & crocheted hosiery	Clothing/Fashion
"	17.72	Manufacture of knitted & crocheted pullovers, cardigans, etc.	"
28	18.1	Manufacture of leather clothes	"
"	18.21	Manufacture of workwear	"
"	18.22	Manufacture of other outerwear	"
"	18.23	Manufacture of underwear	"
"	18.24	Manufacture of other wearing apparel and accessories n.e.c.	"
"	18.3	Dressing and dyeing of fur; manufacture of articles of fur	"
30	19.3	Manufacture of footwear	"
34 (part)	22.11	Publishing of books	Publishing
"	22.12	Publishing of newspapers	"
"	22.13	Publishing of journals and periodicals	"
"	22.14	Publishing of sound recordings	The Arts
"	22.15	Other publishing	Publishing
"	22.31	Reproduction of sound recording	The Arts
"	22.32	Reproduction of video recording	Film
"	22.33	Reproduction of computer media	Software
91 (part)	52.486 to 52.489	Other retail sale in specialised stores n.e.c.	Distribution
"	52.5	Retail sale of second-hand goods in stores	"
107 (part)	72.2	Software consultancy and supply	Software
112 (part)	74.2	Architectural and engineering activities and related technical consultancy	Architecture
113	74.4	Advertising	Advertising
114 (part)	74.81	Photographic activities	The Arts
"	74.87	Other business activities n.e.c.	Clothing/Fashion
121 (part)	92.11	Motion picture and video production	Film
"	92.12	Motion picture and video distribution	"
"	92.13	Motion picture projection	"
"	92.2	Radio and television activities	Radio and TV
"	92.31	Artistic and literary creation and interpretation	The Arts
"	92.32	Operation of arts facilities	"
"	92.34	Other entertainment activities n.e.c.	"
"	92.4	News agency activities	Publishing
"	92.72	Other recreational activities n.e.c.	The Arts

Source: ONS Input-Output Analysis, 2006 edition

Table 6: Scaling factors for DCMS creative industries

SIC Class	SIC Industry Definition	Creative Industry share of total class (%)
17.71-19.30	Various manufacture of textiles/clothing	5.0
22.15	Other publishing	50.0
22.31	Reproduction of sound recording	25.0
22.32	Reproduction of video recording	25.0
22.33	Reproduction of computer media	25.0
52.48-52.49	Other retail sale in specialised stores n.e.c.	5.0
52.5	Retail sale of second-hand goods in stores	5.0
74.2	Achitectural and engineering activities and related technical consultancy	25.0
74.81	Photographic activities	25.0
74.84	No longer used	2.0
92.34	Other entertainment activities n.e.c.	50.0
92.72	Other recreational activities n.e.c.	25.0

Figure 15: Gross Value Added – DCMS, ONS and adjusted ONS definitions of the creative industries



Source: Authors based on ONS UK Input-Output Supply and Use Tables

Table 7: Creative linkage measures: purchases of creative products

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
1 Agriculture	0.00%	0.07%	0.02%	0.21%	0.18%	0.10%	0.16%	0.00%	0.74%
2 Forestry	0.00%	0.37%	0.00%	1.44%	0.18%	0.23%	0.19%	0.00%	2.40%
3 Fishing	0.01%	0.07%	0.00%	0.06%	0.09%	0.01%	0.00%	0.00%	0.23%
4 Coal extraction	0.00%	0.23%	0.09%	0.14%	0.07%	0.03%	0.03%	0.00%	0.59%
5 Oil & gas extraction	0.01%	0.20%	0.21%	0.01%	0.08%	0.02%	0.04%	0.00%	0.56%
6 Metal ores extraction	0.00%	0.02%	0.00%	0.27%	0.21%	0.58%	1.04%	0.00%	2.10%
7 Other mining & quarrying	0.00%	0.26%	0.07%	0.11%	0.10%	0.02%	0.02%	0.00%	0.57%
8 Meat processing	0.02%	0.13%	0.05%	0.13%	0.50%	0.02%	0.02%	0.00%	0.86%
9 Fish & fruit processing	0.02%	0.14%	0.11%	0.15%	1.24%	0.02%	0.00%	0.00%	1.68%
10 Oils & fats	0.00%	0.12%	0.08%	0.39%	0.99%	0.06%	0.05%	0.00%	1.69%
11 Dairy products	0.01%	0.15%	0.05%	0.13%	0.69%	0.02%	0.01%	0.00%	1.05%
12 Grain milling & starch	0.01%	0.21%	0.10%	0.21%	1.87%	0.03%	0.02%	0.00%	2.45%
13 Animal feed	0.00%	0.36%	0.08%	0.19%	1.65%	0.02%	0.00%	0.00%	2.31%
14 Other food products	0.01%	0.61%	0.12%	0.27%	1.65%	0.03%	0.02%	0.00%	2.72%
15 Beverages	0.01%	0.48%	0.12%	0.28%	1.24%	0.04%	0.04%	0.00%	2.22%
16 Tobacco products	0.01%	0.36%	0.22%	0.65%	5.19%	0.06%	0.00%	0.00%	6.50%
17 Textile fibres	0.00%	0.14%	0.16%	0.22%	0.27%	0.04%	0.04%	0.00%	0.88%
18 Textile weaving	0.00%	0.31%	0.24%	0.40%	0.52%	0.12%	0.16%	0.00%	1.75%
19 Textile finishing	0.00%	0.24%	0.15%	0.38%	0.36%	0.03%	0.00%	0.00%	1.17%
20 Made-up textiles	0.01%	0.29%	0.17%	0.34%	1.85%	0.04%	0.01%	0.00%	2.72%
21 Carpets & other textiles	0.01%	0.39%	0.15%	0.39%	1.38%	0.05%	0.04%	0.00%	2.42%
22 Knitted goods	0.01%	0.40%	0.25%	0.49%	0.92%	0.08%	0.06%	0.00%	2.21%
23 Wearing apparel & fur products	0.03%	0.54%	0.35%	0.63%	0.95%	0.07%	0.02%	0.00%	2.58%
24 Leather goods	0.00%	0.02%	0.02%	0.03%	0.09%	0.00%	0.00%	0.00%	0.16%
25 Footwear	0.02%	0.10%	0.05%	0.13%	0.48%	0.01%	0.00%	0.00%	0.79%
26 Wood & wood products	0.00%	0.18%	0.07%	0.11%	0.37%	0.01%	0.01%	0.00%	0.76%
27 Pulp, paper & paperboard	0.00%	0.10%	0.03%	0.18%	0.14%	0.02%	0.00%	0.00%	0.46%
28 Paper & paperboard products	0.01%	0.34%	0.14%	0.46%	0.75%	0.05%	0.03%	0.00%	1.78%
29 Printing & publishing (non-creative)	0.01%	0.58%	0.20%	10.00%	2.17%	1.33%	0.89%	0.00%	15.18%
30 Coke ovens, petroleum & nuclear fuel	0.01%	0.21%	0.07%	0.12%	0.13%	0.01%	0.01%	0.00%	0.55%
31 Basic chemicals	0.01%	0.37%	0.17%	0.37%	0.17%	0.04%	0.02%	0.00%	1.15%
32 Pesticides	0.01%	1.47%	0.25%	0.60%	1.08%	0.06%	0.01%	0.00%	3.48%
33 Paints, varnishes, printing ink etc.	0.01%	0.50%	0.19%	0.54%	1.59%	0.06%	0.03%	0.00%	2.92%

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
34 Pharmaceuticals	0.03%	0.89%	0.33%	0.82%	1.96%	0.08%	0.02%	0.00%	4.13%
35 Soap & toilet preparations	0.01%	0.49%	0.09%	0.25%	7.27%	0.02%	0.00%	0.00%	8.15%
36 Other chemical products	0.01%	0.40%	0.19%	0.52%	1.36%	0.05%	0.01%	0.00%	2.55%
37 Man-made fibres	0.01%	0.63%	0.14%	0.29%	0.41%	0.03%	0.00%	0.00%	1.52%
38 Rubber products	0.01%	0.26%	0.11%	0.30%	0.94%	0.04%	0.02%	0.00%	1.68%
39 Plastic products	0.01%	0.25%	0.16%	0.35%	0.63%	0.03%	0.00%	0.00%	1.44%
40 Glass & glass products	0.01%	0.23%	0.09%	0.21%	0.31%	0.04%	0.04%	0.00%	0.93%
41 Ceramic goods	0.01%	0.24%	0.15%	0.71%	0.80%	0.11%	0.10%	0.00%	2.12%
42 Structural clay products	0.00%	0.17%	0.08%	0.14%	0.52%	0.01%	0.00%	0.00%	0.93%
43 Cement, lime & plaster	0.00%	0.22%	0.04%	0.00%	0.24%	0.00%	0.01%	0.00%	0.52%
44 Articles of concrete, stone etc.	0.00%	0.22%	0.10%	0.12%	0.43%	0.04%	0.05%	0.00%	0.96%
45 Iron & steel	0.00%	0.45%	0.10%	0.15%	0.12%	0.02%	0.02%	0.00%	0.86%
46 Non-ferrous metals	0.00%	0.17%	0.06%	0.14%	0.13%	0.05%	0.06%	0.00%	0.62%
47 Metal castings	0.01%	0.21%	0.11%	0.10%	0.08%	0.04%	0.06%	0.00%	0.62%
48 Structural metal products	0.01%	0.22%	0.12%	0.08%	0.31%	0.03%	0.04%	0.00%	0.80%
49 Metal boilers & radiators	0.02%	0.36%	0.15%	0.18%	0.60%	0.02%	0.02%	0.00%	1.35%
50 Metal forging, pressing etc.	0.01%	0.23%	0.18%	0.32%	0.17%	0.04%	0.02%	0.00%	0.96%
51 Cutlery, tools etc.	0.01%	0.29%	0.16%	0.30%	0.56%	0.03%	0.02%	0.00%	1.36%
52 Other metal products	0.01%	0.24%	0.13%	0.26%	0.25%	0.02%	0.00%	0.00%	0.91%
53 Mechanical power equipment	0.01%	0.52%	0.18%	0.33%	0.33%	0.04%	0.02%	0.00%	1.42%
54 General purpose machinery	0.01%	0.25%	0.17%	0.33%	0.40%	0.04%	0.02%	0.00%	1.22%
55 Agricultural machinery	0.01%	0.19%	0.10%	0.28%	0.75%	0.03%	0.01%	0.00%	1.37%
56 Machine tools	0.01%	0.40%	0.22%	0.46%	0.64%	0.05%	0.02%	0.00%	1.78%
57 Special purpose machinery	0.01%	0.33%	0.17%	0.40%	0.49%	0.04%	0.01%	0.00%	1.45%
58 Weapons & ammunition	0.01%	1.40%	0.21%	0.50%	0.32%	0.06%	0.03%	0.00%	2.54%
59 Domestic appliances n.e.c.	0.01%	0.23%	0.14%	0.36%	1.44%	0.05%	0.03%	0.00%	2.26%
60 Office machinery & computers	0.01%	0.28%	0.11%	0.32%	0.34%	0.04%	0.02%	0.00%	1.12%
61 Electric motors & generators etc.	0.01%	0.45%	0.19%	0.36%	0.33%	0.04%	0.02%	0.00%	1.40%
62 Insulated wire & cable	0.01%	0.35%	0.17%	0.41%	0.25%	0.04%	0.01%	0.00%	1.22%
63 Electrical equipment n.e.c.	0.01%	0.38%	0.19%	0.41%	0.47%	0.04%	0.00%	0.00%	1.51%
64 Electronic components	0.01%	0.39%	0.17%	0.37%	0.20%	0.06%	0.05%	0.00%	1.24%
65 Transmitters for TV, radio & phone	0.01%	0.57%	0.26%	0.74%	0.73%	0.10%	0.07%	0.00%	2.49%
66 Receivers for TV & radio	0.01%	0.23%	0.17%	0.44%	0.88%	0.06%	0.05%	0.00%	1.84%
67 Medical & precision instruments	0.01%	0.72%	0.18%	0.40%	0.59%	0.05%	0.03%	0.00%	1.98%

