DESIGN AND INNOVATION: DETERMINANTS AND IMPLICATIONS

A thesis submitted to The University of Manchester for the degree of
Doctor of Philosophy
in the Faculty of Humanities

2022

XIAOXIAO YU

ALLIANCE MANCHESTER BUSINESS SCHOOL
INNOVATION, MANAGEMENT AND POLICY DIVISION

LIST OF CONTENTS

Word count (excluding references, appendices, declaration, copyright statement and acknowledgements): 64420

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This is a "journal format" thesis which consists of six chapters. The first chapter introduces the general background and methodology of the research. Chapters 2 to 5 are four interrelated papers revolving around design in business. The last is the conclusions chapter.

Chapter 2 is a review of empirical evidence on the extent to which firms engage in design as well as the potentially associated activities and factors. The reviewed studies cover more than twenty surveys that were conducted in the UK or Europe between 1996 and 2016. The review finds design has been increasingly important to the UK economy; firms' investments in design are modest on average; there are potentially complementarities between design and R&D and between design and marketing; moreover, design is associated with firms' activities in relation to technological and market opportunities.

Based on the findings from chapter 2, in chapter 3, I examine the industrial and market environment, business activities and structural characteristics that are associated with firms' commitment to design, informed by the framework of organisational capabilities. I analyse cross-sectional data collected from a large-scale survey (i.e. Innobarometer) which was conducted in the EU-28 and Switzerland in 2015 and 2016. I find the extent of companies' commitment to design is positively associated with technological opportunities, differentiation opportunities, R&D commitment, branding commitment, firm-size and whether the firm is a subsidiary.

Also utilising the framework of organisational capabilities, in chapter 4, I argue that design capabilities can help product innovators reach distant customers and improve their sales in distant places, potentially interacting with R&D and marketing. By testing the hypotheses using cross-sectional data collected through the UK Innovation Survey 2017, I find design investment is positively associated with the propensity to trade overseas but not necessarily the value of exports, albeit spending a modest amount on design is still better than not; meanwhile, R&D investment is positively related to both the propensity to export and the value of exports. I do not find design interacting with R&D or marketing in improving the geographical market reach or the exports of product innovators.

Likewise, in chapter 5, I examine if and to what extent design and R&D are associated with exporting in the UK Creative Industries, using cross-sectional data collected through a government-commissioned survey. I find investing in design and R&D

(within which applied research in particular) to both be related to the propensity to export; moreover, investing in both design and applied research is more strongly associated with export participation than investing in only one of these; further, firms with more investments in design or R&D are more likely to export. I also find design investments to be positively associated with export sales, while R&D is not statistically related to it.

DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

COPYRIGHT STATEMENT

ACKNOWLEDGEMENTS

First and foremost, I would like to express my sincere gratitude to my supervisor Prof. Bruce Tether for his invaluable advice, patient guidance and consistent support throughout my journey of postgraduate study. I would also like to thank my supervisor Dr. Khaleel Malik for his considerate advice and encouragement.

Further, I would like to thank Eurostat for offering the data of the Innobarometer survey; the Office for National Statistics (ONS) for offering the data of the UK Innovation Survey; the Department for Digital, Culture, Media and Sport (DCMS) for offering the data of the R&D in Creative Industries Survey; and UKDS for providing access to the data of the UK Innovation Survey.

Furthermore, I am thankful to Alliance Manchester Business School for funding this PhD project; to the Innovation, Management and Policy division (Manchester Institute of Innovation Research) for creating a diversified and sharing research environment; to the AMBS PGR Office for their support; to Prof. Silvia Massini, Dr. Leonid Tarasov and Ms. Tracy Moreland for coordinating the data access office; to the AMBS reception for supporting access to the school building under the pandemic situation.

Finally, I would like to say a special thank you to my family and friends for their unfailing understanding, care and support through the difficult times – thank you for being there for me. Mom and dad, thank you for being my strength as always.

CHAPTER 1

INTRODUCTION

Introduction, objectives and overview

This chapter provides an introduction to the thesis, its objectives, contents and claimed contributions. The aim of this thesis is to contribute to understanding design's utilisation among firms, particularly its determinants and performance implications, especially in context of innovation.

The thesis is presented in a "journal format". It consists of four essentially self-contained but inter-related papers.

The first paper provides a review of empirical studies on the distributions of firms' design activities and its associated factors. This review includes studies published in English up to 2016.

The second paper is an analysis of the Innobarometer survey. It examines the factors associated with the extent of firms' commitment to design, including technological and market opportunities as well as the innovation activities and structural characteristics of a company.

The third paper is an analysis of the UK Innovation Survey. It examines the relationship between design investments and the geographical market reach or export sales of product innovators, and if the relationship is influenced by the interactions between design and R&D or marketing.

The fourth paper is an analysis of the relationship between design engagement and exporting among creative industries firms based in the UK.

Contributions

My thesis is a set of empirical studies that contribute especially to advancing understanding of the relationships between engaging in design and achieving greater geographical market reach as well as export sales. These empirical contributions are developed especially in papers 2, 3 and 4.

Specifically, paper 2 finds that a greater extent of commitment to design is associated with more intensive technological opportunities and more differentiated demand, and within companies a greater degree of commitment to other innovation activities, especially R&D and branding.

Paper 3 contributes by examining the relationship between the level of commitment to design and the geographical market reach for product innovators, and their value of exports.

Paper 4 shows that, within the specific context of the UK's creative industries, design investment is positively associated with the propensity to export as well as the value of export sales. Moreover, investing in both design and applied research is found to be related to a greater propensity to export.

In addition to academic contributions, these findings also have value in business practice and policy development. In relation to business practice, the findings indicate that relatively modest investments in design are associated with substantial advantages in terms of enhanced geographical market reach and exporting. In relation to policy development, the findings indicate that if policy-makers are keen to enhance exporting, then encouraging firms to engage in and invest modestly in design is likely to be beneficial to achieving this goal.

The thesis also seeks to make a modest conceptual contribution by conceiving design as an organisational capability and so contributing to the small literature on design capabilities that already exists (Swan, et al., 2005; Björklund, et al., 2020; Carlgren, et al., 2014). The use of this perspective is most explicit in Paper 2 (and Paper 3). I contend that conceptualising design as organisational capabilities is helpful in unfolding the multiple influences of design as opposed to treating it as an ad-hoc activity.

What is design, and how is it understood in this thesis?

Design, like innovation, is both an outcome and a process; that is, it is both noun and verb. As an outcome, it has been commonly associated with (beautiful or appealing) aesthetics, shapes or form, and colours or patterns. However, design outcomes extend beyond the visual, and include how a product, service or experience is intended to be used. As a process, design involves sense-making, problem-solving, and strategic choices concerning the use of materials, approach to construction and other matters (See D'Ippolito (2014) for a review). It is the bringing together of design as processes leading to outcomes that shapes the human world. As Heskett states: "Design can be defined as the human capacity to shape and make our environment in ways without precedent in nature, to serve our needs and give meaning to our lives" (Heskett, 2002, p. 7)

Design can contribute in multiple ways within companies, including to the development of design-driven and design-inspired innovations (Verganti, 2009; Utterback, et al., 2006). However, few studies have viewed design through the lens of organisational capability including innovation capability.

Numerous scholars have attempted to define design, often within certain contexts where a cohort of people share the same understanding of it and how it is used. Among all those definitions of design, a capabilities perspective highlights design as creating things, serving needs and wants and imparting meanings. Likewise, and expressed in a more pragmatic manner, in the proposed guidelines for collecting and interpreting design data, design is identified as “an economic factor of production” (Nomen, 2014, p. 5) and is regarded as “the integration of functional, emotional and social utilities” and “the integration of the satisfaction of users/customer’s/consumer’s functional, emotional and social needs and wants” (Nomen, 2014, p. 13). This thesis therefore considers design as an organisational capability or a set of organisational capabilities oriented not only to product aesthetics and integrating forms and functions into goods, services and solutions, but also serving human needs and wants as well as imparting meanings.

Existing literature has examined the impacts of design on a range of business activities/performance, which include consumers’ response to products (Bloch, 1995; Veryzer, 1995; Creusen & Schoormans, 2004; Chitturi, et al., 2008) and firms’ overall economic performance (Gemser & Leenders, 2001; Hertenstein, et al., 2005; Montresor & Vezzani, 2020). The literature has also discussed the conditions under which design is more or less impactful (Walsh, et al., 1992; Chiva & Alegre, 2009; Candi & Saemundsson, 2011; Czarnitzki & Thorwarth, 2012). However, the literature has scarcely addressed the reasons for the uneven distribution of design use (i.e. why companies use/not use design and to what extent).

Moreover, when it comes to exporting, an aspect of business performance on which design potentially has a bearing on, the literature is largely silent, certainly relative to the attention paid to R&D and exporting (Di Cintio, et al., 2017; Esteve-Pe´rez & Rodrı´guez, 2013; Harris & Li, 2009; Aw, et al., 2008; Barrios, et al., 2003) or innovation and exporting (Golovko & Valentini, 2011; Basile, 2001; Wakelin, 1998a). Viewing design as organisational capabilities related to innovation capabilities helps to identify these gaps in the literature.

Justification of methods

As stated above, this thesis has been developed in the "journal format", and consists of four self-contained but inter-related papers.

The first paper is a review of existing studies on the extent to which firms conduct design activities and the factors associated with this. It draws on research published in the peer reviewed academic journals as well as on reports released by statistical agencies, research institutes, industry associations or professional survey companies on behalf of governmental bodies. The selection of literature was primarily based on the explicit mention of "design" (that if not the same, is closely identified in economics and management with the conceptualisation of design followed by the thesis) in the paper or report's abstract and findings. Beyond that, the studies are confined to those which were published in the English language that were included by Web of Science or which were publicly accessible at the time the review was conducted, which was in early 2017.

The second, third and fourth papers all share similarities in approach in that they are all based on analysing data-sets gathered by statistical agencies (such as the UK's Office for National Statistics – ONS) or professional survey firms on behalf of governmental bodies (the European Commission and the UK's Department for Media, Culture and Sport – DCMS).

There are costs as well as benefits to choosing to analyse existing databases rather than gathering bespoke data, either through qualitative research or by undertaking a survey.

The primary cost is a loss of control over the definition of key concepts, not least design. Had I undertaken my own survey I would have been able to define what I understand by design (or design capabilities) and ask firms questions specifically about this. However, it should also be appreciated that gathering survey responses from several hundred or more respondents is challenging, as response rates are typically low, and large numbers of responses are required for the application of sophisticated statistical techniques such as those applied in the papers in this thesis. A thesis specific survey also has the drawback that replication of the study would be unlikely due to resources required, and therefore that approach risked the study becoming another ad hoc study of design engagement.

While the use of “off the shelf” datasets gathered by statistical agencies and/or survey companies has disadvantages including loss of control over the questions asked, the use of such data is widespread in the fields of innovation studies and strategy. For example, the journal Research Policy, which is widely regarded as one of the world’s leading innovation studies journal has published over 90 articles which examine the Community Innovation Survey, the UK version of which analysed in the third paper included in this thesis. These studies include analyses of business practices such as cooperation (Tether, 2002) and co-operative R&D (Miotti & Sachwald, 2003; Belderbos, et al., 2004; Marchi, 2012), while other papers examine strategies, e.g., make or buy (Veugelers & Cassiman, 1999), “openness” (Laursen & Salter, 2014) and capabilities/capacities (e.g., “absorptive capacity” (Escribano, et al., 2009)) including by operationalising concepts (such as openness and absorptive capacity) not directly asked about in these surveys. Furthermore, six articles which analyse Community Innovation Surveys or their national variants have been published in the Journal of Product Innovation Management, another world class innovation journal including, most recently, a study of process innovation by Tsinopoulos and colleagues (2018). Also notable here is Laursen and Salter’s (2006) study published in the Strategic Management Journal, which was based on an analysis of UK innovation survey data and which examined the role of “openness” in explaining innovation performance among UK manufacturing firms although “openness” is not defined directly by the UK innovation survey.[1]

Although less widely used, papers which undertake analyses of the Innobarometer data have also been published in highly regarded journals. These include Tether and Tajar’s (2008) (Research Policy) use of the 2002 Innnobarometer survey to identify the organisational cooperation mode of innovation and its prominence among European service firms, Meanwhile, Montresor and Vezzani’s (2016) (Industry and Innovation) study of intangible investments and innovation propensity used the 2013 version of the Innobarometer.

The fourth paper is based on an ad hoc survey (although based on the Community Innovation Survey), and can be considered similar to Roper and colleagues’ (2016) (Research Policy) study on the roles and effectiveness of design in new product development which used existing “off the shelf” survey data on Irish manufacturing plants.

[1] This paper, which is among the most highly cited Strategy Management Journal papers won the 2021 Dan and Mary Lou Schendel Best Paper Prize in the Strategic Management Society awards.

All of these published studies have in essence made the same choice that has been made in this thesis, that is giving up control of the questions asked to respondents and instead made use of “off the shelf” datasets, which have many hundreds or thousands of responses. Large existing datasets enable me to utilise statistical methods such as Heckman two-step regressions and a two-stage approach involving a Probit regression followed by a linear regression.

Aside from saving the time and expense of gathering such large amounts of data, the use of established datasets, and especially those such as the Community Innovation Survey, have the advantage of replicability: studies undertaken in one country and one time period can be replicated in another country and/or time period, something that is difficult and costly to do with bespoke surveys. They also have the advantage that the surveys are conducted professionally, by statistical agencies or research businesses whose core competences include the gathering of reliable statistical evidence. For example, the Office for National Statistics undertakes cognitive testing before putting surveys into the field.

The thesis follows a quantitative research design that adopts a pragmatic perspective; that is “considering theories, concepts, ideas, hypotheses and research findings not in an abstract form, but in terms of the roles they play as instruments of thought and action, and in terms of their practical consequences in specific contexts” (Saunders, et al., 2019). This perspective can be associated partly with positivism and partly with interpretivism. On the one hand, the objects of research are considered observable “facts”; they are measured; and the hypotheses about them are tested using statistical methods, highly structured data and large samples. On the other hand, it is acknowledged that the survey data are self-reported, hence reflect the respondents’ interpretations and are constrained by their own circumstances. Therefore, the thesis focuses on the research questions; selects, analyses and interprets the data to the best of our knowledge and resources available; and aims to create new knowledge/understandings and inform future practice.

In selecting the surveys to be analysed, I have (with the exception of the Creative Industries study – see below) prioritised breadth and representativeness, including by firm size, industrial sectors included and geographical location of the businesses. I have also sought to analyse recent data to maximise contemporary relevance. In relation to the study on the Creative Industries, this is narrower in scope, and the dataset is smaller. However, the opportunity to analyse this dataset became available during the Covid-19 pandemic when access to other data such as the UK Innovation

Survey – which is only accessible through the secure data service – became very difficult. I therefore decided to use this dataset to study investments in design and connections between design and exporting in the Creative Industries.

More details about the research methods are discussed in each paper.

These papers are presented in the following chapters, before the final concluding chapter bringing together the findings.

References

Aw, B. Y., Roberts, M. J., & Xu, D. Y. (2008). R&D investments, exporting, and the evolution of firm productivity. American Economic Review, 98(2), 451-456.

Barrios, S., Görg, H., & Strobl, E. (2003). Explaining firms' export behaviour: R&D, spillovers and the destination market. Oxford Bulletin of Economics and Statistics, 65(4), 475-496.

Basile, R. (2001). Export behaviour of Italian manufacturing firms over the nineties: the role of innovation. Research Policy, 30(8), 1185-1201.

Belderbos, R., Carree, M., & Lokshin, B. (2004). Cooperative R&D and firm performance. Research Policy, 33(10), 1477-1492.

Björklund, T., Maula, H., Soule, S. A., & Maula, J. (2020). Integrating design into organizations: The coevolution of design capabilities. California Management Review, 62(2), 100-124.

Bloch, P. H. (1995). Seeking the ideal form: Product design and consumer response. Journal of Marketing, 59(3), 16-29.

Candi, M., & Saemundsson, R. J. (2011). Exploring the relationship between aesthetic design as an element of new service development and performance. Journal of Product Innovation Management, 28(4), 536-557.

Carlgren, L., Elmquist, M., & Rauth, I. (2014). Design thinking: Exploring values and effects from an innovation capability perspective. The design journal, 17(3), 403-423.

Chitturi, R., Raghunathan, R., & Mahajan, V. (2008). Delight by design: The role of hedonic versus utilitarian benefits. Journal of Marketing, 72(3), 48-63.

Chiva, R., & Alegre, J. (2009). Investment in design and firm performance: The mediating role of design management. Journal of Product Innovation Management, 26(4), 424-440.

Creusen, M. E., & Schoormans, J. P. (2004). The different roles of product appearance in consumer choice. Journal of Product Innovation Management, 22(1), 63-81.

Czarnitzki, D., & Thorwarth, S. (2012). The contribution of in-house and external design activities to product market performance. Journal of Product Innovation Management, 29(5), 878-895.

D′Ippolito, B. (2014). The importance of design for firms′ competitiveness: A review of the literature. Technovation, 34(11), 716-730.

Di Cintio, M., Ghosh, S., & Grassi, E. (2017). Firm growth, R&D expenditures and exports: an empirical analysis of italian SMEs. Research Policy, 46(4), 836-852.

Escribano, A., Fosfuri, A., & Tribó, J. A. (2009). Managing external knowledge flows: The moderating role of absorptive capacity. Research Policy, 38(1), 96-105.

Esteve-Pe´rez, S., & Rodrı´guez, D. (2013). The dynamics of exports and R&D in SMEs. Small Business Economics, 41(1), 219-240.

Gemser, G., & Leenders, M. A. (2001). How integrating industrial design in the product development process impacts on company performance. Journal of Product Innovation Management, 18(1), 28-38.

Golovko, E., & Valentini, G. (2011). Exploring the complementarity between innovation and export for SME's growth. Journal of International Business Studies, 42(3), 362-380.

Harris, R., & Li, Q. C. (2009). Exporting, R&D, and absorptive capacity in UK establishments. Oxford Economic Papers, 61(1), 74-103.

Hertenstein, J. H., Platt, M. B., & Veryzer, R. W. (2005). The impact of industrial design effectiveness on corporate financial performance. Journal of Product Innovation Management, 22(1), 3-21.

Heskett, J. (2002). Toothpicks and logos: Design in everyday life. Oxford: Oxford University Press.

Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. Strategic Management Journal, 27(2), 131-150.

Laursen, K., & Salter, A. J. (2014). The paradox of openness: Appropriability, external search and collaboration. Research Policy, 43(5), 867-878.

Marchi, V. D. (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. Research Policy, 41(3), 614-623.

Miotti, L., & Sachwald, F. (2003). Co-operative R&D: Why and with whom?: An integrated framework of analysis. Research Policy, 32(8), 1481-1499.

Montresor, S., & Vezzani, A. (2016). Intangible investments and innovation propensity: Evidence from the Innobarometer 2013. Industry and Innovation, 23(4), 331-352.

Montresor, S., & Vezzani, A. (2020). Design centrality, design investments and innovation performance: An empirical analysis of European firms. Industrial and Corporate Change, 29(2), 351–374.

Nomen, E. (2014). Guidelines for collecting and interpreting design data: A proposal for a future Barcelona manual on design. Barcelona: Barcelona Design Centre.

Roper, S., Micheli, P., Love, J. H., & Vahter, P. (2016). The roles and effectiveness of design in new product development: A study of Irish manufacturers. Research Policy, 45(1), 319-329.

Saunders, M. N., Lewis, P., & Thornhill, A. (2019). Research methods for business students (Eighth ed.). Harlow: Pearson Education.

Swan, K. S., Kotabe, M., & Allred, B. B. (2005). Exploring robust design capabilities, their role in creating global products, and their relationship to firm performance. Journal of product innovation management, 22(2), 144-164.

Tether, B. (2002). Who co-operates for innovation, and why: An empirical analysis. Research Policy, 31(6), 947-967.

Tether, B. S., & Tajar, A. (2008). The organisational-cooperation mode of innovation and its prominence amongst European service firms. Research Policy, 37(4), 720-739.

Tsinopoulos, C., Sousa, C. M., & Yan, J. (2018). Abandoning innovation activities and performance: The moderating role of openness. Journal of Product Innovation Management, 35(1), 27-48.

Utterback, J. M., Ekman, S., Sanderson, S. W., Vedin, B.-a., Verganti, R., Tether, B., & Alvarez, E. (2006). Design-inspired innovation. World Scientific Publishing.

Verganti, R. (2009). Design driven innovation: changing the rules of competition by radically innovating what things mean. Boston: Harvard Business Press.

Veryzer, J. R. (1995). The place of product design and aesthetics in consumer research. Advances in Consumer Research, 22(1), 641-645.

Veugelers, R., & Cassiman, B. (1999). Make and buy in innovation strategies: Evidence from Belgian manufacturing firms. Research Policy, 28(1), 63-80.

Wakelin, K. (1998a). Innovation and export behaviour at the firm level. Research Policy, 26(7-8), 829-841.

Walsh, V., Roy, R., Bruce, M., & Potter, S. (1992). Winning by design: Technology, product design and international competitiveness. Oxford: Blackwell Publishers.

CHAPTER 2

DESIGN AND INNOVATION:

A REVIEW OF EMPIRICAL STUDIES

Introduction

The aim of this chapter is to review existing empirical evidence on the extent to which businesses engage in design activities, and how this has been found to vary, for example by firm size and/or sector of activity. In order to address these questions, this review will first introduce the distribution of design (investment) at macro-level, through the lens of intangible (knowledge) assets; it will then move on to micro-level evidence derived from a selection of business surveys (where company is the unit of analysis) or studies based on these surveys. These surveys which request firm-level data on design activities and investments were published in the English language up to 2016; they are large-scale surveys conducted by national statistical agencies or other professional surveying services. They are categorised into four groups based on their similarity in the themes or initiators. By describing and summarising the key findings from existing surveys (and studies based on them), this review aims to understand what has been discovered about the distribution of businesses' design activities in the economy and the factors potentially affecting this distribution. This review therefore provides the foundations for future research on the factors associated with businesses' commitment to design, and helps to ground future studies on the extent and distribution of design activities.

Design is increasingly recognised as a crucial contributor to innovation, economic growth and competitiveness, and the contribution of design is understood to be changing. Historically, design has been used as a tool to "wrap" ideas in the form of styling or presentation – that is as a "last touch" in the innovation process; however, it is now increasingly acknowledged as an approach to innovation at the front end; that is, the process of idea generation and selection.

As "an economic factor of production", design can be understood as "the integration of functional, emotional and social utilities" and "the integration of the satisfaction of users/customer's/consumer's functional, emotional and social needs and wants" (Nomen, 2014, p. 13). Among all notions of design, this one highlights its contribution to the economy and the approaches by which that contribution could be realised, from the perspective of economic production, with businesses as the primary units of production. That is, it implies that businesses could achieve economic value through design. It also implies that one of the methods to understand design in businesses could be to observe firms' input to design.

The contribution of knowledge assets to economic growth offers a distinct perspective to look at design. While it is realised that knowledge development and implementation is not costless, relevant literature has long devoted to incorporate R&D investment into the growth-accounting framework (Solow, 1956). Nevertheless, not all industries undertake (measured) R&D. Thus, the source of growth is considered necessary to count in other knowledge investments in addition to R&D (Borgo, et al., 2013).

Design is recognised as a source of economic growth. Corrado, Hulten and Sichel [CHS] (2005) proposed an expanded growth-accounting framework for the economic measurement of capital that encompasses a wider range of components of business investment in intangibles, provided that the accounting practice had historically treated expenditure on (most) intangible assets as an intermediate expense rather than as an investment that is part of GDP[2]. The framework involves three broad categories of knowledge capital of a firm – computerised information, innovative property and economic competencies, which could be represented by investments in nine types of intangible assets – (1) computer software; (2) computerised databases; (3) science and engineering R&D; (4) mineral exploration; (5) copyright and license costs; (6) other product development, design, and research expenses; (7) brand equity; (8) firm-specific human capital; and 9) organisational structure.

Within this framework, design was first proxied by "new architectural and engineering design". Spending on the new architectural and engineering designs was estimated by half of industry purchased services. Their research subsequently suggested that the inclusion of intangible capital and the associated flow of income from that capital increases the capital share of income and lower the labour share of income (in the US) (Corrado, et al., 2009).

The CHS framework later was applied to assess intangible investment and its impact on productivity and growth in the UK (Marrano, et al., 2007; Gil & Haskel, 2008; Haskel, et al., 2009; Goodridge, et al., 2012; Goodridge, et al., 2014; Martin, et al., 2018)[3].

Galindo-Rueda, Haskel and Pesole (2008; 2010) in particular sought to measure the UK's "investment in design", estimated as half of the UK's total "expenditure on

[2] For instance, the US National Income and Product Accounts (NIPAs) and the System of National Accounts 1993 (SNA; Commission of the European Communities) had included computer software and mineral exploration in fixed investments, whereas scientific R&D was regarded as intermediate consumption at that time.

[3] This project was funded initially by HM Treasury (Marrano, et al., 2007), subsequently NESTA (Haskel, et al., 2009; Goodridge, et al., 2012) and IPO (Goodridge, et al., 2014). The most recent estimates are provided by ONS (Martin, et al., 2018).

design")[4] in accordance with the CHS framework. Their study relied upon the existing statistical infrastructure, including people engaged in design occupations identified by "standard occupation codes" (SOC) and "design based industries" identified by "standard industrial codes" (SIC)[5]. This will provide a macro-economic perspective to look at the aggregates of investments in intangible assets including design.

Subsequently, this research team participated in the NESTA[6] led National Innovation Index Project which sought to measure innovation in the UK market sector[7]. As part of this, Goodridge et al. (2012)[8] measured the investment in intangibles at an aggregate and industry level and used the data to perform a "source-of-growth analysis" based on the CHS framework (Corrado, et al., 2005). In particular, Goodridge et al. (2012; 2014) estimated own-account investments in design by 1) identifying design occupations and, through interviews with design companies, the time by these workers spend on design[9], 2) accounting for overhead costs by applying a multiple to their wage bills and 3) applying a fraction of time that these occupations spend developing "long-lived design". They focused on architectural and engineering design activities and undertook interviews with architects and engineers (excluding software), as well as with graphic, product and clothing designers. Estimates for

[4] The estimates of expenditures and investments in design reported in 2008 were later incorporated into Gil and Haskel (2008). As their methods for estimating investments in design were revised over time, the present paper will refer to more recent estimates that were based on updated methods instead of the estimates reported in Galindo-Rueda et al. (2008; 2010). More specifically, in the 2008 report (Galindo-Rueda et al.), the estimated "spending" on purchased and own-account design in 2004 were around £17bn and £27bn respectively (£27bn is when engineers are assumed using 75% of their time on long-lived design; this number was modified later (Galindo-Rueda, et al., 2010) assuming designers using 100% and engineers using 10% of their time on "long-lived design" – £17bn); and the "investment" in design was estimated around half of total design "spending" – a distinction was made between design spending and design investment. The 2008 design investment reported in Haskel and Pesole (2011), Farooqui, Goodridge and Haskel (2011) and Borgo et al. (2013) was £23bn. Nevertheless, the measurement was considered with a risk of double-counting and therefore amended again subsequently – purchases of design by design companies were excluded. Further explanation can be found in Goodridge, Haskel and Wallis (2012, pp. 65-66; 2014, p. 15). The amended 2008 design investment suggested in 2012 report is £15.5bn.

[5] Notably, Pina and Tether (2016) found a substantial number of firms classified as being engaged in "architecture (and engineering consultancy)" (57%), "computer software and IT consulting" (19%) and "specialist design" (23%) appeared to emphasise producing and selling products, as opposed to providing services.

[6] National Endowment for Science Technology and the Arts

[7] That is, the results of Galindo-Rueda et al. (2008) was later incorporated into Gil and Haskel (2008).

[8] The 2012 report applied an amended methodology for measuring expenditure on design relative to the interim report Haskel et al. (2009). Meanwhile, this report updated the industry-level intangible data reported in Gil and Haskel (2008).

[9] It was found that almost all of the design firms they interviewed had time sheets for recording the time their employees spend on design, administration and client interaction/pitching for new business; and almost all of them expected, for example, that junior designers would spend less time on administration, and senior designers would spend more time on pitching for new business. Therefore, they assigned 50% of time spending on "long-lived design" for professional designers, 10% for engineers and 60% for the rest (Goodridge, et al., 2014). In addition, as mentioned earlier, the estimate of design expenditure will be further reduced by 50% to account for design investment, based on the findings of interview and study by the UK Design Council. Nonetheless, they noted the possibility of double-counting with R&D due to the wages and salaries of engineers that would be reported elsewhere, albeit not all engineers are involved in R&D.

purchased design were allocated to industries on the basis of exchanges recorded in the official Supply-Use (or Input Output) tables used to compile the national accounts.

Drawing on the data covering eight broad industries[10], Goodridge et al. found that the UK's investment in "long-lived knowledge" which subsequently creates intangible assets has exceeded investment in tangible assets since the early 2000s. Their 2012 estimates of intangible and tangible investment in the UK market sector were £124bn and £93bn in 2009 respectively, with 70% of the intangible investment being own-account rather than bought-in. As presented in Table 1, in terms of investments in individual intangible assets, training (£26bn; 21%), organisational capital (£26bn; 21%) and software (£23bn; 18%) constituted the largest investments in intangibles - and incidentally were "particularly important in services" - while the estimated investment in design was slightly higher (£16bn; 13%) than that in R&D (£14bn; 11%). Table 2 shows the estimated investments in design by sector based on 2007 data. These estimates of the UK market sector's investment in design indicated that a quarter of the total investment in design was from manufacturing; nearly a fifth by distribution, hotels and transport; 17% by business services; 15% by construction; 11% by financial services; 7% by personal services; 3% by utilities; and 3% by agriculture, fishing and mining. By contrast, investment in R&D was highly concentrated in manufacturing (87%); and some investments were found in distribution, hotels and transport (12%). This implies that design was more accessible than R&D to a variety of businesses across the economy. In 2007, over half of the UK GVA was attributable to manufacturing, distribution, hotels and transport (over three quarters was attributable to these sectors plus business services) (see Table 3). Provided that a considerable proportion of the investment in design was provided by these sectors, this implies that design was not only "universal" to different businesses cross industrial sectors, but also an essential element of the UK economy.

[10] The eight industries (classified according to NACE rev. 1) include 1) agriculture, fishing and mining (A, B and C); 2) manufacturing (D); 3) electricity, gas and water supply (E); 4) construction(F); 5) wholesale and retail trade, hotels and restaurants, transport and communications (G,H and I); 6) financial services (J); 7) business services (K); and 8) personal services (O and P).

Table 1 UK investment in intangibles, by asset, 2009

	£bn	% [11]
Software	22.6	18.2
Scientific R&D	14.0	11.3
Design	15.5	12.5
Branding	12.8	10.3
Organisational capital	25.7	20.7
Training	25.8	20.8
Sum[12]	116.4	93.7
Total intangibles	124.2	100.0

Source: Goodridge et al. (2012, p.27).