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
68 Motor vehicles	0.01%	0.39%	0.10%	0.26%	0.32%	0.02%	0.00%	0.00%	1.10%
69 Shipbuilding & repair	0.01%	0.58%	0.19%	0.17%	0.36%	0.02%	0.01%	0.00%	1.34%
70 Other transport equipment	0.03%	0.62%	0.23%	0.35%	0.36%	0.09%	0.12%	0.00%	1.80%
71 Aircraft & spacecraft	0.01%	1.34%	0.61%	0.45%	0.19%	0.07%	0.06%	0.00%	2.73%
72 Furniture	0.01%	0.24%	0.15%	0.27%	0.89%	0.03%	0.02%	0.00%	1.61%
73 Jewellery & related products	0.01%	0.36%	0.12%	0.43%	1.01%	0.09%	0.10%	0.00%	2.12%
74 Sports goods & toys	0.01%	0.34%	0.08%	0.21%	1.80%	0.03%	0.02%	0.00%	2.49%
75 Mis. manufacturing n.e.c. & recycling	0.01%	0.19%	0.06%	0.16%	0.36%	0.10%	0.16%	0.00%	1.04%
76 Electricity production & distribution	0.01%	0.45%	0.10%	0.16%	0.31%	0.03%	0.02%	0.00%	1.07%
77 Gas distribution	0.00%	0.34%	0.09%	0.25%	0.52%	0.03%	0.01%	0.00%	1.23%
78 Water supply	0.08%	0.62%	0.11%	0.35%	0.15%	0.04%	0.01%	0.00%	1.36%
79 Construction	0.02%	0.30%	0.37%	0.07%	0.33%	0.01%	0.01%	0.00%	1.11%
80 Motor dist. & repair, fuel retail	0.04%	1.26%	0.33%	0.37%	1.34%	0.04%	0.02%	0.00%	3.41%
81 Wholesale distribution	0.06%	1.48%	0.17%	0.47%	1.42%	0.06%	0.03%	0.00%	3.70%
82 Retail distribution (non-creative)	0.03%	0.92%	0.16%	0.16%	1.65%	0.03%	0.02%	0.00%	2.96%
83 Hotels, catering, pubs etc.	0.03%	1.05%	0.16%	0.16%	1.11%	0.08%	0.11%	0.00%	2.71%
84 Railway transport	0.02%	1.21%	0.11%	0.10%	1.22%	0.03%	0.04%	0.00%	2.72%
85 Other land transport	0.05%	1.63%	0.14%	0.28%	1.34%	0.05%	0.04%	0.00%	3.52%
86 Water transport	0.02%	2.00%	0.19%	0.04%	1.12%	0.01%	0.01%	0.00%	3.40%
87 Air transport	0.02%	4.00%	0.05%	0.10%	1.92%	0.04%	0.05%	0.00%	6.19%
88 Ancillary transport services	0.05%	2.43%	0.32%	0.46%	0.91%	0.11%	0.13%	0.00%	4.42%
89 Postal & courier services	0.04%	2.69%	0.21%	0.22%	1.57%	0.09%	0.12%	0.00%	4.94%
90 Telecommunications	0.02%	1.76%	0.13%	0.19%	1.00%	0.09%	0.14%	0.00%	3.33%
91 Banking & finance	0.05%	2.45%	0.28%	0.85%	2.03%	0.12%	0.08%	0.00%	5.85%
92 Insurance & pension funds	0.10%	2.27%	0.56%	1.25%	3.62%	0.15%	0.08%	0.00%	8.03%
93 Auxiliary financial services	0.04%	3.56%	0.08%	0.80%	0.73%	0.08%	0.03%	0.00%	5.32%
94 Real Estate Activities	0.01%	0.25%	0.11%	0.06%	0.25%	0.01%	0.01%	0.00%	0.71%
95 Estate agent activities	0.02%	1.48%	1.02%	0.25%	1.78%	0.03%	0.02%	0.00%	4.59%
96 Renting of machinery etc.	0.05%	0.77%	0.70%	0.08%	3.16%	0.03%	0.03%	0.00%	4.81%
97 Computer services (non-creative)	0.17%	3.03%	0.79%	0.21%	2.74%	0.11%	0.14%	0.00%	7.19%
98 Research & development	0.22%	0.65%	0.19%	0.12%	0.22%	0.04%	0.03%	0.00%	1.47%
99 Legal, accounting & marketing serv.	0.11%	1.06%	0.43%	0.60%	1.35%	0.10%	0.07%	0.00%	3.72%
100 Technical consultancy	0.07%	2.01%	1.68%	0.38%	1.87%	0.07%	0.06%	0.00%	6.13%
101 Other business services	0.24%	1.23%	0.84%	0.31%	0.98%	0.12%	0.14%	0.00%	3.85%

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
102 Public administration & defence	0.03%	1.46%	0.14%	0.62%	0.64%	0.15%	0.18%	0.00%	3.22%
103 Education	0.04%	1.48%	0.06%	0.71%	0.21%	0.12%	0.10%	0.00%	2.71%
104 Health & veterinary services	0.02%	0.62%	0.26%	0.25%	0.34%	0.04%	0.03%	0.00%	1.55%
105 Social work activities	0.03%	0.46%	0.03%	0.55%	0.51%	0.18%	0.24%	0.00%	2.00%
106 Sewage & sanitary services	0.07%	0.87%	0.30%	0.27%	0.35%	0.08%	0.10%	0.00%	2.04%
107 Membership organisations	0.05%	0.82%	0.20%	0.45%	1.60%	0.58%	0.99%	0.00%	4.69%
108 Recreational services	0.09%	0.94%	0.31%	1.30%	1.62%	1.71%	2.92%	0.00%	8.88%
109 Other service activities	0.09%	2.54%	0.35%	0.50%	1.99%	0.12%	0.13%	0.00%	5.72%
110 Private households with employed persons	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
111 Clothing	0.25%	1.32%	0.89%	0.35%	1.06%	0.12%	0.16%	0.00%	4.15%
112 Software	0.18%	3.05%	0.79%	0.21%	2.75%	0.10%	0.15%	0.00%	7.23%
113 Architecture	0.07%	2.01%	1.68%	0.38%	1.87%	0.06%	0.06%	0.00%	6.13%
114 Publishing	0.02%	0.57%	0.19%	7.45%	1.81%	1.15%	1.15%	0.00%	12.35%
115 Advertising	0.03%	1.31%	0.54%	0.77%	3.55%	0.24%	0.35%	0.00%	6.79%
116 The Arts	0.07%	0.82%	0.27%	2.47%	1.57%	1.42%	2.48%	0.00%	9.09%
117 Radio & TV	0.09%	1.01%	0.33%	1.38%	1.72%	1.70%	3.23%	0.00%	9.47%
118 Distribution	0.03%	0.94%	0.16%	0.16%	1.67%	0.03%	0.02%	0.00%	3.01%
119 Film	0.04%	0.68%	0.22%	5.32%	1.71%	1.26%	1.72%	0.00%	10.95%

Source: Authors' calculations based on ONS Input-Output Supply and Use Tables (see McVittie, 2007)

Table 8: Creative linkage measures: sales to creative industries (II)

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
1 Agriculture	0.00%	0.00%	0.00%	0.01%	0.00%	0.01%	0.03%	0.00%	0.05%
2 Forestry	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3 Fishing	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4 Coal extraction	0.00%	0.00%	0.00%	0.01%	0.00%	0.02%	0.04%	0.01%	0.08%
5 Oil & gas extraction	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6 Metal ores extraction	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
7 Other mining & quarrying	0.00%	0.00%	0.00%	0.01%	0.02%	0.02%	0.04%	0.01%	0.10%
8 Meat processing	0.00%	0.06%	0.01%	0.05%	0.04%	0.04%	0.07%	0.02%	0.30%
9 Fish & fruit processing	0.01%	0.08%	0.02%	0.07%	0.05%	0.08%	0.14%	0.03%	0.47%
10 Oils & fats	0.01%	0.07%	0.01%	0.03%	0.02%	0.04%	0.08%	0.02%	0.30%
11 Dairy products	0.00%	0.07%	0.02%	0.04%	0.04%	0.03%	0.06%	0.02%	0.28%
12 Grain milling & starch	0.00%	0.01%	0.00%	0.02%	0.01%	0.04%	0.07%	0.01%	0.16%
13 Animal feed	0.00%	0.00%	0.00%	0.43%	0.00%	0.81%	1.59%	0.30%	3.14%
14 Other food products	0.01%	0.07%	0.02%	0.05%	0.04%	0.05%	0.09%	0.02%	0.35%
15 Beverages	0.00%	0.01%	0.00%	0.05%	0.04%	0.09%	0.18%	0.04%	0.42%
16 Tobacco products	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.01%
17 Textile fibres	0.05%	0.01%	0.01%	0.00%	0.04%	0.01%	0.01%	0.00%	0.14%
18 Textile weaving	0.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.14%
19 Textile finishing	0.11%	0.04%	0.01%	0.09%	0.03%	0.16%	0.32%	0.06%	0.83%
20 Made-up textiles	0.00%	0.02%	0.01%	0.01%	0.03%	0.02%	0.04%	0.01%	0.15%
21 Carpets & other textiles	0.04%	0.06%	0.01%	0.05%	0.04%	0.05%	0.09%	0.02%	0.36%
22 Knitted goods	0.01%	0.00%	0.00%	0.01%	0.00%	0.02%	0.03%	0.01%	0.08%
23 Wearing apparel & fur products	0.00%	0.03%	0.01%	0.02%	0.03%	0.03%	0.07%	0.01%	0.20%
24 Leather goods	0.02%	0.06%	0.00%	0.07%	0.05%	0.13%	0.24%	0.05%	0.61%
25 Footwear	0.01%	0.07%	0.02%	0.05%	0.07%	0.09%	0.18%	0.03%	0.52%
26 Wood & wood products	0.00%	0.06%	0.02%	0.11%	0.07%	0.08%	0.14%	0.04%	0.52%
27 Pulp, paper & paperboard	0.00%	0.03%	0.02%	14.81%	0.40%	1.19%	0.03%	2.52%	19.00%
28 Paper & paperboard products	0.01%	0.12%	0.13%	4.33%	0.31%	0.40%	0.13%	0.77%	6.20%
29 Printing & publishing (non-Creative)	0.01%	0.29%	0.15%	7.46%	0.39%	0.73%	0.29%	1.34%	10.66%
30 Coke ovens, refined petroleum & nuclear fuel	0.01%	0.27%	0.05%	0.11%	0.06%	0.05%	0.09%	0.03%	0.67%
31 Basic Chemicals	0.00%	0.01%	0.00%	0.08%	0.04%	0.06%	0.11%	0.03%	0.32%
32 Pesticides	0.01%	0.00%	0.00%	0.08%	0.00%	0.16%	0.31%	0.06%	0.63%

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
33 Paints, varnishes, printing ink etc.	0.00%	0.09%	0.02%	4.54%	0.33%	0.45%	0.19%	0.82%	6.44%
34 Pharmaceuticals	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.04%
35 Soap & toilet preparations	0.00%	0.04%	0.00%	0.02%	0.06%	0.04%	0.07%	0.01%	0.25%
36 Other chemical products	0.01%	0.02%	0.00%	1.67%	0.09%	0.38%	0.50%	0.35%	3.03%
37 Man-made fibres	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
38 Rubber products	0.00%	0.05%	0.00%	0.02%	0.00%	0.01%	0.03%	0.01%	0.11%
39 Plastic products	0.00%	0.31%	0.01%	0.45%	0.05%	0.08%	0.08%	0.09%	1.07%
40 Glass & glass products	0.00%	0.05%	0.00%	0.04%	0.01%	0.07%	0.14%	0.03%	0.34%
41 Ceramic goods	0.00%	0.05%	0.00%	0.03%	0.00%	0.06%	0.11%	0.02%	0.27%
42 Structural clay products	0.00%	0.00%	0.00%	0.01%	0.01%	0.03%	0.05%	0.01%	0.12%
43 Cement, lime & plaster	0.00%	0.01%	0.00%	0.11%	0.02%	0.20%	0.39%	0.07%	0.80%
44 Articles of concrete, stone etc.	0.00%	0.01%	0.00%	0.09%	0.03%	0.16%	0.32%	0.06%	0.66%
45 Iron & steel	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%
46 Non-ferrous metals	0.00%	0.11%	0.00%	0.06%	0.03%	0.01%	0.00%	0.01%	0.23%
47 Metal castings	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.01%	0.00%	0.03%
48 Structural metal products	0.00%	0.00%	0.01%	0.04%	0.02%	0.03%	0.05%	0.01%	0.16%
49 Metal boilers & radiators	0.00%	0.10%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.15%
50 Metal forging, pressing etc.	0.00%	0.06%	0.00%	0.45%	0.02%	0.04%	0.00%	0.08%	0.65%
51 Cutlery, tools etc.	0.00%	0.01%	0.00%	0.14%	0.00%	0.03%	0.04%	0.03%	0.25%
52 Other metal products	0.00%	0.05%	0.00%	0.03%	0.05%	0.02%	0.03%	0.01%	0.19%
53 Mechanical power equipment	0.00%	0.19%	0.00%	0.02%	0.06%	0.01%	0.02%	0.01%	0.31%
54 General purpose machinery	0.00%	0.11%	0.00%	0.04%	0.04%	0.00%	0.00%	0.01%	0.21%
55 Agricultural machinery	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.00%	0.00%	0.04%
56 Machine tools	0.00%	0.00%	0.00%	0.19%	0.03%	0.01%	0.00%	0.03%	0.26%
57 Special purpose machinery	0.00%	0.04%	0.00%	0.86%	0.02%	0.07%	0.01%	0.15%	1.15%
58 Weapons & ammunition	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.02%
59 Domestic appliances n.e.c.	0.00%	0.17%	0.03%	0.02%	0.09%	0.04%	0.08%	0.02%	0.45%
60 Office machinery & computers	0.00%	0.03%	0.00%	0.10%	0.01%	0.03%	0.04%	0.02%	0.24%
61 Electric motors & generators etc.	0.00%	0.33%	0.01%	0.02%	0.02%	0.02%	0.04%	0.01%	0.45%
62 Insulated wire & cable	0.00%	1.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.02%
63 Electrical equipment n.e.c.	0.00%	0.66%	0.01%	0.04%	0.03%	0.07%	0.13%	0.02%	0.97%
64 Electronic components	0.00%	0.24%	0.00%	0.00%	0.02%	0.01%	0.02%	0.00%	0.29%
65 Transmitters for TV, radio & phone	0.00%	0.36%	0.00%	0.02%	0.01%	0.03%	0.05%	0.01%	0.49%
66 Receivers for TV & radio	0.00%	0.85%	0.02%	0.09%	0.03%	0.17%	0.32%	0.06%	1.54%

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
67 Medical & precision instruments	0.00%	0.40%	0.08%	0.02%	0.03%	0.02%	0.03%	0.01%	0.59%
68 Motor vehicles	0.00%	0.11%	0.02%	0.02%	0.04%	0.01%	0.02%	0.01%	0.22%
69 Shipbuilding & repair	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
70 Other transport equipment	0.00%	0.19%	0.02%	0.02%	0.09%	0.04%	0.07%	0.01%	0.45%
71 Aircraft & spacecraft	0.00%	0.02%	0.00%	0.01%	0.00%	0.01%	0.02%	0.00%	0.07%
72 Furniture	0.00%	0.08%	0.03%	0.04%	0.04%	0.05%	0.10%	0.02%	0.36%
73 Jewellery & related products	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.03%
74 Sports goods & toys	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.00%	0.05%
75 Misc. manufacturing n.e.c.. & recycling	0.01%	0.13%	0.02%	0.02%	0.12%	0.03%	0.07%	0.01%	0.41%
76 Electricity production & distribution	0.01%	0.48%	0.06%	0.35%	0.09%	0.08%	0.11%	0.08%	1.25%
77 Gas distribution	0.00%	0.08%	0.04%	0.25%	0.05%	0.06%	0.08%	0.06%	0.63%
78 Water supply	0.00%	0.03%	0.02%	0.32%	0.08%	0.13%	0.21%	0.09%	0.89%
79 Construction	0.00%	0.00%	0.03%	0.02%	0.02%	0.02%	0.04%	0.01%	0.15%
80 Motor dist. & repair, fuel retail	0.01%	1.40%	0.09%	0.07%	0.11%	0.06%	0.10%	0.03%	1.87%
81 Wholesale distribution	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
82 Retail distribution (non-creative)	0.00%	0.04%	0.01%	0.08%	0.08%	0.01%	0.01%	0.01%	0.24%
83 Hotels, catering, pubs etc.	0.00%	0.11%	0.04%	0.05%	0.07%	0.03%	0.05%	0.02%	0.36%
84 Railway transport	0.00%	0.06%	0.03%	0.48%	0.15%	0.11%	0.15%	0.11%	1.09%
85 Other land transport	0.01%	0.24%	0.12%	0.76%	0.18%	0.09%	0.05%	0.14%	1.59%
86 Water transport	0.00%	0.00%	0.00%	0.80%	0.03%	0.09%	0.05%	0.14%	1.12%
87 Air transport	0.02%	0.25%	0.04%	0.33%	0.20%	0.11%	0.16%	0.08%	1.20%
88 Ancillary transport services	0.02%	0.16%	0.16%	0.08%	0.12%	0.09%	0.16%	0.04%	0.82%
89 Postal & courier services	0.01%	0.42%	0.24%	0.19%	0.45%	0.15%	0.27%	0.07%	1.81%
90 Telecommunications	0.02%	0.76%	0.14%	0.31%	0.47%	0.14%	0.24%	0.09%	2.17%
91 Banking & finance	0.00%	0.12%	0.03%	0.03%	0.04%	0.02%	0.03%	0.01%	0.28%
92 Insurance & pension funds	0.01%	0.73%	0.03%	0.22%	0.09%	0.06%	0.09%	0.05%	1.29%
93 Auxiliary financial services	0.01%	0.57%	0.18%	0.05%	0.05%	0.02%	0.03%	0.01%	0.91%
94 Real Estate Activities	0.00%	0.16%	0.01%	0.20%	0.06%	0.03%	0.04%	0.04%	0.54%
95 Estate agent activities	0.03%	0.29%	0.31%	0.11%	0.13%	0.22%	0.42%	0.08%	1.59%
96 Renting of machinery etc.	0.01%	0.38%	0.05%	0.53%	0.11%	0.12%	0.15%	0.11%	1.45%
97 Computer services (non-creative)	0.03%	2.83%	0.44%	0.32%	0.41%	0.18%	0.31%	0.10%	4.62%
98 Research & development	0.04%	1.76%	0.16%	0.25%	0.48%	0.16%	0.28%	0.08%	3.21%
99 Legal, accounting & marketing services	0.12%	2.41%	0.66%	0.53%	1.93%	0.37%	0.65%	0.19%	6.85%
100 Technical consultancy	0.09%	3.31%	1.65%	0.49%	0.76%	0.27%	0.46%	0.15%	7.18%

	Fashion	Software	Arch.	Pub.	Adv.	Arts	Radio & TV	Film	Creative
101 Other business services	0.16%	4.69%	0.42%	0.31%	0.28%	0.43%	0.81%	0.17%	7.28%
102 Public administration & defence	0.00%	0.00%	0.46%	0.00%	0.00%	0.00%	0.00%	0.00%	0.48%
103 Education	0.01%	0.29%	0.09%	0.03%	0.15%	0.04%	0.07%	0.02%	0.70%
104 Health & veterinary services	0.00%	0.02%	0.01%	0.02%	0.01%	0.01%	0.03%	0.01%	0.11%
105 Social work activities	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
106 Sewage & sanitary services	0.01%	0.29%	0.04%	0.15%	0.39%	0.12%	0.22%	0.06%	1.28%
107 Membership organisations	0.03%	0.08%	0.05%	1.26%	0.77%	2.16%	4.20%	0.82%	9.37%
108 Recreational services	0.01%	0.38%	0.04%	1.80%	0.30%	1.51%	2.79%	0.70%	7.53%
109 Other service activities	0.01%	0.21%	0.10%	0.21%	0.45%	0.22%	0.41%	0.10%	1.71%
110 Private households with employed persons	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
111 Clothing	0.14%	4.06%	0.37%	0.27%	0.24%	0.38%	0.71%	0.15%	6.34%
112 Software	0.03%	2.82%	0.44%	0.32%	0.41%	0.18%	0.31%	0.10%	4.61%
113 Architecture	0.09%	3.29%	1.64%	0.48%	0.75%	0.27%	0.46%	0.15%	7.14%
114 Publishing	0.01%	0.30%	0.13%	6.52%	0.37%	0.84%	0.67%	1.23%	10.08%
115 Advertising	0.03%	3.62%	0.58%	1.46%	1.56%	0.49%	0.77%	0.37%	8.88%
116 The Arts	0.01%	0.35%	0.05%	2.49%	0.28%	1.19%	2.03%	0.71%	7.12%
117 Radio & TV	0.01%	0.36%	0.03%	1.72%	0.29%	1.44%	2.66%	0.67%	7.18%
118 Distribution	0.00%	0.04%	0.01%	0.08%	0.08%	0.01%	0.01%	0.01%	0.24%
119 Film	0.01%	0.31%	0.09%	4.79%	0.33%	1.00%	1.27%	1.03%	8.82%

Source: Authors' calculations based on ONS Input-Output Supply and Use Tables (see McVittie, 2007)

Appendix B: Innovation Measures: The fourth Community Innovation Survey (CIS4)

The first edition of the Oslo Manual, published in 1992, formed the basis of the first European Union (EU) Community Innovation Survey (CIS) along with comparable surveys in Australia and Canada. The United Kingdom survey is part of a wider CIS covering European countries. It is based on a core questionnaire developed for the European Commission by Eurostat. The fourth of these surveys, CIS4, covers the period 2002 to 2004 and was carried out in 2005.

The UK CIS4 was funded by the Department of Trade and Industry (DTI) and conducted by the Office for National Statistics (ONS). It includes enterprises with ten or more employees in sections C-K of the Standard Industrial Classification (SIC) 2003. In this respect it specifically excluded many micro-firms with fewer than ten employees, including many creative firms.

Some additional service sectors were included in the 2005 survey. These were sale, maintenance and repair of motor vehicles (SIC 50), retail trade (SIC 52), and hotels and restaurants (SIC 55). Those service sectors that were excluded from CIS4 are shown in Table 9.

Table 9: Service sectors excluded from CIS4

75: Public administration and defence; compulsory social security
80: Education
85: Health and social work
90: Sewage and refuse disposal, sanitation and similar activities
91: Activities of membership organisations not elsewhere classified
92: Recreational, cultural and sporting activities
93: Other service activities
95: Private households as employers of domestic staff
96: Undifferentiated goods producing activities of private households for own use
97: Undifferentiated services producing activities of private households for own use
99: Extra-territorial organisation and bodies

The coverage of creative industries within CIS4 is also patchy. The table below shows, at the 3-digit level, which of the creative industry SICs were included and excluded in CIS4. Around two-thirds of the sectors defined as creative industries were included.

The sample is drawn from the ONS Inter-Departmental Business Register (IDBR). Responses are received from 16,446 enterprises giving a response rate of 58 per cent. Results of the survey are weighted by the ONS in order to be representative of the total population of UK firms with ten or more employees. As a result each respondent comes to represent roughly eleven enterprises in the total population. In our analysis we use the unweighted sample.

Table 10: Creative Industries included/excluded in CIS4

SIC	Description	In CIS4
22.1	Publishing	√
22.3	Reproduction of recorded media	√
72.2	Software consultancy & supply, including software publishing	√
74.2	Architecture & engineering activities, related technical consultancy	√
74.4	Advertising	√
74.81	Photographic activities	√
92.1	Motion pictures and video activities	X
92.2	Radio & television activities	X
92.31	Artistic & literary creation & interpretation	X
92.32	Operation of arts facilities	X
92.40	News agency activities	X

Appendix C: Statistical analysis

Table 11: Rank correlations matrix for industry-level data (excluding the creative industries) – innovation measures[1, 2]

	In-house R&D	Design	Marketing	Product innovation	Novel product	Process innovation	Expanded product range	Improved quality	Market expansion
Innovation Activities									
In-house R&D	**1.0000** *0.0000*								
Design	**0.7176** *0.0000*	**1.0000** *0.0000*							
Marketing	**0.7913** *0.0000*	**0.5951** *0.0000*	**1.0000** *0.0000*						
Innovation Outputs									
Product innovation	**0.8370** *0.0000*	**0.6753** *0.0000*	**0.8097** *0.0000*	**1.0000** *0.0000*					
Novel product	**0.4733** *0.0000*	**0.3736** *0.0003*	**0.4224** *0.0000*	**0.4207** *0.0000*	**1.0000** *0.0000*				
Process innovation	**0.6785** *0.0000*	**0.5133** *0.0000*	**0.6364** *0.0000*	**0.7263** *0.0000*	**0.3488** *0.0008*	**1.0000** *0.0000*			
Innovation Impacts									
Expanded product range	**0.8221** *0.0000*	**0.6308** *0.0000*	**0.7514** *0.0000*	**0.8369** *0.0000*	**0.3815** *0.0002*	**0.5932** *0.0000*	**1.0000** *0.0000*		
Improved quality	**0.6111** *0.0000*	**0.6254** *0.0000*	**0.5624** *0.0000*	**0.6442** *0.0000*	**0.2557** *0.0150*	**0.5069** *0.0000*	**0.6699** *0.0000*	**1.0000** *0.0000*	
New market or increased market share	**0.7616** *0.0000*	**0.6521** *0.0000*	**0.7292** *0.0000*	**0.8017** *0.0000*	**0.3402** *0.0010*	**0.6153** *0.0000*	**0.8324** *0.0000*	**0.7372** *0.0000*	**1.0000** *0.0000*

1. Figures in bold are Spearman rank-order correlation indices which show the extent of correspondence between the rankings of industries on the row and column measures.