Table 2 UK investment in intangible assets, by sector, 2007

	Software		**Sci. R&D**		**Design**		**Branding**	
	£bn	**%**	**£bn**	**%**	**£bn**	**%**	**£bn**	**%**
Agr., fishing & mining	0.2	0.9	0.1	0.7	0.5	3.3	0.1	0.8
Manufacturing	2.9	13.6	11.8	87.4	3.8	25.2	2.3	18.3
Utilities	0.6	2.8	0.0	0.0	0.4	2.6	0.2	1.6
Construction	0.4	1.9	0.0	0.0	2.3	15.2	0.5	4.0
Distribution, hotels & transp.	6.1	28.6	1.6	11.9	3.0	19.9	4.6	36.5
Finance	4.7	22.1	0.0	0.0	1.6	10.6	2.4	19.0
Business services	5.1	23.9	0.0	0.0	2.5	16.6	1.4	11.1
Personal services	1.3	6.1	0.0	0.0	1.0	6.6	1.1	8.7
Sum[13]	21.3	100.0	13.5	100.0	15.1	100.0	12.6	100.0

	Org. capital		Training		Sum	Total
	£bn	%	£bn	%	£bn	£bn
Agr., fishing & mining	0.5	1.9	0.5	1.7	1.9	2.5
Manufacturing	4.9	18.3	3.8	13.1	29.5	29.5
Utilities	0.7	2.6	0.6	2.1	2.5	2.5
Construction	1.6	6.0	2.6	9.0	7.4	7.4
Distribution, hotels & transp.	7.6	28.4	8.0	27.6	30.9	30.9
Finance	5.3	19.8	1.3	4.5	15.3	16.6
Business services	5.2	19.4	10.1	34.8	24.3	24.8
Personal services	1.0	3.7	2.1	7.2	6.5	11.7
Sum[14]	26.8	100.0	29.0	100.0	118.3	125.9

Source: Goodridge et al. (2012, pp.30-31).

[11] Authors' calculations based on the data provided.
[12] This table does not contain all the intangible assets identified by the source.
[13] The sums and percentages are authors' calculations.
[14] The sums and percentages are authors' calculations.

Table 3 UK Gross Value Added, by sector, 2007

	£m	% of market sector	% of whole economy
Agriculture, fishing & mining	29009	3.5	3.4
Manufacturing	158234	19.3	18.7
Utilities	30149	3.7	3.6
Construction	74860	9.2	8.9
Distribution, hotels & transport	282705	34.6	33.5
Finance	-	-	-
Real estate renting and business activities	206014	25.2	24.4
Community social and personal service activities	37089	4.5	4.4
Sum[15] (market sector[16])	818060	100.0	96.8
Total (whole economy)	844871	-	100.0

Source: ONS (2010).

According to their 2014 estimates (see Table 4), UK market sector invested £13bn in design in both 2010 and 2011 respectively. This corresponded to 10% of the UK market sector's total investment in intangibles in 2010 (£128bn) and 2011 (£126bn); and was the smallest of the six intangible assets assessed in both years. Training (21%; 20%), organisational capital (21%; 20%) and software (18%; 19%) remained the largest fractions of the total intangible investments in 2010 and 2011, while investments in R&D (12%; 13%) and branding (11%; 11%) also exceeded those in design.

Table 4 UK investment in intangibles, by asset, 2010 and 2011

	£bn		% [17]	
	2010	**2011**	**2010**	**2011**
Software	23.3	24.2	18.3	19.1
Scientific R&D	14.5	15.9	11.4	12.5
Design	12.8	12.9	10.0	10.2
Branding	13.5	14.0	10.6	11.0
Organisational capital	27.0	25.5	21.2	20.1
Training	27.4	25.0	21.5	19.7
Sum[18]	118.5	117.5	92.9	92.6
Total intangibles	127.6	126.9	100.0	100.0

Source: Goodridge et al. (2014, p.9).

The most recent estimates of investment in intangible assets in the UK provide data for 2015 (see Table 5) (Martin, et al., 2018). These estimates record that UK businesses spent almost £15bn on design, including £10bn on purchased design and £5bn on own-account design. These estimates again show design as being the smallest of the six intangible investments, with training, organisational capital and

[15] The sums and percentages are authors' calculations.
[16] SIC 2003 sections A-I, K and O.
[17] Authors' calculations based on the data provided.
[18] This table does not contain all the intangible assets identified by the source.

software still leading. The extent of investment in design is however estimated as being close to that in brandings and is more than three-quarters that in R&D.

Table 5 UK investment in intangibles, by asset, 2015

	£bn	%
Software	20.2	15.0
R&D	19.2	14.3
Design	14.7	11.0
Branding	15.0	11.2
Organisational capital	24.9	18.6
Training	31.8	23.7
Sum[19]	125.8	93.7
Total intangibles	134.2	100.0

Source: Martin et al. (2018, p.10).

Although the precise concept and measurement of design in these studies is open to question, these various studies have "put design on the map", alongside other intangibles, not least R&D which has long been recognised as an "engine of innovation", and have demonstrated that substantial investments are made by the UK market sector into design. We suggest that the true contribution of design may also be being under-recorded in these studies, as design is a contributor to the development of arguably all of the other intangible assets. Some design is certainly "hidden" within R&D, while design is a contributor to the development of software and branding. Less obviously, design can also be understood to contribute to the development of training and/or organisational capital.

Micro-level survey on intangibles

While the studies reported above have highlighted the scale of the UK market sector's aggregate investment in design, they do not shed light on the extent of, or patterns of investment at the micro level. However, in the course of their work, the same researchers undertook two surveys of firms' investment in intangibles, including requesting estimates of firms' investments in design. Note that these surveys essentially relied upon the survey respondents not only being cognisant of what design is, but were also able to report the extent of their firm's investments in design.

Investment in Intangible Assets Survey

The Investment in Intangible Assets (IIA) Survey was also part of the NESTA Innovation Index project and was conducted by the Office for National Statistics

[19] This table does not contain all the intangible assets identified by the source.

(ONS). It was a voluntary survey which concerned UK businesses' spending (both own-account and purchased) on intangibles, including R&D, design, training, software, branding and business process – the same set intangibles identified by Corrado et al. (2005). The IIA survey also asked about the length of time respondents expected to benefit from such investment.

The first IIA Survey was undertaken between October 2009 and January 2010 (Awano, et al., 2010), and received completed responses from 838 UK firms with ten or more employees across the production and service industries[20]. The survey achieved a response rate of 42%, and of the participating firms 58% (unweighted) reported spending on at least one of the six intangible assets.

The second IIA Survey was undertaken between October 2011 and January 2012 (Field & Franklin, 2012). This involved an increased sample size (2,540) and obtained a larger response and a higher response rate (1,180 firms; 47%).[21] Overall, two-fifths (40% - weighted) of the firms responding to this survey reporting spending on at least one of the six types of intangible assets

Table 6 reports the share of firms that reported expenditures on the six types of intangible asset, as well as their aggregated expenditures on these assets. The two surveys conducted both detected 10% of UK businesses (with 10 or more employees) investing in design. In both years design was found to be more widespread than R&D, which was undertaken by 8% and 6% of firms in 2008 and 2010 respectively. Notable also is that while the share of firms engaged in design remained unchanged, the share of firms that invested in all of the other intangible assets had declined. The amount spent on design was also unchanged while expenditures on the other intangibles (except for training) had decreased. This was a period of economic uncertainty following the financial crisis of 2008.

[20] Sampling was modified "to reduce the sample weight on construction, utilities and Sections G (Distribution), H (Transport) and I (Accommodation) of the service sector" due to the below-average levels of innovation in these industries. Instead, engineering-based manufacturing, Section J (information and communication) and Section K (financial and insurance activities) were slightly over-sampled. Furthermore, the data of expenditure was weighted using employment weights to represent the UK population of businesses including those with employees fewer than 10.

[21] The IIA survey obtained higher rates of response from smaller firms (10 – 499 employees) than larger firms (500 or more employees).

Table 6 IIA Survey – expenditure in intangible assets

	% of firms		Total £m	
	2008	2010	2008	2010
Training	35.0	30.0	7059	7307
Software	30.0	22.2	11332	9995
Reputation & branding	22.0	15.5	9165	8325
R&D	8.0	5.9	9230	5721
Design	10.0	10.0	1156	1150
Business process improvement	13.0	8.3	1377	846

Source: Field and Franklin (2012, pp.5-6).

The first IIA survey found that production firms (i.e., manufacturing, construction and utilities) were more likely to have invested in design than firms in the services sector (14%, cf. 9%). Overall, 46% of design investment was made by manufacturers industry, whereas the financial services sector accounted for just 1%. Also notable is that large firms with more than 500 employees (19%) were almost twice as likely to have invested in design as smaller firms with under 500 employees (10%)[22]. Design investments were also more widespread among established (or older) firms than younger firms, with 92% of the firms investing in design having been established for more than five years. Overall, 90% of all of the UK intangibles investments were made by established firms, and established firms also spent four times more on in-house design (£0.8bn) than on purchased design (£0.4bn). Young firms, meanwhile, were recorded to have spent a negligible amount on design externally and spent just £0.1m on in-house design.

Table 7 First IIA Survey - engagement of expenditure on intangibles (% of firms), by sector, firm size and firm age

	Training	Software	Reputation & branding	R&D	Design	Business process improvement
Sector						
Production	35	30	18	14	14	14
Services	34	30	23	6	9	13
Firm size						
10-499	34	30	22	8	10	13
≥ 500	70	57	38	19	19	33
Firm age						
> 5 years	91	89	87	84	92	87
≤ 5years	9	11	84	16	8	13

Source: Awano et al. (2010, pp.14-15).

The first IIA Survey found that the average life-span of investments in design was 4 years, with this being longer in the production sector (4.6 years) than in services (3.7 years). Larger firms also reported longer life-spans than smaller firms (5 years, cf. 4 years). However, the second IIA Survey found the average life-span of design

[22] Larger firms also had higher average expenditure on design than smaller firms (Awano et al., 2010, p.18).

investments was under 3 years (2.9 years), and the average life-span of design investments in the production sector was now below that in the services sector (2.7 years, cf. 3 years).

Table 8 IIA Survey - average life-span of intangible assets (years), by sector and firm size

		Training	Software	Reputation & branding	R&D	Design	Business process improvement
Total	2008	2.7	3.2	2.8	4.6	4.0	4.2
	2010	2.7	3.4	2.6	4.2	2.9	3.1
Sector							
Production	2008	2.9	3.4	4.1	5.5	4.6	5.4
	2010	3.2	3.8	3.0	4.1	2.7	4.2
Services	2008	2.7	3.2	2.6	4.3	3.7	4.0
	2010	2.4	3.2	2.4	4.2	3.0	2.5
Firm size							
10-499	2010	2.7	3.2	2.8	4.6	4.0	4.2
≥ 500		2.5	3.6	2.9	4.8	5.0	3.2

Source: Awano et al. (2010, pp.24-25); Field and Franklin (2012, pp.14-15).

Section summary

The aforementioned studies on intangibles indicate that around 10-13% of the total investment in intangibles has been spent on design in the UK since 2007. Expenditure on design is more widespread than spending on R&D but less widespread than the other intangible assets identified. Firms invest more in in-house design than bought-in design. Design could be an accessible intangible asset to business across a wide scope of industrial sectors, while it was relatively more widespread among larger firms and those operating in production sectors. Design also played a significant role in the UK economy provided the relative importance of the sectors to which a substantial proportion of the UK GVA and investment in design could attribute.

In 2013, a survey of intangibles was undertaken across the European Union. As this is part of a set of Innobarometer surveys which have also addressed the extent to which firms engaged in design, this survey will be included in the section of Innobarometer.

Community Innovation Survey

A further source of information on firms' expenditures on design is the Community Innovation Surveys (CIS) which have been undertaken in European Union countries since the early 1990s. These surveys are based on the OECD/European Commission

“Oslo Manual” guidelines on the collection and interpretation of innovation data, three editions of which have been published (OECD and Eurostat, 1992; 1997; 2005)[23]. An aim of the CIS was to directly estimate the extent to which firms engage in innovation, and to uncover the importance of various inputs to innovation, including but also extending beyond R&D.

Specifically, conventions have been adopted to deliver operational definitions that can be applied to standardised surveys.

The Oslo Manual was initially developed to identify and measure technological product and process (TPP) innovation[24] within the manufacturing sector. The framework has since been expanded to include services provided by private sector businesses, and to embrace additional forms of innovation, specifically “marketing innovation” and “organisational innovation”[25].

In the third and current edition of the manual (OECD and Eurostat, 2005), Innovation is defined as “*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations*” (p.46). Table 9 provides the precise definitions of these four types of innovation (OECD and Eurostat, 2005). A firm that has implemented at least one innovation during the period under review is considered as innovative firm[26].

[23] Surveys based on the Oslo Manual are also undertaken in other countries, including the United States and Canada. By the time this review was conducted (early 2017), the Oslo Manual was being reviewed by the OECD; and the fourth edition was later published in 2018 (OECD and Eurostat, 2018).
[24] The first and second editions of Oslo manual both apply the TPP definition of innovation which refers to innovations comprising “implemented technologically new products and processes and significant technological improvements in products and processes”. Additionally, “a TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation)” (OECD and Eurostat, 1997, p. 130).
[25] Marketing innovation was newly introduced to the third edition, whilst organisational innovation had been discussed in the second edition and data on organisational changes had been included in some innovation surveys including the CIS 3.
[26] The (TPP) innovative firm defined in the first and second editions of Oslo manual is similar to the definition of product/process innovative firm introduced in the third edition, which refers to a firm that has “implemented a new or significantly improved product or process during the period under review” (OECD and Eurostat, 2005, p. 47).

Table 9 Four types of innovation defined in the 3rd edition of Oslo Manual

Type of Innovation	Definition
Product innovation	"*…is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in the technical specifications, components and materials incorporated software, user friendliness or other functional characteristics*."
Process innovation	"*…is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses.* This includes significant improvements in technical specifications, component and materials incorporated software, user friendliness or other functional characteristics."
Marketing innovation	*"…is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.*"
Organisational innovation	"*…is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations*."

Source: OECD & Eurostat (2005, pp.48-51). Emphasis added.

The Oslo Manual considers that innovation activities comprise "*all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations*" (OECD and Eurostat, 2005, p. 47).

Design is considered in relation to both innovation outputs and the inputs to innovation, but it is positioning within both is subsidiary (i.e., it is a part of a larger category, rather than a category in its own right).

In relation to the outputs, an innovation in product design, where design is confined to the "the form and appearance of products" is considered one form of a "marketing innovation" (rather than a "product innovation") if the functionality of the product remains essentially unchanged. However, a new or significantly changed product which includes both changes in functionality and in form or appearance should be classified as a "product innovation", not all of which need to have a significantly changed form or appearance. So, leaving aside whether design innovations should be confined to those with new forms or appearances, this means that design innovations are a combination of a sub-set of "marketing innovations" plus a sub-set of "product innovations".

In relation to the "inputs to innovation", design is recognised by the Oslo Manual as being partially included in R&D, and partially being separate from R&D. Specifically, the Oslo Manual recognises that "design" involves a variety of activities directed at "planning and designing procedures, technical specifications and other user and functional characteristics for new product and processes" (p. 94). The Manual suggests that all design activities for the development and implementation of product[27] and process innovation should be included in R&D[28] or as "other preparations for product and process innovation". Because of the primacy of R&D, and the desire to avoid double counting, in most countries' CIS surveys, design activities (and related expenditures) are not explicitly identified, but are partially "hidden" within R&D and otherwise included in the category of "other preparations". Therefore, while the Oslo Manual recognises that "design" makes significant contributions to innovation, unlike the surveys of intangibles reviewed in last section in which design-related information was requested explicitly, the Community Innovation Survey (CIS) explicitly consider design as a form of marketing innovation and as part of the preparations for product or process innovation.

Exceptionally, the UK's versions of the CIS have departed from the Oslo Manual's guidelines in some aspects related to design. In particular, the UK innovation surveys have not asked about "other preparations" but have instead asked about "all forms of design" from the CIS 4, which was conducted in 2005[29]. Also, in the 4th, 5th (UK CIS 2006) and 6th waves (UK CIS 2008) of the UK Innovation Survey, "design activities in the R&D phase of product development" were excluded from "all forms of design". However, since UK CIS 2010, firms have not been asked to deduct design activities undertaken within R&D, therefore potentially allowing double counting.

The CIS's approach to break down innovation activities is shown in Table 10.

The CIS is in essence a set of large-scale surveys on the innovation activities of firms, which is now (since 2004) carried out every second year by the national statistical departments and agencies of the member states of European Union (EU), and some other countries. Eurostat started to offer a standard core questionnaire with supplementary definitions and methodological recommendations from the third wave of the CIS, which was carried out in 2000/2001[30].

---

27 Including the effort made for the form and appearance of a product

28 R&D involves design activities including "initial preparations for the planning of new products and processes, and work on their design and implementation, including adjustments and further changes"; and also planning of technical specifications for new products and processes accomplished by industrial design (OECD and Eurostat, 2005, p. 94).

29 In the UK CIS 3, firms were asked about "all design functions, including industrial, product, process and service design and specifications for production or delivery". In the UK CIS 2, design was not asked explicitly.

30 The first CIS was confined to manufacturing. Second survey extended the CIS to services yet two different core questionnaires were offered to manufacturing and services respectively. These two waves of the CIS were implemented on a voluntary basis by countries. There was no standardised methodology or questionnaire implemented at national level. For more details, see http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm.

The remainder of this session will review the findings of several empirical studies that draw upon the CIS and present their key findings with regard to design. Note that care needs to be taken in comparing the findings from these studies as the definitions of design involved have not been entirely consistent.

Table 10 Innovation activities categorised by the 3rd edition of Oslo Manual

Innovation Activities	Description
Research and experimental development	
Intramural (in-house) R&D	*"Creative work undertaken on a systematic basis within the enterprise in order to increase the stock of knowledge and use it to devise new applications"*[31]
Acquisition of extramural R&D	*"Same activities as intramural R&D, but purchased from public or private research organisations or from other enterprises*[32]*."*
Activities for product and process innovations	
Acquisition of other external knowledge	"*Acquisition of rights to use patents and non-patented inventions, trademarks, know-how and other types of knowledge from other enterprises and institutions such as universities and government research institutions, other than R&D*."
Acquisition of machinery, equipment and other capital goods	"*Acquisition of advanced machinery, equipment, computer hardware or software, and land and buildings (including major improvements, modifications and repairs), that are required to implement product or process innovations*."[33]
Other preparations for product and process innovations	"*Other activities related to the development and implementation of product and process innovations, such as* ***design****, planning and testing for new products (goods and services), production processes, and delivery methods that are not already included in R&D*."
Market preparation for product innovations	"*Activities aimed at the market introduction of new or significantly improved goods or services*."
Training	"*Training (including external training) linked to the development of product or process innovations and their implementation*."
Activities for marketing and organisational innovations	
Preparations for marketing innovations	"*Activities related to the development and implementation of new marketing methods*."[34]
Preparations for organisational innovations	"*Activities undertaken for the planning and implementation of new organisation methods*."[35]

Source: OECD & Eurostat (2005, pp.97-98). Emphasis added.

CIS 3

Ciriaci (2011) undertook an analysis of the results of the third wave of the CIS which was conducted in 23 European countries in 2000/2001. Firms engaged in

[31] Including basic research
[32] Including other enterprises within the group
[33] Acquisition of capital goods that is included in intramural R&D activities is excluded.
[34] Including acquisition of other external knowledge and other capital goods that is specifically related to marketing innovations
[35] Including acquisition of other external knowledge and other capital goods that is specifically related to organisational innovations

"technological product and process" (TPP) innovation between 1998 and 2000 were asked if they had invested in training, marketing and /or design[36] in 2000. Ciriaci (2011) found that of the 15,595 "product innovators" which had invested in innovation activities (including R&D, design, marketing and training) 58% (9,118 firms) had invested in non-R&D innovation activities, which includes design[37].

Ciriaci (2011) also found that nearly 90% of the firms with spending on design were small and medium-sized enterprises (SMEs; employees $<$ 250 and turnover $\leq$ €50m), but that the extent of expenditure on design did not vary systematically with firm size, or with company ownership status (i.e., whether the firm was independent, or part of a wider group of firms). Furthermore, design investment was found to be widely distributed across industries, rather than concentrated in certain sectors. However, firms active in international markets tended to spend slightly more (1.27%) on design than firms that only served domestic markets. Ciriaci (2011) also found that firms with valid patents and registered-designs tended to spend more on design. The use of trademark, complex designs and secrecy as means to protect innovations were also associated with greater expenditures on design, especially when used to protect internally developed innovations.

UK CIS 3

The UK's version of the CIS is also known as the UK Innovation Survey, and is carried out by the UK's statistical agency – the Office of National Statistics (ONS) – on behalf of UK Government. For the UK CIS 3, firms with 10 or more employees were randomly selected using stratified sampling to include small, medium and large businesses, all UK regions and the core private sector industries, including both production and services industries. The survey generated a sample of 8,172 firms (with a response rate of 41.5%) representing a population of 126,775 enterprises.

Of the firms reporting investments in innovation activities, 9% reported investments in design, only slightly fewer than the 10% that reported investments in intramural R&D and 12% in investment in marketing (Cereda, et al., 2005).

---

[36] Labelled *rothx* in the CIS 3.

[37] Among the 9,118 firms, for those who had paid for design in 2000, there were (1) 5,134 (33%, n=15,595) investing in design as well as marketing and training; (2) 1,052 (7%, n=15,595) investing in design and marketing, yet not in training; (3) 1,487 (10%, n=15,595) investing in design and training, yet not in marketing; and (4) 1,445 (9%, n=15,595) investing exclusively in design – not in marketing and training. Notably, R&D and non-R&D innovation activities were not mutually exclusive.

Table 11 reports the percentages of firms that engaged in expenditures[38] on intramural R&D, design and marketing by firm size, industry and market. Cereda et al. (2005) found that the share of firms with expenditure on design varied systematically with firm size: 6% of small firms (with between 10 and 49 employees) reported that they had expenditures on design, compared with 11% of medium sized firms (with between 50 and 249 employees); 16% of smaller large firms (with between 250 and 499 employees); 21% of large firms (with between 500 and 999 employees); and 16% of the largest firms (with at least 1000 employees). Variation was also found across industries: 15% of manufacturing companies reported that they had expenditures on design, compared with just 4% of the firms offering traditional services, and 6% of the firms providing knowledge intensive business services (KIBS). The shares of firms investing in innovation activities, including design, also increased systematically with the geographical scope of market that the company served.

Table 11 UK CIS 3 - engagement of expenditures on innovation activities (% of firms), by firm size, industry and market

		Intramural R&D	Design	Marketing
Firm Size (Employees)	10-49	6	6	10
	50-249	11	11	13
	250-499	16	16	19
	500-999	23	21	19
	≥ 1000	23	16	19
	Total (n=8,121)	10	9	12
Industry	Primary products	-	-	-
	Manufacturing	16	15	14
	Utilities	-	-	-
	Construction	3	5	6
	Traditional services	4	4	11
	KIBS	10	6	16
	Total (n=8,121)	10	9	12
Market	Local	2	3	6
	Regional	4	4	9
	National	12	12	15
	International	27	21	21
	Total (n=7,972)	10	9	12

Source: Cereda et al. (2005, pp.35-38).

Table 12 shows that among firms reporting any expenditure on innovation activities (i.e. intra-mural R&D, extra-mural R&D, machinery related to innovation, licensing of know-how etc., design, training and marketing), design typically accounted for 9% of innovation expenditures, compared with 13% on intra-mural R&D plus 3% on extra-mural R&D; 8% on training; 7% on marketing; 7% on licensing of know-how; and more than half (53%) on machinery and equipment. Manufacturing sector was found

[38] I.e. the shares of firms reporting that they had spent on that activity, while firms might not report an estimate of the expenditure on that activity.

spending the most proportion of innovation expenditure on design (13%), compared with primary products (9%), construction (6%), traditional services and KIBS (5%). Interestingly, Cereda et al. (2005) also found that firms engaged in international business reported spending a greater proportion of their total spending on innovation on design (15%), compared to 12% for firms active in national market, 4% for firms active within their regional (but not national) market and 3% for firms only active in their local market.

Table 12 UK CIS 3 - expenditures on innovation activities (% of innovation expenditure), by firm size, industry and market

	Intramural R&D	Extramural R&D	Machinery	Knowhow	Design	Training	Marketing
Firm Size (Employees)							
10-49	8	2	61	6	6	9	7
50-249	14	3	50	7	11	8	7
250-499	18	4	41	8	13	7	10
500-999	23	7	35	8	16	5	6
≥ 1000	27	5	38	7	13	5	6
Industry							
Primary prod.	5	5	59	10	9	7	4
Manufacturing	17	3	51	5	13	5	6
Utilities	26	10	34	8	0	20	2
Construction	4	1	64	6	6	15	5
Trad. services	5	2	59	9	5	10	10
KIBS	15	4	46	9	5	12	9
Market							
Local	2	1	72	6	3	12	5
Regional	5	1	68	6	4	10	6
National	15	4	47	7	12	7	9
International	26	5	37	6	15	5	6
Total	13	3	53	7	9	8	7

Source: Cereda et al. (2005, pp.41-42).

UK CIS 4

Utilising data from the UK's fourth edition of the CIS (UK CIS-4), which was conducted in 2005, Vinodrai et al. (2007) found that 19% of the firms[39] reported design expenditure in relation to their innovation activities. This was fewer than the share of firms which reported spending on in-house R&D (32%) and capital expenditures (47%) as inputs to innovation. Vinodrai et al. also found that design investments accounted for 5% of firms' total expenditures on innovation in 2004. Vinodrai et al. did not find a significant difference between the propensity to invest in design among KIBS firms, those in manufacturing and those in retailing.

Vinodrai et al. (2007) defined "design-led" innovators as those that had either invested in design, or applied for a registered design or used design complexity to protect

[39] Information of sampling is not available.

innovations. They found that 31% of innovators could be identified as “design-led”. They also identified as “technology led” those innovators that engaged in internal or external R&D, and/or assigned some importance to patents to protect innovations, finding that a third of innovators could be identified as such. Considerable overlap (24%) was found between these two sets of innovators (see Table 13), which suggests that many firms are both design and technology innovators, rather than one or the other.

Table 13 UK CIS 4 - technology-led and design-led firms (% of firms)

	Not design-led	**Design-led**	Total
Not technology-led	59.5	7.3	66.8
Technology-led	9.2	24.0	33.2
Total	68.7	31.3	100.0

Source: Vinodrai et al. (2007, p.70).

The complementarities between design and other innovation activities were further assessed using conditional probabilities of innovation activities (see Table 14). This indicated that high proportions of firms that invested in design also reported expenditures on other innovation related activities, including intramural R&D (71%), investments in capital equipment and software (81%), innovation-related training (76%) and marketing (63%). However, the reverse was not necessarily true – the percentages of firms investing in other innovation activities that invested in design ranged between 28% and 49%[40].

Table 14 UK CIS 4 - conditional probabilities of engaging in innovation activities (%)

	Int. R&D	**Ext. R&D**	**Capital & Software**	**External Knowledge**	**Training**	**Design**	**Marketing**
Int. R&D	-	31	73	28	68	39	51
Ext. R&D	82	-	82	45	73	49	60
Cap. & Software	45	19	-	25	67	28	39
Ext. Knowl.	59	36	85	-	81	43	57
Training	49	20	77	27	-	30	45
Design	71	33	81	37	76	-	63
Marketing	60	27	74	31	74	42	-

Source: Vinodrai et al. (2007, p.72).

[40] The two activities are considered complementing each other when a conditional probability is greater than 50%.

UK CIS 2010, 2012 and 2014

For the UK versions of the CIS 2010, 2012 and 2014[41], innovation was defined as the introduction of "new or significantly improved goods or services and/or the processes used to produce or supply these"[42].

As from UK CIS 2010, innovation activity has been defined including any of the activities listed below in which enterprises were engaged during the period under review[43][44]:

(1) Introduction of a new or significantly improved product (good or service) or process;
(2) Engagement in innovation projects not yet complete or abandoned;
(3) New and significantly improved forms of organisation, business structures or practices and marketing concepts or strategies;
(4) Investment activities in areas such as internal research and development, training, acquisition of external knowledge or machinery and equipment linked to innovation activities.

Prior to the UK CIS 2010, the UK CIS 2008[45] used a definition of innovation activity which differed from that adopted by Eurostat for the CIS 2008. The EU-wide definition for the CIS 2008 includes activities (1) and (2) – it excludes expenditure and activities linked to innovation, while the UK's definition for the corresponding survey includes activities (1), (2) and (4) (Robson & Kenchatt, 2010, pp. 28-29). The EU-wide definition was later extended to include activity (1) to (3) for the CIS 2010. As from this wave of the survey, the UK has followed the definition of innovation activity adopted by Eurostat to define "innovation active" as a business engaged in any of the activities (1), (2) and (3).

---

[41] I.e. the UK Innovation Survey (UKIS) 2011, 2013 and 2015

[42] In the questionnaires, this definition was given "for the purpose of this survey".

[43] For the purpose of the survey: "innovation active" is defined as a business engaged in any of the activities (1) to (3); a "broader innovator" is defined as a business engaged in any of the activities (1) to (4); and a "wider innovator" is defined as a business engaged in activity (3). "Wider innovation" or "strategic innovation" refers to new and significantly improved forms of organisation, business structures or practices aimed at improving internal efficiency or effectiveness of approaching markets and customers.

[44] In addition, as from the UKIS 2011, the survey has adopted a sample based on the Standard Industrial Classification 2007 (SIC 2007) as this is an EU legislative requirement on the collection of innovation statistics. This wave of the Innovation Survey also included another two significant changes: the sample was further classified into four classes – the medium-size is split into two groups of 20-99 and 100-249; and the sample base was refreshed to bring in new firms, which led to considerable businesses that were new to the survey.

[45] I.e. UKIS 2009

Therefore, as from the CIS 2010, for the purpose of the UK Innovation Survey, business engaged in any of the activities (1) to (3) is defined as "innovation active"; business engaged in any of the activities (1) to (4) is defined as a "broader innovator"; and business engaged in activity (3) is defined as a "wider innovator". "Wider innovation" or "strategic innovation" refers to "new and significantly improved forms of organisation, business structures or practices aimed at improving internal efficiency or effectiveness of approaching markets and customers".

For each wave of the survey, questionnaire was sent to around 28,000 UK manufacturing and services enterprises in the UK with 10 or more employees; a 50% response rate was achieved (see Table 15).

The questionnaires adopted by the UK CIS 2010, 2012 and 2014 were essentially the same. Firms were asked if they had invested in seven innovation-related activities during the three-year period under review, and were asked to estimate their expenditures on each of the seven categories in the last of these three years. The activities included were: (1) internal R&D, (2) acquisition of R&D, (3) acquisition of advanced machinery, equipment and software[46], (4) acquisition of existing knowledge, (5) training for innovative activities, (6) all forms of design, and (7) marketing introduction of innovations[47]. Firms were also asked whether they had employed individuals in-house with the following skills or had acquired these skills from external sources: (1) graphic arts or layout or advertising, (2) design of objects or services, (3) Multimedia or web design, e.g. audio, graphics, text, still pictures, animation, video, etc., (4) software development or database management, (5) engineering or applied sciences, and (6) mathematics or statistics.

As presented in Table 15[48], around 10% of firms had invested in "all forms of design" between 2008 and 2014. Design was less widely undertaken than most of the other innovation activities, including R&D, but was more widespread than acquisition of external knowledge. Average share of the total innovation expenditure spent on design between 2012 and 2014 (8.8%) was nearly twice as much as that spent between 2008 and 2010 (4.5%), and more than twice that spent between 2010 and

[46] Firms were asked to indicate it specifically whether they had invested in (1) advanced machinery and equipment, (2) computer hardware, or (3) computer software.
[47] Firms were asked to indicate it specifically whether they had invested in (1) changes to product or service design, (2) market research, (3) changes to marketing methods, or (4) launch advertising.
[48] The results reported were weighted to represent the total business population of the UK which were recorded in the Inter-Departmental Business Registration (IDBR).

2012 (3.3%). Firms were also found spending less on design than most of the other innovation activities but spending more on design than on training.

Table 16 indicates that small firms (with less than 50 employees) were less likely to invest in design than medium-size or large firms. Manufacturing industries in general were most likely to spend on design than other industries, with design expenditures especially common in engineering-based and high-tech manufacturing. KIBS were more likely to spend on design than the rest of the other sectors except engineering-based manufacturing, including non-engineering-based manufacturing and other services.

While manufacturing industries, especially high-tech or engineering-based manufacturing, spent more of their innovation expenditure on design, the share of innovation expenditure spent on design did not vary systematically with firm size.

The share of total innovation expenditure spent on design had increased substantially between 2012 and 2014 (8.8% in 2014, cf. 3.3% in 2012).

The survey in 2011, 2013 and 2015 also found firms employed more individuals with design skills than those with engineering or applied science and mathematics or statistics skills (see Table 15). Larger firms, manufacturing and KIBS especially showed significant demand for individuals with design skills (Table 17).

Table 15 UK CIS 2010, 2012 and 2014 - investments in innovation and skills

		2010	2012	2014
Survey time		2011	2013	2015
Review period		2008-10	2010-12	2012-14
Achieved sample		14,342	14,487	15,091
Response rate (%)		51.1	51.1	50.8
Innovator				
	Innovation active	36.8	44.4	53.0
	Broader innovator	38.6	45.2	53.8
	Wider innovator	30.8	36.9	42.0
	Activities	33.1	39.0	43.6
	Product innovator	18.9	18.0	19.2
	Process innovator	10.3	10.3	12.8
	Both product AND process innovator	7.5	7.0	7.7
	Either product OR process innovator	21.6	21.3	24.2
Innovation activities				
Internal R&D	Engagement (% of all firms)	14.4	14.5	15.5
	Expenditure (% of total expenditure on innov.)	33.9	39.1	35.1
External R&D	Engagement (% of all firms)	5.2	3.5	3.9
	Expenditure (% of total expenditure on innov.)	23.8	12.4	4.4
Capitals	Engagement (% of all firms)	24.1	29.2	34.3
	Expenditure (% of total expenditure on innov.)	30.3	26.9	36.4
Acq. of ext. knowledge	Engagement (% of all firms)	5.0	3.3	3.3
	Expenditure (% of total expenditure on innov.)	1.5	4.4	1.2
Training	Engagement (% of all firms)	12.1	13.9	14.4
	Expenditure (% of total expenditure on innov.)	1.7	3.1	3.4
All forms of design	Engagement (% of all firms)	10.3	9.8	9.9
	Expenditure (% of total expenditure on innov.)	4.5	3.3	8.8
Market intro. of innov.	Engagement (% of all firms)	19.6	20.1	19.4
	Expenditure (% of total expenditure on innov.)	4.4	10.8	10.8
Skills				
Graphic arts/ layout/ adver.	% of in-house employees by all firms	15.0	27.5	17.9
	% of in-house employees by broad innovators	31.3	33.0	26.5
Design of objects or services	% of in-house employees by all firms	9.4	18.3	11.0
	% of in-house employees by broad innovators	20.9	22.9	16.6
Multimedia/ web design	% of in-house employees by all firms	16.4	28.3	19.0
	% of in-house employees by broad innovators	34.4	34.7	28.4
Software dev./ database mgt.	% of in-house employees by all firms	14.3	23.7	15.2
	% of in-house employees by broad innovators	31.1	29.8	23.2
Engineering/ applied sci.	% of in-house employees by all firms	7.8	13.5	9.5
	% of in-house employees by broad innovators	16.7	16.7	13.7
Mathematics/ statistics	% of in-house employees by all firms	5.1	9.5	7.2
	% of in-house employees by broad innovators	10.2	11.1	10.1

Source: BIS (2012; 2014); BEIS (2016).

Table 16 UK CIS 2010, 2012 and 2014 - investment in "all forms of design", by firm size and sector

	% of all firms			% of total innovation expenditure		
	2008-10	2010-12	2012-14	2008-10	2010-12	2012-14
Total	10.3	9.8	9.9	4.5	3.3	8.8
Firm size						
10-49	9.5	9.2	8.9	3.7	3.6	4.9
50-99	12.8	12.8	14.2	6.2	6.7	4.1
100-249	14.8	12.7	14.3	11.2	2.7	9.3
≥ 250	14.9	14.6	15.8	4.0	2.6	14.9
High/low technology industries						
High tech manufacturing	27.4	24.3	25.4	6.7	7.7	35.9
Low tech manufacturing	17.0	15.0	17.2	4.0	3.5	3.0
Other industries	8.0	8.1	7.9	4.2	2.5	4.6
Broad sector						
Primary Sector	6.7	7.0	8.5	0.5	1.0	1.3
Engineering-based manufacturing	34.0	29.7	34.4	7.8	10.7	44.3
Other manufacturing	16.2	15.0	16.3	3.8	2.6	2.9
Construction	5.5	5.2	6.7	3.4	18.2	6.4
Retail & distribution	8.3	7.9	8.8	1.0	2.6	5.6
Knowledge intensive services	17.3	17.1	19.9	5.5	2.2	7.5
Other services	16.2	15.0	5.0	4.4	1.9	1.1

Source: BIS (2012; 2014); BEIS (2016).

Table 17 UK CIS 2010, 2012 and 2014 - skill of "design of objects or services" (% of individuals employed in-house), by firm size and sector

	All firms			Broad innovators		
	2008-10	2010-12	2012-14	2008-10	2010-12	2012-14
Total	9.4	18.3	11.0	20.9	22.9	16.6
Firm size						
10-49	8.3	17.1	9.9	18.8	21.4	14.9
50-99	13.9	21.9	14.8	28.6	26.5	22.4
100-249	15.0	24.8	17.4	27.3	30.1	25.9
≥ 250	15.3	30.2	19.5	31.0	35.4	28.0
High/low technology industries						
High tech manufacturing	22.5	36.0	26.3	39.5	39.5	36.9
Low tech manufacturing	17.0	24.6	17.9	29.7	29.4	25.4
Other industries	7.2	16.1	9.1	17.0	20.2	13.4
Broad sector						
Primary Sector	6.8	19.5	6.5	11.9	27.8	11.3
Engineering-based manufacturing	29.1	43.6	28.6	45.6	47.0	37.2
Other manufacturing	16.6	24.9	18.4	30.3	29.6	26.2
Construction	7.7	17.1	12.5	16.6	20.4	21.6
Retail & distribution	7.8	14.4	8.3	17.7	18.3	13.1
Knowledge intensive services	15.5	33.2	19.1	30.3	37.6	26.5
Other services	4.7	12.1	6.8	11.9	15.2	8.6

Source: BIS (2012; 2014); BEIS (2016).

German CIS 2006, 2008 and 2010

As mentioned, all EU countries have undertaken innovation surveys since the 1990s. In this document we review the findings of these with respect to design and where these are published in the English language.

The German CIS 2006, 2008 and 2010 were commissioned by the German Federal Ministry of Education and Research (BMBF) and were conducted in 2007, 2009 and

2011 respectively[49]. In addition to the CIS, an innovation survey is undertaken every other year so that in effect an innovation survey is conducted every year in Germany, which forms the Mannheim Innovation Panel (MIP)[50]. The MIP "fully applies the methodological recommendations laid down in the Oslo Manual" (Aschhoff, et al., 2013, p. 15). An extensive questionnaire based on the harmonised CIS questionnaire and the full panel sample are implemented for the CIS years. In the other years, a shortened questionnaire and a reduced sample are implemented.

The CIS 2006 was the first wave of the CIS to incorporate the amended concepts introduced in the third edition of the Oslo Manual, published in 2005. In the German CIS 2006 and 2008 (i.e. MIP 2007 and 2009), design was included as 1) part of innovation-related expenditure – firms were required to report the total amount of expenditure for innovation activities as well as the capital expenditure for innovation; 2) one area of marketing innovations – firms were required to indicate whether they had introduced "significant changes to the aesthetic design or packaging of a good or service". In addition, for the 2008 survey, companies were required to indicate whether they had carried out each of the innovation activities during 2006 to 2008 before reporting their total innovation expenditures and explicitly their capital expenditures for innovation, expenditures on in-house R&D, expenditures on bought-in R&D, expenditures on acquisition of machinery or software for innovation, and expenditures on acquisition of other external knowledge, in 2008. This was not the case for the 2006 survey, in which companies were asked to estimate their total expenditures on all innovation activities in 2006 as well as their "investments" for innovation. Moreover, firms were also asked to estimate their expenditures on R&D in 2005 and 2006 respectively. However, they were not asked to indicate whether they had undertaken any specific innovation activities. Among the innovation activities, product design was included as an example of the preparations for the introduction of product or process innovations. The German CIS 2010 included some newly added design-related questions in the session on the "internationalisation of R&D / innovation activities" and "intellectual property, patents and trademarks". The former distinguished four innovation activities conducted at foreign facilities – R&D; design and preparations; production of new products or launch of new services; and implementation of new production technologies (process innovation) – respondents were required to indicate whether they had conducted any of these innovation

[49] The surveys were undertaken by the Centre for European Economic Research (ZEW) in cooperation with the Fraunhofer Institute Systems and Innovation Research (ISI) and the Institute for Applied Social Science (infas).
[50] The Mannheim Innovation Panel was started in 1993, with the first CIS.

activities abroad between 2008 and 2010. The later asked about the application of intellectual property protection mechanisms, including – formal mechanism including patent application, utility model application, design registration, trademark registration and copyright enforcement; and strategic mechanism which comprises secrecy, complex design and lead-time advantage.

Firms with at least five employees were randomly selected by stratified sampling from the target population of businesses[51], and 4,270, 5,881 and 5,788 completed responses were received in 2007, 2009 and 2011 respectively from firm in the target population[52], which corresponded to 18%, 23% and 24% of the sample of 2006, 2008 and 2010[53] net of neutral loses[54] respectively from 55 divisions and 1 group of NACE rev.2 (including R&D-intensive manufacturing, other manufacturing, knowledge-intensive services and other services), 8 size classes and 2 regions.

With respect to design, Aschhoff et al. (2013) report the following:

1) The share of German business that had introduced "significant changes to the aesthetic design or packaging of a good or service" (as a result of new marketing concepts)[55] was 15% in 2004 to 2006 and increased to 18% in 2006 to 2008; and 19% in 2008 to 2010. Moreover, for product or process innovators, 25%, 31% and 29% were found to have introduced innovations in aesthetic design for marketing according to the German CIS of 2006, 2008 and 2010 respectively.

Table 18 German CIS 2006, 2008 and 2010 - significant changes to aesthetic design or packaging

	% all enterprises	% product and/or process innovators
2004-2006	15	25
2006-2008	18	31
2008-2010	19	29

Source: Aschhoff et al. (2013, p.268 and p.270).

51 N_{2006}=264,709, N_{2008}=273,907, N_{2010}=269,459 (estimated).

52 The survey in fact received completed questionnaires from 5,236 firms in 2007, 7,061 firms in 2009 and 6,851 in 2011, which included firms did not belong to the target population (i.e. firms outside the sector coverage and firms with less than five employees) and recipients of public R&D grants deliberately added for evaluation purposes.

53 The sample refers to the sample of target population (i.e. excluding firms outside sector or firm size coverage or deliberately added to the sample as public funding recipients for evaluation purposes); n_{2006}=25,862, n_{2008}=31,048, n_{2010}=31821.

54 I.e. firms that ceased business or were not be able to be contacted for other reasons during the fieldwork; 2,012, 4,912, and 8,030 firms for the 2006, 2008 and 2010 survey respectively

55 The German CIS excludes changes of product's functional or user characteristics from "design innovation" (i.e. a type of marketing innovation) as such changes are considered as product innovations. Therefore, it is deemed that the corresponding proportions should be taken as "the percentages of non-product innovators using aesthetic design".

2) Two-fifths (40%) of “innovative firms”[56] had engaged in “other preparation” activities during 2006 to 2008, e.g. design, industrial engineering, feasibility studies, software development, preparatory work, etc.
3) During 2008 to 2010, 10% of German innovative firms[57] conducted innovation activities in foreign locations. This corresponded to 18% of German innovative firms that had foreign business activities (i.e. exporting to at least one foreign country or having at least one foreign location). 37% of the firms with foreign innovation activities had undertaken design or preparations of innovations at foreign locations during the 2008-2010 period. This corresponded to 4% of all innovative firms. The innovative firms had a similar propensity to undertake the other innovation activities at foreign locations: 4% undertook R&D; 5% the production of new product; and 4% the implementation of new processes.

Table 19 German CIS 2010 - Foreign innovation activity

	% innovative firms	% firms with foreign innovation activities
R&D	4	37
Design/preparation of innovations	4	37
Production of new products	5	50
Implementation of new processes	4	37

Source: Aschhoff et al. (2013, p.257)

4) With regard to the methods for protecting intellectual property, in the 2008 to 2010 period, 15% of German enterprises chose to register their designs and 25% used the “complexity of design” to protect their innovations. Among firms classified as innovators[58], these proportions were higher: 22% had registered designs and 36% used the complexity of designs to protect their innovations. However, only 3% of the “innovators” considered that design registration was highly important as a means of protecting innovations, while 13% took this view regarding the complexity of designs[59].

[56] See note below.
[57] According to Aschhoff et al. (2013), the “innovative firms” (or “firms with innovation activities”) refer to “firms that have introduced new products or processes or that have still ongoing or abandoned innovation projects” in the period under review (p.135). Another example of such definition for “innovative firm” can be found in p.22. Nonetheless, it is worth noting that this definition is inconsistent with that can be found in the third edition of the Oslo Manual (2005), where an innovative firm is defined beyond the scope of product or process innovation.
[58] In the report by Aschhoff et al. (2013), “innovators” are defined as “firms that introduced at least one innovation in the previous three-year period” (p.36).
[59] . Another 3% of innovators indicated design registration was of medium important, while 11% of innovators regarded the complexity of design as a protection mechanism of medium importance.

Table 20 German CIS 2010 - IP protection mechanisms

	% all enterprises	% product/process innovators
Patent application	19	31
Utility model application	17	28
Registration of a design	15	22
Registration of a trademark	21	33
Copyright enforcement	17	26
Secrecy	37	54
Complex design	23	36
Lead-time advantage	31	49

Source: Aschhoff et al. (2013, pp.263-264).

German CIS 2012 and 2014

Behrens et al. (2017) provide some results of the German CIS of 2012 and 2014.These two waves of the CIS were conducted in 2013 and 2015 respectively (also known as the MIP 2013 and 2015). Samples were created for the target population[60] of German firms with at least five employees which covered 55 divisions and 1 group of NACE rev.2 and 2 regions of the country. 5,866 and 5,226 completed questionnaires were received, which corresponded to 23% and 21% (respectively) of the sample[61] of target population net of neutral losses[62].

These surveys requested the total amount spent on all innovation activities in 2012 and 2014 survey respectively. The 2012 survey asked about the total expenditure (as well as other expenditures requested in the 2008 survey) on eight innovation activities – internal R&D; external R&D; acquisition of machinery, equipment, software and buildings[63]; acquisition of external knowledge; training; market introduction of innovations; design for innovations (i.e. in-house or contracted out activities to design or alter the shape or appearance of innovations); and other preparatory and implementation activities for innovations – between 2010 and 2012. In addition, this survey also required firms to indicate whether or not they had engaged in the aforementioned innovation activities during the three-year period under review. The separation of design from “other preparations” indicates the significance of this activity was better recognised in Germany (even though the conceptualisation of design was still that of shapes and forms). However, the 2014 survey did not ask about design explicitly – design was a subset of preparations for innovation. Firms were asked to estimate their total innovation expenditure in 2014, which included expenditures on seven categories of activities: in-house R&D; external R&D; acquisition of equipment,

[60] N_{2012}=276,600, N_{2014}=279,398.
[61] n_{2012}=29,605, n_{2014}=30,090.
[62] 3731 and 5042 respectively
[63] Buildings procured to be used for product or process innovation.

machinery or software; acquisition of external knowledge; product design, service philosophy, preparation of production or distribution; professional development; and marketing. This survey also asked firms to estimate their total expenditures on R&D in 2014 and to split up their 2014 innovation expenditures by product and process innovations.

Table 21 shows that among “innovation-active firms”[64], the acquisition of machinery, software etc. was (at 60%) the most widely undertaken activity in 2012, followed by training (57%), other preparations (44%), in-house R&D (40%), and both design and marketing (at 27%). The acquisition of external knowledge (22%) and the commissioning of external R&D (16%) were less widespread.

Further categorised by sector, showed that design was more widespread in manufacturing industries (R&D-intensive manufacturing – 38%; other manufacturing – 31%) than in services (knowledge-intensive services – 26%; other services – 20%), and that larger firms were more likely to engage in design, but that there was very little variation in the propensity to engage in design among smaller firms (5-9 employees – 25%; 10-19 employees – 26%; 20-49 employees – 24%; 50-99 employees – 34%; 100-249 employees – 37%; 250-499 employees – 46%; 500-999 employees – 45%; 1,000+ employees – 53%). Behrens et al. (2017) also note that the firm size differences in the propensity to engage in design were “rather low”, at least when compared the differences in the commissioning of external R&D or the acquisition of external knowledge. This implies that design can be an accessible way to innovate.

[64] I.e. firms that had conducted innovation activities within the three-year period under review.

Table 21 German CIS 2012 – engagement of innovation activities (% of innovation-active firms), by sector and firm size

	Int. R&D	Ext. R&D	Acq. of mach., software etc.	Acq. of other ext. knowl.	TRA	MKT	Design	Other prep.	None
Total	40	16	60	22	57	27	27	44	8
Sector									
R&D-int. manuf.	76	32	65	23	54	42	38	74	3
Other manuf.	43	16	64	18	50	24	31	48	9
Knowl.-int. svcs	43	15	57	29	67	30	26	41	7
Other svcs	17	10	57	18	55	20	20	29	11
Firm size (employees)									
5-9	31	14	55	22	54	20	25	36	9
10-19	39	13	54	18	55	27	26	42	9
20-49	42	14	63	21	55	27	24	47	11
50-99	48	21	70	23	65	36	34	54	5
100-249	61	28	75	24	68	43	37	61	3
250-499	66	37	75	38	72	44	46	68	2
500-999	69	46	76	47	74	54	45	69	3
≥ 1000	76	63	89	69	78	62	53	73	0

Source: Behrens et al. (2017, pp.50-51).

Meanwhile, 31% of German enterprises reported having introduced at least one marketing innovation in 2010-2012; and 33% reported the same in 2012-2014, with subsets of these reporting having introduced new designs. Specifically, one in eight (13%) of businesses in Germany (corresponding to 41% of marketing innovators) had introduced a new “aesthetic designs” in 2010-2012, and 15% of firms had introduced new “aesthetic designs” in 2012-14 (i.e., 45% of marketing innovators).

Table 22 German CIS 2012 and 2014 - significant changes to aesthetic design or packaging

	% all enterprises	% marketing innovators
2010-2012	13	41
2012-2014	15	45

Source: Behrens et al. (2017, p.115).

The survey also concerned measures for the protection of intellectual property in both years. The 2012 survey asked companies about the effectiveness of the eight formal and strategic protection methods for maintaining or improving competitiveness of product and process innovations, while the 2014 survey only focused on whether firms had applied for formal protection of intellectual property rights during the 2012-14 period[65].

65 It is necessary to note it in advance that the 2012 survey found the shares of “innovating firms” that used IPRs within 2010 to 2012 was substantially higher than the corresponding percentages suggested in the 2014 survey (see next paragraph); and the corresponding absolute number of “innovating firms” that indicated using each of the IPRs was greater than the number of German firms that had actually applied for each of the IPRs at any IP office. Therefore, it was speculated by the authors (Behrens, et al., 2017) that the respondents of 2012 survey indicated their general attitudes to the effectiveness of

According to the 2012 survey (see Table 23), design registration was the least widely used protection mechanism among "innovating firms"[66] (32%) between 2010 and 2012, while using complex design was the second most widespread (72%, second to lead-time advantage - 77%).[67] Specifically, with respect to the effectiveness of design registration for securing or improving competitiveness of innovations, only 6% of "innovating firms" considered that this mechanism was highly effective; while 12% deemed it moderately effective; 14% considered it to have low effectiveness – the remaining 68% of firms did not use the registration of designs to protect their innovations. By comparison, 26% of "innovating firms" considered that design complexity was highly effective; 30% considered it of medium-effectiveness, while 16% regarded it as having low effectiveness. The remaining 28% did not use this protection mechanism.

Table 23 German CIS 2012 - effectiveness of IP protection mechanisms (% of innovators)

	High effectiveness	Medium effectiveness	Low effectiveness	Not used
Patent	16	15	12	57
Utility patent	8	17	15	60
Industrial design	6	12	14	68
Trademark	16	19	14	51
Copyright	12	16	17	55
Lead-time advantage	41	25	11	23
Complex design	26	30	16	28
Secrecy	21	25	23	31

Source: Behrens et al. (2017, p.108).

Broken down by sector (see Table 24) – 35% of "innovating firms" in research-intensive industries rated complex design as highly effective in maintaining or increasing innovation competiveness; whereas almost one in four companies in all the other identified industries held the same opinion. In addition, medium-sized firms with 10 to 99 employees tended to be more likely to consider that complex designs were a highly effective for maintaining or improving the competiveness of innovations.

the IP protection mechanisms listed instead of their actual applications of these methods for their innovation during 2010 to 2012.

[66] I.e. firms that had introduced product or process innovations during the three-year period under review.

[67] The shares of "innovating firms" using other methods are: 43% (patents); 40% (utility patents); 49% (trademarks); 45% (copyright); and 69% (secrecy).

Table 24 German CIS 2012 - highly effective IP protection mechanisms (% of innovators), by sector

	Research-intensive industries	Other industries	Knowledge-intensive services	Other services
Lead-time advantage	55	35	44	38
Complex design	35	25	25	24
Secrecy	32	20	19	20
Patent	27	17	10	15
Trademark	17	18	14	18

Source: Behrens et al. (2017, p.108).

The 2014 survey found that design registration remained the least widely used of the intellectual property rights (IPR) , with only 2% of all German enterprises reporting having registered an industrial design between 2012 and 2014. This increased to 3.1% among “innovative enterprises”[68], while just 0.2% of “non-innovative enterprises” had registered a design. Trademarks were the most used IPR, but even these were not widely used (7.4% of all firms; 11.1% of “innovative firms”; 1.8% of “non-innovative firms”). Meanwhile, 5.5% of firms reported having applied for a patent (including 8.9% of “innovative firms” and 0.6% of “non-innovative firms”) and 4.1% for a utility model (6.5% of “innovative firms”; 0.4% of “non-innovative firms”), while 2.9% had claimed copyrights (4.3% of “innovative firms”; 0.7% of “non-innovative firms”).

Table 25 German CIS 2014 - use of IPRs

	% all enterprises	% innovative enterprises	% non-innovative enterprises
Patent	5.6	8.9	0.6
Utility patent	4.1	6.5	0.4
Industrial design	2.0	3.1	0.2
Trademark	7.4	11.1	1.8
Copyright	2.9	4.3	0.7

Source: Behrens et al. (2017, p.105).

The use of registered-design showed some variation by sector (see Table 26), with 5% of firms in research-intensive industries having registered designs during 2012 to 2014; compared with 2% of knowledge-intensive business service firms, 1% of other service and 3% of firms in other industries. The distribution by firm size (ibid.) showed an increasing rate of registration rate of design registrations from small firms to large firms – 1% of firms with 5 to 9 employees had applied for registered designs over the past three years; 2% of firms with 10 to 99 employees had done that, following 5% of firms with 100 to 249 employees, 9% of firms with 250 to 499 employees, 15% of firms with 500 to 999 employees and 15% of firms with 1000 and more employees.

[68] Innovative enterprises include firms with product or process innovation activities as well as firms with marketing or organisational innovations.

Table 26 German CIS 2014 - use of IPRs (% of all enterprises), by sector and firm size

	Patent	Utility patent	Industrial design	Trademark	Copyright
Sector					
Research-intensive industries	27	17	5	19	6
Other industries	7	5	3	7	3
Knowledge- intensive services	5	3	2	8	5
Other services	1	1	1	4	1
Firm size (employees)					
5-9	3	3	1	4	2
10-19	4	2	2	7	3
20-49	6	4	2	7	2
50-99	10	7	2	11	4
100-249	19	12	5	19	6
250-499	26	16	9	26	10
500-999	38	26	15	29	13
≥1000	38	24	15	36	19

Source: Behrens et al. (2017, p.106)

Dutch CIS 2

Drawing upon the Dutch CIS 2, Marsili and Salter (2006) found that 22% of the “innovative firms” (n=2008) operating in manufacturing industries that had at least 10 employees had invested in “design” in 1996[69]. This was a smaller share than the proportion of innovating firms investing in the three other innovation activities: R&D (75%), marketing (27%) and investments in machinery and equipment (62%).

The average intensity of expenditures on design (i.e. expenditures on design as a proportion of total sales) was also less than the average intensity of R&D expenditures (i.e. R&D as a proportion of total sales). The distribution of expenditure on design was more concentrated than that on R&D; and extreme values at a great distance from the average, especially which of low-performing companies, occurred more frequently for expenditure on design than expenditure on R&D. This suggested the manufacturing firms were more likely to spend on R&D than on design; and many of the firms with design expenditures spent much-less-than-average on this activity.

[69] 3299 responses were obtained with a response rate of 71%, of which 2205 were classified as innovators. Innovator was defined as a firm that had introduced at least one product or process innovation or carried out innovation projects. The sample represented a population of 10,260 firms with at least 10 employees operating in manufacturing industries during 1994 and 1996, of which 6069 were classified as innovators. 189 firms were excluded due to implausible data provided.

Table 27 Dutch CIS 2 - intensities of expenditures on innovation activities

	% performing firms	Mean	Std Dev	Skewness	Kurtosis
R&D	75.3	1.35 (1.79)	2.80 (3.10)	6.1 (5.6)	61.6 (50.7)
Design	21.9	0.19 (0.85)	0.99 (1.97)	13.6 (6.8)	265.0 (64.7)
Marketing	26.8	0.13 (0.47)	0.60 (1.08)	15.7 (8.9)	334.2 (102.6)
Machine	61.7	1.94 (3.15)	4.78 (5.76)	4.8 (3.8)	29.7 (18.6)

Source: Marsili and Salter (2006, p.525).

Belgian CIS 2006

Czarnitzki and Thorwarth (2012) studied the contribution of design to the market performance of products based on the data from Flanders in Belgium gathered as part of the CIS 2006. Overall, this study found that 18% (268 of 1,511 firms manufacturing and business services firms) of the participating firms indicated design innovation, of which 70% reported conducting deign activities mainly in house, whilst the other 30% also acquired design from external sources (over the 2004-2006 period).

Larger firms were found more likely to invest in design. Firms investing in design also had much higher average R&D intensities than the other firms (i.e. expenditure on R&D per employee; £12.5k, cf. £4.2k). Czarnitzki and Thorwarth (2012) also found some other differences between the firms investing in design and those not. Of the firms that had expenditures on design, 59% had engaged in collaboration for innovation, compared with 23% of those that did not have expenditures on design had done this. Meanwhile, two thirds (65%) of those with expenditures on design had combined their innovation projects with market launch strategies, compared with 17% of the firms which did not report expenditures on design had done so.

Table 28 Belgian CIS 2006 - comparison between firms with and without expenditure on design

	Firms w/ design expenditure	Firms w/o design expenditure
Expenditure on R&D per employee	€12.5k	€4.2k
Firm size	More than twice larger	Baseline
Collaboration	59%	23%
Innovation projects w/ mkt launch strategies	65%	17%

Source: Czarnitzki and Thorwarth (2012, pp.884-885).

Section summary

This CIS section involves both multi-country and single-country studies. The separation of design from “other preparations” implies that the value of design has been better recognised in the UK than other countries involved, including Germany. Spending on design is more common among firms than spending on R&D. Design complements other intangibles including R&D. Most firms that invest in design spend modestly on it. Larger firms and firms that are engaged in collaboration or exploiting market opportunities/technological opportunities are more active in investing in design.

Prevalence of design investment/average design investment/design intensity

1) There has been typically a relatively small portion (up to a quarter) of firms recognising that they are investing in design than in other innovation activities (Marsili & Salter, 2006; Cereda, et al., 2005; Vinodrai, et al., 2007; Czarnitzki & Thorwarth, 2012; BIS, 2012; 2014; BEIS, 2016). Part of the reason why design is less widespread than other innovation activities is that design is often "hidden" – the part of design included in R&D is not reported as design, even though design is undertaken.
2) Within-firm design intensity (i.e. design expenditure over innovation expenditure) is also typically lower than the intensities of other innovation expenditures (Cereda, et al., 2005; Vinodrai, et al., 2007; BIS, 2012; 2014; BEIS, 2016).