2. Figures in italics are p-values, which show the probability of obtaining (at least) the value of the correlation index for two independent series.

Source: Authors based on CIS4 micro-unit data aggregated to Input-Output industry groups

Table 12: Rank correlations matrix for industry-level data (excluding the creative industries) – creative linkage measures (I)[1, 2]

	Creative employm.	Purchases of: Advert.	Arch.	Arts	Fashion	Film	Publish.	Radio & TV	Software	Creative
Creative employment	**1.0000** *0.0000*									
Purchases of advertising	**-0.0534** *0.6075*	**1.0000** *0.0000*								
Purchases of architecture	**0.1276** *0.2180*	**0.3098** *0.0023*	**1.0000** *0.0000*							
Purchases of the arts	**0.2316** *0.0240*	**0.3546** *0.0004*	**0.5432** *0.0000*	**1.0000** *0.0000*						
Purchases of fashion	**-0.0809** *0.4357*	**0.4516** *0.0000*	**0.4756** *0.0000*	**0.3160** *0.0018*	**1.0000** *0.0000*					
Purchases of film	**0.0928** *0.3712*	**-0.2002** *0.0518*	**-0.1442** *0.1634*	**-0.0165** *0.8739*	**-0.3574** *0.0004*	**1.0000** *0.0000*				
Purchases of publishing	**0.2667** *0.0090*	**0.3290** *0.0011*	**0.5289** *0.0000*	**0.7342** *0.0000*	**0.1347** *0.1932*	**0.1454** *0.1597*	**1.0000** *0.0000*			
Purchases of radio & TV	**0.1109** *0.2846*	**0.2641** *0.0097*	**0.3610** *0.0003*	**0.7990** *0.0000*	**0.2759** *0.0068*	**-0.0820** *0.4296*	**0.2688** *0.0085*	**1.0000** *0.0000*		
Purchases of software	**-0.0630** *0.5440*	**0.4864** *0.0000*	**0.6028** *0.0000*	**0.4869** *0.0000*	**0.6670** *0.0000*	**-0.2095** *0.0416*	**0.3849** *0.0001*	**0.3612** *0.0003*	**1.0000** *0.0000*	
Purchases of creative	**-0.0341** *0.7427*	**0.8586** *0.0000*	**0.5643** *0.0000*	**0.5908** *0.0000*	**0.6064** *0.0000*	**-0.1848** *0.0730*	**0.5206** *0.0000*	**0.4223** *0.0000*	**0.8021** *0.0000*	**1.0000** *0.0000*

1. Figures in bold are Spearman rank-order correlation indices which show the extent of correspondence between the rankings of industries on the row and column measures.
2. Figures in italics are p-values, which show the probability of obtaining (at least) the value of the correlation index for two independent series.

Source: Authors based on data from ONS Input-Output Supply and Use Tables, 2002-2004 (See McVittie, 2007)

Table 13: Rank correlations matrix for industry-level data (excluding the creative industries) – creative linkage measures (II)[1, 2]

	Sales to: Advert.	Arch.	Arts	Fashion	Film	Publish.	Radio & TV	Software	Creative
Sales to advertising	**1.0000** *0.0000*								
Sales to architecture	**0.8480** *0.0000*	**1.0000** *0.0000*							
Sales to the arts	**0.6307** *0.0000*	**0.5346** *0.0000*	**1.0000** *0.0000*						
Sales to fashion	**0.6744** *0.0000*	**0.6646** *0.0000*	**0.5928** *0.0000*	**1.0000** *0.0000*					
Sales to film	**0.6582** *0.0000*	**0.5533** *0.0000*	**0.9419** *0.0000*	**0.5364** *0.0000*	**1.0000** *0.0000*				
Sales to publishing	**0.6654** *0.0000*	**0.5717** *0.0000*	**0.8411** *0.0000*	**0.4872** *0.0000*	**0.9662** *0.0000*	**1.0000** *0.0000*			
Sales to radio & TV	**0.5629** *0.0000*	**0.5103** *0.0000*	**0.9122** *0.0000*	**0.6303** *0.0000*	**0.7680** *0.0000*	**0.6350** *0.0000*	**1.0000** *0.0000*		
Sales to software	**0.6700** *0.0000*	**0.7780** *0.0000*	**0.3958** *0.0001*	**0.4569** *0.0000*	**0.4026** *0.0001*	**0.4134** *0.0000*	**0.4167** *0.0000*	**1.0000** *0.0000*	
Sales to creative	**0.7236** *0.0000*	**0.6911** *0.0000*	**0.8658** *0.0000*	**0.5793** *0.0000*	**0.8889** *0.0000*	**0.8545** *0.0000*	**0.7336** *0.0000*	**0.6796** *0.0000*	**1.0000** *0.0000*

1. Figures in bold are Spearman rank-order correlation indices which show the extent of correspondence between the rankings of industries on the row and column measures.

2. Figures in italics are p-values, which show the probability of obtaining (at least) the value of the correlation index for two independent series.

Source: Authors based on data from ONS Input-Output Supply and Use Tables, 2002-2004 (See McVittie, 2007)

Table 14: Rank correlations matrix for industry-level data (excluding the creative industries) – creative linkage measures (III)[1, 2]

	Creative employm.	Purchases of: Advert.	Arch.	Arts	Fashion	Film	Publish.	Radio & TV	Software	Creative
Sales to advertising	**-0.0967** *0.3514*	**0.3086** *0.0023*	**0.0714** *0.4917*	**0.1385** *0.1806*	**0.4406** *0.0000*	**-0.3076** *0.0024*	**-0.0844** *0.4161*	**0.1710** *0.0976*	**0.2859** *0.0050*	**0.3128** *0.0020*
Sales to architecture	**-0.0842** *0.4173*	**0.2919** *0.0041*	**0.1535** *0.1374*	**0.2486** *0.0151*	**0.4965** *0.0000*	**-0.2177** *0.0340*	**0.0374** *0.7190*	**0.2557** *0.0124*	**0.3178** *0.0017*	**0.3392** *0.0008*
Sales to the arts	**-0.0264** *0.7994*	**0.2998** *0.0032*	**0.0215** *0.8365*	**0.0636** *0.5406*	**0.1819** *0.0777*	**-0.1811** *0.0790*	**-0.0263** *0.8001*	**0.0172** *0.8684*	**0.1273** *0.2191*	**0.2515** *0.0140*
Sales to fashion	**-0.0237** *0.8196*	**0.2738** *0.0073*	**0.1371** *0.1852*	**0.1877** *0.0685*	**0.3148** *0.0019*	**-0.2135** *0.0378*	**-0.0082** *0.9372*	**0.1721** *0.0953*	**0.2335** *0.0228*	**0.2863** *0.0049*
Sales to film	**-0.0900** *0.3858*	**0.2862** *0.0049*	**0.0427** *0.6810*	**0.0468** *0.6526*	**0.1973** *0.0554*	**-0.2670** *0.0089*	**-0.0296** *0.7757*	**0.0053** *0.9595*	**0.1689** *0.1019*	**0.2529** *0.0134*
Sales to publishing	**-0.1310** *0.2056*	**0.2553** *0.0125*	**0.0386** *0.7101*	**0.0308** *0.7673*	**0.2089** *0.0422*	**-0.2723** *0.0076*	**-0.0284** *0.7849*	**0.0013** *0.9903*	**0.1999** *0.0521*	**0.2328** *0.0232*
Sales to radio & TV	**0.0153** *0.8830*	**0.3283** *0.0012*	**0.0294** *0.7774*	**0.1007** *0.3316*	**0.2416** *0.0183*	**-0.0942** *0.3638*	**-0.0360** *0.7290*	**0.0805** *0.4380*	**0.1424** *0.1686*	**0.2750** *0.0070*
Sales to software	**-0.0021** *0.9842*	**0.2251** *0.0283*	**0.2256** *0.0279*	**0.3308** *0.0011*	**0.4350** *0.0000*	**-0.0835** *0.4209*	**0.1732** *0.0933*	**0.2859** *0.0050*	**0.3085** *0.0024*	**0.3184** *0.0017*
Sales to creative	**-0.0585** *0.5736*	**0.2788** *0.0062*	**0.1620** *0.1168*	**0.1884** *0.0675*	**0.2888** *0.0045*	**-0.1767** *0.0866*	**0.0954** *0.3580*	**0.0843** *0.4168*	**0.2962** *0.0036*	**0.3279** *0.0012*

1. Figures in bold are Spearman rank-order correlation indices which show the extent of correspondence between the rankings of industries on the row and column measures.
2. Figures in italics are p-values, which show the probability of obtaining (at least) the value of the correlation index for two independent series.

Source: Authors based on data from ONS Input-Output Supply and Use Tables, 2002-2004 (See McVittie, 2007)

Table 15: Rank correlations matrix for industry-level data (excluding the creative industries) – creative linkages vs. innovation measures[1, 2]