Factors associated with the existence of design investment

3) Firms with design expenditure are predominantly SMEs (Ciriaci, 2011)[70] yet **larger firms** are more likely to invest in design (Cereda, et al., 2005; BIS, 2012; 2014; BEIS, 2016; Behrens, et al., 2017).
4) Whether a firm invests in design is probably related to the extent of market internationalisation (Cereda, et al., 2005), whether it is active in **collaboration** or utilising new market opportunities (i.e. combining innovation projects with **market launch strategies**) (Czarnitzki & Thorwarth, 2012) or is led by technological opportunities (i.e. engaging in **R&D** or assigning some importance to **patent**) (Vinodrai, et al., 2007). Some studies did not find industry has an impact on the propensity to invest in design (Ciriaci, 2011; Vinodrai, et al., 2007). Cereda et al. (2005) and Behrens et al. (2017) found **manufacturing** firms are more likely to invest in design than services (including KIBS and traditional services). There is also evidence suggesting that **high-tech** or **engineering-based manufacturing** are more likely to

[70] According to Eurostat (2016), the average percentage of SMEs of the 28 EU Member States is 99.8% of the total businesses.

invest in design than other industries including services; yet **KIBS** show higher propensity to invest in design than non-engineering-based manufacturing (BIS, 2012; 2014; BEIS, 2016).

5) Complementarities potentially exist between design and the other innovation activities, such as marketing (Ciriaci, 2011), in-house R&D, capital and software, innovation-related training. Nevertheless, the complementarity is likely to be one-way only – there are considerable firms investing in design, meanwhile, investing in the aforementioned innovation activities; whereas this is not necessarily true the other way around (Vinodrai, et al., 2007).

   Such a pattern of complementarity seems imply that firms conducting comprehensive innovation activities are likely to invest in design as a complementary part of innovation activity – firms invest in design to complement other innovation activities. If this is true, design investment is not likely to be an "accidental event" in such context; and design is playing an auxiliary role in innovation.

Factors associated with the amount of investment in design

6) Unlike the existence of design expenditure, the amount of design expenditure is not found varying systematically with firm size or ownership of group (Ciriaci, 2011). This suggests that design is a source of innovation that is accessible to smaller firms.
7) Instead, the amount of design expenditure is likely to be relevant to the existence of **international market** and IP protection mechanism (including **patent**, **registered-design**, **trademark**, **complex design** and **secrecy**) (Ciriaci, 2011).

Factors associated with design intensity

8) Manufacturing industries (Cereda, et al., 2005), especially **high-tech** or **engineering-based manufacturing**, spend more of their innovation expenditure on design (BIS, 2012; 2014; BEIS, 2016).
9) The proportion of total innovation expenditure spent on design is not found varying systematically with firm size (BIS, 2012; 2014; BEIS, 2016); but is positively related to market internationalisation (Cereda, et al., 2005).

Internal and external design investment

10) In-house design expenditure (as opposed to external design expenditure) accounts for a dominant share of total design expenditure (Czarnitzki & Thorwarth, 2012).

Innobarometer and Innovation Index Survey

This section will continue discussing design-related phenomenon observed in innovation surveys.

The Innobarometer is another large-scale innovation survey that covers EU Member States and some other countries. The Innobarometer survey, which is sponsored by the European Commission, is designed to probe firms' activities and attitudes to innovation. An Innobarometer survey has been conducted every year since 2001, and each year the survey focuses on one specific topic. The Innobarometers of 2009, 2013, 2015 and 2016 have all included questions on design, although they have defined design differently. The Innobarometer 2013 seeks to capture firms' investments in intangible assets including design. In Innobarometer 2009, 2015 and 2016, questions about design are also included for examining the innovation trends in EU businesses.

Moreover, a relatively small-scale survey was carried out at the pilot stage of the NESTA Innovation Index project for developing measures of the UK's innovation performance. This survey will be introduced with additional information made available by Barnett (2009), who provided his calculations of the aggregates of expenditures in five intangible assets (including design) based on this survey.

Innobarometer 2009

For the 2009 survey, design was investigated as an innovative activity.

The Innobarometer 2009 was the 8th Innobarometer survey. It was carried out in April 2009 by Gallup for Directorate-General Enterprise and Industry of the European Commission, and sought to examine "strategic trends in innovation 2006-2008". Firms with at least 20 employees were randomly selected in "innovation-intensive industry sectors"[71] from the then 27 EU member states, plus Switzerland and Norway. The investments in innovation were categorised into two groups in the survey. One concerned technological investment and included spending on intramural R&D and external R&D; the other concerned non-technological innovation/support and included expenditures on the acquisition of machinery, equipment and software; purchasing or licensing of patents, inventions, know-how and other types of

[71] For the full list of the industries, please refer to page 4 of the report.

knowledge; training; design (including graphic, packaging, process, product, service and industrial design); and application for a patent or registration of a design.

The survey found that 30% of the enterprises in the EU-27 (n=5,034) had invested in design between 2006 and 2008; and 57% of those with expenditures on design had increases their investments in design in 2008, which corresponded to 17% of all enterprises. Additionally, a small group (10%) of the surveyed EU-27 enterprises had expenditures related to patent applications or design registrations; and half (51%) of the firms with expenditures on patent applications or design registrations had increased their investments in design in 2008, which corresponded to 5% of all enterprises (European Commission, 2009b).

Table 29 Innobarometer 2009 - investment in innovation activities (% of EU-27)

	Investment	**Increased investment**	
		Firms with expenditures	All firms
Acquisition of machinery, equipment, etc.	76	65	49
Training	50	63	31
In-house R&D	36	55	20
Design	30	57	17
Bought-in R&D	23	49	11
Purchase/licensing of patents, etc.	15	46	7
Application for a patent/registration of a design	10	51	5

Source: European Commission (2009b, p. 29).

Although the data was collected from companies operating in innovation-intensive business sectors, not all the surveyed enterprises had introduced innovations. Drawing upon the Innobarometer 2009 survey data, Filippetti (2011) found that when restricted to "innovative firms" (n=4,664)[72], the share that considered design as a source of innovation increased to 43% (1,846 firms). By comparison 54% and 35% of firms drew on in-house and external R&D for innovation, and 59% drew on acquired external knowhow for innovation.

Table 30 Innobarometer 2009 - sources of innovation for innovative firms

	No. of innovative firms	**%**
Design	1846	43
In-house R&D	2277	54
Bought-in R&D	1498	35
Acquisition of machinery	3747	83
Acquisition of external knowhow	2525	59

Source: Filippetti (2011, p.12).

[72] The number of "innovative firms" quoted (see Filippetti, 2011, p.12) seems inconsistent with that reported elsewhere in the same paper – according to "Table AI" (p.26), 615 "non-innovative firms" were excluded from the sample, which led to a total of 4,619 "innovative firms". The quoted share of firms that invested in design (43%) also needs to be interpreted with care.

Filippetti (2011) also identified five modes of innovation associated with characteristics of firms, identifying these modes through factor analysis (see Table 31). This found that design as a source of innovation was predominantly associated with an "outward-oriented multifaceted innovation" mode characterised by comprehensive innovation activities including both technological and non-technological innovation. This mode accounted for 17% of the firms in sample (n=3,073). Firms within this mode of innovation were active in exploiting both market and technological opportunities[73]. Note that in general market opportunities demonstrated stronger associations with all of the innovation modes identified than technological opportunities. Many characteristics were found highly correlated with this mode of innovation, such as engaging in-house R&D (0.97), design (0.86), the acquisition of machinery (0.97), and exploiting market opportunities (0.86). Firms active in this mode tended to be large (43%, compared with 28% of the sample as a whole), but medium sized firms (32%) and small firms (25%) were also found to be active in this mode[74] (see Table 32). Additionally, firms active in this mode demonstrated a tendency to apply patents and to register designs.

Filippetti (2011) also found that design contributed to two other modes of innovation primarily characterised by engaging in "non-technological innovation" (i.e. marketing innovation and organisational innovation) (see Table 31), namely "outward-oriented non-technological innovation" (factor loading of 0.4) and "inner-oriented non-technological innovation" (factor loading of 0.41). These modes accounted for 24% and 22% of the sample respectively. The former is associated with being open to new technological and market opportunities, whereas the latter firms are less responsive to opportunities outside their existing boundaries. Both of these modes of innovation were dominated by small firms, followed by medium-sized firms (see Table 32).

[73] "Technological opportunities" is a variable that catch information about the emergence of new technologies to be exploited; "market opportunities" is a variable that catch information about new opportunities to enter new markets or expend sales in existing markets.
[74] Although small firms were relatively underrepresented, as overall 38% of the firms in the sample were small firms.

Table 31 Innobarometer 2009 - mode of innovation, factor loadings

	Outward-oriented non-technological innovation	Cost-saving innovation	R&D-focus with strong basic collaboration	Inner-oriented non-technological innovation	Outward-oriented multifaceted innovation
Marketing innovation	0.76	0.10	0.26	0.81	0.80
Organisational innov.	0.86	0.19	0.36	0.82	0.83
Knowledge mgt	0.76	0.24	0.50	0.54	0.80
Design	0.40	0.32	0.24	0.41	0.86
In-house R&D	0.43	0.42	0.70	0.35	0.97
Bought-in R&D	0.21	0.16	0.59	0.17	0.78
Acq. of knowhow	0.12	0.17	0.08	0.12	0.34
Acq. of machinery	0.91	0.94	0.49	0.79	0.97
Customers	0.86	0.40	0.59	0.14	0.71
Suppliers	0.86	0.38	0.67	0.12	0.78
Uni. and res. centres	0.49	0.18	0.66	0.15	0.78
Other firms	0.66	0.25	0.38	0.07	0.44
Pat. & des. registration	0.04	0.11	0.14	0.08	0.62
Open innov. practices	0.77	0.29	0.79	0.42	0.85
Cost reducing	0.28	0.62	0.15	0.34	0.20
Tech. opportunities	0.65	0.36	0.38	0.22	0.64
Market opportunities	0.83	0.52	0.46	0.57	0.86

Source: Filippetti (2011, p.14).

Table 32 Innobarometer 2009 - mode of innovation, by innovator and firm size

	Outward-oriented non-technological innovation		Cost-saving innovation		R&D-focus with strong basic collaboration		Inner-oriented non-technological innovation		Outward-oriented multifaceted innovation		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Type of innovation												
Product	464	67	370	59	292	63	346	54	461	88	1933	66
Process	529	74	340	53	252	52	400	61	453	85	1974	65
Service	488	68	302	47	266	55	357	55	344	65	1757	58
Firm size												
Small	294	40	289	44	175	36	288	43	131	25	1177	38
Medium	256	35	214	33	171	35	218	33	172	32	1031	34
Large	182	25	152	23	142	29	158	24	231	43	865	28

Source: Filippetti (2011, p.15).

Innobarometer 2013

Interest in the extent to which firms invest in intangibles has extended into Europe and was investigated by the 2013 edition of the Innobarometer survey.

The Innobarometer 2013 focused on “investing in intangibles: economic assets and innovation drivers for growth”; it sought to capture firms’ investments in intangible assets, defined as “non-financial, non-physical assets” and applied the same classification of intangibles that was used in the UK’s IIA Survey (Awano, et al., 2010; Field & Franklin, 2012). Specifically, the intangibles asked about were: training, software development, reputation and branding, R&D, design of products and services, and organisation or business process improvements.

The survey was conducted by telephone in early 2013 by TNS Political & Social. The sample involved manufacturing and service businesses with at least one employee and, in addition to the then EU-27, businesses from Croatia, Iceland, Japan, Norway, Serbia, Switzerland, Turkey, Macedonia and the United States were included.

The questionnaire distinguished between investments involving exclusively internal resources and those utilising external resources. Of the firms in the EU-27 (n=8,715), 41% reported having had expenditures on design (using only internal providers) in 2011. Of these, 8% spent (or reported spending) less than 1% of their turnover on design, 17% spent 1 to 5%, 8% spent 5 to 15%, 4% spent 15 to 25%, 2% spent over a quarter to half of their total turnover on design, and another 2% reporting spending more than half of total turnover on design (see Table 33). While spending on design was less widespread than spending on organisational or business process improvements (60%); training (58%), and improving the company's reputation and branding (52%), internal spending on design (41%) was more widespread than spending on R&D (32%) and software development (39%) (see Table 34).

Table 33 Innobarometer 2013 - investments in intangibles using internal resources (% of total turnover)

	0%	< 1%	1-5%	> 5-15%	> 15-25%	> 25-50%	>50%	Don't know
Org./bus. Proc. improv.	36	12	28	12	5	2	1	4
Training	40	15	29	9	3	1	1	2
Rep. & branding	45	13	24	9	2	2	2	3
Design (excl. R&D)	55	8	17	8	4	2	2	4
Softw. (excl. R&D & web des.)	58	11	18	6	2	1	1	3
R&D	65	8	12	7	2	1	2	3

Source: European Commission (2013b, p. 12).

In relation to sectors (see Table 34), manufacturing firms were the most likely to have expenditure on in-house design (47%), followed by service firms (40%) and utilities and construction[75] (38%). Two thirds of large firms (with 250+ employees) reported having expenditures on design, as did more than half of medium-sized firms (50 to 249 employees - 56%), half of small firms (10 to 49 employees: 49%), and nearly two-fifths of micro-firms (1 to 9 employees - 39%).

Spending on design appears to be associated with "technological innovation". Among the companies that had introduced new products, services or processes between 2009 and 2011, 56% reported some investments in internal design. Note that this is a larger share of "product/service/process innovators" than reported expenditures on internal R&D (45%) or on internal software development (51%), but a smaller share

[75] NACE sections D, E and F.

than reported spending on internal training (66%); on company reputation and branding using internal resources (65%); or on organisation or business process improvements using internal providers (71%) (see Table 34).

Notable also is that 30% of the companies that reported making investments in internal design did not introduce a new product, service or process. This may indicate that some design investments are related to sustaining existing products, services or processes, or making minor improvements to them. It may also be that these investments in design were made in relation to the development of yet to be introduced innovations. This is because firms were required to report information regarding their investment in intangibles in 2011, but also report whether or not they had introduced innovations in the three-year period between 2009 and 2011.

Table 34 Innobarometer 2013 - engagement of investments in intangibles relying solely on internal sources (% of EU-27), by sector, firm size and innovator

		Org./bus. process improvements		Training		Software (excl. R&D and web design)	
		No	Some	No	Some	No	Some
Total		36	60	40	58	58	39
Sector							
	Manufacturing	39	58	42	55	59	38
	Services	36	60	40	58	57	41
	Industry	39	58	39	60	65	32
Firm size							
	1-9	39	58	44	54	61	37
	10-49	26	70	25	73	49	47
	50-249	20	76	16	80	42	53
	≥ 250	8	83	7	86	25	65
Innovator							
Products/services/process	Yes	25	71	32	66	47	51
	No	45	52	46	52	67	30
Marketing	Yes	23	74	30	68	43	54
	No	42	55	44	54	64	34
Organisation	Yes	20	77	27	71	46	52
	No	43	53	45	53	63	34

		Reputation & branding		R&D		Design (excl. R&D)	
		No	Some	No	Some	No	Some
Total		45	52	65	32	55	41
Sector							
	Manufacturing	49	47	56	40	47	47
	Services	44	53	65	31	55	40
	Industry	49	45	68	29	58	38
Firm size							
	1-9	47	50	67	30	57	39
	10-49	38	59	58	40	47	49
	50-249	30	65	44	52	39	56
	≥ 250	27	65	36	57	23	67
Innovator							
Products/services/process	Yes	32	65	51	45	39	56
	No	54	43	75	22	66	30
Marketing	Yes	26	70	51	46	41	55
	No	52	45	70	27	60	36
Organisation	Yes	30	66	53	44	41	56
	No	51	46	70	26	60	35

Source: European Commission (2013b, p. 17).[76]

Regarding investments in intangibles using only external resources, 21% of the EU-27 companies that had not undertaken design internally reported having paid for external design in 2011[77]. Although design was the second least widespread of these

[76] This table excludes "don't knows".
[77] 7% had spent less than 1% of total turnover; 9% spent 1 to 5% of total turnover; 3% spent more than 5 to 15% of total turnover; 1% spent more than 15 to 25%; and 1% spent more than 25% to 50%.

bought in intangible assets[78], the proportion of firms buying design exceeded the share buying-in R&D (15%).[79]

The questionnaire also requested companies' strategic priorities. Respondents were asked to choose two from a set of five items – (1) providing tailored, customized solutions; (2) decreasing production costs; (3) ensuring lower prices; (4) rapid development of new products or services; and (5) increasing labour productivity. Providing "tailored, customised solutions" was the most commonly identified priority (40%), followed by "decreasing the production costs" (33%), "ensuring lower prices" (26%), "increasing labour productivity" (25%) and the "rapid development of new products or services" (25%).

Table 35 reports the findings about bought-in assets in relation to these strategic priorities. A quarter (26%) of businesses prioritising "rapid development of new products or services" reported having made investments in externally provided design, a share that exceeded the proportion of these firms that spent externally on R&D (22%). However, these firms were more likely to make investments in organisational or business process improvements (30%); on software development (31%); on improving their company reputation and branding (34%) and on training (41%).

Although 26% was the highest share of firms investing in bought-in design, significant shares of firms with other priorities also reported having invested in design: 22% among those prioritising tailored solutions; 17% of those prioritising lower prices; 22% for those increasing labour production; and 23% for those seeking to decrease production costs).

Overall, R&D was the least likely of the six intangible assets to be acquired externally, followed by design. That is, investment in external design and investment in external

---

[78] Training was the most pervasive (38%); company reputation and branding was the second most prevalent (30%); software development and organisation or business process improvements were both invested by the third most businesses (26%);

[79] The sectoral difference of the share of firms engaging in external design investment was small – there were 23% of manufacturing firms with external design outlays in 2011, compared to 21% of firms in services and 20% in utilities and construction. As with internal design investments, the large firms were more likely to make external design investments in 2011 – 19% of firms with 1 to 9 employees, 25% of firms with 10 to 49 employees, 32% of firms with 50 to 249 employees, and 38% of firms with more than 250 employees had expenditures on external design in 2011. Additionally, 30% of the companies who had introduced new products, services or processes between 2009 and 2011 had invested in external resources for design in 2011, whilst 22% did for R&D; 34% for software development; 45% for training; 37% for company reputation and branding and 33% for organisation or business process improvements.

R&D were underrepresented in the sample even among firms prioritising product and service innovation.

Table 35 Innobarometer 2013 - engagement of investments in intangibles relying solely on external resources (% of EU-27), by sector, firm size, strategic priority and innovator

		Org./bus. process improvements		Training		Software (excl. R&D and web design)	
		No	Some	No	Some	No	Some
Total		71	26	76	21	82	15
Sector							
	Manufacturing	71	26	74	23	77	19
	Services	70	27	76	21	82	15
	Industry	70	27	77	20	82	14
Firm size							
	1-9	73	24	78	19	84	13
	10-49	64	33	72	25	79	18
	50-249	51	44	63	32	62	33
	≥ 250	34	59	55	38	55	37
Strategic priority							
	Dvpt new prod./svcs	68	30	71	26	76	22
	Tailored solutions	70	27	75	22	81	16
	Ensuring lower prices	75	23	81	17	85	13
	Incr labour production	66	32	76	22	83	14
	Decr production costs	69	28	74	23	80	16
Innovator							
Products/services/process	Yes	65	33	67	30	75	22
	No	75	22	83	14	87	10
Marketing	Yes	59	38	66	31	74	23
	No	75	22	80	17	85	12
Organisation	Yes	58	39	67	30	75	22
	No	76	21	80	17	85	12

		Reputation & branding		R&D		Design (excl. R&D)	
		No	Some	No	Some	No	Some
Total		67	30	71	26	60	38
Sector							
	Manufacturing	73	25	71	25	59	38
	Services	67	30	71	26	61	37
	Industry	66	30	71	25	57	40
Firm size							
	1-9	69	28	73	24	64	34
	10-49	63	33	68	28	48	49
	50-249	54	41	53	42	30	64
	≥ 250	53	40	32	60	25	68
Strategic priority							
	Dvpt new prod./svcs	64	34	66	31	57	41
	Tailored solutions	67	30	69	28	59	39
	Ensuring lower prices	68	30	73	25	65	33
	Incr labour production	65	32	70	27	56	42
	Decr production costs	65	31	69	27	59	38
Innovator							
Products/services/process	Yes	60	37	63	34	53	45
	No	72	25	77	20	66	32
Marketing	Yes	56	40	61	36	55	42
	No	71	26	75	22	63	35
Organisation	Yes	56	40	60	37	50	47
	No	71	26	75	22	65	33

Source: European Commission (2013b, p. 23).

Innobarometer 2015 and 2016

The Innobarometer 2015 and 2016 were carried out in February 2015 and February 2016 respectively by TNS Political & Social for Directorate-General Enterprise and Industry of the European Commission, and sought to investigate the innovation trends at EU businesses.

The 2015 (n=14,118, of which 13,117 were from the EU-28) and 2016 sample (n=14,117, of which 13,117 were from the EU-28) covered enterprises across the 28 Member States of the European Union, Switzerland and the United States. For each survey, at least 500 cases were collected from each country (except for Cyprus, Luxemburg and Malta, where the baseline was reduced to 200). Companies with at least 1 employee were selected in manufacturing (NACE section C), services (NACE sections G, H, I, J, K, L, M, N and R), and the industry sector (NACE sections D, E and F). Quota sampling was applied based on firm size and industrial sectors. Interviews were carried out with decision-makers of the surveyed firms through phone calls in their mother tongue.

The Innobarometers of 2015 and 2016, which focused on innovation trends in EU businesses, also used the categories of intangible assets applied to the Innobarometer 2013 and the IIA Survey, with additional question on the acquisition of machinery and equipment, software and licenses. It is worth noting that the questionnaires of these two waves of the Innobarometer did not specify the activities of interest; they did not for instance provide a definition of design but did provide an indication as to how design could be applied to: i.e., design can provide an approach to “integrate functionality, appearance and user experience, for good and services”; design can also provide an approach to “build corporate identity and brand recognition”. The two questionnaires are essentially the same.

In 2015 and 2016, firms were asked about the share of their turnover that they had invested in the following activities over the past three years: (1) acquisition of machines, equipment, software or licenses; (2) training; (3) company reputation and branding, including web design; (4) organisation or business process improvements; (5) the design of products and services; (6) software development; and (7) R&D.

Firms were also asked about the positioning of design in their businesses in accordance with the *Design Ladder*[80] which had previously been developed by the

[80] Design Ladder is a model of positing of design developed by Danish Design Centre. This will be explained in more details in the section of ad-hoc surveys.

Danish Design Council: (1) design is a central element in the company's strategy; (2) design is an integral, but not central element of development work in the company; (3) design is used as last finish, enhancing the appearance and attractiveness of the final product; (4) the company does not work with design; (5) design is not used in the company; or (6) don't know.

In combination, these two surveys (see Table 36) obtained data from 26, 229 enterprises from the EU-28. Businesses using design as an "integral but not central element of the development work" (21%) made up the largest proportion of firms which applied design; the remainder being nearly evenly distributed between those using design as "last finish" (14%) and using design as a "central element in the company's strategy" (13%). While one third of the total companies reported using design as either a central element of strategy or as an integral element for development work, another third (34%) stated that they did not use design; and a further 18% stated that they did not work systematically with design.[81]

Almost half (49%) of the EU-28 businesses declared that they had some investments in design, with 14% of the firms spending less than 1% of their total turnover on design; 23% of them 1 to 5%; and 12% spending over 5% of their total turnover on design. However, almost half (46%) of the firms reported spending nothing on design; with the remaining 6% not knowing, or not being willing to answer.[82]

As shown in Table 37, investment in design (44%; 42%) was more widespread than R&D (31%; 29%) and software development (43%; 40%) in both 2015 and 2016.

[81] Authors' calculations based on data files (European Commission, 2015a; 2016a).
[82] Authors' calculations based on data files (European Commission, 2015a; 2016a)

Table 36 Innobarometer 2015 and 2016 - positioning of design and investment in design (% of EU-28)

		%
Positioning of design	Central	13.0
	Integral	20.6
	Last finish	13.6
	Not used systematically	17.6
	Non-design	33.6
	Don't know	1.5
% of past 3 yrs' turnover invested in design	0%	45.8
	< 1%	14.3
	1-5%	22.6
	> 5%	11.7
	Don't know	5.6

Source: European Commission, 2015a; 2016a.

Table 37 Innobarometer 2015 and 2016 - investment activity (% of EU-28)

Investment activity	% of past 3 yrs' turnover	% EU-28	
		2015	2016
Training	0%	33	37
	< 1%	19	17
	1-5%	34	31
	> 5%	11	11
	Don't know	3	2
Software	0%	54	58
	< 1%	12	12
	1-5%	21	20
	> 5%	10	8
	Don't know	3	2
Branding	0%	38	41
	< 1%	16	16
	1-5%	29	29
	> 5%	14	11
	Don't know	3	3
R&D	0%	65	69
	< 1%	8	9
	1-5%	14	13
	> 5%	9	7
	Don't know	4	2
Design	0%	51	54
	< 1%	11	10
	1-5%	21	20
	> 5%	12	12
	Don't know	5	4
Organisation/business process improvements	0%	43	45
	< 1%	14	14
	1-5%	29	27
	> 5%	10	11
	Don't know	4	3
Acquisition of machines/equipment/software/licenses	0%	27	30
	< 1%	14	14
	1-5%	34	33
	> 5%	22	21
	Don't know	3	2

Source: European Commission (2015b, pp. T26-T32); European Commission (2016b, pp. T12-T18).

Table 38 and Table 39 indicate the distributions of the roles of design by firm size, sector, firm age and type of innovation in 2015 and 2016 respectively. While larger firms were more likely to engage in design than smaller firms, the role played by design in the firms did not vary systematically with firm size. Little difference was found between sectors for the positioning of design, except that the industry sector (i.e. utilities and construction) was less likely to use design as a central element of business strategy and were less likely to use design in general than firms active in the other three sectors. New firms were generally more likely to use design. Goods or services innovators were also more likely to use design; meanwhile, they were also more likely to use design either as a central element of business strategy or as an integrated element.

Table 38 Innobarometer 2015 - positioning of design, by firm size, sector, firm age and innovator (% of EU-28)

		Positioning of design					
		Central	Integral	Last finish	Not used systematically	Non-design	Don't know
Total		13	18	14	16	38	1
Firm size (employees)	1-9	12	17	14	16	40	1
	10-49	12	22	13	19	33	1
	50-249	23	25	8	14	28	2
	≥ 250	19	40	11	12	17	1
Sector	Manufacturing	15	23	14	14	33	1
	Retail	12	16	14	17	39	2
	Services	15	18	14	16	36	1
	Industry	7	17	13	17	45	1
Firm age	Before 2009	12	17	14	16	40	1
	2009-2014	13	21	15	16	33	2
	After 2014	16	21	13	19	27	4
Innovator	Goods/services innovator	17	21	17	16	27	2
	Other innovator	9	19	15	17	38	2
	Non-innovator	5	10	7	16	61	1

Source: European Commission (2015b, pp.80-81).

Table 39 Innobarometer 2016 - positioning of design, by firm size, sector, firm age and innovator (% of EU-28)

		Positioning of design				
		Central	Integral	Last finish	Not used systematically	Non-design
Total		12	18	14	17	37
Firm size (employees)	1-9	12	17	14	16	39
	10-49	15	21	15	19	29
	50-249	11	30	17	13	26
	≥ 250	34	21	6	20	18
Sector	Manufacturing	13	19	16	15	35
	Retail	12	18	15	18	36
	Services	14	19	15	15	36
	Industry	6	15	12	18	47
Firm age	Before 2010	12	17	14	17	39
	2010-2015	13	21	17	17	31
	After 2015	16	18	19	6	35
Innovator	Goods/services innovator	16	23	17	17	28
	Other innovator	11	18	21	10	30
	Non-innovator	6	9	9	10	56

Source: European Commission (2016b, p.99).

Innovation Index Survey

As well as the Investments in Intangible Assets (IIA) survey, the NESTA led Innovation Index project included a survey of innovation in nine sectors. This survey (Roper, et al., 2009) was intended to contribute to the development of a new index to measure the UK's innovation performance. It was conducted at the pilot stage of the NESTA Innovation Index project and included interviews with 1,497 firms with 5 or more employees active in nine sectors[83], including architectural services, accountancy services, business consultancy, legal services, software and IT services, automotive, construction, energy and design services. The sectors included several knowledge-intensive business service (KIBS) sectors where a significant amount of "hidden innovation" was expected, as well as high value added manufacturing sectors where scientific and technical R&D had long been regarded as strong while non-R&D elements of innovation were considered to have been overlooked.

The survey took an activity-based view of innovation – innovation process comprises several activities each of which has different characteristics and resource requirements – based on the concept of the *Innovation Value Chain* (IVC) (Hansen & Birkinshaw, 2007) and its three phases: *accessing knowledge* (i.e. investing in new knowledge and ideas and engaging in "open innovation" activities with other organisations); *building innovation* (i.e. translating knowledge investment into innovation output); and *commercialising innovation* (i.e. exploiting innovation in the market place). The questionnaire also contained questions tailored for specific sectors in order to create a better account of innovation in different sectors as well as a wider range of innovations, which hereby enabled cross-sectoral comparisons of innovation process in terms of three stages of the IVC. (Roper, et al., 2009)

As a result, 16 metrics were identified – 5 for *assessing knowledge* (including 4 cross-sectoral metrics and 1 metric defined differently for each sector); 6 for *building innovation* (including 4 cross-sectoral metrics and 2 metrics defined differently for each sector); and 5 for *commercialising innovation* (including 2 cross-sectoral metrics and 3 metrics defined differently for each sector). Specially, the use of different internal skill groups and the use of external partners were common across the three phases of the IVC.

[83] The survey initially involved 10 sectors including aerospace. Nonetheless, given the far fewer firms than any of the other nine sectors as well as the small number of response received from aerospace sector, fieldwork was stopped in this sector. Therefore, the report only considers the other nine sectors.

Design intensity (i.e. design expenditure as a share of sales) was one of the metrics used to measure firms' capability for *accessing knowledge*; the other four metrics were – proportion of externally sourced ideas, R&D intensity, use of external partners in accessing knowledge and multi-functionality (sector specific). Firms were asked if they had invested in design of new or improved products and services and the amount of such investment. Combined with the turnover data, the results (weighted by sector and size band) suggested that firms operating in the nine sectors had typically spent 1% of turnover on design in 2009 (or the most recent business year for which data were available). Variation was also found among the sectors studied (see Table 40). Software and IT services was the most design-intensive sector, with a design intensity of 5.2%, more than twice of that of consultancy services (2.4%). The design intensity of architectural services was, meanwhile, less than half of that of consultancy services (1.1%), which was followed by specialist design (1%). Other sectors with low design intensities included the automotive sector (0.7%), energy production (0.7%), accountancy services (0.4%), construction (0.2%) and legal services (0.1%).

Table 40 Innovation Index survey - R&D intensity and design intensity (% of sales), by sector

	R&D intensity	Design intensity
Accountancy services	0.0	0.4
Architectural services	1.4	1.1
Consultancy services	0.7	2.4
Legal services	0.0	0.1
Software & IT services	4.3	5.2
Automotive	1.0	0.7
Construction	0.1	0.2
Energy production	1.1	0.7
Specialist design	1.0	1.0
Total	0.7	1.0

Source: Roper et al. (2009, p.20).

By comparison, the average R&D intensity (i.e. R&D expenditure as a share of sales) across all sectors was 0.7%. Software and IT services, in addition to having the highest design intensity, reported the highest R&D intensity (4.3%); while specialist design had the same expenditure on design and R&D (1% of sales). Architectural service was, surprisingly, the second most R&D-intensive sector, with 1.4% of sales, which was followed by energy production (1.1%), automotive and specialist design (1%), and consultancy services (0.7%). Construction, meanwhile, spent 0.1% of sales on R&D, and accountancy and legal services reported no expenditure on R&D. (Roper, et al., 2009)

Firms were required to indicate whether they had carried out certain types of innovation between 2006 and 2009: a third (35%) of them claimed to be product or service innovators, and a quarter (24%) process innovators, while the proportions of firms claiming to have introduced marketing, organisational, strategic or management technique innovations were 36%, 25%, 22% and 21% respectively. In general, the survey found significant levels of "hidden innovation" in several low-R&D sectors; but also that "hidden innovation" was important for high-R&D sectors. The within-sector variations of innovation capability were also found high for a few sectors investigated. (Roper, et al., 2009)

Barnett's analysis of firms' expenditure on intangible assets (Barnett, 2009) utilised the data from this survey. His analysis focused on the questions used to identify expenditures on five intangible assets – software and computer networks, marketing, R&D, design, and process changes. The analysis examines the data from firms providing complete information on their expenditures on the five categories of intangible asset (n=989), among which 713 provided turnover data[84]. This found 21% of total expenditure on intangibles was spent on design (32% on process improvements; 17% on marketing; 16% on R&D; 14% on software and computer networks expenditure). And if firms in the highest 1% of expenditure on any asset are excluded from the sample (n=968) for reducing the skewing effects that these firms had on the overall percentages, the share of design expenditure increased by 1%; if the highest 5% are excluded (n=875), design expenditure increased to 26% of total intangible expenditure.

Table 41 Innovation Index survey - expenditures on intangibles (% of total expenditures on intangibles)

	All firms with complete information	Excluding firms in highest 1% of expenditure on any asset	Excluding firms in highest 5% of expenditure on any asset
Software & computer network	14	17	23
Marketing	17	16	19
R&D	16	19	14
Design	21	22	26
Process changes	32	26	19

Source: Barnett (2009).

Section summary

The value of design is increasingly recognised, especially in manufacturing industries and larger firms. Design is commonly used as an integrated element within firms.

Prevalence of design investment/design intensity

[84] Barnett's sample (n=989) includes two observations from aerospace sector.

1) There seems a growing share of firms investing in design (up to more than half of businesses) (European Commission, 2009b; 2013b; 2015a; 2016a).
2) Design is less widespread than most of the other intangible investments except for R&D. Even for product/service/process innovators, design is more prevalent than R&D (European Commission, 2013b).
3) Most of the firms with design investment spend up to 5% of total turnover on design (European Commission, 2013b; 2015a; 2016a).

Factors associated with the existence of design investment/ amount of design investment/design intensity

4) Design investment is more widespread in **larger firms** and **manufacturing industries** (European Commission, 2013b). The impact of firm size on design investment may depend on other factors (e.g. **technological/marketing opportunities**) (Filippetti, 2011).
5) Design intensity (i.e. design expenditure over turnover) also varies between **sectors** (Roper, et al., 2009).
6) For innovative firms, whether investing in design can be associated with the pursuit of **new technological and marketing opportunities**, as well as IP protection mechanism (e.g. **patent** and **registered-design**) (Filippetti, 2011).

Design use

7) Most of the firms using design regard it as an integrated element of the development work (European Commission, 2015a; 2016a).

Ad-hoc surveys

Finally – before summarising all of the findings from these studies - this section draws together a set of “ad hoc” studies which have examined firms’ commitments to design. This includes the Danish Design Centre survey which first applied the concept of the *Design Ladder*, which was also subsequently integrated into the Danish version of the CIS in 2010. Therefore, the Danish CIS 2010 examined not only the expenditures on innovation activities including design but the positioning of design in terms of the *Design Ladder* as well.

Survey by Danish Design Centre in 2003

The *Design Ladder* was developed by the Danish Design Centre (in 2001) with the aim of capturing variation in how design is used within firms. The ladder consists of four steps, and concerns not only the use of design, but also the role and positioning within the firm of trained designers. The first level is “non-design”, where design is not used systematically. For instance, product development and solutions are achieved by the involvement of non-designers who resolve issues about functionality and aesthetics. Level 2 is the “design as form-giving”, in which design is used as a “styling tool” at the last stage of product development. This task may be handled by professional designers but may also be undertaken by people without background in design. Level 3 is “design as process”, in which design is an integrated element from the early stage of product development process and, consequently, solutions tend to be problem-driven and user-driven, and require a variety of expertise, including that of trained designers. “Design as strategy” is the highest level, in which design is utilised as a strategic element of business model. Designers working in “design as strategy” firms will work with others at key decision-making level. (Danish Design Centre, 2015)

In 2003, Denmark’s National Agency for Enterprise and Housing commissioned the Danish Design Centre to undertake a survey of the economic effects of design: 1,016 firms (with at least 10 employees) participated in this survey. Meanwhile 460 declined due to their lack of interest in design. Among those participating, 998 provided information about their positioning on the design ladder (see Table 42), with 15%

"using design as innovation" (level 4) and 35% of "using design as process" (level 3); 13% using design as styling (level 2) and 36% not using design (level 1).[85]

Table 42 Survey by Danish Design Centre 2003 - positioning on the Design Ladder

		% of firms
Step 1	Non-design	36
Step 2	Design as form-giving	13
Step 3	Design as process	35
Step 4	Design as strategy	15

Source: Danish Design Centre (2003, p. 28).

Based on the data of 1,456 companies with valid answers to the relevant question, firms were also categorised into four groups according to their design purchase profiles (see Table 43): 1) do not use design; 2) only purchase design internally in the form of training staff in design; 3) only purchase design externally from external design providers; and 4) purchase design both internally and externally. More than half (51%) of the respondents did not purchase design either internally or externally, while 39% only purchased design externally, and a small share (4%) only invested in internal design through staff design training. Only 6% of the companies chose to purchase design both internally and externally. That is, 10% of the companies had professional designers working in house, whereas 45% of companies procured design from external design providers.

Table 43 Survey by Danish Design Centre 2003 - in-house and bought-in design (% of firms), by firm size

	Do not purchase	Purchase externally	Purchase internally	Purchase internally & externally
Firm size (employees)				
10-19	54.9	37.8	3.9	3.3
20-49	49.8	39.5	3.1	7.5
50-99	47.2	38.5	6.2	8.1
≥ 100	40.2	37.8	5.5	16.5
Total	51.1	38.5	4.1	6.4

Source: Danish Design Centre (2003, p. 10).

In order to assess the internal investment in design in the form of salaries paid to in-house designers, the survey also requested the number of professional designers employed within the companies. The result suggested that of the 10% (152) of Danish

[85] In terms of firm size, firms with 10-19 employees were commonly located at level 1 (44%) and secondly widespread at level 3 (33%). Businesses with 20 employees or above mainly distributed at level 3 (35% of firms with 20-49 employees, 35% of firms with 50-100 employees and 47% of firms with more than 100 employees) and secondly spread over level 1 (33% of firms with 20-49 employees, 27% of firms with 50-100 employees and 20% of firms with at least 100 employees). (Danish Design Centre, 2003)

firms directly employed professional designers, the vast majority of which (82%) employed not more than 3 designers. (Danish Design Centre, 2003)

This survey also found design purchasers had higher shares of turnover being generated by exports.

Danish CIS 2010

As part of the CIS 2010, Statistics Denmark also tested the design ladder in their pilot survey which produced 4,306 responses from firms. Galindo-Rueda and Millot (2015)[86] report that 5% of these firms indicated that they used design as last finish, 12% used design as an integrated process, and 7% considered it a central strategic element. Meanwhile, more than 20% reported that they did not work systematically with design, and more than half of the respondents did not reveal the information.

Firms reporting using design as an integrated element were further asked about the six specific roles that design activities might contribute. For approximately half of these firms, design was used for “solving problems related to development of new concepts, products or services”. 18% of them had “designers involved in the definition of new business area”. By comparison, more than 40% of these firms were where design had taken “part of development of new concepts and products from the start-up”. There were also more than 40% of firms had designers working in “interdisciplinary teams concerning development of new concepts or products”. Additionally, less than 40% of these firms had “a design policy for the development of concepts and products”; whereas more than 40% of them had “a design policy, ensuring visible coherence between products, services, concepts and products”. Notably, there were 15% of the firms using design as an integrated element did not match any of the proposed roles.

Furthermore, the difference in the propensity of using design as an integrated element by industry was found to be especially relevant to technology intensity and consumer focus– compared to low-tech/consumer manufacturing (the baseline for comparison) and controlling for firm size, firms in high-tech/consumer manufacturing, ICT services firms and high-tech/process manufacturing firms were around 10%, 8% and 7% respectively more likely to use design as an integrated element, whereas low-tech/process manufacturing, finance and insurance, transport and construction were

[86] Where the explicit percentages are not reported in text, approximate percentages are read from the bar charts presented in the source (Galindo-Rueda & Millot, 2015, pp. 28-29).

around 10%, 19%, 19% and 22% respectively less likely to do so (Galindo-Rueda & Millot, 2015).

Design Management Europe Survey

Using a concept similar to the *Design Ladder*, the *Design Management Staircase* (DMS) identifies design management practices within firms at four levels of increasing strategic importance (Kootstra, 2009). Companies at the lowest level possess no or little design related knowledge or experience. As design is not a clearly defined process, any possible design activities in place are unpredictable and yield inconsistent results. At the second level, design management is a project in which design is used to meet direct business needs and mainly as a marketing tool. Design is not associated with new product development and innovation, and design activities involve little to no collaboration and coordination between different departments. At the third level, design management is a function that requires a dedicated set of people or a department with formal responsibility for managing the whole design process. Here, product development is undertaken continuously, and design is used proactively in order to achieve shortened product cycles. At the fourth and highest level firms are design-driven; design is part of their main business processes, and the use of design is at its broadest. Design management, meanwhile, is part of the corporate culture. Firms at this level pursue design innovation (which includes first-to-market non-technological innovations) and use design as a core element for differentiation. In addition to being present in different departments in the company, the senior management is involved with design, and employees generally are informed about the importance of design.

Kootstra (2009) considers that the levels of the staircase can be measured by five variables: 1) the awareness of the benefits of design and design management; 2) effective deign management process; 3) widely communicated business plans in which a strategy for design is articulated in; 4) design expertise represented by the quality of staff and the range of tools and methods applied; and 5) resources of design including investments in design projects and deployment of appropriate design staff.

Both the *Design Ladder* and *Design Management Staircase* imply that the highest rung represents the best way to work with design or design management practices. Kootstra (2009) however points out that design-driven innovation strategy (level 4 of the DMS) is not necessarily an objective for every company – level 2 or level 3 can be sufficient depending on the company's ambitions. Likewise, the "higher" levels of the design ladder are not necessarily “smarter” than using design as a styling tool. Design as a strategy or as an integrated tool can serve as the extension of the traditional areas of design, yet their viability varies in circumstances (Perks, et al., 2005).

The Design Management Europe (DME) survey was conducted over the winter of 2008-09 and tested the validity of *Design Management Staircase* among a group of “active design users” active in manufacturing, services, wholesale and retailing, agriculture, forestry and fishing, non-business and other sectors. 605 responses were processed, with 421 providing information on Kootstra’s five variables to measure design management (n=421). The survey found that in 36% of the companies design played no role or a very limited role (level 1); 23% were at level 2 (undertaking design management on a project basis); 35% had integrated design with other processes (level 3); while 6% of the companies had managed design strategically (level 4). (Kootstra, 2009)

Table 44 Design Management Europe survey 2008 – Design Management Staircase

		% of firms
Level 1	No design management	36
Level 2	Design management as project	23
Level 3	Design management as function	35
Level 4	Design management as culture	6

Source: Kootstra (2009, p.41).

Design Council National Survey of Firms 2005 and 2008

In 2005 and 2008 the UK’s Design Council undertook two surveys on the use of design, and attitudes to design, within businesses in the UK.

The 2005 survey comprised 1,500 interviews with firms with ten or more employees (Design Council, 2007). It found that 15% of the UK businesses considered design as an integral element to their operations; and a further 22% recognised that design had a significant role to play. By contrast, a quarter of firms considered that design did not have a role in their business, while almost two in five (39%) recognised that design only played a limited role.

With respect to “factors for business success”, 15% of companies regarded design as a crucial factor, the same proportion saw R&D as crucial.

Among the seven business success factors (i.e. design, R&D, marketing, internal communication, quality of staff, operational management and financial management), design was placed first by 16% of companies (see Table 45). Interestingly, almost twice this proportion of large firms (29%) put design first.[87] With regard to the areas of design application (see Table 46), half of UK businesses used design for "externally facing functions, such as corporate communications and branding" and nearly half (48%) for marketing. Fewer firms applied design to new product development (28%), "internally facing functions (such as workplace design and internal communications)" (19%), business planning (16%) or R&D (12%).

Table 45 Design Council National Survey 2005 - crucial factor for business success

	% of firms
Financial management	74
Operational management	66
Quality of staff	64
Internal communications	44
Marketing	34
R&D	15
Design	15

Source: Design Council (2007, p.23).

Table 46 Design Council National Survey of Firms 2005 - areas of design application

	% of firms
Externally facing functions	50
Marketing	48
New product development	28
Internally facing functions	19
Business planning	16
R&D	12
None of the above	24

Source: Design Council (2007, p.28).

In terms of design investment (see Table 47), a third (34%) of the firms employed designers internally, while a quarter (25%) had a dedicated design department; and a fifth (19%) bought design from external design consultants. Of those that employed designers, nearly half (47%) employed two to four, but 10% employed more than 10 designers. Meanwhile, a considerable proportion (88%) of firms had between 1 and 4 employees working as designers as a secondary part of their job.

[87] Compared to 23% of medium-sized firms and 15% of small firms

Table 47 Design Council National Survey of Firms 2005 - in-house design and bought-in design

	% of firms
We employ designers internally	34
We have a dedicated design department	25
We have external design consultants	19
We don't have any design activity	45

Source: Design Council (2007, p.29).

Table 48 Design Council National Survey of firms 2005 - no. of designers employed and no. of employees doing design as secondary job

		% of firms
No. of designers employed	1	26
	2-4	47
	5-9	17
	≥ 10	10
No. of employees doing design as secondary part of their job	1	38
	2-4	50
	5-9	6
	≥ 10	6

Source: Design Council (2007, p.29).

Overall, 43% of the businesses did not invest in design between 2002 and 2005 (see Table 50), and 3% had reduced their investments in design. By contrast, 31% stated that they had increased their investments in design during this period of time.

In 2008, the Design Council undertook a similar "Design in Britain" survey (Design Council, 2009). Based on responses from 1,522 firms, the survey indicated that since 2005 a growing share of UK firms considering that design had a role to play in their businesses (see Table 49). The proportion of firms that viewed design as integral to their operations doubled to 30% (from 15%), while 26% (c.f. 22% in 2005) more claimed design played a significant role. Meanwhile, a smaller share (13%, from 25%) considered that design had no role to play in their business. With respect to the areas of design application, 71% of all UK businesses applied design to marketing.

Table 49 Design Council National Survey 2005 and 2008 - importance of design (% of firms)

	2005	2008
Integral role	15	30
Significant role	22	26
Limited role	39	31
No role	25	13

Source: Design Council (2007, p.24); Design Council (2009, p.4).

Meanwhile, 42% of firms the firms reported having an in-house design department, and 42% also reported commissioning design from design agencies, a proportion double that recorded in the 2005 survey. Commitment to design was increasing among the surveyed firms, with 34% reporting that they had increased their design expenditures during previous year; 61% had not changed their design expenditures in the past twelve months[88], while only 5% reported reducing their design spending.

Table 50 Design Council National Survey 2005 and 2008 - change of investment in design (% of firms)

	2005	2008
We've increased investment	31	34
It's stayed the same	23	61
We've invested less	3	5
We don't invest in design	43	-

Source: Design Council (2007, p.25); Design Council (2009, p.5).

Section summary

Design is better and increasingly recognised in the UK, especially among larger firms. It can integrate into both technology-led and consumer-focused processes.

Design use/investment

1) Galindo-Rueda and Millot (2015) found a relatively small portion of Danish firms reporting using design.
2) Most firms either do not use design or use it as a process (Danish Design Centre, 2003) or a function integrated with other processes (Kootstra, 2009).
3) There appears increasing importance of design within UK businesses; and there are at least half of the UK businesses investing in design (Design Council, 2007; 2009).

Factors associated with design use

4) Design is more likely to be used for **marketing** than for R&D or New Product Development (Design Council, 2007; 2009); and the critical role of design is positively associated with **firm size** (Design Council, 2007).
5) Design used as an integrated element is mainly for **new product development** (Galindo-Rueda & Millot, 2015).

[88] There were 23% of all UK businesses falling into this group in 2005; and the sum of "it's stayed the same" and "we don't invest in design" accounted for 66%. The 2008 survey seems not distinguish "we don't invest in design" from "it's stayed the same".

6) To use design as an integrated element is associated with **technology-intensity** and **consumer focus** (Galindo-Rueda & Millot, 2015).

Internal and external design

7) In contrast to the finding of most of the other surveys reviewed, a significant proportion of Danish firms only purchase design externally; and Danish firms are more likely to invest in external design than internal design (Danish Design Centre, 2003). There also appears to be an increasing proportion of UK businesses with external design investment (Design Council, 2009).
8) Most of the businesses with in-house designers employ only a small number of them (typically less than 4) (Danish Design Centre, 2003; Design Council, 2007).

Summary

Design accounts for around 10-13% of the UK's total investments in intangibles (Goodridge, et al., 2012; 2014).

In the UK, the investment in design was estimated to have been higher than the UK's investments in R&D and branding between 2007 and 2009, while lower than investments in training, organisational capital and software (Goodridge, et al., 2012). However, design investment was then exceeded by R&D and branding investments after 2010 (Goodridge, et al., 2014). By 2015, the estimate of design investment was more than three-quarters of the estimate of R&D investment (Martin, et al., 2018). However, compared to R&D investments, which were highly concentrated in manufacturing, design investments were more widespread across sectors (although manufacturing still accounted for the largest part) with high-value-added sectors had greater investments in design (Goodridge, et al., 2012). This implies design is not only more accessible than R&D to a variety of businesses across sectors, but also essential for the growth of the UK economy.

Different from the macro data, the aggregates of self-reported firm data suggest UK businesses have much lower spending on design than R&D and branding in 2008 and 2010, albeit more of them reported spending on design than on R&D (Field & Franklin, 2012). This implies that on average UK firms invest only modestly in design. On the other hand, the disparity between the macro and micro-level estimates implies that design seems to be neither well-understood nor well-measured.

The reviewed studies (surveys) have understood design differently including as an intangible asset, an input into innovation, part of R&D (as an input into innovation), part of product or marketing innovation, part of a firm's capability to access knowledge, a form-giving tool, an integral element to development or operation, a strategy, a function in business, a success factor. While there are various understandings of design, existing practices of design measurement have regarded design as a whole thing rather than a collection of different specific activities or elements. For example, the UK Innovation Survey, albeit departing from the Community Innovation Survey under the Oslo Manual and has asked about design, has requested businesses' expenditure on "all forms of design" for innovation; and the Innobarometer has asked about design positioning and the investments in bands for products and services design. These measurement approaches have not yet sought to disaggregate businesses' design activities.

Bearing with these issues, specifically, the review found:

There are complementarities between design and other innovation inputs (Vinodrai, et al., 2007; Ciriaci, 2011), while design is also less widespread than most of the other innovation inputs (Marsili & Salter, 2006; Cereda, et al., 2005; Vinodrai, et al., 2007; Czarnitzki & Thorwarth, 2012; BIS, 2012; 2014; BEIS, 2016; Awano, et al., 2010; Field & Franklin, 2012). Nevertheless, design is found to be more widespread than R&D (Awano, et al., 2010; Field & Franklin, 2012; European Commission, 2013b), which is seen as the main "engine" of innovation. There also seems to be a growing share of firms reporting investing in design (European Commission, 2009b; 2013b; 2015a; 2016a). This again suggests the increasing significance of design within firms. Compared to expenditures on the other innovation inputs, the expenditure on design as a proportion of total innovation expenditure is lower (Cereda, et al., 2005; Vinodrai, et al., 2007; BIS, 2012; 2014; BEIS, 2016). This implies that most firms that invest in design spend modestly on it.

A range of structural and behavioural factors are associated with the distribution of design engagement, including firm size (Cereda, et al., 2005; BIS, 2012; 2014; BEIS, 2016; Behrens, et al., 2017; Design Council, 2007; European Commission, 2013b; Awano, et al., 2010; Field & Franklin, 2012), industrial sector (BIS, 2012; 2014; BEIS, 2016; Behrens, et al., 2017; Cereda, et al., 2005), R&D (Vinodrai, et al., 2007), marketing (Design Council, 2007; 2009; Ciriaci, 2011), collaboration (Czarnitzki & Thorwarth, 2012), international/domestic market orientation (Cereda, et al., 2005), owning patents (Vinodrai, et al., 2007), registered-designs and trademarks (Filippetti, 2011).

Larger firms (Cereda, et al., 2005; BIS, 2012; 2014; BEIS, 2016; Behrens, et al., 2017; European Commission, 2013b), high-tech and engineering-based manufacturing and Knowledge Intensive Business Services (KIBS) (BIS, 2012; 2014; BEIS, 2016) are especially more likely to spend on design. Manufacturing industries also tend to spend a larger share of their total innovation expenditures on design than other industries (Cereda, et al., 2005). However, the extent to which firms are engaged in expenditure on design (i.e. the share of total innovation expenditure spent on design) is not found varying systematically with firm size (Ciriaci, 2011). This suggests that design plays a significant role in a wide scope of the economy; and it can be an accessible way to innovate for small firms. Specially, design is important for firms that seek to exploit technological and market opportunities (Galindo-Rueda & Millot, 2015; Filippetti, 2011). This includes but is not limited to high R&D engagement and assigning importance to IPRs including patents, trademarks and registered designs (Ciriaci, 2011; Filippetti, 2011; Vinodrai, et al., 2007). Firms active in collaboration and international market also see design as an important element of their businesses (Cereda, et al., 2005; Czarnitzki & Thorwarth, 2012). Most firms use design as an integrated element of the development work (European Commission, 2015a; 2016a; Kootstra, 2009).

In summary, design has been an increasingly important part of the UK economy. Design potentially complements R&D and marketing. It provides SMEs with an accessible relatively low-cost way to innovate; however, paradoxically, its value has not been widely recognised by these firms. Design is better recognised in firms that are actively exploiting technological and market opportunities, both internally and externally.

Most of the findings above derive from reports of surveys. Therefore, they are direct observations of the specific variables. The concepts they represent have not been discussed and reasoned in specific contexts. For the better-informed practices, under a conceptual framework that companies can relate to and operate, future research could further examine if, how and where design complements R&D and/or marketing; and if, how and where design enhances firms' capabilities of seizing technological and market opportunities. As part of the effort, more research should seek to capture the diversity of businesses' design activities and improve the measurement of design.

References

Aschhoff, B. et al., 2013. *Innovation in Germany - results of the Germany CIS 2006 to 2010,* Mannheim: ZEW.

Awano, G., Franklin, M., Haskel, J. & Kastrinaki, Z., 2010. *Investing in innovation: Findings from the UK investment in intangible assets survey,* s.l.: National Endowment for Science, Technology and the Arts.

Barnett, D., 2009. *UK intangible investment: Evidence from the innovation index survey,* s.l.: s.n.

Behrens, V. et al., 2017. *Innovation activities of firms in Germany-Results of the German CIS 2012 and 2014: Background report on the surveys of the Mannheim Innovation Panel Conducted in the Years 2013 to 2016,* s.l.: ZEW-Dokumentation.

BEIS, 2016. *UK innovation survey 2012 to 2014: Statistical annex [Data file],* London: Department for Business, Energy and Industrial Strategy.

BIS, 2012. *UK Innovation Survey 2011: Statistical annex [revised] [Data file],* London: Department for Business, Innovation and Skills.

BIS, 2014. *UK innovation survey 2010 to 2012: Annex [Data file],* London: Department for Business, Innovation and Skills.

Borgo, M. D., Goodridge, P., Haskel, J. & Pesole, A., 2013. Productivity and growth in UK industries: An intangible investment approach. *Oxford Bulletin of Economics and Statistics,* 75(6), pp. 806-834.

Cereda, M., Crespi, G., Criscuolo, C. & Haskel, J., 2005. *Design and company performance: Evidence from the Community Innovation Survey,* s.l.: DTI Report.

Ciriaci, D., 2011. *Design and European firms' innovative performance: A less costly innovation activity for European SMEs?,* s.l.: Joint Research Centre of the European Commission.

Corrado, C., Hulten, C. & Sichel, D., 2005. Measuring capital and technology: An expanded framework. In: C. Corrado, J. Haltiwanger & D. Sichel, eds. *Measuring capital in the new economy.* Chicago: University of Chicago Press, pp. 11-46.

Corrado, C., Hulten, C. & Sichel, D., 2009. Intangible capital and US economic growth. *Review of Income and Wealth,* 55(3), pp. 661-685.

Czarnitzki, D. & Thorwarth, S., 2012. The contribution of in-house and external design activities to product market performance. *Journal of Product Innovation Management,* 29(5), pp. 878-895.

Danish Design Centre, 2003. *The economic effects of design,* Copenhagen: s.n.

Danish Design Centre, 2015. *The Design Ladder: Four steps of design use.* [Online] Available at: http://danskdesigncenter.dk/en/design-ladder-four-steps-design-use [Accessed 2 June 2017].

Design Council, 2007. *The value of design factfinder report,* London: Design Council.

Design Council, 2009. *The design economy: The value of design to the UK,* London: Design Council.

European Commision, 2016a. *Flash Eurobarometer 433: Innobarometer 2016 – EU business innovation trends [Data file],* Brussels: European Commision.

European Commission, 2009b. *Flash Eurobarometer 267: Innobarometer 2009 analytical report,* Brussels: European Commission.

European Commission, 2013b. *Flash Eurobarometer 369: Investing in intangibles: economic assets and innovation drivers for growth,* Brussels: European Commission.

European Commission, 2015a. *Flash Eurobarometer 415: Innobarometer 2015 – the innovation trends at EU enterprises [Data file],* Brussels: European Commission.

European Commission, 2015b. *Flash Eurobarometer 415: Innobarometer 2015 – the innovation trends at EU enterprises,* Brussels: European Commission.

European Commission, 2016b. *Flash Eurobarometer 433: Innobarometer 2016 – EU business innovation trends,* Brussels: European Commission.

Eurostat, 2016. *Number of enterprises, persons employed and gross value added (GVA) and the share of SMEs, 2012.* [Online] Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Number_of_enterprises,_persons_employed_and_gross_value_added_(GVA)_and_the_share_of_SMEs,_2012.png [Accessed 12 April 2018].

Farooqui, S., Goodridge, P. & Haskel, J., 2011. *The role of intellectual property rights in the UK market sector,* s.l.: Intellectual Property Office.

Field, S. & Franklin, M., 2012. *Results from the second survey of Investment in Intangible Assets, 2010,* s.l.: Office for National Statistics.

Filippetti, A., 2011. Innovation modes and design as a source of innovation: a firm-level analysis. *European Journal of Innovation Management,* 14(1), pp. 5-26.

Galindo-Rueda, F., Haskel, J. & Pesole, A., 2008. *How much does the UK employ, spend and invest in design?,* s.l.: s.n.

Galindo-Rueda, F., Haskel, J. & Pesole, A., 2010. *How much does the UK employ, spend and invest in design?,* s.l.: s.n.

Galindo-Rueda, F. & Millot, V., 2015. *Measuring Design and its Role in Innovation,* Paris: OECD Publishing.

Gil, V. & Haskel, J., 2008. *Industry-level expenditure on intangible assets in the UK,* s.l.: s.n.

Goodridge, P., Haskel, J. & Wallis, G., 2012. *UK Innovation Index: productivity and growth in UK industries,* London: NESTA.

Goodridge, P., Haskel, J. & Wallis, G., 2014. *Estimating UK investment in intangible assets and Intellectual Property Rights,* s.l.: Intellectual Property Office.

Hansen, M. T. & Birkinshaw, J., 2007. The innovation value chain. *Harvard Business Review,* 85(6), pp. 121-130.

Haskel, J. et al., 2009. *Innovation, knowledge spending and productivity growth in the UK: Interim report for NESTA Innovation Index Project,* s.l.: s.n.

Haskel, J. & Pesole, A., 2011. *Design services, design rights and design life lengths in the UK,* s.l.: Intellectual Property Office.

Kootstra, G. L., 2009. *The incorporation of design management in today's business practices: An analysis of design management practices in Europe,* s.l.: Design Management Europe.

Marrano, M. G., Haskel, J. & Wallis, G., 2007. *Intangible investment and Britain's productivity: Treasury Economic Working Paper No. 1,* London: HM Treasury.

Marsili, O. & Salter, A., 2006. The dark matter of innovation: Design and innovative performance in Dutch manufacturing. *Technology Analysis & Strategic Management,* 18(5), pp. 515-534.

Martin, J., O'Brien, R. & Proctor, H., 2018. *Experimental estimates of investment in intangible assets in the UK: 2015,* s.l.: Office for National Statistics.

Nomen, E., 2014. *Guidelines for collecting and interpreting design data: A proposal for a future Barcelona manual on design,* Barcelona: Barcelona Design Centre.

OECD and Eurostat, 1992. *Oslo manual: OECD proposed guidelines for collecting and interpreting technological innovation data,* Paris: OECD Publishing.

OECD and Eurostat, 1997. *Oslo manual: the measurement of scientific and technological activities: proposed guidelines for collecting and interpreting technological innovation data,* Paris: OECD Publishing.

OECD and Eurostat, 2005. *Oslo Manual: Guidelines for collecting and interpreting innovation data,* Paris: OECD Publishing.

OECD and Eurostat, 2018. *Oslo Manual 2018: guidelines for collecting, reporting and using data on innovation,* Paris: OECD Publishing.

Perks, H., Cooper, R. & Jones, C., 2005. Characterizing the role of design in new product development: An empirically derived taxonomy. *Journal of Product Innovation Management,* 22(2), pp. 111-127.

Pina, K. & Tether, B. S., 2016. Towards understanding variety in knowledge intensive business services by distinguishing their knowledge bases. *Research Policy,* 45(2), pp. 401-413.

Robson, S. & Kenchatt, M., 2010. First findings from the UK Innovation Survey 2009. *Economic & Labour Market Review,* Volume 4, pp. 28-35.

Roper, S., Hales, C., Bryson, J. R. & Love, J., 2009. *Measuring sectoral innovation capability in nine areas of the UK economy,* London: NESTA.