	In-house R&D	Design	Marketing	Product innovation	Novel product	Process innovation	Expanded product range	Improved quality	Market expansion
Creative employment	**0.2608** *0.0130*	**0.3459** *0.0008*	**0.1976** *0.0620*	**0.3062** *0.0033*	**0.3237** *0.0019*	**0.2245** *0.0334*	**0.2950** *0.0048*	**0.2797** *0.0076*	**0.2293** *0.0297*
Purchases of advertising	**-0.0346** *0.7463*	**-0.1175** *0.2702*	**0.3023** *0.0038*	**0.1209** *0.2562*	**-0.0334** *0.7544*	**-0.0625** *0.5584*	**0.1212** *0.2552*	**0.0364** *0.7332*	**0.0593** *0.5791*
Purchases of architecture	**-0.0606** *0.5701*	**-0.1115** *0.2955*	**-0.0349** *0.7437*	**-0.0233** *0.8277*	**0.1118** *0.2944*	**-0.0429** *0.6881*	**-0.0393** *0.7128*	**-0.1857** *0.0797*	**-0.1093** *0.3052*
Purchases of the arts	**0.1562** *0.1415*	**0.0697** *0.5140*	**0.2490** *0.0179*	**0.1751** *0.0988*	**0.2447** *0.0201*	**0.2346** *0.0260*	**0.1794** *0.0906*	**0.1282** *0.2286*	**0.1347** *0.2055*
Purchases of fashion	**-0.1893** *0.0740*	**-0.2260** *0.0322*	**0.0449** *0.6741*	**-0.0167** *0.8761*	**-0.2028** *0.0552*	**-0.1319** *0.2152*	**-0.0429** *0.6883*	**-0.0858** *0.4212*	**-0.0617** *0.5635*
Purchases of film	**0.3948** *0.0001*	**0.4473** *0.0000*	**0.1970** *0.0627*	**0.3237** *0.0019*	**0.2848** *0.0065*	**0.2327** *0.0273*	**0.3042** *0.0036*	**0.3359** *0.0012*	**0.2748** *0.0088*
Purchases of publishing	**0.3864** *0.0002*	**0.3386** *0.0011*	**0.3651** *0.0004*	**0.3740** *0.0003*	**0.3141** *0.0026*	**0.3224** *0.0019*	**0.3492** *0.0007*	**0.2020** *0.0562*	**0.2665** *0.0111*
Purchases of radio & TV	**-0.1050** *0.3245*	**-0.1573** *0.1388*	**0.0285** *0.7900*	**-0.0924** *0.3862*	**0.1138** *0.2856*	**0.0521** *0.6260*	**-0.0632** *0.5538*	**0.0290** *0.7862*	**-0.0564** *0.5972*
Purchases of software	**-0.2349** *0.0259*	**-0.1301** *0.2218*	**0.0122** *0.9091*	**-0.0613** *0.5661*	**-0.0003** *0.9977*	**-0.0849** *0.4260*	**-0.1825** *0.0852*	**-0.1842** *0.0823*	**-0.1714** *0.1062*
Purchases of creative	**-0.0666** *0.5329*	**-0.1004** *0.3466*	**0.2291** *0.0298*	**0.0953** *0.3718*	**0.0308** *0.7735*	**-0.0050** *0.9627*	**0.0585** *0.5839*	**-0.0318** *0.7658*	**-0.0057** *0.9573*
Sales to advertising	**-0.2895** *0.0056*	**-0.3538** *0.0006*	**-0.0848** *0.4267*	**-0.1670** *0.1158*	**-0.3209** *0.0020*	**-0.1622** *0.1267*	**-0.2393** *0.0231*	**-0.0311** *0.7711*	**-0.1042** *0.3282*
Sales to architecture	**-0.2919** *0.0053*	**-0.2940** *0.0049*	**-0.1322** *0.2143*	**-0.1716** *0.1059*	**-0.3295** *0.0015*	**-0.1657** *0.1186*	**-0.2104** *0.0466*	**-0.0058** *0.9566*	**-0.1397** *0.1893*
Sales to the arts	**-0.1404** *0.1870*	**-0.1791** *0.0912*	**0.0367** *0.7314*	**0.0416** *0.6971*	**-0.1865** *0.0784*	**0.0956** *0.3698*	**-0.0763** *0.4750*	**-0.0003** *0.9978*	**0.0493** *0.6445*
Sales to fashion	**-0.3130** *0.0027*	**-0.3576** *0.0005*	**-0.1170** *0.2722*	**-0.2222** *0.0353*	**-0.1725** *0.1039*	**-0.0776** *0.4670*	**-0.2238** *0.0340*	**-0.2892** *0.0057*	**-0.1678** *0.1140*
Sales to film	**-0.2304** *0.0289*	**-0.2436** *0.0207*	**-0.0741** *0.4878*	**-0.0439** *0.6811*	**-0.2551** *0.0152*	**0.0015** *0.9889*	**-0.1623** *0.1265*	**-0.0341** *0.7494*	**-0.0229** *0.8301*
Sales to publishing	**-0.2863** *0.0062*	**-0.2811** *0.0073*	**-0.1473** *0.1658*	**-0.1061** *0.3196*	**-0.3017** *0.0039*	**-0.0428** *0.6884*	**-0.2227** *0.0348*	**-0.0381** *0.7213*	**-0.0672** *0.5294*
Sales to radio & TV	**-0.1052** *0.3237*	**-0.1471** *0.1665*	**0.0883** *0.4077*	**0.0722** *0.4991*	**-0.0967** *0.3645*	**0.1188** *0.2648*	**-0.0262** *0.8060*	**-0.0102** *0.9237*	**0.0493** *0.6448*
Sales to software	**-0.1068** *0.3162*	**-0.1178** *0.2690*	**0.0097** *0.9275*	**0.0034** *0.9744*	**-0.2423** *0.0214*	**0.0021** *0.9843*	**-0.0543** *0.6114*	**0.1414** *0.1837*	**-0.0300** *0.7790*
Sales to creative	**-0.1855** *0.0800*	**-0.2049** *0.0527*	**-0.0111** *0.9173*	**-0.0186** *0.8621*	**-0.2871** *0.0061*	**0.0173** *0.8712*	**-0.1334** *0.2100*	**0.0201** *0.8506*	**-0.0347** *0.7453*

1. Figures in bold are Spearman rank-order correlation indices which show the extent of correspondence between the rankings of industries on the row and column measures.
2. Figures in italics are p-values, which show the probability of obtaining (at least) the value of the correlation index for two independent series.

Source: Authors based on data from ONS Input-Output Supply and Use Tables, 2002-2004 (See McVittie, 2007) CIS4 data

Appendix D: Descriptive statistics

Table 16: Descriptive statistics (I)

		Source	Industry-level Descriptives		Firm-level Descriptives	
			Mean	St. Dev.	Mean	St. Dev.
Innovation measures						
Innovation Activities						
In-house R&D	Undertook in-house R&D activities	CIS4	0.453	0.312	0.312	0.463
Design Activities	Undertook design activities	CIS4	0.441	0.321	0.187	0.390
Marketing Activities	Undertook innovation-related marketing activities	CIS4	0.202	0.151	0.250	0.433
Innovation Outputs						
Product Innovation	Produced new or significantly improved product	CIS4	0.390	0.211	0.290	0.454
Novel Product	Produced novel (new to market) product innovation	CIS4	0.589	0.188	0.161	0.368
Process Innovation	Introduced new or significantly improved process	CIS4	0.273	0.161	0.201	0.401
Novel Process	Produced novel (new to industry) process innovation	CIS4	0.293	0.184	0.265	0.442
Innovation Impacts						
Innovation Impact - Range	Innovation led to expanded product range	CIS4	0.483	0.190	0.415	0.493
Innovation Impact - Quality	Innovation led to improved product quality	CIS4	0.580	0.152	0.545	0.498
Innovation Impact - Market	Innovation led to increased market share of new markets	CIS4	0.510	0.168	0.438	0.496
Creative linkage measures (defined for relevant Input-output industry)						
Purchases of creative products (Share of Output)						
Purchases of Fashion	Industry purchases of fashion products	McVittie, 2007	0.000	0.000	0.001	0.001
Purchases of Software	Industry purchases of software products	McVittie, 2007	0.007	0.008	0.010	0.008
Purchases of Architecture	Industry purchases of architecture products	McVittie, 2007	0.002	0.003	0.003	0.003
Purchases of Publishing	Industry purchases of publishing products	McVittie, 2007	0.005	0.013	0.005	0.014

		Source	Industry-level descriptives		Firm-level descriptives	
			Mean	St. Dev.	Mean	St. Dev.
Purchases of Advertising	Industry purchases of advertising products	McVittie, 2007	0.010	0.010	0.011	0.008
Purchases of Arts	Industry purchases of arts products	McVittie, 2007	0.001	0.002	0.001	0.002
Purchases of Radio & TV	Industry purchases of radio & tv products	McVittie, 2007	0.001	0.003	0.001	0.001
Purchases of Film	Industry purchases of film products	McVittie, 2007	0.000	0.000	0.000	0.000
Purchases of Creative	Industry purchases of all creative products	McVittie, 2007	0.028	0.026	0.031	0.024
Sales to Creative Industries (Share of Demand)						
Sales to Fashion	Industry sales to fashion industry	McVittie, 2007	0.000	0.000	0.001	0.001
Sales to Software	Industry sales to software industry	McVittie, 2007	0.004	0.009	0.008	0.014
Sales to Architecture	Industry sales to architecture industry	McVittie, 2007	0.001	0.003	0.002	0.003
Sales to Publishing	Industry sales to publishing industry	McVittie, 2007	0.006	0.019	0.004	0.013
Sales to Advertising	Industry sales to advertising industry	McVittie, 2007	0.001	0.003	0.002	0.004
Sales to Arts	Industry sales to arts industry	McVittie, 2007	0.001	0.002	0.001	0.002
Sales to Radio & TV	Industry sales to radio & tv industry	McVittie, 2007	0.002	0.003	0.002	0.002
Sales to Film	Industry sales to film industry	McVittie, 2007	0.001	0.003	0.001	0.002
Sales to Creative	Industry sales to all creative industries	McVittie, 2007	0.017	0.030	0.020	0.029
Creative Employment (% of total employment, Headcount)						
Creative Employment	Industry employment of creative occupations	McVittie, 2007	0.081	0.109	0.050	0.064
Firm-level explanatory variables						
Turnover	Total value of business turnover (£ thousand, 2004)	CIS4	86,426	235,251	59,214	1,077,216
Enterprise group	Part of larger enterprise group (Yes = 1, No = 0)	CIS4	0.440	0.181	0.359	0.480
New business	Established after 1 Jan 2000 (Yes = 1, No = 0)	CIS4	0.129	0.079	0.153	0.360
Employee science qualifications	Scientific & Engineering Degree Qualifications as % of total workforce	CIS4	6.18	6.62	5.931	29.838
Employee non-science qualifications	Other Degree Qualifications as % of total workforce	CIS4	6.65	5.72	7.478	28.053
Market area - local	Main market area is local (sub-UK) (Yes = 1, No = 0)	CIS4	0.178	0.169	0.333	0.472
Market area - EU	Main market area is EU (Yes = 1, No = 0)	CIS4	0.517	0.263	0.307	0.461
Market area - global	Main market area is Global (Yes = 1, No = 0)	CIS4	0.403	0.269	0.223	0.416
IP Protection Measures (Score: High = 3, Medium = 2, Low = 1, None = 0)						
Design registration	Registration of design of medium or high importance	CIS4	0.646	0.417	0.413	0.870
Trademarks	Trademarks of medium or high importance	CIS4	0.771	0.456	0.521	0.970
Patents	Patents of medium or high importance	CIS4	0.691	0.478	0.425	0.907
Confidentiality agreements	Confidentiality agreements of medium or high importance	CIS4	1.053	0.521	0.798	1.123

		Source	Industry-level Descriptives		Firm-level Descriptives	
			Mean	St. Dev.	Mean	St. Dev.
Copyright	Copyright of medium or high importance	CIS4	0.639	0.378	0.440	0.885
Secrecy	Secrecy of medium or high importance	CIS4	1.022	0.484	0.750	1.069
Complexity of design	Complexity of design of medium or high importance	CIS4	0.869	0.457	0.574	0.922
Lead time advantage	Lead time advantage of medium or high importance	CIS4	1.059	0.460	0.773	1.083
Barriers to Innovation (Score: High = 3, Medium = 2, Low = 1, None = 0)						
Risk	Risk an important barrier to innovation	CIS4	1.181	0.308	0.983	1.103
Direct Costs	Direct Innovation Costs an important barrier to innovation	CIS4	1.230	0.347	1.013	1.131
Financial Costs	Finance Costs an important barrier to innovation	CIS4	1.040	0.294	0.925	1.051
Availability of Finance	Availability of Finance an important barrier to innovation	CIS4	0.951	0.280	0.823	1.016
Lack of Skills	Lack of relevant skills an important barrier to innovation	CIS4	0.934	0.258	0.846	0.969
Lack of information on technology	Lack of info on technology an important barrier to innovation	CIS4	0.761	0.227	0.660	0.811
Lack of information on markets	Lack of info on markets an important barrier to innovation	CIS4	0.794	0.261	0.656	0.816
Dominant supplier(s)	Dominant market suppliers an important barrier to innovation	CIS4	1.012	0.309	0.840	1.002
Lack of demand	Lack of expected demand an important barrier to innovation	CIS4	1.055	0.312	0.840	0.993
UK Regulations	UK Regulations an important barrier to innovation	CIS4	0.886	0.315	0.818	1.050
EU Regulations	EU Regulations an important barrier to innovation	CIS4	0.829	0.307	0.730	1.004
Support for Innovation						
Regional	Received innovation support from local agency	CIS4	0.071	0.072	0.054	0.226
National/Devolved	Received innovation support from national agency	CIS4	0.101	0.108	0.065	0.246
EU	Received innovation support from EU	CIS4	0.062	0.089	0.038	0.191
Cooperation & Information Sources (Yes =1, No = 0)						
Cooperation with suppliers	Cooperated on innovation with suppliers	CIS4	0.142	0.089	0.112	0.315
Cooperation with Customers	Cooperated on innovation with customers	CIS4	0.124	0.085	0.099	0.299
Information from Suppliers	Information from suppliers important to innovation	CIS4	0.560	0.148	0.496	0.500
Information from Customers	Information from customers important to innovation	CIS4	0.583	0.144	0.529	0.499

Appendix E: Econometric analysis

Econometric analysis is carried out on the firm-level CIS4 data using the STATA statistical analysis package. Our approach is to model the probability that a firm engaged in a particular type of innovation activity (or produced an innovation output or enjoyed an innovation impact) is related to the strength of supply chain linkages to the creative industries for the industry to which the firm belongs, and to a set of firm-level control variables.

Specifically, we estimate various versions of the binary response model:

$$p_i = \Pr(y_i = 1) = G(z_i)$$

$$z_i = \alpha + \sum_m \beta_m L_{im} + \sum_n \gamma_n C_{in} + \varepsilon_i$$

Here p_i is the probability of firm i giving a 'positive' response $(y_i = 1)$ for that innovation measure. This probability is determined by the 'index' variable z_i, via the cumulative distribution function (cdf) $G(z_i)$. All models are estimated using the 'probit' method, so that $G(z_i)$ is the cumulative standard normal distribution.