Solow, R. M., 1956. A contribution to the theory of economic growth. *The Quarterly Journal of Economics,* 70(1), p. 65–94.

Vinodrai, T., Gertler, M. S. & Lambert, R., 2007. Capturing design: Lessons from the United Kingdom and Canada. In: *Science, technology and innovation indicators in a changing world: Responding to policy needs.* Paris: OECD Publishing, pp. 65-86.

Appendices

Table 51 Summary of empirical studies

No.	Data Source	Year of Survey	Ref. Period[89]	Geog. Area	Population	Sample Size	Key Findings [90]	Factor & Sign of Influence[91]	Source
1	**Community Innovation Survey 2** (CIS 2)	1996	1994-1996	NL	Dutch "innovative firms" in manufacturing (employees ≥ 10)	n=2,008	% of the firms **investing** in certain innovation component: R&D – 75% **Design – 22%** Marketing – 27% Machine – 62%	-	Marsili and Salter, 2006
2	**Community Innovation Survey 3** (CIS 3)	2000	Calendar year 2000	23 European countries	-	n=15,595	% of "product innovators" **investing** in certain non-R&D innovation activity (i.e. design, marketing and training): Invest in any of the non-R&D innovation activities – 58% Invest in design, marketing and training – 33% Invest in design and marketing, not in training – 7% Invest in design and training, not in marketing – 10% Invest in design, not in marketing and training – 9%	**If spend on design:** Firm SZ ? Ind. ✕ **Design expenditure:** Firm SZ ✕ GRP ✕ Int. MKT + PAT + RD + TM + CPLX DESG + SCCY +	Ciriaci, 2011

89 The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

90 I.e. findings about the role/use of design and design expenditure/investment.

91 Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[92]	Geog. Area	Population	Sample Size	Key Findings [93]	Factor & Sign of Influence[94]	Source
3	**Community Innovation Survey 3** (CIS 3)	2001	Calendar year 2000	UK	UK businesses (employees ≥ 10)	n=8,121	% (weighted) of firms **investing** in certain innovation activity: Intramural R&D – 10% **Design – 9%** Marketing – 12%	**If spend on design:** Firm SZ COR Ind. ? **Design expenditure:** Ind. ? **Design exp./innovation exp.:** Int. MKT ? RD COR TM COR CPLX DESG COR LTAD COR	Cereda et al., 2005
4	**A survey conducted by Danish Design Centre**	2003	-	DK	Danish businesses (employees ≥ 10)	n=1,484	% (weighted) of firms on each rung of ***Design Ladder*** (n=998): Step 1 Non-design – 36% Step 2 Design as styling – 13% Step 3 Design as process – 35% Step 4 Design as innovation – 15%	**Use design:** Firm SZ ?	Danish Design Centre, 2003
			Past 5 fiscal years (std.[95])				% (weighted) of firms **investing** in internal or external resources for design (n=1,456): Do not purchase – 51% Purchase externally – 39% Purchase internally – 4% Purchase internally and externally – 6%		
							Design Ladder in relation to **design investments**[96] (average) (n=494): Step 1 Non-design – DKK 285,987 (n=197) Step 2 Design as styling – DKK 96,717 (n=72) Step 3 Design as process – DKK 821,696 (n=150) Step 4 Design as innovation – DKK 431,434 (n=74)		

92 The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm
93 I.e. findings about the role/use of design and design expenditure/investment.
94 Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.
95 This refers to the standard reference period of the indicators in the survey.
96 Reported investments of external procurement of design and the number of in-house designers employed (based on monthly salary of 31,975)

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[97]	Geog. Area	Population	Sample Size	Key Findings [98]	Factor & Sign of Influence[99]	Source
5	**Community Innovation Survey 4** (CIS 4)	2005	Calendar year 2004	UK	-	-	% of firms regarding **expenditure** on certain innovation activity as important: **Design – 19%** In-house R&D – 32% Capital – 47%	**If spend on design:** R&D/PAT ?	Vinodrai, Gertler and Lambert, 2007
							Design **expenditure** as a % of total expenditure on innovation – 5%		
6	**National Survey of Firms**	2005	-	UK	UK businesses (employees ≥ 10)	n=1,500	% (weighted) of firms where design plays certain **role**: Design does not have a role – 25% Design has a limited role – 39% Design has a significant role – 22% Design is integral to operations – 15%	**Design as first success factor:** Firm SZ ?	Design Council, 2007
			Past 3 years				% (weighted) of firms **investing** in design: Do not invest in design – 43% Have invested less – 3% Stayed the same – 23% Have increased investment – 31%	-	
7	**Community Innovation Survey 2006** (CIS 2006)	2006	Calendar year 2004-2006	BE (Flemish region)	Belgian (Flemish) businesses	n=1511	% of firms i**nvesting** in design activities – 18%	**If spend on design:** Collab. ? New MKT oppo. ?	Czarnitzki and Thorwarth, 2012
8	**Community Innovation Survey 2006, 2008 and 2010** (CIS 2006, 2008 and 2010)	2007	2004-2006	GE	German businesses in manufacturing and services (employees ≥ 5)	n=25,862	% (weighted) of firms introducing “significant changes to the **aesthetic design** or packaging of a good or service” – 15%	-	Aschhoff et al. 2013
		2009	2006-2008			n=31,048	% (weighted) of firms introducing “significant changes to the **aesthetic design** or packaging of a good or service” – 18%		
		2011	2008-2010			n=31,821	% (weighted) of firms introducing “significant changes to the **aesthetic design** or packaging of a good or service” – 19%		

[97] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm
[98] I.e. findings about the role/use of design and design expenditure/investment.
[99] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[100]	Geog. Area	Population	Sample Size	Key Findings [101]	Factor & Sign of Influence[102]	Source
9	**National Survey of Firms**	2008	-	UK	UK businesses (employees ≥ 10)	n=1,522	% (weighted) of firms where design plays certain **role**: Design does not have a role – 13% Design has a limited role – N.A.[103] Design has a significant role – 26% Design is integral to operations – 30%	-	Design Council, 2009
			Past 1 year				% (weighted) of firms **investing** in design: Have invested less – 5% Stayed the same – 61% Have increased investment – 34%	-	
10	**Design Management Europe Survey**	Nov.2008-Feb.2009	-	Europe	Active design users in Europe	n=421	% (unweighted) of firms on each level of the ***Design Management Staircase***: Level 1 No design management – 36% Level 2 Design as project – 23% Level 3 Design as function – 35% Level 4 Design as project – 6%	-	Kootstra, 2009

[100] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

[101] I.e. findings about the role/use of design and design expenditure/investment.

[102] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

[103] The percentage of “design has a limited role” is not reported in the source of reference.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[104]	Geog. Area	Population	Sample Size	Key Findings [105]	Factor & Sign of Influence[106]	Source
11	**Innobarometer 2009**	2009	Fiscal year 2006-2008	27 EU Member States	Businesses in innovation-intensive industries (employees ≥ 20)	n=5,034	% of firms **investing** in certain activity: Acquisition of machinery, equipment and software – 76% Training – 50% In-house R&D – 36% **Design – 30%** External R&D – 23% Purchase/licensing of patents, etc. – 15% Application for a patent/registration of a design – 10% % of firms with **increased expenditures** on certain activity (2008 compared to 2006): Acquisition of machinery, equipment and software – 49% Training – 31% In-house R&D – 20% **Design – 17%** External R&D – 11% Purchase/licensing of patents, etc. – 7% Application for a patent/registration of a design – 5% % of firms (who had innovation expenditures) with **increased expenditures** on certain activity (2008 compared to 2006): Acquisition of machinery, equipment and software – 65% Training – 63% In-house R&D – 55% **Design – 57%** External R&D – 49% Purchase/licensing of patents, etc. – 46% Application for a patent/registration of a design – 51%	-	European Commission , 2009b

104 The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

105 I.e. findings about the role/use of design and design expenditure/investment.

106 Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[107]	Geog. Area	Population	Sample Size	Key Findings [108]	Factor & Sign of Influence[109]	Source
				27 EU Member States, NO and CH	-	n=4,664	% of "innovative firms" in relation to certain "**source of innovation"**: **Design – 43%** R&D performed in house – 54% R&D acquired outside – 35% Acquisition of machineries – 83% Acquisition of external knowhow 59%	**Use design:** R&D ? Firm SZ ? Ext. collab. ? High-tech manuf. ? New tech. oppo. ? New MKT oppo. ? KIS ?	Filippetti, 2011
12	**Innovation Index Survey**	2009	2009	UK	UK businesses (employees ≥ 5) in 9 selected sectors	n=1,497	Design expenditure as a % (weighted) of sales – 1%	**Design expenditure:** Ind. ?	Roper et al., 2009
					UK businesses (employees ≥ 5) in 10 selected sectors	n=989	Expenditure on each intangible asset as a % of total expenditure on intangibles: Process changes – 32% **Design – 21%** Marketing – 17% R&D – 16% Software & computer networks expenditure – 14%	-	Barnett, 2009
13	**Community Innovation Survey 2010** (CIS 2010)	2011	Calendar year 2010	DK	Danish businesses (specification not available)	n=4,306	% (unweighted) of firms on each rung of ***Design Ladder***: Level 1 Design not used systematically – approximately 23%[110] Level 2 Design as last finish – 5% Level 3 Design as integrated element – 12% Level 4 Design as central determining element – 7%	**Use design as integrated element:** High-tech ind. + Consumer ind. +	Galindo-Rueda and Millot, 2015

[107] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

[108] I.e. findings about the role/use of design and design expenditure/investment.

[109] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

[110] The accurate percentage of "design not used systematically" is not available in text of the reference, yet the approximate share can be read from the bar chart.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[111]	Geog. Area	Population	Sample Size	Key Findings [112]	Factor & Sign of Influence[113]	Source
14	**Community Innovation Survey 2010** (CIS 2010)	2011	Calendar year 2008-2010	UK	UK businesses (employees ≥ 10)	n=14,342	% (weighted) of firms **investing** in each innovation activity: Internal R&D – 14% External R&D – 5% Acquisition of capital – 24% Acquisition of external knowledge – 5% Training – 12% **All forms of design – 10%** Market introduction of innovations – 20%	**If spend on design:** Firm size COR Industry COR	BIS, 2012
							% (weighted) of total **innovation expenditure** spent on each innovation activity: Internal R&D – 34% External R&D – 24% Acquisition of capital – 30% Acquisition of external knowledge – 2% Training – 2% **All forms of design – 5%** Market introduction of innovations – 4%	**Design expenditure:** Firm size ⨯ Industry COR	

111 The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm
112 I.e. findings about the role/use of design and design expenditure/investment.
113 Sign of influence: ⨯ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[114]	Geog. Area	Population	Sample Size	Key Findings [115]	Factor & Sign of Influence[116]	Source
15	**The First Investment in Intangible Assets** (IIA) **Survey**	Oct.2009-Jan.2010	2008	UK	UK businesses (employees ≥ 10)	n=2,004 (incl. 838 valid responses)	% (weighted) of firms **investing** in each intangible asset (n≈487[117]): Training – 35% Software – 30% Reputation & Branding – 22% R&D – 8% **Design – 10%** Business Process Improvement – 13%	If spend on design: Ind. ? Firm SZ ? Time of EST ?	Awano et al., 2010
					UK businesses investing in intangible assets		Average **expenditure** (weighted) on each intangible asset (each amount was calculated for firms reported positive spending on that category): Training – £90k Software – £182k Reputation & Branding £182k R&D – £547k **Design – £50k** Business Process Improvement - £45k	**If spend on design:** Firm SZ ? **Design expenditure:** Ind. ? Firm SZ ?	

[114] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm
[115] I.e. findings about the role/use of design and design expenditure/investment.
[116] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.
[117] 58% of the total respondents (n=838) reporting positive investments in one or more intangible assets

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[118]	Geog. Area	Population	Sample Size	Key Findings [119]	Factor & Sign of Influence[120]	Source
16	**The Second Investment in Intangible Assets** (IIA) **Survey**	Oct.2011-Jan.2012	2010	UK	UK businesses (employees ≥ 10)	n=2,540 (incl. 1180 valid responses)	% (weighted) of firms **investing** in each intangible asset (n≈472[121]): Training – 30% Software – 22% Reputation & Branding – 16% R&D 6% **Design 10%** Business Process Improvement – 8%	-	Field and Franklin, 2012
					UK businesses with positive spending on intangible asset		Average **expenditure** (weighted) on each intangible asset (each amount was calculated for firms reported positive spending on that category): Training – £78k Software – £148k Reputation & Branding £171k R&D – £341k **Design – £35k** Business Process Improvement - £32k		

[118] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

[119] I.e. findings about the role/use of design and design expenditure/investment.

[120] Sign of influence: ⨯ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

[121] 40% of the total respondents (n=1180) reporting positive investments in one or more intangible assets

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[122]	Geog. Area	Population	Sample Size	Key Findings [123]	Factor & Sign of Influence[124]	Source
17	**Community Innovation Survey 2012 and 2014 (CIS 2012 and 2014)**	2012	2010-2012	GE	German businesses in manufacturing and services (employees ≥ 5)	n=29,605	% (weighted) of "innovation-active firms" conducting each **innovation activity**: In-house R&D – 40% External R&D – 16% Acquisition of machinery, software and other tangible assets – 60% Acquisition of external knowledge – 22% Training – 57% Marketing – 27% **Design – 27%** Other preparations – 44% None of the eight activities – 8%	**Use design:** Sector ? Firm SZ ?	Behrens et al., 2017
							% (weighted) of firms introducing "significant changes to the aesthetic design or packaging of a good or service" – 13%		
		2014	2012-2014			n=30,090	% (weighted) of firms introducing "significant changes to the aesthetic design or packaging of a good or service" – 15%	-	

[122] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

[123] I.e. findings about the role/use of design and design expenditure/investment.

[124] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[125]	Geog. Area	Population	Sample Size	Key Findings [126]	Factor & Sign of Influence[127]	Source
18	**Community Innovation Survey 2012** (CIS 2012)	2013	Calendar year 2010-2012	UK	UK businesses (employees ≥ 10)	n=14,487	% (weighted) of firms **investing** in each innovation activity: Internal R&D – 15% External R&D – 4% Acquisition of capital – 29% Acquisition of external knowledge – 3% Training – 14% **All forms of design – 10%** Market introduction of innovations – 20%	**If spend on design:** Firm size COR Industry COR	BIS, 2014
							% (weighted) of total **innovation expenditure** spent on each innovation activity: Internal R&D – 39% External R&D – 12% Acquisition of capital – 27% Acquisition of external knowledge – 4% Training – 3% **All forms of design – 3%** Market introduction of innovations – 11%	**Design expenditure:** Firm size ✕ Industry COR	

125 The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

126 I.e. findings about the role/use of design and design expenditure/investment.

127 Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[128]	Geog. Area	Population	Sample Size	Key Findings [129]	Factor & Sign of Influence[130]	Source
19	**Innobarometer 2013**	2013	2011	27 EU Member States	Businesses (employee(s) ≥ 1)	n=8,715	% of firms **investing** in only the internal sources (as opposed to external sources) for each intangible asset: Organisation/business process improvements – 60% Training – 58% Company reputation & branding – 52% **Design** of products & services – 41% Software development – 39% R&D – 32% % of firms **investing** certain % of total turnover in internal design of products and services: 0% of total turnover – 55% < 1% of total turnover – 8% 1 - 5% of total turnover – 17% > 5 - 15% of total turnover – 8% > 15 - 25% of total turnover – 4% > 25 - 50% of total turnover – 2% > 50% of total turnover – 2% Don't know – 4% % of firms **investing** in only the external sources (as opposed to internal sources) for each intangible asset: Training – 38% Company reputation & branding – 30% Software development – 26% Organisation/business process improvements – 26% **Design** of products & services – 21% R&D – 15%	**If spend on design:** Ind. ? Firm SZ ?	European Commission , 2013b

[128] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

[129] I.e. findings about the role/use of design and design expenditure/investment.

[130] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[131]	Geog. Area	Population	Sample Size	Key Findings [132]	Factor & Sign of Influence[133]	Source
							% of firms **investing** certain % of total turnover in external design of products and services: 0% of total turnover – 76% < 1% of total turnover – 7% 1 - 5% of total turnover – 9% > 5 - 15% of total turnover – 3% > 15 - 25% of total turnover – 1% > 25 - 50% of total turnover – 1% > 50% of total turnover – 0% Don't know – 3%		
20	**Community Innovation Survey 2014** (CIS 2014)	2015	Calendar year 2012-2014	UK	UK businesses (employees ≥ 10)	n=15,091	% (weighted) of firms **investing** in each innovation activity: Internal R&D – 16% External R&D – 4% Acquisition of capital – 34% Acquisition of external knowledge – 3% Training – 14% **All forms of design – 10%** Market introduction of innovations – 19% % (weighted) of total **innovation expenditure** spent on each innovation activity: Internal R&D – 35% External R&D – 4% Acquisition of capital – 36% Acquisition of external knowledge – 1% Training – 3% **All forms of design – 9%** Market introduction of innovations – 11%	**If spend on design:** Firm size COR Industry COR **Design expenditure:** Firm size ✕ Industry COR	BEIS, 2016

[131] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm

[132] I.e. findings about the role/use of design and design expenditure/investment.

[133] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 51 (Continued)

No.	Data Source	Year of Survey	Ref. Period[134]	Geog. Area	Population	Sample Size	Key Findings [135]	Factor & Sign of Influence[136]	Source
21	**Innobarometer 2015 and 2016**	2015/2016	-	EU-28	EU-28 businesses (employees ≥ 1)	n=26,229	% of firms on each rung of ***Design Ladder***: Design not used – 34% Design not used systematically – 18% Design as last finish – 14% Design as integral but not central element of development work – 21% Design as central element in strategy – 13% Don't know – 1.5%	-	Authors' calculations based on European Commission, 2015a; 2016a
			Past 3 calendar years				% of firms **investing** certain % of turnover in design: 0 of total turnover – 46% < 1% of total turnover – 16% 1 - 5% of total turnover – 23% > 5% of total turnover – 12% Don't know – 6%		

[134] The reference period may not be the standard reference period of the indicators in certain survey – it only applies to key questions of interest (i.e. key findings presented in the current table) unless stated elsewhere. More information about the reference period of the CISs can be found via http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm
[135] I.e. findings about the role/use of design and design expenditure/investment.
[136] Sign of influence: ✕ - not found influenced; + - positively influence; ? – not clear; COR – correlated.

Table 52 Design notions of the reviewed empirical studies

Design notions	Source	Survey
Design is an intangible or "soft" asset. Design activities include the design of products or services to improve their look or performance, web design, etc., which excludes the design of scientific prototypes (part of R&D) and the design of software.	Awano et al., 2010; Field and Franklin, 2012	Investment in Intangible Assets (IIA) Survey
Design is the procedures, choice of elements and technical preparation to implement a new product.	Ciriaci, 2011	CIS 3
Design is an innovation-related activity, including industrial, product, process and service design and specifications for production or delivery	Cereda et al., 2005	UK CIS 3
Design is referred to as innovation activities; a key input in the innovation process and a source of value added in a wide range of sectors	Vinodrai et al., 2007	UK CIS 4
Design activities are referred to as including strategic design activities and design activities for the development or implementation of new or improved goods, services and processes.	BIS, 2012; 2014; BEIS, 2016	UK CIS 2010,2012 and 2014
Design is part of a category of innovation activities: "engineering, design, preparatory, conceptual and other activities". Design is one area of marketing innovations: "significant changes to the aesthetic design or packaging of a good or service".	Aschhoff et al., 2013	German CIS 2006 and 2008
Design is part of innovation activities: "design and preparations"	Aschhoff et al., 2013	German CIS 2010
Design is innovation activities. Design is referred to as including in-house or contracted out activities to design or alter the shape or appearance of innovations.	Behrens et al., 2017	German CIS 2012
Design is referred to as product design, and is part of a category of innovation activities: "product design, service philosophy, preparation of production / distribution for innovation activities".	Behrens et al., 2017	German CIS 2014
Design is the preparations aimed at taking into actual production new or improved products and/or processes.	Marsili and Salter, 2006	Dutch CIS 2
Design is the form and appearance of products and not their technical specifications or other user functional characteristics.	Czarnitzki and Thorwarth, 2012	Belgian CIS 2006
Design is referred to as graphic, packaging, process, product, service or industrial design.	Filippetti, 2011; European Commission, 2009b	Innobarometer 2009
Design is referred to as the design of products and services (excluding research and development (R&D)).	European Commission, 2013b,	Innobarometer 2013
Design covers a range of applications within companies, providing means to integrate functionality, appearance and user experience, for goods and services. Design can also provide a means to build corporate identity and brand recognition.	European Commission, 2015a, 2016a	Innobarometer 2015 and 2016
Design is referred to as the design of new or improved products and services. Design is firms' capability for "accessing knowledge". Design skills form a bridge as innovation moves from creative idea through prototype towards a marketable product or service.	Roper, et al., 2009	Innovation Index Survey
Design is an intangible asset. Design is referred to as the design of new or improved products or services.	Barnett, 2009	Innovation Index Survey
Design is referred to as design strategies, development and styling – everything that takes place prior to production or implementation of products (printed matter, sales fair stalls, web sites, interiors, etc).	Danish Design Centre, 2003	Survey by Danish Design Centre in 2003
Design referred to as an ability of firm.	Kootstra, 2009	Design Management Europe Survey

Note: design notions are not found in Galindo-Rueda and Millot (2015) (which is based on Danish CIS 2010) and Design Council (2007; 2009) (which are based on Design Council National Survey of Firms 2005 and 2008 respectively).

CHAPTER 3

THE DETERMINANTS OF COMPANIES' DESIGN COMMITMENT: INSIGHTS FROM THE INNOBAROMETER SURVEYS OF 2015 AND 2016*

*The data are used with permission.
Source: European Union, Eurobarometer
https://op.europa.eu/en/publication-detail/-/publication/fec2b4d2-63de-4a9d-9c69-b9738cfc5034; https://op.europa.eu/en/publication-detail/-/publication/69e52157-2ba9-11e6-b616-01aa75ed71a1.
The European Union does not endorse changes, if any, made to the original data and, in general terms to the original survey, and such changes are the sole responsibility of the author and not of the EU.

Introduction

Design has increasingly interested companies, policy makers as well as academics in recent years.

In 2010, for the first time, design was written into an EU innovation policy (the Innovation Union). An action plan for “design-driven innovation” was later introduced at the EU level (European Commission, 2013a), and in some Member States. By 2015, more than half of the 28 Member States of the EU had included design explicitly in their national innovation policies (Whicher, et al., 2015). Evidence suggests the increasing inclusion of design in innovation policy making has been accompanied by an improving recognition of design among European companies (European Commission, 2009; 2013b; 2015b; 2016b).

In the domain of management and business studies, the number of publications concerning design has been growing exponentially during the past two decades. Research has, among other things, examined the impact of design on consumers’ response to products (Bloch, 1995; Veryzer, 1995; Creusen & Schoormans, 2004; Chitturi, et al., 2008) and on firms’ overall commercial/financial performance (Gemser & Leenders, 2001; Hertenstein, et al., 2005; Montresor & Vezzani, 2020); as well as the conditions under which the impact is positive (Walsh, et al., 1992; Chiva & Alegre, 2009; Candi & Saemundsson, 2011; Czarnitzki & Thorwarth, 2012). Research has also specified design as an investment/expenditure, an Intellectual Property Right or a set of skills of a business or economy, which can be linked to innovative or economic outcome (Galindo-Rueda, et al., 2010; Bascavusoglu-Moreau & Tether, 2011; Moultrie & Livesey, 2014; Galindo-Rueda & Millot, 2015; Filitza, et al., 2015; Montresor & Vezzani, 2020).

Which businesses engage in design and to what extent? Why do some companies engage in design substantially while others do not? These remain poorly answered questions in prior literature. It is evident that many businesses do not recognise they utilise design, and therefore much design, and designing, remains “silent” (Gorb & Dumas, 1987). Existing literature has scarcely addressed the reasons for this uneven distribution of design use, or at least recognised design use among businesses.

An Innobarometer survey conducted in 2015 (European Commission, 2015a)[137] found variety in firms' commitment to design (i.e. conducting design activities) in two aspects: (1) the strategic position of design within the company, and (2) the investment in design, measured by the percentage of turnover invested in the design of products and services. Regarding the former, the survey found that while almost one third of firms had integrated design into their development work or even placed it at the centre of strategy, more than half did not use design or did not use it systematically. As for investing in the design of products and services, nearly two fifth of the firms had invested at least 1% of their turnover in design, but half reported no investment in design. The survey was repeated in 2016 and found very similar results (European Commision, 2016a).

What factors are associated with businesses' commitment to design? To address this question, this study utilises the micro data from the large-scale surveys summarized above, and examines the relationship between firms' commitment to design and their other business activities, firms' structures and their socio-technical environment. In the following sections, we first discuss design as an organisational capability. This provides a conceptual context for the subsequent analysis and leads to the specification of hypotheses concerning the anticipated patterns for engaging in design. We then introduce the data and the methods used for testing the hypotheses, including the analytical strategy employed. This is followed by the analysis and discussion of the results. It ends with a discussion of the implications of the findings for policy-making and future research.

[137] The reporting is based on the data file (unweighted), which may be different from that reported in the Innobarometer report.

Conceptual background

This section seeks to explain varying extents of design commitment of firms from the perspective of organisational capabilities. A changing environment requires businesses to build certain capabilities in order to survive and prosper (Helfat, et al., 2007), we propose that design is one such capability, or set of capabilities, that concern not only the aesthetics of products and integration of forms and functions into goods or service offerings, but also serve human needs and wants and impart meanings (Nomen, 2014). Firms can utilise design capabilities to respond to challenges and opportunities arising in the environment. The extent of these opportunities, and their rate of change, will likely influence a companies' involvement in design. The greater the opportunities, and the greater their rate of change, the greater the incentive to engage in design. Moreover, design is likely to interact with other capabilities (such as marketing and R&D) to enable the sensing and seizing of opportunities, hence firms' commitment to design is likely to be influenced by the firms commitment to other activities. Furthermore, we anticipate that development and maintenance of capabilities will be related to businesses' structural characteristics.

Capabilities and design capabilities

Capabilities include "the ability to perform a particular task or activity" (Helfat, et al., 2007, p. 1) and the ability to coordinate or integrate tasks (Helfat & Peteraf, 2003). Businesses possess different levels of capabilities (e.g. efficiency and effectiveness) to perform, coordinate and integrate activities specific to them, with different resource requirements. Such variations exist within industries and across industries and market environments. Although firms may be able to survive in a static environment with adequate "ordinary capabilities" (Winter, 2003), these are often insufficient in a changing environment, with, for example, changing user preferences and/or changing technological possibilities. In these contexts, firms are advised to "develop the 'dynamic capabilities' to create, extend and modify the ways in which they make their living" (Helfat, et al., 2007, p. 1).

Regardless of whether firms respond to changes in the environment or proactively seek to shape their environment, dynamic capabilities include the ability to identify the need or opportunity for change, to formulate a response, and to implement it (Helfat, et al., 2007, p. 2). Teece (2007, p. 1319) considers that that "dynamic capabilities can be disaggregated into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets". In a somewhat different conceptualization, Eisenhardt and Martin (2000, p. 1105) considers dynamic capabilities to be specific and identifiable processes, such as new product development, strategic decision-making and alliancing; these processes create or manipulate resources which enable market and organisational change. While there is a debate as to whether the Teece and Eisenhardt and Martin are compatible or incompatible (Peteraf, et al., 2013) with respect to the scope and content of dynamic capabilities, they both recognise the ability to introduce new or significantly changed products and processes (i.e. innovation) as a manifestation of dynamic capabilities. Several researchers have identified innovation capabilities as a subset of dynamic capabilities (Lawson & Samson, 2001; Guan & Ma, 2003; Wang & Ahmed, 2007).

Innovation capabilities can be understood to go beyond "ordinary capabilities" as innovation is not a day-to-day activity for most businesses[138]. Having innovation capabilities does not necessarily lead to introduction of innovations as capabilities are also capacities. Innovation is typically understood as the development and introduction of new or improved products or processes (or combinations thereof) that differ significantly from the firm's previous products or processes (OECD and Eurostat, 2018, p. 20). This implies a threshold below which the changes are inadequate to be considered innovations. This includes minor aesthetic changes, such as a change in colour or a minor change in shape (OECD and Eurostat, 2018, p. 79).

Design is a set of abilities or capacities (Swan, et al., 2005; Björklund, et al., 2020)[139] that includes the ability to contribute to the development of new products and processes, but also to identify and implement minor changes to products and processes (hereinafter referred to as "tweaking capabilities", which includes minor

[138] We recognise that where firms "make their living" from innovation, capabilities oriented to developing innovations should be considered "ordinary" or "everyday" (Helfat & Winter, 2011). Such firms include R&D enterprises and innovation consultancies. However, these are exceptional, and for most companies it sensible to separate, at least conceptually, their ordinary and innovation capabilities.

[139] Swan et al.,(2005, p. 148) identify four specific design capabilities, namely functional, aesthetic, technological and quality-based design capabilities; they also note these capabilities intersect with other functions including R&D and marketing. Björklund et al. (2020, p. 100) consider design capabilities in two dimensions – "deep expertise in design practices" and "wide understanding, application, and scaffolds of design"; and they contend these two types of design capabilities need to coevolve to help manage the possible frictions between design, engineering and business decisions in organisations.

changes to products or processes, including their usability and functionality, and how they are packaged or presented). Furthermore, engaging in design may lead to the recognition that there is no immediate need for innovation. Engaging in design does not necessarily imply that the firm is seeking to innovate; in some cases, it may be used to postpone the need for innovation. However, design also has the capacity to contribute to innovation, a capacity which has been increasingly recognised (Walsh, et al., 1992; Bruce & Bessant, 2002; Von Stamm, 2003; Utterback, et al., 2006).

Specifically, design, or design capabilities can be linked to at least three different types of innovations. The first we identify as “design-invention innovations”. Here design is used to conceptualise products, often with distinctive identities. This type of design is closely associated with designers’ inventive use of ideas. The highest profile of these include celebrity and celebrated designers, such as Philippe Starck’s (of Juicy Salif fame), Dieter Rams (formerly of Braun) and Jonathan Ive (formerly of Apple), and the late Zaha Hadid in architecture. These designers often have an underlying philosophy to their design approach (e.g., Rams’ fixation with simplicity). The development of these designs is not led by, or the result of detailed research into users’ needs or preference, albeit they may involve designers’ own thoughts about the user experience (e.g. Achille Castiglioni and Pier Giacomo’s Arco Floor Lamp).

The second type of design is “user-centred”, and leads to the development of “user-centred (design) innovations”. This is closely associated with “design thinking” (Brown, 2008), which Carlgren el al. (2014) depict as a long-term innovation capability. Design here starts by seeking to understand users’ needs and wants, including where these are latent and unarticulated. The aim is to develop desirable solutions to these wants and needs. “Desirability” is then coupled with technical “feasibility” and “viability” from a business perspective.