The value of z_i is assumed to be a linear function of the creative linkage measures and control variables. L_{im} is the value of the creative linkage variable relevant to firm ($m = 1,..,M$ refer to 'forward' linkages, 'backward' linkages, creative employment and 'interaction' variables depending on the specific model being estimated), and the C_{in} ($n = 1,..,N$) are the values for firm i of each of the N control variables included in the model, and α, β_m and γ_n are $1 + M + N$ parameters to be estimated.

Some versions of the model include 'interaction' variables in an attempt to identify the mechanisms through which creative linkages support innovation, and also the possible role of direct creative employment in increasing the 'absorptive capacity' of firms to benefit from creative linkages.

The interaction variables are obtained by simply multiplying the relevant variable with the creative linkage measure. Thus, for example, the interaction variable which attempts to capture the role of knowledge transfers from creative suppliers is given by:

> Creative Purchases x Knowledge from Suppliers Important to Innovation

Since the knowledge transmission mechanism variable is binary (1 = yes, 0 = no), the interaction variable is the creative purchases measure for those firms who have stated that suppliers are an important source of information for innovation, and zero otherwise.

Similar variables are constructed for other potential knowledge transmission mechanisms (information from customers; cooperation with suppliers; cooperation with customers).

As is standard practice, we report 'marginal effects' estimates, rather than the coefficient estimates from the probit regression (α, β_m and γ_n) themselves.

The marginal effect shows the effect of a change in a variable on the probability of observing a 'positive' response, e.g. that a firm has reported a product innovation.

Thus, for the creative linkage variables the marginal effect is defined by

$$\frac{\partial p}{\partial L} = \frac{dp}{dz}\frac{\partial z}{\partial L} = g(z)\beta$$

where $g(z)$ is the standard normal distribution.

Since the probit model is non-linear, the marginal effects vary depending on the values of all explanatory variables. As is conventional, we report marginal effects calculated at mean values for the regressors (i.e. for the 'average firm').

Econometric problems may arise due to 'endogeneity' of explanatory variables arising from omitted variables or because some explanatory variables reflect firms' choices concerning their innovation activities.

Dealing with such problems is difficult given the available data, since we don't have an appropriate instrument, and the pure cross section nature of CIS4 precludes estimation of firm-level 'fixed effects'.

The available CIS panel dataset, which combines firms covered by both CIS3 and CIS4 surveys, is not suitable for panel data estimation due to its small size (less than 1,000 firms) and the lack of time variation in the creative linkage variables.

Instead, we estimate all models including industry and region dummy variables within the control variable set (the C_{im}), in an attempt to isolate industry and region 'fixed effects' on innovation performance. The industry dummy variables are defined at the 2-digit SIC level; regional dummy variables are defined based on the UK Government Office Regions.

The creative linkage measures are defined at the industry level rather than for individual firms. Moulton (1990) shows for ordinary least squares regressions that if aggregated (e.g. industry level) variables are included in regressions on micro (e.g. firm level) data, then the standard errors will be underestimated, leading to mistaken inferences concerning the statistical significance of the results. Similar problems also arise for binary response regressions (Wooldridge, 2002).

It is therefore necessary to adjust the standard errors for coefficient estimates within our models. We do this by 'clustering' standard errors at the level of input-output industries (on which the linkage measures are based) using the relevant STATA routine.

The resulting 'robust' standard errors are reported in the results tables below together with *p-values* for tests of significance carried out using these robust standard errors. These show the 'significance level' for each variable (or for a group of variables), i.e. the probability of inferring that the variable is significant in explaining innovation when in fact it is not.

Our standard results tables also report the 'pseudo R-squared' measure for the binary response model: a measure of the 'success' of the explanatory variables in accounting for the observed variation in firms' innovation performance.

This is obtained by comparing the log-likelihood from the regression (as reported in the table) with the log-likelihood that would have been obtained from a model containing only a constant (intercept). The pseudo R-squared takes a value between 0 and 1, with a higher value implying a model with greater 'explanatory power'.

Table 17: Probit regression results. Engagement in innovation activities during 2002-2004

	In-house R&D	Design	Innovation -related marketing
Observations	12799	12799	12779
Pseudo-R2	0.3141	0.2609	0.2475
Log pseudo-likelihood	-5512.4	-4655.1	-5448.7
Purchases of creative products[1]	**0.328**	**1.086**	**-0.143**
Robust (clustered) standard error[2]	0.984	0.535	0.303
p-value[3]	*0.739*	*0.040*	*0.638*
Sales to creative industries	**0.802**	**-0.322**	**0.157**
Robust (clustered) standard error	0.653	0.220	0.138
p-value	*0.220*	*0.146*	*0.256*
Control Variables (robust p-values for Joint Tests of Significance)[4]			
Firm size	*0.2461*	*0.0005*	*0.0000*
Industry	*0.0000*	*0.0000*	*0.0000*
Location	*0.0009*	*0.6329*	*0.0005*
Enterprise type and age	*0.6467*	*0.7280*	*0.3434*
Product market area	*0.0000*	*0.0000*	*0.0000*
IP protection methods	*0.0000*	*0.0000*	*0.0000*
Barriers to innovation	*0.0000*	*0.0000*	*0.0000*
Public support	*0.0000*	*0.0032*	*0.0000*

1. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

2. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

3. p-values for the standard z test of significance for explanatory variables (in italics).

4. p-values for joint (chi-square) tests of significance for each group of explanatory variables (in italics).

Table 18: Probit regression results. Engagement in innovation activities during 2002-2004[1]

	In-house R&D			Design			Marketing		
Observations	12799	12799	12799	12799	12799	12799	12799	12799	12779
Method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.3149	0.3151	0.315	0.2615	0.2624	0.2618	0.2121	0.2122	0.2122
Log pseudo-likelihood	-5506.1	-5504.8	-5505.4	-4651.3	-4645.6	-4649.2	-5704.8	-5704.4	-5704.2
Creative employment[2]	**0.110**	**0.149**	**.**	**0.057**	**0.059**	**.**	**0.133**	**0.148**	**.**
Robust (clustered) standard error[3]	0.146	0.152	.	0.104	0.095	.	0.133	0.133	.
p-value[4]	*0.452*	*0.327*	.	*0.586*	*0.535*	.	*0.318*	*0.267*	.
Purchases of creative products	**.**	**0.955**	**.**	**.**	**1.480**	**.**	**.**	**0.009**	**.**
Robust (clustered) standard error	.	0.922	.	.	0.449	.	.	0.298	.
p-value	.	*0.300*	.	.	*0.001*	.	.	*0.975*	.
Sales to creative industries	**.**	**0.678**	**.**	**.**	**-0.398**	**.**	**.**	**0.493**	**.**
Robust (clustered) standard error	.	0.536	.	.	0.170	.	.	0.202	.
p-value	.	*0.206*	.	.	*0.020*	.	.	*0.015*	.
Creative employment x creative purchases	**.**	**.**	**-3.152**	**.**	**.**	**7.557**	**.**	**.**	**7.822**
Robust (clustered) standard error	.	.	4.988	.	.	4.644	.	.	4.512
p-value	.	.	*0.528*	.	.	*0.102*	.	.	*0.083*
Creative employment x creative sales	**.**	**.**	**11.986**	**.**	**.**	**-13.467**	**.**	**.**	**0.225**
Robust (clustered) standard error	.	.	10.380	.	.	6.957	.	.	5.325
p-value	.	.	*0.251*	.	.	*0.048*	.	.	*0.966*

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 19: Probit regression results. Innovation activities during 2002-2004: design[1]

	ALL	Fashion	Software	Arch.	Publish.	Advert.	Arts	Radio & TV	Film
Observations	12799	12799	12799	12799	12799	12799	12799	12799	12799
Method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.2629	0.2619	0.2621	0.2624	0.2615	0.2620	0.2622	0.2620	0.2615
Log pseudo likelihood	-4642.5	-4648.4	-4647.6	-4645.5	-4615.3	-4648.3	-4647.0	-4947.8	-4651.4
Purchases of creative products									
Fashion[2]	**-271.84**	**-28.40**	.	.	.	.	.	.	.
Robust (clustered) standard error[3]	524.60	14.19	.	.	.	.	.	.	.
p-value[4]	*0.604*	*0.041*	.	.	.	.	.	.	.
Software	**-0.691**	.	**4.220**	.	.	.	.	.	.
Robust (clustered) standard error	4.481	.	1.640	.	.	.	.	.	.
p-value	*0.878*	.	*0.009*	.	.	.	.	.	.
Architecture	**4.530**	.	.	**5.651**	.	.	.	.	.
Robust (clustered) standard error	4.449	.	.	0.887	.	.	.	.	.
p-value	*0.309*	.	.	*0.000*	.	.	.	.	.
Publishing	**-361.54**	.	.	.	**-2.169**	.	.	.	.
Robust (clustered) standard error	691.11	.	.	.	5.644	.	.	.	.
p-value	*0.601*	.	.	.	*0.701*	.	.	.	.
Advertising	**1.049**	.	.	.	.	**1.764**	.	.	.
Robust (clustered) standard error	0.489	.	.	.	.	0.772	.	.	.
p-value	*0.032*	.	.	.	.	*0.021*	.	.	.
The arts	**4250.6**	.	.	.	.	.	**-72.88**	.	.
Robust (clustered) standard error	8167.7	.	.	.	.	.	25.40	.	.
p-value	*0.603*	.	.	.	.	.	*0.004*	.	.
Radio & TV	**-2348.2**	.	.	.	.	.	.	**-40.03**	.
Robust (clustered) standard error	4460.0	.	.	.	.	.	.	16.15	.
p-value	*0.598*	.	.	.	.	.	.	*0.011*	.
Film	**-7864.3**	.	.	.	.	.	.	.	**-5160.6**
Robust (clustered) standard error	21689.2	.	.	.	.	.	.	.	14565.2
p-value	*0.717*	.	.	.	.	.	.	.	*0.723*

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 20: Probit regression results. Innovation outputs during 2002-2004

	New product	Novel product	New process
Observations	12799	12799	12799
Method	Probit	Probit	Probit
Pseudo-R2	0.2768	0.2768	0.2211
Log pseudo-likelihood	-5757.8	-4297.8	-5256.2
Purchases of creative products[1]	**2.376**	**1.383**	**0.856**
Robust (clustered) standard error[2]	0.862	0.303	0.722
p-value[3]	*0.006*	*0.000*	*0.236*
Sales to creative industries	**0.933**	**0.009**	**0.586**
Robust (clustered) standard error	0.360	0.178	0.478
p-value	*0.010*	*0.959*	*0.221*
Control variables (robust p-values for joint tests of significance)[4]			
Cooperation	*0.0000*	*0.0000*	*0.0000*
Information sources	*0.0000*	*0.0000*	*0.0000*
Firm size	*0.2131*	*0.1592*	*0.0000*
Industry	*0.0000*	*0.0000*	*0.0000*
Location	*0.0225*	*0.0026*	*0.3337*
Enterprise type and age	*0.1619*	*0.3193*	*0.0638*
Product market area	*0.0000*	*0.0000*	*0.0182*
IP protection methods	*0.0000*	*0.0000*	*0.0000*
Barriers to innovation	*0.0000*	*0.0000*	*0.0000*
Public support	*0.0000*	*0.0000*	*0.0000*

1. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

2. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

3. p-values for the standard z test of significance for explanatory variables (in italics).

4. p-values for joint (chi-square) tests of significance for each group of explanatory variables (in italics).