The third type of design is “design-driven innovation”, which was identified and developed by Roberto Verganti and colleagues. This centres on creating and embedding meanings, with products as conduits of vehicles for conveying meanings. Design here is a mix of shaping material objects and manipulating socio-cultural symbols, and can be used to trigger or build meaningful interpretations of products by users or consumers (Verganti & Dell'Era, 2014).

In the following sections, we relate engaging in design to a business’s capacity to sense and seize opportunities – in particular technological opportunities and opportunities derived from demand, while being intertwined with other business activities such as R&D and branding, with variations among different firm structures.

Opportunities for design

Technology and demand both shape sectoral differences in firms' competencies, behaviour and organisation (Malerba, 2002). Different social-technical regimes interplay and define the predominant pattern of innovation in an industry (Geels, 2004).

The patterns of innovation can be linked to different technological regimes which are characterised by varying extent of technological opportunities (Breschi, et al., 2000).

Technological developments of advances generate opportunities for businesses to develop entirely new goods, processes or services, or to incorporate novel technological features into existing goods, processes or services. New technologies often need to be explained, or made understandable and observable (Roy, 1993) to users or consumers. Users' interpretation of new products or processes is largely built on their past understanding and habits – taking this into consideration, balancing the novelty and similarity to customers' existing knowledge while developing technologically innovative products is often critical for the success of an innovation in the marketplace (Hargadon & Douglas, 2001). Design can be used to understand and communicate with customers, "translating" unfamiliar technologies into understood functions (Eisenman, 2013) and shaping their understanding of these (technological) innovations. Design thereby increases the chances that this novelty will be accepted by users (Hargadon & Douglas, 2001).

When technological opportunities are scarce, businesses are likely to put effort into enhancing differentiation to avoid commoditisation (Matthyssens & Vandenbempt, 2008; Rangan & Bowman, 1992). They could seek to provide "innovativeness" through alternative methods, or to optimise offerings by paying more attention to the subtle changes or differences in customers' preferences; needs and wants in this context tend to be more refined as customers become familiar to the basic utility of products and are likely to develop differentiated demands as their experience of products develops. In order to understand and cater for these needs, firms can use design to communicate with customers by adjusting product functionality to meet more specific needs (Rothwell & Gardiner, 1983), create products that satisfy latent needs by applying design-thinking (Brown, 2008) and/or use "design driven innovation" to develop products that are especially meaningful to target audiences (Verganti & Dell'Era, 2014; Eisenman, 2013). Design can also draw on well-established technologies to develop "design-intention innovation".

Specifically, “innovative design” may be particularly effective in enabling the business to stand out in industries where the technology-base is mature (Gemser & Leenders, 2001; Candi & Saemundsson, 2011). Investing in non-innovative design is still likely to be “needed to compete but no longer provides a firm with a competitive edge” (Gemser & Barczak, 2020, p. 463).

In contrast to contexts where there is rapid or slow technological change, and therefore high or low technological opportunities, intermediate contexts are thought to provide fewer opportunities for design, especially innovative design in relation to products. Some argue that this is due to firms focusing their efforts on improving production efficiency in these contexts (Eisenman, 2013; Utterback & Abernathy, 1975). Therefore, design is generally likely to be of less relevance in this context, although some design may be used for tweaking existing products for maintaining competitiveness.

Therefore, the relationship between the intensity of technological opportunities and the extent of businesses’ commitment to design (including both innovative and non-innovative design) can be expected to be as follows: in industries where there are high technological opportunities, design can be used to explain technologies to users, to “package” technologies into products, and to adapt technological developments to the marketplace; in industries where there are moderate technological opportunities, design is likely to be less important; and in industries where there is little technological novelty, design can be used to understand and address refined demand, and for creating novel products or product meanings (Priem, et al., 2011; McCracken, 1986; Verganti, 2009; Creusen & Schoormans, 2004; Eisenman, 2013).

Scant evidence exists pertaining to the relationship between businesses’ commitment to design and the technological opportunities in industries. Eisenman (2013) expounded and proposed that there is a U-shaped relationship between the importance of aesthetic innovation and the stages of technological evolution underlying a particular product category. Talke et al. (2009), Rubera (2015) and Rubera and Droge (2013) discussed and examined how the interaction between design innovation/novelty and technology innovation/novelty influence the outcome (e.g. product sales or firm sales). While our hypothesis could find theoretical support in these studies, it differs from theirs as it depicts the link between design and technology per se as opposed to the impact of this link; moreover, we consider design and technology in both innovative and non-innovative scenarios; further, we address the connection between factors from different levels (i.e. firm level and industry level).

Thus, our first hypothesis is:

H1 There is a U-shaped relationship between the extent of businesses' commitment to design and the intensity of technological opportunities in the industry.

Opportunities can also come from variety in demand. Where the demand is heterogeneous, businesses can have target groups of customers which are more various, and have more options about the element(s) of demand which they are able and willing to satisfy. Strategies that take advantage of differentiated demand include market segmentation and product differentiation (Dickson & Ginter, 1987), where design can play an important part.

Market segments can refer to groups of customers with similar characteristics or groups of products with similar attributes (Tynan & Drayton, 1987). Recognising that "people differ in their tastes, needs, attitudes, motivations, life-styles, family size and composition" (Chisnall, 1985, p. 264), market segmentation suggests "a state of demand heterogeneity such that the total market demand can be disaggregated into segments with distinct demand functions" (Dickson & Ginter, 1987, p. 5). Similarly, product differentiation can be considered as a product being "perceived to differ from competing products on at least one element of the vector or physical and nonphysical product characteristics" (p. 6); heterogeneous demand therefore offers multiple opportunities along which products can be differentiated from competing products (Dickson & Ginter, 1987).

A market segmentation strategy typically involves developing programmes for specific segments using knowledge about the targeted segments – it is noteworthy that the characterisation and perception of the state of demand heterogeneity is likely to be specific to (the market of) each business; thus, knowledge about market segmentation is often critical for acquiring competitive advantage (Dickson & Ginter, 1987). As design helps understand customers' needs and wants, it can be an approach to acquire knowledge about market segmentation; and further, reflect what customers need and want in products, serving certain market segments.

Likewise, design can address differences in customer preferences in product variations; and hence help defend the firm's position in a product market, including by enabling it to stay relevant without the need for substantial innovations. This ability may be sufficient for firms to compete against more innovative firms. Nevertheless, this does not mean that such firms should not invest in developing innovation capabilities, because the scope for maintaining competitiveness by tweaking existing products and processes will ultimately be limited (Winter, 2003)

When mere tweaking is insufficient, firms can be expected to differentiate themselves in fundamentally new ways (Hamel & Prahalad, 1994). In context of heterogeneous demand, companies have an opportunity to turn to innovation by taking advantage of the varieties of customer knowledge and desires. Design helps in pursuit of this pattern of innovation given its human-centred nature.

The human-centeredness can find expression in the emphasis on empathy in design thinking; the command of which could enhance firms' capabilities to recognise problems for which the solutions would be valuable to people (Brown, 2008). Design can coordinate a firm's capabilities and resources in the course of problem-solving, by forming shared understanding between the business's capacity and customers' needs and wants (Knight, et al., 2020). Meanwhile, it can address the coevolved relationship between problems (which can be considered as interpretations of people's needs) and solutions through framing and reframing the problems; problems and solutions coevolve in the sense that problems are defined in ways that the businesses are capable to resolve, vice versa (Björklund, et al., 2020; Dorst & Cross, 2001). Design also helps develop and test solutions to the focal problems through rapid prototyping (Brown, 2008). These design capabilities for user-centred problem solving, which typically lead to new or significantly improved products if successful, could be an approach for companies to achieve a differentiated position in customers' perception. Moreover, products are also differentiated by their meanings, which could be created by addressing latent needs of customers for meaning, and expressing meaning, through "design-driven innovation" (Verganti & Dell'Era, 2014).

In other words, design can lead to "perceived superiority along dimensions that are valued by customers", which is a differentiated position in the market (Day & Wensley, 1988, p. 4). The differentiation, which is enabled by design, can improve businesses' ability to charge a price premium (Desai, et al., 2001), which helps them to survive without necessarily competing by price (Dickson & Ginter, 1987; Banker, et al., 1998).

Thus, design is expected to be favoured by businesses in context of higher demand heterogeneity.

In reverse, design could help create new market segments and therefore increase heterogeneity in demand. By "tweaking" existing goods/services and/or engaging in innovative design, businesses could appeal to new demographic groups of customers or even create new product categories. These generate new demand or new dimensions of demand, and thus increase the varieties in demand.

Therefore, we hypothesise that

H2 The extent of businesses' commitment to design is positively related to the heterogeneity of demand.

Firm-level determinants of design

In the previous section we considered the environment within which firms are operating. Here, we consider within-firm characteristics related to design, grouped into two sets. One group concerns activities like design, which businesses may choose to conduct; the other concerns the structural characteristics of organisations.

Business activities

The use of design supports companies to "connect and align different stakeholders" (Simeone, et al., 2017a; Bogers & Horst, 2014). In the current study, we consider R&D and branding in particular, to be inter-related with design.

Commonly regarded as the engine of technological innovation, research and development (R&D) increases "the stock of knowledge" from which new applications can be devised (OECD, 2015, p. 44); R&D also has to be novel, creative, uncertain, systematic and transferable and/or reproducible (OECD, 2015).

As recognised by the OECD's Oslo Manual (OECD and Eurostat, 2005), design has often been considered to partly overlap with R&D as an innovative input, but also to be partly separate from R&D when involved with, for example, the marketing or production of existing or new products (Walsh, 1996).

Design can support the translation of knowledge, needs and interests of different stakeholders, drawing on different working styles and languages and providing shared understandings in R&D processes (Simeone, et al., 2017a; 2017b); it can also improve product development, leading to refinements or innovations – it has been found that new product development involving design, or that is design-led, is more likely to lead to significant product changes (i.e. "radical development" or "breakthrough innovation") (Perks, et al., 2005).

We consider design should benefit R&D especially at the front end of the innovation process given the risks of conducting R&D – there is in general uncertainty about its outcome and costs (including expenditure and time) (OECD, 2015). The early participation of design is expected to complement R&D as this should assist in reducing the cost of trail-and-error and the overall development time needed (Veryzer, 2005). Early integration of design as understanding of user needs can also improve the chances of ultimate success in marketplace. Thus, design could complement R&D, not only for its expertise per se but for integrating the expertise of multiple functions (Swink, 2000).

Design complements R&D also in the sense that it supports the translation of identified technological opportunities into (understandable and useable) products, for which the user-centred and problem-centred nature of design can be highlighted. This may involve identifying and solving user problems, and balancing between the novelty of new technologies and familiarity in the context in which the technologies are applied (Hargadon & Douglas, 2001; Rindova & Petkova, 2007); which as a consequence, reduces the perceived learning costs of users and enhancing their evaluation of the innovations or their experience of evaluating the innovations (Mugge & Dahl, 2013), and therefore lessen the risk of market failure.

Empirical evidence also supports complementarities between design and R&D in terms of investments (Vinodrai, et al., 2007; Filippetti, 2011; Moultrie & Livesey, 2014).

As a result, we anticipate:

H3 Firms' commitment to design is positively associated their commitment to R&D.

Design has been argued to be a set of dynamic capabilities that provide "a powerful source of competitive advantage, renewal, growth, and adaption as the environment changes" as well as "a strategic tool to develop dominant brands with lasting advantages" (Luchs, et al., 2015, p. 324).

Brands are bridges in the relationship between a firm and its customers. A brand identifies products and/or services as belonging to a business and differentiates a firm's offerings from those of others; they tend to be viewed as an endorsement of quality, or a mark of approval. A brand[140] can be manifested as a symbol, or design.

[140] A brand is "a name, term, sign, symbol, or design, or a combination of these, that identifies the products or services of one seller or group of sellers and differentiates them from those of competitors" (Kotler & Armstrong, 2016, p. 263).

Design can therefore be used to impart meaning into a brand, which ideally, is paired with what a brand claims. Design converts an abstract brand into perceivable information (e.g. functionality, quality, category and origins), which implies the possibility to direct consumers' understanding of the brand. A strategic employment of design can create visual recognition for the core values of a brand (Karjalainen & Snelders, 2010). In order to do this, companies can translate their brand value into a design philosophy including design principles and features that are used in product design or any design used in interactions with users or consumers (e.g. web design, shop design, advertisements and service design). Customers are therefore able to perceive and interpret the brand value through the design that they are exposed to during these interactions with the businesses. Notably, the consistency between strategic intent and design philosophy can be important, since this should allow the latter to be the framework of product design and the other relevant activities, and should implant strategic intent in the brand image of the company (Ravasi & Lojacono, 2005).

While design helps branding, it is also argued that the effectiveness of design can be limited to the brand under which the design is introduced (Rubera & Droge, 2013). As such, a design can also be especially influential if introduced by a powerful brand. For instance, a range and generations of Apple's and Dyson's products have adopted "bold" designs that have initially challenged established aesthetics and user habits but ended up convincing and altering them significantly, becoming dominant designs and leading to a new round of evolution of aesthetics, technologies, user habits and/or consumption habits. Therefore, a strong commitment to design and strong brands are expected to complement each other.

Although design conceivably can be linked to branding, direct empirical evidence about this (Design Council, 2007) is relatively scarce. Nevertheless, evidence demonstrates that design is more generally associated with marketing (Ciriaci, 2011; Czarnitzki & Thorwarth, 2012; Design Council, 2007; 2009; Filippetti, 2011); Ciriaci (2011) also finds the attendance to trademark is connected to more design expenditures; which increase the confidence on the association between design and branding.

Therefore, we anticipate that:

H4 Firms' commitment to design is positively associated with their commitment to branding.

Structural characteristics

The other group of influencers on firms' commitment to design relate to their organisational structures. Organisational structure impact and is affected by the goals and policies of the organization; especially, it determines the allocation of resources. Organizational structure may be altered strategically. Yet, unlike the aforementioned strategic activities, this type of change is usually more fundamental and multifaceted, hence it is likely to cause broader changes within the company through slower processes.

Innovation is understood to vary with firm size, while literature shows contradictory findings regarding the direction of their relationship. The arguments in support of the positive relationship between firm size and innovation mainly lie in the resources and capabilities that large firms can mobilise, as well as their greater risk-taking capacity (Chandy & Tellis, 2000; Damanpour, 1992; Hitt, et al., 1990). In comparison, the negative effects of size are considered to include less flexible structure and more bureaucratic inertia than in small firms (Chandy & Tellis, 2000; Dean, et al., 1998; Damanpour, 1996; Hitt, et al., 1990).

Nevertheless, despite the divergence, meta-analyses point to a positive association between size of organisation and innovation (Damanpour, 2010; Camisón-Zornoza, et al., 2004; Damanpour, 1992); and Camisón-Zornoza et al. (2004) points out the conflicting results are due to different methods used to operationalise size. In addition, the present study conceptualises the design to be explained as an input of innovation or a strategic element according to which the operation of business and the resources devoted to back up the strategy would vary – which seems to be the case in which large firms have more advantage.

The inference is also endorsed by empirical evidence: although the amount of design expenditure does not vary systematically with firm size (Ciriaci, 2011; BIS, 2012; 2014; BEIS, 2016), larger firms are more likely to invest in design (Awano, et al., 2010; Cereda, et al., 2005; BIS, 2012; 2014; BEIS, 2016; Behrens, et al., 2017; European Commission, 2013b) or have it play a critical role (Design Council, 2007).

Based on the above, our fifth hypothesis states:

H5 The propensity to commitment to design is positively related to firm size.

A consensus has not been reached regarding the relationship between firm age and innovation (Sørensen & Stuart, 2000). Some argue that aging results in a series of negative influences on innovation, such as inefficiency due to carrying out routines, ineffective actions caused by taken-for-granted understandings, and rigidity of communication (Barron, et al., 1994; Cohen & Levinthal, 1989; 1990). Others contend that competence grows over time by addressing the "liability of newness" (Hannan & Freeman, 1984), viewing routines from the angle of organisational learning as what enhances competency (March, 1991; Tushman & Anderson, 1986), or showing knowledge accumulation improves the capabilities for innovation (Cohen & Levinthal, 1990). As pointed out by Sørensen and Stuart (2000), these competing opinions imply that the relationship between firm age and companies' competencies for innovation relies on the relative gains from experience and the losses owing to organisational ossification.

Taking external environment into consideration, research suggests the relationship between firm age and innovation is conditioned. For example, the "low-competition, resource-rich, and high-demand environments" are found to support innovation in firms which have already obtained resources, whereas new firms innovate better in markets characterised by the opposite conditions (Katila & Shane, 2005). In changing environments, aging could probably extend the breach between a firm's capabilities and that required by the environment, if the firm is relatively sluggish (i.e. a firm may become less capable to catch the opportunities for innovation in the evolving environments as it ages, if it is more reluctant to make changes in early decisions and practices compared to otherwise similar firms) (Sørensen & Stuart, 2000; Amburgey, et al., 1993; Delacroix & Swaminathan, 1991; Hannan & Freeman, 1984). Further, such resistance to change is likely to become stronger as companies age, because the accumulated knowledge and experience which enhance a firm's competencies for existing activities in the particular domain(s) is likely to lead to a disinclination to change especially if the accumulation led to improved performance or where the cost for change is high (e.g. high-technological contexts)(Sørensen & Stuart, 2000; Levitt & March, 1988; Cohen & Levinthal, 1990). Therefore, older firms will be better at the activities or in the domains that are less appreciated by the shifting environment; while new firms by comparison will be relatively more adept at what will potentially bring the "radical change" to the environment (Abernathy & Utterback, 1978). This is probably because the innovations emerging from new firms are more likely to be perceived as radical than those produced by long established businesses.

Therefore, from the perspective of industrial evolution – at a given point in time, design should be more needed in new firms than older firms for explaining novelty. This is in line with the notion that new firms have higher propensity to invest in “technically radical inventions” and better at the commercialisation of them (Katila & Shane, 2005; Arrow, 1962; Henderson & Clark, 1990).

Moreover, the lack of established routines and relationships with customers (Rosenbloom & Christensen, 1994) and external stakeholders (Freeman, et al., 1983) drives new firms’ use of design to define what they do and who they are – that is, to position themselves and their products or services in the market; meanwhile to differentiate themselves for attracting customers away from the old businesses or other markets, or attracting customers that are new to the market. The alleged liability of newness indicates the necessity of design.

In addition, because of the absence of routines, new firms are prone to use resources creatively (Katila & Shane, 2005; Baker, et al., 2003). Thus, design as idea generation is less likely to be discouraged in such a context. Further, given that they are often bounded by insufficient financial resources, new firms may value design as a less costly option of innovation or complement to R&D.

Therefore, it is expected that:

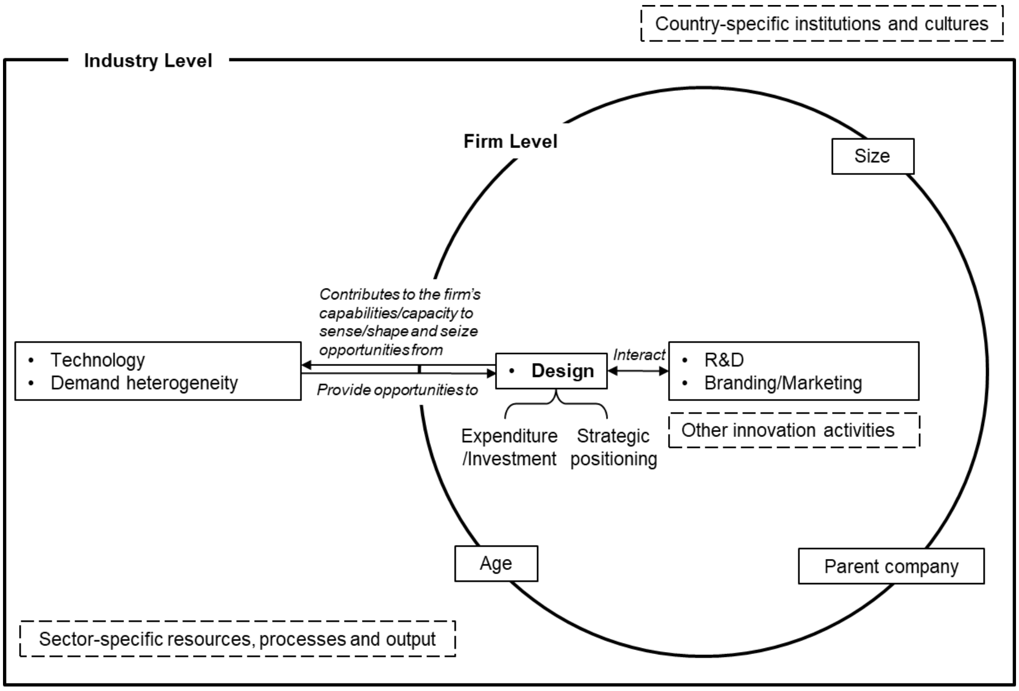
H6 New firms are more likely to have a greater commitment to design than their mature counterparts.

The strategy of knowledge creation and learning is a source of the variance of corporate innovation behaviour (Jensen, et al., 2007). There is commonly knowledge transfer within a business group between the parent companies and their subsidiaries and among subsidiaries. From a recipient’s perspective, knowledge transfer is not replicating knowledge, but rather learning useful knowledge and applying it to its own contexts (Minbaeva, et al., 2003). While we expect that larger enterprises may tend to use design, we consider that subsidiaries perhaps propend to use design also. This concerns that subsidiaries are likely to absorb the knowledge transferred from their parent companies (which are commonly large-scale businesses) and be consistent or compatible with parent companies in terms of the overall strategy. Therefore, the behaviours of subsidiaries are likely to mirror or complement those of their parent organisations. The dominant logic (Prahalad & Bettis, 1986) of the parent company (e.g. using design strategically, especially placing design at a high strategic position), is likely to influence the dominant logic (or at least the relevant practices) of the subsidiaries. Further, the resources (including those dedicated to design and other fungible resources) available to the subsidiaries can be hardly captured by their own size or age.

Therefore, it is anticipated that:

H7 Subsidiaries are more likely to have a greater commitment to design than independent businesses.

Figure 1 Conceptual framework



Methods

Data

The Innobarometer 2015 and 2016 are large-scale surveys undertaken in the EU-28, Switzerland and the United States on companies' innovation activities. They were conducted by TNS Political and Social using computer assisted telephone interviewing (CATI) under instruction from the European Commission.

The surveys were carried out in the respondents' native languages. All respondents were required to be in managerial positions. The companies were sampled from an international database and local sources where additional cases are needed. Businesses with 1 or more employees were included, and the survey covered manufacturing, services and other sectors (NACE[141] Section C – N and R). Quota sampling was applied based on firm size and industrial sectors. A total number of 28,230 responses[142] are gathered by the two surveys jointly.

The 2015 and 2016 questionnaires both included design-related questions and are identical. An advantage of the Innobarometer surveys relative to the Community Innovation Surveys (CIS), is that whereas the CIS considers that at least some design is included in R&D, and is therefore not asked about due to concerns about double counting, in the Innobarometer each of these activities is asked about on an equal footing.

Specifically, the Innobarometer 2015 and 2016 provide two different variables concerning design. They asked about firms' investment in design and about how design is positioned in companies; together these can be used to advance our understanding of design utilisation. Further, the large sample is able to accommodate the factors of interest while generating a robust analysis. The analysis also adds to existing findings derived from the Innobarometer 2015 and 2016 by addressing the questions which have not been well-understood.

Since micro firms (i.e. up to 9 employees) are understood as often not recording their activities distinctively or systematically, the analysis will apply to businesses with at

[141] Nomenclature des Activités Économiques dans la Communauté Européenne.
[142] For each of the two surveys, at least 500 cases were collected for each country (except for Cyprus, Luxemburg and Malta, where the baseline was reduced to 200).

least 10 employees. The sample consists of 9966 valid cases, excluding US cases and cases with incomplete information or inconsistent answers.[143]

Measures

Dependent variables

Concerning the commitment to design, the Innobarometer asked companies to choose the statement which best describes their activities with regard to design from the following:

1) Design is a central element in the company's strategy;
2) Design is an integral, but not central element of development work in the company;
3) Design is used as last finish, enhancing the appearance and attractiveness of the final product;
4) The company does not work systematically with design;
5) Design is not used in the company.

These specific positioning of design indicates different degrees of commitment to design, and different design capabilities. For example, statement (3) focuses on design used for visual appeal; statements (2) suggests the implementation of design capabilities beyond styling; and statement (1) implies that the firms are able to conceptualise design, which is likely to be based on comprehensive design capabilities.

The other question concerning design commitment requests the percentage of total turnover (i.e. 0, less than 1%, 1-5% or more than 5%) that the company has invested in the design of products and services during the past three years. The same question is asked in relation to six other activities:

1) Training;
2) Software development;
3) Company reputation and branding, including web design;
4) R&D;
5) Organisation or business process improvements;
6) Acquisition of machines, equipment, software or licenses.

The intensity of design investment (hereafter design investment) can also indicate the extent of commitment to design, which relate to the level of firms' design capabilities.

---

[143] The inconsistent cases refer to those which claimed using design while reporting zero design investment, and those which claimed that design is not used while reporting positive design investments.

Notably, possessing the capabilities does not necessarily mean the capabilities are implemented. Although a high level of design commitment is likely to be on account of complex design application on the basis of advanced design capabilities, it could also be possibly due to the intensive repetition of less advanced design capabilities. While design positioning and design investment both to some degrees reflect the “level” of design capabilities, in this analysis, what they are intended to measure is the extent of firms’ commitment to design. That is, we regard the strategically centralised role of design or intensive investment in design as an indicator of a high level of commitment to design, which is considered likely to mirror a firm’s advanced design capabilities – however, we are not able to confirm this as we do not have data pertaining to how design is specifically used in a company.

Design positioning and design investment will be the dependent variables of interest. Notably, design investment is specified as that for products and services; and web design is included in “company reputation and branding”. This potentially allows some hidden design investment.

Independent variables

Technological opportunities are a dimension of technological regime. As noted by (Klevorick, et al., 1995), more technological opportunities should lead to more innovative output; yet, not necessarily more innovative input, i.e. R&D. Nevertheless, technological opportunity in practice is difficult to measure directly (Sutton, 1998). Apart from asking firms to rate the relevance of the identified sources of technological opportunity (Klevorick, et al., 1995; Breschi, et al., 2000), innovative inputs are used as “the best proxies available” (Peneder, 2010) – R&D intensity can be an indirect measure of technological opportunity.

Following the method of the OECD taxonomy of industries based on R&D intensity (Galindo-Rueda & Verger, 2016), we create country-specific R&D intensity of industry for EU-28 and Switzerland based on the data collected from Eurostat (Eurostat, 2019a; 2019b). The R&D intensity (i.e. R&D divided by GVA) is specific to each country at 2-digit industry level. The cases from the Innobarometer are matched with their country-specific R&D intensity for the industry in which they are primarily active; and those which cannot be matched in the first step are matched to the average R&D intensity (weighted by GVA).

High technological opportunities signify the industrial environment that is “not functionally constrained by scarcity”, in which the “potential innovators may come up with frequent and important technological innovations" (Breschi, et al., 2000). Therefore, patent intensity as an indicator of intermediate outputs of technological innovation can be another measure of technological opportunity.

With respect to the measure of demand heterogeneity – the Innobarometer requests the percentage of turnover coming from each of the four geographic markets – local area or region where the company is located, national outside of local area or region, EU excluding own country, or extra-EU. Based on this we are able to identify companies' furthest reach in geographic space. The reasoning behind measuring demand heterogeneity by furthest market concerns that demand or market heterogeneity can be denoted by variation between market segments (Adner & Zemsky, 2006; Adner & Levinthal, 2001), and geography is a way to achieve market segmentation (Kotler & Keller, 2016); therefore, further market reach is expected to indicate a degree of demand heterogeneity that deviates more from the vicinity of where the business is located.

Moreover, we consider the intensity of trademarks and registered-designs could be used as additional proxies of demand heterogeneity. A trademark (i.e. a legally protected form of brand name) is intended to protect the authenticity of the supplier. A registered design protects the physical appearance of products; it is a sign of observable differentiated products attributes. Therefore, the intensities of these two types of IPRs in an industry could indicate the extent to which the products supplied in the industry are needed to be different in physical form or as endorsed by brands.

We identify if the firms operate in patent, trademark or registered-design-intensive industries by matching the 4-digit NACE codes of their industries with the lists of the corresponding industries provided by the European Patent Office and European Union Intellectual Property Office (2016). They identify the patent, trademark or design-intensive industries as those with above-the-average intensity of a certain type of IPR protection. Taking the patent-intensive industries for instance: (1) the total number of patents protected at the EU level for each industry is divided by the size of workforce in the corresponding industry at the EU level, which gives the "relative intensity" of patent in an industry; (2) and then by averaging the "relative intensities" of all the industries with patents, one can get a number of "patent-intensive industries" with above-the-average "relative patent intensities". Through the same approach, 140 patent-intensive, 276[144] trademark-intensive and 165 design-intensive industries are identified at the NACE 4-digit level.

The commitment to R&D and branding are measured by the levels of investment in these two activities. Further, we also include in the analysis the investments of other activities as identified in the Innobarometer survey, for the purpose of exploring other relevant factors related to company's design commitment.

Firm size is measured by the number of employees. Firm age is measured by a binary variable that indicates whether the firm has been established for less than 6 years by the time the survey was conducted. Subsidiary status is also measured by a binary variable. Meanwhile, the variances that are potentially caused by the broader socio-cultural environment are controlled by adding country dummy variables into the analysis.

All the variables are summarized in Table 53.

[144] The data matching for the present study was conducted according to the full list of the trademark-intensive industries given from page 132 to page 137, in which 276 industries were identified (note that the number is claimed 277 in text).