Table 21: Probit regression results. Innovation outputs during 2002-2004

	New product	Novel product	New process
Observations	12779	12779	12799
Method	Probit	Probit	Probit
Pseudo-R2	0.3363	0.3303	0.2811
Log pseudo-likelihood	-5284.0	-3979.5	-4850.8
Purchases of creative products[1]	**1.425**	**1.224**	**0.254**
Robust (clustered) standard error[2]	0.741	0.259	0.655
p-value [3]	*0.056*	*0.000*	*0.700*
Sales to creative industries	**1.051**	**-0.086**	**0.711**
Robust (clustered) standard error	0.467	0.172	0.472
p-value	*0.024*	*0.615*	*0.132*
Control variables (robust p-values for joint tests of significance)[4]			
Innovation activities	*0.0000*	*0.0000*	*0.0000*
Cooperation	*0.0000*	*0.0000*	*0.0000*
Information sources	*0.0000*	*0.0000*	*0.0000*
Firm size	*0.6518*	*0.3478*	*0.0000*
Industry	*0.0000*	*0.0000*	*0.0000*
Location	*0.0691*	*0.0109*	*0.1751*
Enterprise type and age	*0.2776*	*0.5020*	*0.0300*
Product market area	*0.0000*	*0.0000*	*0.3178*
IP protection methods	*0.0000*	*0.0000*	*0.0000*
Barriers to innovation	*0.0000*	*0.0000*	*0.0000*
Public support	*0.0000*	*0.0000*	*0.0000*

1. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

2. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

3. p-values for the standard z test of significance for explanatory variables (in italics).

4. p-values for joint (chi-square) tests of significance for each group of explanatory variables (in italics).

Table 22: Probit regression results. Innovation outputs during 2002-2004[1]

	Product innovations			Novel product innovations		
Observations	12799	12799	12799	12799	12799	12799
Method	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.3359	0.3363	0.3362	0.3297	0.3304	0.3299
Log pseudo-likelihood	-5286.9	-5284.0	-5285.3	-3983.4	-3979.0	-3982.1
Creative employment[2]	**-0.115**	**-0.053**	**.**	**0.095**	**0.111**	**.**
Robust (clustered) standard error[3]	0.190	0.187	.	0.097	0.099	.
p-value[4]	*0.543*	*0.776*	.	*0.326*	*0.262*	.
Purchases of creative products	**.**	**1.407**	**.**	**.**	**1.253**	**.**
Robust (clustered) standard error	.	0.748	.	.	0.258	.
p-value	.	*0.061*	.	.	*0.000*	.
Sales to creative industries	**.**	**1.026**	**.**	**.**	**-0.044**	**.**
Robust (clustered) standard error	.	0.464	.	.	0.167	.
p-value	.	*0.027*	.	.	*0.792*	.
Creative employment x creative purchases	**.**	**.**	**6.394**	**.**	**.**	**0.802**
Robust (clustered) standard error	.	.	9.725	.	.	5.029
p-value	.	.	*0.511*	.	.	*0.111*
Creative employment x creative sales	**.**	**.**	**-17.398**	**.**	**.**	**-7.651**
Robust (clustered) standard error	.	.	9.904	.	.	4.057
p-value	.	.	*0.079*	.	.	*0.059*

1. Additional control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 23: Probit regression results. Innovation outputs during 2002-2004[1]

	Product innovations				Novel product innovations			
Observations	12779	12779	12779	12779	12779	12779	12779	12779
Method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.3296	0.3298	0.3269	0.327	0.3274	0.3275	0.3234	0.3235
Log pseudo-likelihood	-5337.5	-5336.1	-5358.6	-5357.9	-3997.1	-3996.3	-4020.5	-4020.0
Cooperate with suppliers[2]	**0.096**	**0.107**	**.**	**.**	**0.031**	**0.028**	**.**	**.**
Robust (clustered) standard error[3]	0.024	0.035	.	.	0.015	0.017	.	
p-value[4]	*0.000*	*0.002*	.	.	*0.027*	*0.068*	.	.
Cooperate with customers	**0.120**	**0.098**	**.**	**.**	**0.056**	**0.048**	**.**	**.**
Robust (clustered) standard error	0.029	0.035	.	.	0.016	0.017	.	
p-value	*0.000*	*0.003*	.	.	*0.000*	*0.002*	.	.
Cooperate with suppliers x creative purchases	**.**	**-0.296**	**.**	**.**	**.**	**0.068**	**.**	**.**
Robust (clustered) standard error	.	0.541	.	.	.	0.265	.	.
p-value	.	*0.584*	.	.	.	*0.799*	.	.
Cooperate with customers x creative sales	**.**	**0.906**	**.**	**.**	**.**	**0.323**	**.**	**.**
Robust (clustered) standard error	.	0.679	.	.	.	0.257	.	.
p-value	.	*0.184*	.	.	.	*0.210*	.	.
Information from suppliers	**.**	**.**	**0.032**	**0.034**	**.**	**.**	**0.008**	**0.004**
Robust (clustered) standard error	.	.	0.012	0.013	.	.	0.007	0.010
p-value	.	.	*0.011*	*0.009*	.	.	*0.229*	*0.729*
Information from customers	**.**	**.**	**0.102**	**0.095**	**.**	**.**	**0.038**	**0.036**
Robust (clustered) standard error	.	.	0.010	0.012	.	.	0.008	0.009
p-value	.	.	*0.000*	*0.000*	.	.	*0.000*	*0.000*
Information from suppliers x creative purchases	**.**	**.**	**.**	**-0.078**	**.**	**.**	**.**	**0.156**
Robust (clustered) standard error	.	.	.	0.244	.	.	.	0.259
p-value	.	.	.	*0.748*	.	.	.	*0.549*
Information from suppliers x creative sales	**.**	**.**	**.**	**0.366**	**.**	**.**	**.**	**0.120**
Robust (clustered) standard error	.	.	.	0.236	.	.	.	0.230
p-value	.	.	.	*0.123*	.	.	.	*0.602*

1. Additional control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 24: Probit regression results. Innovation outputs during 2002-2004: product innovation[1]

	ALL	Fashion	Software	Arch.	Publish.	Advert.	Arts	Radio & TV	Film
Observations	12779	12779	12779	12779	12779	12779	12779	12779	12779
Method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.3380	0.3364	0.3367	0.3366	0.3359	0.3368	0.3362	0.3363	0.336
Log pseudo-likelihood	-5270.4	-5283.0	-5281.1	-5282.0	-5286.9	-5280.2	-5284.9	-5284.1	-5286.7
Purchases of creative products									
Fashion[2]	**1534.1**	**91.934**	.	.	.	.	.	.	.
Robust (clustered) standard error[3]	710.25	30.281	.	.	.	.	.	.	.
p-value[4]	*0.031*	*0.003*	.	.	.	.	.	.	.
Software	**3.426**	.	**3.255**	.	.	.	.	.	.
Robust (clustered) standard error	8.798	.	1.150	.	.	.	.	.	.
p-value	*0.697*	.	*0.005*	.	.	.	.	.	.
Architecture	**-36.53**	.	.	**12.270**	.	.	.	.	.
Robust (clustered) standard error	18.68	.	.	1.178	.	.	.	.	.
p-value	*0.051*	.	.	*0.000*	.	.	.	.	.
Publishing	**2236.5**	.	.	.	**-2.956**	.	.	.	.
Robust (clustered) standard error	973.30	.	.	.	9.455	.	.	.	.
p-value	*0.021*	.	.	.	*0.757*	.	.	.	.
Advertising	**2.245**	.	.	.	.	**2.482**	.	.	.
Robust (clustered) standard error	0.925	.	.	.	.	1.227	.	.	.
p-value	*0.021*	.	.	.	.	*0.043*	.	.	.
The arts	**-26070.8**	.	.	.	.	.	**-7.087**	.	.
Robust (clustered) standard error	11483.6	.	.	.	.	.	44.077	.	.
p-value	*0.023*	.	.	.	.	.	*0.872*	.	.
Radio & TV	**14182.3**	.	.	.	.	.	.	**-18.613**	.
Robust (clustered) standard error	6268.8	.	.	.	.	.	.	32.087	.
p-value	*0.024*	.	.	.	.	.	.	*0.561*	.
Film	**13230.0**	.	.	.	.	.	.	.	**-9749.2**
Robust (clustered) standard error	43205.4	.	.	.	.	.	.	.	21299.3
p-value	*0.759*	.	.	.	.	.	.	.	*0.647*

	ALL	Fashion	Software	Arch.	Publish.	Advert.	Arts	Radio & TV	Film
Sales to creative industries									
Fashion	**-73.259**	**-136.959**	**.**	**.**	**.**	**.**	**.**	**.**	**.**
Robust (clustered) standard error	95.802	67.465	.	.	.	.	.	.	.
p-value	*0.445*	*0.043*	.	.	.	.	.	.	.
Software	**9.805**	**.**	**3.775**	**.**	**.**	**.**	**.**	**.**	**.**
Robust (clustered) standard error	6.637	.	0.427	.	.	.	.	.	.
p-value	*0.139*	.	*0.000*	.	.	.	.	.	.
Architecture	**29.508**	**.**	**.**	**-11.240**	**.**	**.**	**.**	**.**	**.**
Robust (clustered) standard error	15.945	.	.	1.165	.	.	.	.	.
p-value	*0.064*	.	.	*0.000*	.	.	.	.	.
Publishing	**-473.85**	**.**	**.**	**.**	**0.382**	**.**	**.**	**.**	**.**
Robust (clustered) standard error	297.34	.	.	.	0.357	.	.	.	.
p-value	*0.111*	.	.	.	*0.285*	.	.	.	.
Advertising	**-15.017**	**.**	**.**	**.**	**.**	**-5.500**	**.**	**.**	**.**
Robust (clustered) standard error	11.17	.	.	.	.	0.739	.	.	.
p-value	*0.179*	.	.	.	.	*0.000*	.	.	.
The arts	**4891.1**	**.**	**.**	**.**	**.**	**.**	**16.315**	**.**	**.**
Robust (clustered) standard error	2969.9	.	.	.	.	.	5.934	.	.
p-value	*0.100*	.	.	.	.	.	*0.006*	.	.
Radio & TV	**-2460.9**	**.**	**.**	**.**	**.**	**.**	**.**	**13.258**	**.**
Robust (clustered) standard error	1506.8	.	.	.	.	.	.	5.071	.
p-value	*0.102*	.	.	.	.	.	.	*0.009*	.
Film	**519.58**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**3.818**
Robust (clustered) standard error	391.84	.	.	.	.	.	.	.	2.532
p-value	*0.185*	.	.	.	.	.	.	.	*0.131*

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 25: Probit regression results. Innovation outputs during 2002-2004: novel product innovation[1]

	ALL	Fashion	Software	Arch.	Publish.	Advert.	Arts	Radio & TV	Film
Observations	12799	12799	12799	12799	12799	12799	12799	12799	12799
Method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.3308	0.3296	0.3302	0.33	0.3299	0.3299	0.3296	0.3296	0.3296
Log pseudo-likelihood	-3976.5	-3983.6	-3980.1	-3981.6	-3982.1	-3982.0	-3983.7	-3983.8	-3983.7
Purchases of creative products									
Fashion[2]	**426.24**	**-6.492**	.	.	.	.	.	.	.
Robust (clustered) standard error[3]	321.69	5.815	.	.	.	.	.	.	.
p-value[4]	*0.186*	*0.260*	.	.	.	.	.	.	.
Software	**1.957**	.	**3.710**	.	.	.	.	.	.
Robust (clustered) standard error	4.102	.	0.806	.	.	.	.	.	.
p-value	*0.634*	.	*0.000*	.	.	.	.	.	.
Architecture	**2.688**	.	.	**3.065**	.	.	.	.	.
Robust (clustered) standard error	3.892	.	.	0.682	.	.	.	.	.
p-value	*0.490*	.	.	*0.000*	.	.	.	.	.
Publishing	**553.92**	.	.	.	**7.175**	.	.	.	.
Robust (clustered) standard error	424.25	.	.	.	4.233	.	.	.	.
p-value	*0.192*	.	.	.	*0.086*	.	.	.	.
Advertising	**0.816**	.	.	.	.	**1.177**	.	.	.
Robust (clustered) standard error	0.405	.	.	.	.	0.508	.	.	.
p-value	*0.044*	.	.	.	.	*0.020*	.	.	.
The arts	**-6428.8**	.	.	.	.	.	**11.030**	.	.
Robust (clustered) standard error	5013.6	.	.	.	.	.	20.411	.	.
p-value	*0.200*	.	.	.	.	.	*0.590*	.	.
Radio & TV	**3518.1**	.	.	.	.	.	.	**-4.110**	.
Robust (clustered) standard error	2738.8	.	.	.	.	.	.	8.588	.
p-value	*0.199*	.	.	.	.	.	.	*0.631*	.
Film	**-10092.7**	.	.	.	.	.	.	.	**6060.5**
Robust (clustered) standard error	19796.2	.	.	.	.	.	.	.	9591.0
p-value	*0.610*	.	.	.	.	.	.	.	*0.527*

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 26: Probit regression results. Innovation impacts during 2002-2004

	Increased product range	Improved quality	Expanded markets
Observations	12790	12799	12799
Method	Probit	Probit	Probit
Pseudo-R2	0.2412	0.2573	0.2370
Log pseudo-likelihood	-6648.5	-6490.2	-6741.7
Purchases of creative products[1]	**0.780**	**0.866**	**1.140**
Robust (clustered) standard error[2]	0.540	0.516	1.125
p-value[3]	*0.149*	*0.093*	*0.311*
Sales to creative industries	**-0.139**	**1.753**	**1.672**
Robust (clustered) standard error	0.370	0.931	1.146
p-value	*0.708*	*0.060*	*0.145*
Control variables (robust p-values for joint tests of significance) [4]			
Cooperation	*0.0000*	*0.0000*	*0.5503*
Information sources	*0.0000*	*0.0000*	*0.0000*
Firm size	*0.7939*	*0.0614*	*0.0117*
Industry	*0.0000*	*0.0000*	*0.0000*
Location	*0.0002*	*0.0305*	*0.0002*
Enterprise type and age	*0.2825*	*0.2174*	*0.0000*
Product market area	*0.0000*	*0.0630*	*0.0000*
IP protection methods	*0.0000*	*0.0000*	*0.0000*
Barriers to innovation	*0.0000*	*0.0000*	*0.0000*
Public support	*0.0081*	*0.6425*	*0.0001*

1. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

2. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

3. p-values for the standard z test of significance for explanatory variables (in italics).

4. p-values for joint (chi-square) tests of significance for each group of explanatory variables (in italics).

Table 27: Probit regression results. Innovation impacts during 2002-2004

	Increased product range	Improved quality	Expanded markets
Observations	12790	12799	12799
Method	Probit	Probit	Probit
Pseudo-R2	0.2588	0.2719	0.2516
Log pseudo-likelihood	-6494.7	-6362.4	-6613.1
Purchases of creative products[1]	**0.546**	**0.608**	**0.988**
Robust (clustered) standard error[2]	0.584	0.589	1.171
p-value [3]	*0.349*	*0.302*	*0.399*
Sales to creative industries	**-0.179**	**1.987**	**1.674**
Robust (clustered) standard error	0.351	0.857	1.148
p-value	*0.611*	*0.021*	*0.145*
Control variables (robust p-values for joint tests of significance)[4]			
Innovation activities	*0.0000*	*0.0000*	*0.0000*
Cooperation	*0.0131*	*0.0242*	*0.5755*
Information sources	*0.0000*	*0.0000*	*0.0000*
Firm size	*0.4502*	*0.1930*	*0.0568*
Industry	*0.0000*	*0.0000*	*0.0013*
Location	*0.0002*	*0.1150*	*0.0000*
Enterprise type and age	*0.3287*	*0.2543*	*0.0000*
Product market area	*0.0000*	*0.2038*	*0.0000*
IP protection methods	*0.0000*	*0.0000*	*0.0000*
Barriers to innovation	*0.0000*	*0.0000*	*0.0000*
Public support	*0.3745*	*0.6398*	*0.0220*

1. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

2. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

3. p-values for the standard z test of significance for explanatory variables (in italics).

4. p-values for joint (chi-square) tests of significance for each group of explanatory variables (in italics).

Table 28: Probit regression results. Innovation outputs during 2002-2004: increased product range

	ALL	Fashion	Software	Arch.	Publish.	Advert.	Arts	Radio & TV	Film
Observations	12799	12799	12799	12799	12799	12799	12799	12799	12799
Method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.2228	0.2216	0.2216	0.2215	0.2213	0.2216	0.2213	0.2213	0.2215
Log pseudo-likelihood	-6821.9	-6832.5	-6833.2	-6833.7	-6835.4	-6833.0	-6835.8	-6835.7	-6833.4
Purchases of creative products									
Fashion[2]	**-950.4**	**103.1**	.	.	.	.	.	.	.
Robust (clustered) standard error[3]	1029.1	36.6	.	.	.	.	.	.	.
p-value[4]	*0.356*	*0.005*	.	.	.	.	.	.	.
Software	**-12.867**	.	**-1.588**	.	.	.	.	.	.
Robust (clustered) standard error	7.206	.	1.637	.	.	.	.	.	.
p-value	*0.074*	.	*0.332*	.	.	.	.	.	.
Architecture	**13.763**	.	.	**8.136**	.	.	.	.	.
Robust (clustered) standard error	19.737	.	.	0.800	.	.	.	.	.
p-value	*0.486*	.	.	*0.000*	.	.	.	.	.
Publishing	**-1482.9**	.	.	.	**-6.486**	.	.	.	.
Robust (clustered) standard error	1480.9	.	.	.	5.827	.	.	.	.
p-value	*0.317*	.	.	.	*0.265*	.	.	.	.
Advertising	**2.624**	.	.	.	.	**1.991**	.	.	.
Robust (clustered) standard error	0.946	.	.	.	.	0.823	.	.	.
p-value	*0.006*	.	.	.	.	*0.015*	.	.	.
The arts	**17607.7**	.	.	.	.	.	**-7.755**	.	.
Robust (clustered) standard error	17449.4	.	.	.	.	.	42.95	.	.
p-value	*0.313*	.	.	.	.	.	*0.857*	.	.
Radio & TV	**-9668.5**	.	.	.	.	.	.	**-3.830**	.
Robust (clustered) standard error	9528.4	.	.	.	.	.	.	31.22	.
p-value	*0.310*	.	.	.	.	.	.	*0.901*	.
Film	**-30653.6**	.	.	.	.	.	.	.	**-62835.9**
Robust (clustered) standard error	41689.8	.	.	.	.	.	.	.	16757.3
p-value	*0.462*	.	.	.	.	.	.	.	*0.000*

	ALL	Fashion	Software	Arch.	Publish.	Advert.	Arts	Radio & TV	Film
Sales to creative industries									
Fashion	**-275.2**	**-184.4**	.	.	.	.	.	.	.
Robust (clustered) standard error	54.12	87.35	.	.	.	.	.	.	.
p-value	*0.000*	*0.035*	.	.	.	.	.	.	.
Software	**4.986**	.	**2.763**	.	.	.	.	.	.
Robust (clustered) standard error	8.313	.	0.353	.	.	.	.	.	.
p-value	*0.549*	.	*0.000*	.	.	.	.	.	.
Architecture	**12.554**	.	.	**-8.454**	.	.	.	.	.
Robust (clustered) standard error	23.62	.	.	0.796	.	.	.	.	.
p-value	*0.595*	.	.	*0.000*	.	.	.	.	.
Publishing	**-372.3**	.	.	.	**-0.282**	.	.	.	.
Robust (clustered) standard error	383.9	.	.	.	0.409	.	.	.	.
p-value	*0.332*	.	.	.	*0.490*	.	.	.	.
Advertising	**15.234**	.	.	.	.	**-3.725**	.	.	.
Robust (clustered) standard error	16.75	.	.	.	.	0.678	.	.	.
p-value	*0.363*	.	.	.	.	*0.000*	.	.	.
The arts	**3966.1**	.	.	.	.	.	**2.804**	.	.
Robust (clustered) standard error	3569.8	.	.	.	.	.	6.452	.	.
p-value	*0.266*	.	.	.	.	.	*0.664*	.	.
Radio & TV	**-1997.2**	.	.	.	.	.	.	**3.291**	.
Robust (clustered) standard error	1832.4	.	.	.	.	.	.	6.281	.
p-value	*0.276*	.	.	.	.	.	.	*0.600*	.
Film	**339.4**	.	.	.	.	.	.	.	**-3.194**
Robust (clustered) standard error	645.5	.	.	.	.	.	.	.	2.283
p-value	*0.599*	.	.	.	.	.	.	.	*0.162*

1. Control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 29: Probit regression results. Innovation impacts during 2002-2004[1]

	Increased product range			Improved quality		
Observations	12799	12799	12799	12799	12799	12799
Method	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.2412	0.2413	0.2413	0.2570	0.2573	0.2571
Log pseudo-likelihood	-6648.8	-6648.2	-6648.1	-6492.6	-6490.0	-6492.2
Creative employment[2]	**0.154**	**0.173**	**.**	**0.052**	**0.126**	**.**
Robust (clustered) standard error[3]	0.194	0.206	.	0.149	0.142	.
p-value[4]	*0.427*	*0.402*	.	*0.726*	*0.373*	.
Purchases of creative products	**.**	**0.843**	**.**	**.**	**0.914**	**.**
Robust (clustered) standard error	.	0.514	.	.	0.527	.
p-value	.	*0.101*	.	.	*0.083*	.
Sales to creative industries	**.**	**-0.060**	**.**	**.**	**1.814**	**.**
Robust (clustered) standard error	.	0.386	.	.	0.929	.
p-value	.	*0.877*	.	.	*0.051*	.
Creative employment x creative purchases	**.**	**.**	**13.025**	**.**	**.**	**9.145**
Robust (clustered) standard error	.	.	10.653	.	.	8.215
p-value	.	.	*0.221*	.	.	*0.265*
Creative employment x creative sales	**.**	**.**	**-6.074**	**.**	**.**	**-7.011**
Robust (clustered) standard error	.	.	10.653	.	.	8.025
p-value	.	.	*0.467*	.	.	*0.382*

1. Additional control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Table 30: Probit regression results. Innovation impacts during 2002-2004[1]

	Increased product range				Improved quality			
Observations	12779	12779	12779	12779	12779	12779	12779	12779
Method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo-R2	0.2412	0.2412	0.2412	0.2412	0.2570	0.2573	0.2570	0.2574
Log pseudo-likelihood	-6649.1	-6648.8	-6649.1	-6648.4	-6492.7	-6490.4	-6492.7	-6489.4
Cooperate with suppliers[2]	**0.040**	**0.026**	**.**	**.**	**0.076**	**0.046**	**.**	**.**
Robust (clustered) standard error[3]	0.024	0.032	.	.	0.025	0.036	.	.
p-value[4]	*0.093*	*0.412*	.	.	*0.004*	*0.208*	.	.
Cooperate with customers	**0.071**	**0.075**	**.**	**.**	**0.033**	**0.173**	**.**	**.**
Robust (clustered) standard error	0.025	0.032	.	.	0.032	0.037	.	.
p-value	*0.005*	*0.017*	.	.	*0.304*	*0.638*	.	.
Cooperate with suppliers x creative purchases	**.**	**0.469**	**.**	**.**	**.**	**1.045**	**.**	**.**
Robust (clustered) standard error	.	0.754	.	.	.	0.857	.	.
p-value	.	*0.533*	.	.	.	*0.223*	.	.
Cooperate with customers x creative sales	**.**	**-0.163**	**.**	**.**	**.**	**0.779**	**.**	**.**
Robust (clustered) standard error	.	0.691	.	.	.	0.705	.	.
p-value	.	*0.533*	.	.	.	*0.269*	.	.
Information from suppliers	**.**	**.**	**0.152**	**0.140**	**.**	**.**	**0.199**	**0.168**
Robust (clustered) standard error	.	.	0.013	0.016	.	.	0.013	0.015
p-value	.	.	*0.000*	*0.000*	.	.	*0.000*	*0.000*
Information from customers	**.**	**.**	**0.209**	**0.208**	**.**	**.**	**0.239**	**0.242**
Robust (clustered) standard error	.	.	0.012	0.013	.	.	0.011	0.013
p-value	.	.	*0.000*	*0.000*	.	.	*0.000*	*0.000*
Information from suppliers x creative purchases	**.**	**.**	**.**	**0.403**	**.**	**.**	**.**	**1.038**
Robust (clustered) standard error	.	.	.	0.242	.	.	.	0.263
p-value	.	.	.	*0.097*	.	.	.	*0.000*
Information from suppliers x creative sales	**.**	**.**	**.**	**0.087**	**.**	**.**	**.**	**-0.057**
Robust (clustered) standard error	.	.	.	0.252	.	.	.	0.255
p-value	.	.	.	*0.732*	.	.	.	*0.824*

1. Additional control variables included in these regressions: Firm size; Industry; Location; Business type and age; Employee qualifications; Product market area; IP protection methods; Barriers to innovation; Public support; Innovation activities.

2. Numbers in bold represent marginal effects estimates, which show the increase in the probability of observing that behaviour in response to a unit change in the explanatory variable.

3. The standard errors are adjusted for heteroskedasticity and for the effect of 'clustering' of industry-level explanatory variables within the firm-level analysis.

4. p-values for the standard z test of significance for explanatory variables (in italics).

Appendix F: References

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