Table 53 Measures

Concept	Measure/Variable	Values
Design commitment	Design positioning	1. Design is a central element in the company's strategy. 2. Design is an integral, but not central element of development work in the company. 3. Design is used as last finish, enhancing the appearance and attractiveness of the final product. 4. The company does not work systematically with design. 5. Design is not used in the company.
	Design investment	1. 0% of total turnover 2. Less than 1% of total turnover 3. 1 - 5% of total turnover 4. More than 5% of total turnover
R&D commitment	R&D investment	Same coding as design investments
Branding commitment	Branding investment	Same coding as design investments
Software commitment	Software investment	Same coding as design investments
Training commitment	Training investment	Same coding as design investments
Process commitment	Process investment	Same coding as design investments
Capitals commitment	Capitals investment	Same coding as design investments
Firm structure	Firm size	Natural logarithm of the number of employees
	New firm (dummy)	0. More than 6 years 1. 6 years or below
	Subsidiary (dummy)	0. No 1. Yes
Technological opportunity	R&D intensity	Weighted R&D/GVA
	Patent intensiveness (dummy)	0. Non-patent-intensive 1. Patent-intensive
Demand heterogeneity	Geographic market	1. Local area/region 2. National outside of local area/region 3. EU countries excluding own country 4. Extra-EU
	Trademark intensiveness (dummy)	0. Non-trademark-intensive 1. Trademark-intensive
	Registered-design intensiveness (dummy)	0. Non-design-intensive 1. Design-intensive
General context (control variables)	Country (dummy)	0. Not [country name] 1. [Country name]

Analytical strategy

Although the two dependent variables can be considered as hierarchical measures of design commitment and are statistically positively correlated[145], conceptually, the specific "levels" of the two variables do not necessarily go side by side – the perceived importance of design does not always lead to firms investing "proportionally" in design. Thus, the two measures could be regarded as two independent aspects of design commitment; and therefore they will be examined separately. The aim of this analysis is to detect factors associated with firms' commitment to design, for

[145] Spearman's correlation coefficient: 0.773 ($p<0.05$, $N=9966$).

establishing the basis of further research on any causal relationship between them. Descriptive statistics will be reported and discussed before entering into regressions. As the two dependent variables are both categorical, Multinomial Logistic Regression[146] is used for both.

[146] As the assumption of proportional odds for Ordinal Regression is violated, Multinomial Logistic Regression is used instead of Ordinal Logistic Regression. Multi-collinearity is tested, which does not indicate a problem.

Results

Descriptive statistics

Table 54 reports the distribution of companies by their structural characteristics and business activities. Table 55 and Table 56 further present the distribution by their commitment to design (i.e. “design positioning” and “design investment”) – the percentages are by rows.

Manufacturing and wholesale and retailing account for nearly half of the sample. 60% of manufacturing companies at least use design as last finish or invest in design. This percentage is higher than the sample average (i.e. 49% reported using design systematically and 52% claimed to have invested in design). The proportion of wholesale or retailing businesses which ”use” or “invest” in design is close to the average for the whole sample. The energy, construction and transportation sectors mostly do not “use” or “invest” in design. More than 60% of the firms in accommodation and food, information and communication and the arts sectors “use” or “invest” in design. The information and communication sector has the highest propensity to engage in design.

The survey includes relatively small numbers of companies active in industries which make intensive use of IP protections. Probably surprisingly, firms active in industries which register designs intensively are not more likely to engage in design than those operating in trademark or patent-intensive industries (while these industries overlap). Three quarters of the respondents were operating in industries with low R&D intensity. Those engaged in design were disproportionately operating in industries of higher average R&D intensity. This implies the extent of firms’ commitment to design probably increases with the R&D intensity at the industry level, without controlling any other factors. More than half (58%) of the companies served only national markets, among which more than half reached beyond their local areas. The most localised businesses were the least likely to “use” or “invest” in design.

The mean size of firms that reported a certain type of design positioning does not suggest that firm size and design commitment vary systematically; and the mean size does not rise significantly with more design investments. Subsidiaries account for one third of the businesses; they demonstrate higher propensities than independents to invest in design or regard design as an integral/central element.

With regard to business activities, the investments in R&D or branding broadly corresponds to the investment in design. That is, those without R&D or branding investments are also more likely to be without design investments; and those investing in R&D or branding are more likely to invest in design as well.

Table 54 Descriptive statistics of the sample

Variables		Statistics
C - Manufacturing		23%
D - Electricity, gas, steam & air conditioning supply		1%
E - Water supply, sewerage, waste management & remediation		2%
F - Construction		15%
G - Wholesale & retail trade		23%
H - Transportation & storage		7%
I - Accommodation & food services		7%
J - Information & communication		4%
K - Financial & insurance activities		2%
L - Real estate activities		2%
M - Professional, scientific & technical activities		7%
N - Administrative & support services		5%
R - Arts, entertainment & recreation		2%
Patent-intensive industry	No	84%
	Yes	16%
Trademark-intensive industry	No	64%
	Yes	36%
Registered-design-intensive industry	No	79%
	Yes	21%
Industry R&D intensity	Mean	1.39
	SD	3.79
	Minimum	0.00
	Maximum	57.26
	25 percentile	0.08
	50 percentile	0.33
	75 percentile	1.02
	Valid obs.	9966
Furthest geographic market	Local	27%
	National	31%
	EU	23%
	Extra-EU	20%
Firm size	Mean	176
	SD	1705
	Minimum	10
	Maximum	68945
	25 percentile	15
	50 percentile	35
	75 percentile	80
	Valid obs.	9966
New firm (<=6 years)	No	92%
	Yes	8%
Subsidiary	No	68%
	Yes	32%
Design positioning	Not used	28%
	Not used systematically	24%
	Last finish	13%
	Integral	22%
	Central	13%
% total turnover invested in design	0%	40%
	< 1%	18%
	1-5%	29%
	> 5%	13%

Table 54 (Continued)

Variables		Statistics
% total turnover invested in R&D	0%	54%
	< 1%	15%
	1-5%	22%
	> 5%	10%
% total turnover invested in branding	0%	28%
	< 1%	27%
	1-5%	34%
	> 5%	11%
% total turnover invested in training	0%	15%
	< 1%	30%
	1-5%	43%
	> 5%	11%
% total turnover invested in software	0%	42%
	< 1%	21%
	1-5%	27%
	> 5%	11%
% total turnover invested in process	0%	27%
	< 1%	24%
	1-5%	37%
	> 5%	12%
% total turnover invested in capitals	0%	15%
	< 1%	16%
	1-5%	40%
	> 5%	29%
Total		100%

Table 55 Descriptive statistics by design positioning

		Positioning of design				
		Not used	Not used systematically	Last finish	Integral	Central
C - Manufacturing		26%	16%	15%	25%	18%
D - Electricity, gas, steam & air conditioning supply		48%	22%	10%	12%	8%
E - Water supply, sewerage, waste management & remediation		56%	19%	8%	12%	5%
F - Construction		43%	21%	12%	17%	8%
G - Wholesale & retail trade		34%	18%	14%	20%	13%
H - Transportation & storage		51%	19%	10%	13%	7%
I - Accommodation & food services		24%	13%	19%	26%	17%
J - Information & communication		20%	16%	14%	29%	21%
K - Financial & insurance activities		33%	15%	15%	23%	14%
L - Real estate activities		38%	19%	16%	19%	8%
M - Professional, scientific & technical activities		33%	17%	12%	20%	17%
N - Administrative & support services		34%	19%	12%	21%	14%
R - Arts, entertainment & recreation		23%	14%	19%	29%	14%
Patent-intensive industry	No	35%	18%	14%	20%	13%
	Yes	29%	18%	14%	23%	15%
Trademark-intensive industry	No	37%	18%	13%	19%	12%
	Yes	28%	17%	15%	24%	16%
Registered-design-intensive industry	No	36%	18%	14%	20%	12%
	Yes	26%	16%	14%	24%	20%

Table 55 (Continued)

		Positioning of design				
		Not used	Not used systematically	Last finish	Integral	Central
Industry R&D intensity	Mean	0.99	1.37	1.43	1.76	1.66
	SD	3.13	4.09	3.52	4.29	3.81
	Minimum	0.00	0.00	0.00	0.00	0.00
	Maximum	40.65	57.26	40.65	57.26	38.69
	25 percentile	0.08	0.08	0.07	0.08	0.08
	50 percentile	0.15	0.25	0.40	0.57	0.61
	75 percentile	0.66	0.88	1.14	1.42	1.67
	Valid obs.	2817	2414	1277	2146	1312
Furthest geographic market	Local	42%	18%	13%	17%	10%
	National	33%	18%	14%	21%	14%
	EU	31%	18%	15%	22%	14%
	Extra-EU	24%	16%	15%	27%	18%
Firm size	Mean	158	139	201	214	194
	SD	1902	1578	1795	1712	1342
	Minimum	10	10	10	10	10
	Maximum	43739	68945	43739	43739	43739
	25 percentile	15	15	15	17	15
	50 percentile	25	34	37	49	40.5
	75 percentile	64	76	92.5	121	103.75
	Valid obs.	2817	2414	1277	2146	1312
New firm (<=6 years)	No	34%	18%	14%	21%	13%
	Yes	34%	16%	15%	21%	14%
Subsidiary	No	37%	18%	14%	19%	12%
	Yes	26%	17%	14%	26%	17%
% total turnover invested in R&D	0%	43%	27%	9%	14%	7%
	< 1%	13%	26%	16%	28%	16%
	1-5%	11%	21%	18%	31%	20%
	> 5%	7%	16%	16%	33%	27%
% total turnover invested in branding	0%	56%	25%	7%	8%	4%
	< 1%	24%	30%	13%	22%	11%
	1-5%	15%	22%	17%	29%	17%
	> 5%	10%	15%	16%	31%	28%
% total turnover invested in training	0%	48%	24%	8%	12%	8%
	< 1%	29%	26%	13%	21%	12%
	1-5%	23%	24%	14%	24%	14%
	> 5%	19%	20%	15%	27%	19%
% total turnover invested in software	0%	42%	25%	10%	15%	8%
	< 1%	22%	26%	13%	23%	15%
	1-5%	18%	24%	15%	27%	17%
	> 5%	13%	19%	17%	30%	21%
% total turnover invested in process	0%	52%	26%	7%	10%	6%
	< 1%	22%	26%	14%	26%	13%
	1-5%	19%	24%	15%	25%	16%
	> 5%	15%	17%	17%	29%	21%
% total turnover invested in capitals	0%	46%	23%	8%	14%	10%
	< 1%	29%	25%	11%	22%	13%
	1-5%	25%	25%	14%	23%	14%
	> 5%	24%	23%	14%	24%	14%
Total		34%	18%	14%	21%	14%

Table 56 Descriptive statistics by levels of design investment

		% of total turnover invested in design			
		0%	< 1%	1-5%	> 5%
C - Manufacturing		38%	17%	30%	16%
D - Electricity, gas, steam & air conditioning supply		55%	18%	19%	8%
E - Water supply, sewerage, waste management & remediation		58%	15%	19%	7%
F - Construction		58%	14%	20%	9%
G - Wholesale & retail trade		53%	15%	22%	10%
H - Transportation & storage		62%	15%	17%	7%
I - Accommodation & food services		37%	15%	32%	16%
J - Information & communication		30%	13%	31%	26%
K - Financial & insurance activities		40%	18%	26%	16%
L - Real estate activities		53%	15%	21%	11%
M - Professional, scientific & technical activities		47%	13%	24%	16%
N - Administrative & support services		44%	16%	26%	13%
R - Arts, entertainment & recreation		37%	16%	28%	19%
Patent-intensive industry	No	50%	15%	24%	12%
	Yes	41%	16%	27%	16%
Trademark-intensive industry	No	52%	15%	22%	11%
	Yes	42%	15%	27%	16%
Registered-design-intensive industry	No	50%	15%	23%	11%
	Yes	41%	15%	27%	17%
Industry R&D intensity	Mean	1.01	1.41	1.59	2.09
	SD	3.17	3.64	4.00	4.97
	Minimum	0.00	0.00	0.00	0.00
	Maximum	40.65	40.65	57.26	39.10
	25 percentile	0.08	0.08	0.08	0.08
	50 percentile	0.15	0.40	0.51	0.61
	75 percentile	0.66	1.14	1.38	1.90
	Valid obs.	3983	1817	2864	1302
Furthest geographic market	Local	59%	13%	20%	9%
	National	49%	15%	24%	12%
	EU	42%	17%	26%	14%
	Extra-EU	33%	18%	31%	18%
Firm size	Mean	162	180	185	189
	SD	2011	1135	1498	1775
	Minimum	10	10	10	10
	Maximum	68945	43739	43739	43739
	25 percentile	15	17	15	15
	50 percentile	26	50	38	35
	75 percentile	66	127	96	90
	Valid obs.	3983	1817	2864	1302
New firm (<=6 years)	No	48%	15%	24%	12%
	Yes	49%	13%	23%	16%
Subsidiary	No	52%	14%	23%	12%
	Yes	38%	20%	28%	14%
% total turnover invested in R&D	0%	66%	11%	16%	7%
	< 1%	24%	41%	27%	8%
	1-5%	22%	15%	46%	18%
	> 5%	16%	8%	29%	47%
% total turnover invested in branding	0%	75%	7%	12%	6%
	< 1%	42%	33%	19%	6%
	1-5%	33%	14%	39%	14%
	> 5%	23%	7%	30%	39%
% total turnover invested in training	0%	69%	7%	15%	9%
	< 1%	46%	28%	19%	6%
	1-5%	41%	14%	32%	13%
	> 5%	31%	7%	27%	34%
% total turnover invested in software	0%	63%	10%	18%	9%
	< 1%	38%	32%	22%	7%
	1-5%	34%	15%	36%	14%
	> 5%	24%	9%	29%	38%

Table 56 (Continued)

		% of total turnover invested in design			
		0%	< 1%	1-5%	> 5%
% total turnover invested in process	0%	74%	7%	13%	6%
	< 1%	37%	35%	22%	6%
	1-5%	35%	14%	37%	14%
	> 5%	27%	7%	27%	39%
% total turnover invested in capitals	0%	69%	8%	15%	8%
	< 1%	47%	27%	19%	7%
	1-5%	43%	17%	29%	11%
	> 5%	39%	12%	28%	21%
Total		48%	15%	24%	13%

Regressions

Table 57 shows the results of the Multinomial Logistic Regression on design positioning. R&D intensity of industry is found to have a significant effect on the probability to use design as an integral element of development work. For most of the businesses observed (i.e. 97% of the sample, which have an R&D intensity up to 10%), the probability seems to increase with the R&D intensity (Figure 2) – from around 21% to 27%. That is, a curvilinear relationship between R&D intensity and design positioning has not been found, although only a small proportion of firms (less than 1%) were operating in the most R&D-intensive industries (where R&D intensity exceeds 20%) and these have lower propensities to integrate design into the development work of their businesses (See the lower right corner of Figure 2). Furthermore, patent-intensive industries (which account for 16% of the businesses) compared to otherwise similar firms are 3 percentage points less likely to use design as a central strategy, and are 3 percentage points more likely to not to use design.

Firms which serve more distant markets have higher propensities to centralise design, compared to business that only serve their local markets. Firms in trademark-intensive industries are more likely to use design as last finish and are less likely to not to use design than otherwise similar companies. Firms in registered-design-intensive industries have higher probabilities to use design as a central strategy while showing lower tendencies to use design merely as last finish, in comparison with otherwise similar businesses. These results in general provide some support to the hypothesis that businesses are more committed to design in context where demand is more heterogeneous (H2).

Within companies, the positioning of design is found to be essentially positively related to both R&D and branding investments. That is, H3 and H4 are supported.

Firms investing in software turn out to have higher probabilities to centralise design than those not investing in software; and those with investments in organisation and process improvement are also found to have higher propensities to use design than those not investing in these. Small companies are more likely to not to use design or not to use it systematically than their larger counterparts, while the latter are more likely to integrate design into their businesses – although the effect is small: the probability to integrate design is only 2 percentage points higher in a 50-employee firm than that in a 10-employee firm (Figure 3). Subsidiaries show between 1 and 2 percentage points' higher probabilities to use design as a central strategy or integral element, and about 4 percentage points lower probabilities to not use design. These results provide some support to H5 and H7. In the meantime, there is little evidence in support of H6 as most of the effects of "new firm" are statistically non-significant.

Table 57 Multinomial Logistic Regression on design positioning

	Multinomial logistic regression – design positioning				
	Not used	**Not used systematically**	**Last finish**	**Integral**	**Central**
Technological opportunities					
R&D intensity (%)	-0.005	-0.005	0.001	0.007***	0.001
Squared-R&D intensity (%)					
Patent-intensiveness (d)	0.033**	0.024	-0.005	-0.020	-0.032***
Demand heterogeneity					
Furthest geo. market (ref. Local)					
National	-0.008	-0.009	-0.008	0.007	0.018*
EU	-0.011	-0.011	-0.010	0.003	0.028***
Extra-EU	-0.029**	-0.016	-0.005	0.013	0.037***
Trademark-intensiveness (d)	-0.027***	-0.009	0.026***	0.011	-0.002
Registered-design-intensiveness (d)	-0.022*	-0.025*	-0.030***	0.016	0.060***
R&D investment (ref. 0%)					
< 1%	-0.158***	0.006	0.041***	0.070***	0.041***
1 – 5%	-0.158***	-0.027**	0.050***	0.083***	0.052***
> 5%	-0.194***	-0.030	0.037***	0.103***	0.084***
Branding investment (ref. 0%)					
< 1%	-0.130***	0.012	0.015	0.068***	0.035***
1 – 5%	-0.198***	-0.037***	0.038***	0.121***	0.077***
> 5%	-0.215***	-0.079***	0.030**	0.139***	0.125***
Training investment (ref. 0%)					
< 1%	-0.006	0.012	0.012	-0.011	-0.007
1 – 5%	-0.009	0.018	0.006	-0.003	-0.012
> 5%	-0.013	0.013	-0.002	0.006	-0.005
Software investment (ref. 0%)					
< 1%	-0.050***	-0.002	0.005	0.011	0.036***
1 – 5%	-0.061***	0.001	0.009	0.024**	0.027***
> 5%	-0.076***	-0.004	0.022*	0.026*	0.032***
Process investment (ref. 0%)					
< 1%	-0.096***	-0.030**	0.027**	0.081***	0.017
1 – 5%	-0.092***	-0.021*	0.036***	0.057***	0.020*
> 5%	-0.096***	-0.049***	0.052***	0.065***	0.028**
Capitals investment (ref. 0%)					
< 1%	-0.035**	-0.002	0.001	0.032*	0.005
1 – 5%	-0.035**	0.010	0.017	0.015	-0.007
> 5%	-0.011	0.019	0.009	0.007	-0.023*
ln(size)	-0.009**	-0.009**	0.000	0.015***	0.003
New firm (<=6 years) (d)	0.000	-0.040**	0.010	0.021	0.008
Subsidiary (d)	-0.037***	0.001	0.002	0.019**	0.014**
Model Chi-Square	4507				
-2LL	26614				
Pseudo R^2	0.36 (Cox and Snell), 0.38 (Nagelkerke), 0.15 (McFadden)				
N	9966				

Note: The reported are average marginal effects; ***p<0.01, **p<0.05, *p<0.1. There is no marginal effect for quadratic term. “ref.” indicates reference category; “d” indicates dummy variable. Country is controlled but not presented in the table for brevity.

Figure 2 Predicted probabilities of design positioning by industry R&D intensity

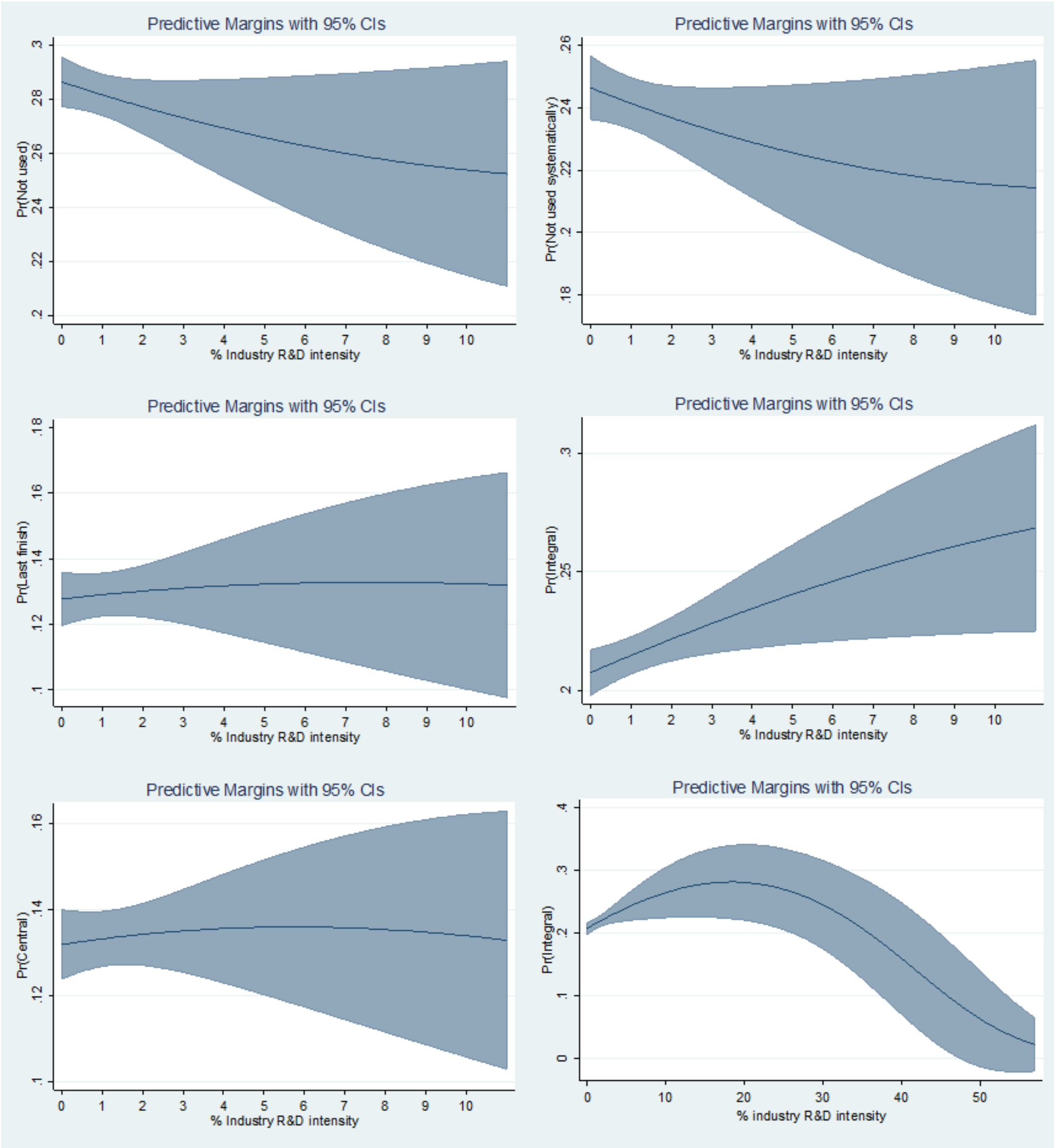
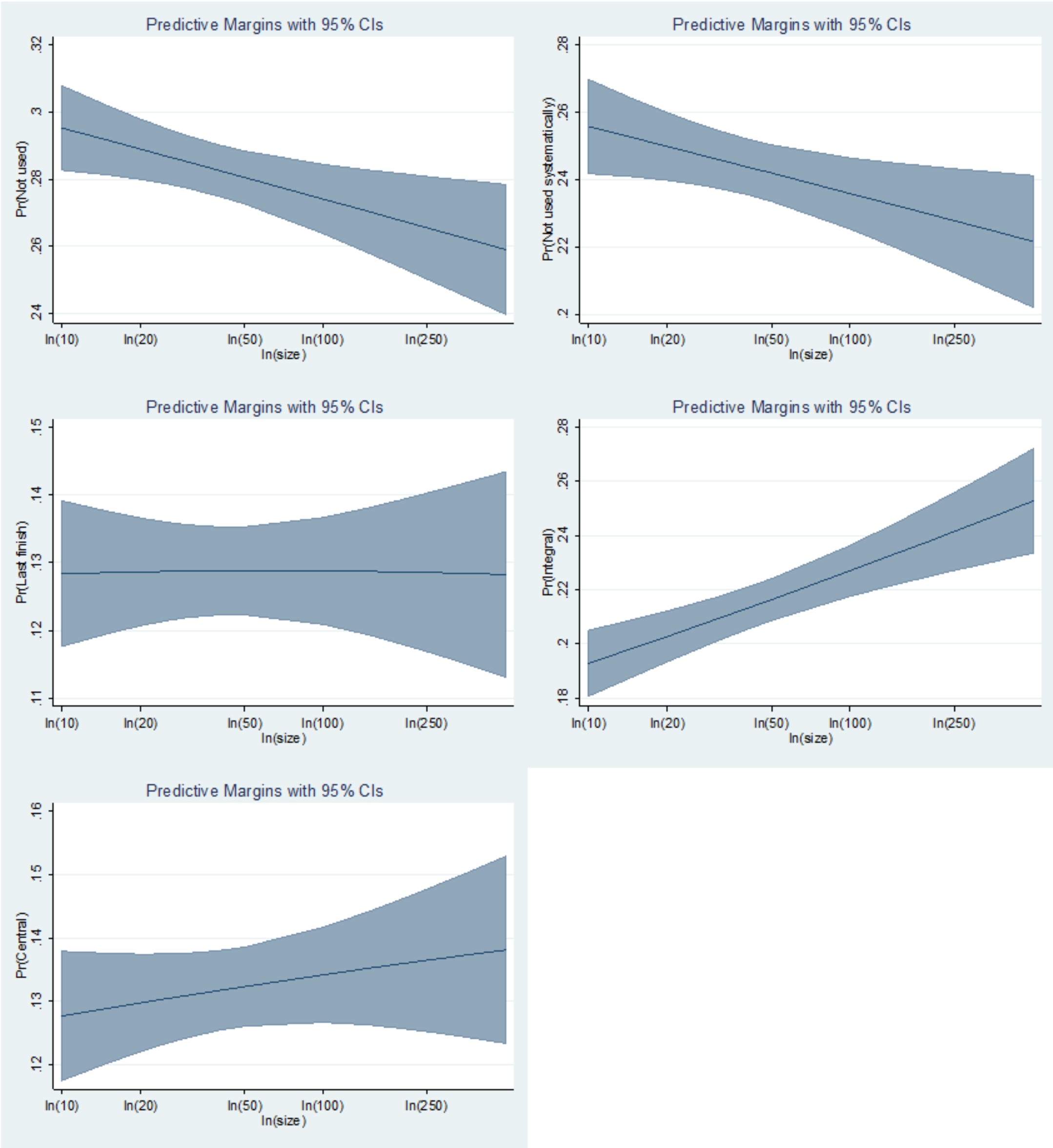


Figure 3 Predicted probabilities of design positioning by organisational size



The results of the Multinomial Logistic Regression on the levels of design investment is presented in Table 58. The R&D intensity of the industry has an impact on firms' propensity to invest more than 5% of total turnover in design, and to not to invest in design. Similar to the findings in relation to industry R&D intensity and the probability to use design as an integral element – for the majority of the businesses observed (i.e. 97%, for which the industry R&D intensity is up to 10%), the probability of investing more than 5% of total sales in design rises from approximately 13% to 16% with the increase of R&D intensity; while there is a small cohort of firms (i.e. less than 1%) in the most R&D-intensive industries which have lower tendencies to spend more than 5% of total turnover on design (Figure 4). The predicted probability of no design investment declines with industry R&D intensity – again, for most of the businesses, which operate in industries where R&D intensity is lower than 10%; and those firms which are active in the most R&D-intensive industries show higher probabilities to not to spend on design. The probability of not investing in design is 4 percentage points higher in patent-intensive industries than in non-patent-intensive industries.

In contrast to local businesses, the companies which serve extra-EU markets are more likely to spend over 5% of their turnover on design, and are less likely to spend nothing on design. The trademark-intensive industries tend to invest a modest amount in design and are less likely to not to invest in design, compared to non-trademark-intensive industries. Likewise, the registered-design-intensive industries also have lower possibilities (i.e. 4 percentage points) to eschew design investment and higher probabilities (by 3.5 percentage points) to spend more than 5% of total turnover on design. These findings provide some support to H2.

Within companies, the level of design investments is typically positively related to their level of R&D and branding investments, which support H3 and H4. That is, those which spend a certain level on R&D or branding seem to have the highest probabilities (by comparing the deviations from the probability for those spending zero on R&D or branding) to also invest the equivalent level in design. Larger firms are more likely to spend less than 1% on design, and are less likely to not to invest in design. Specifically, as illustrated by Figure 5, the probability for a 50-employee firm to invest in design at less than 1% of total turnover is about 1 percentage point higher than the probability for a 10-employee firm (i.e. 18% c.f. 17%). Firm age is not found to have a significant relationship with the level of design investment. Subsidiaries are 3 percentage points less likely to not invest in design than independent firms. These findings provide some support to H5 and H7, while H6 is not supported.

Table 58 Multinomial Logistic Regression on design investment

	Multinomial logistic regression – design investment			
	0%	**< 1%**	**1-5%**	**> 5%**
Technological opportunities				
R&D intensity (%)	-0.006**	0.000	0.002	0.004**
Squared-R&D intensity (%)				
Patent-intensiveness (d)	0.043***	-0.011	-0.018	-0.013
Demand heterogeneity				
Furthest geo. market (ref. Local)				
National	-0.008	0.007	0.011	-0.010
EU	-0.022*	0.010	0.014	-0.002
Extra-EU	-0.045***	0.000	0.024*	0.021**
Trademark-intensiveness (d)	-0.034***	0.019**	0.019*	-0.004
Registered-design-intensiveness (d)	-0.039***	-0.012	0.016	0.035***
R&D investment (ref. 0%)				
< 1%	-0.187***	0.108***	0.077***	0.002
1 – 5%	-0.203***	0.011	0.157***	0.036***
> 5%	-0.218***	-0.019	0.111***	0.126***
Branding investment (ref. 0%)				
< 1%	-0.130***	0.128***	0.024*	-0.022**
1 – 5%	-0.226***	0.059***	0.147***	0.020**
> 5%	-0.263***	0.034**	0.138***	0.091***
Training investment (ref. 0%)				
< 1%	0.000	0.057***	-0.038**	-0.020
1 – 5%	-0.009	0.019	-0.009	0.000
> 5%	-0.008	0.004	-0.040**	0.045
Software investment (ref. 0%)				
< 1%	-0.046***	0.049***	0.003	-0.006
1 – 5%	-0.061***	0.017*	0.042***	0.003
> 5%	-0.074***	-0.019	0.038**	0.055
Process investment (ref. 0%)				
< 1%	-0.129***	0.110***	0.018	0.001
1 – 5%	-0.132***	0.040***	0.072***	0.020
> 5%	-0.136***	0.002	0.042**	0.092
Capitals investment (ref. 0%)				
< 1%	-0.049***	0.044***	0.015	-0.009
1 – 5%	-0.048***	0.028**	0.028*	-0.008
> 5%	-0.020	-0.007	0.026*	0.001
ln(size)	-0.010***	0.009***	0.004	-0.003
New firm (<=6 years) (d)	-0.013	-0.007	0.002	0.018
Subsidiary (d)	-0.030***	0.013*	0.009	0.008
Model Chi-Square	6723			
-2LL	19210			
Pseudo R^2	0.49 (Cox and Snell), 0.53 (Nagelkerke), 0.26 (McFadden)			
N	9966			

Note: The reported are average marginal effects; ***p<0.01, **p<0.05, *p<0.1. There is no marginal effect for quadratic term. “ref.” indicates reference category; “d” indicates dummy variable. Country is controlled but not presented in the table for brevity.

Figure 4 Predicted probabilities of the levels of design investment by industry R&D intensity

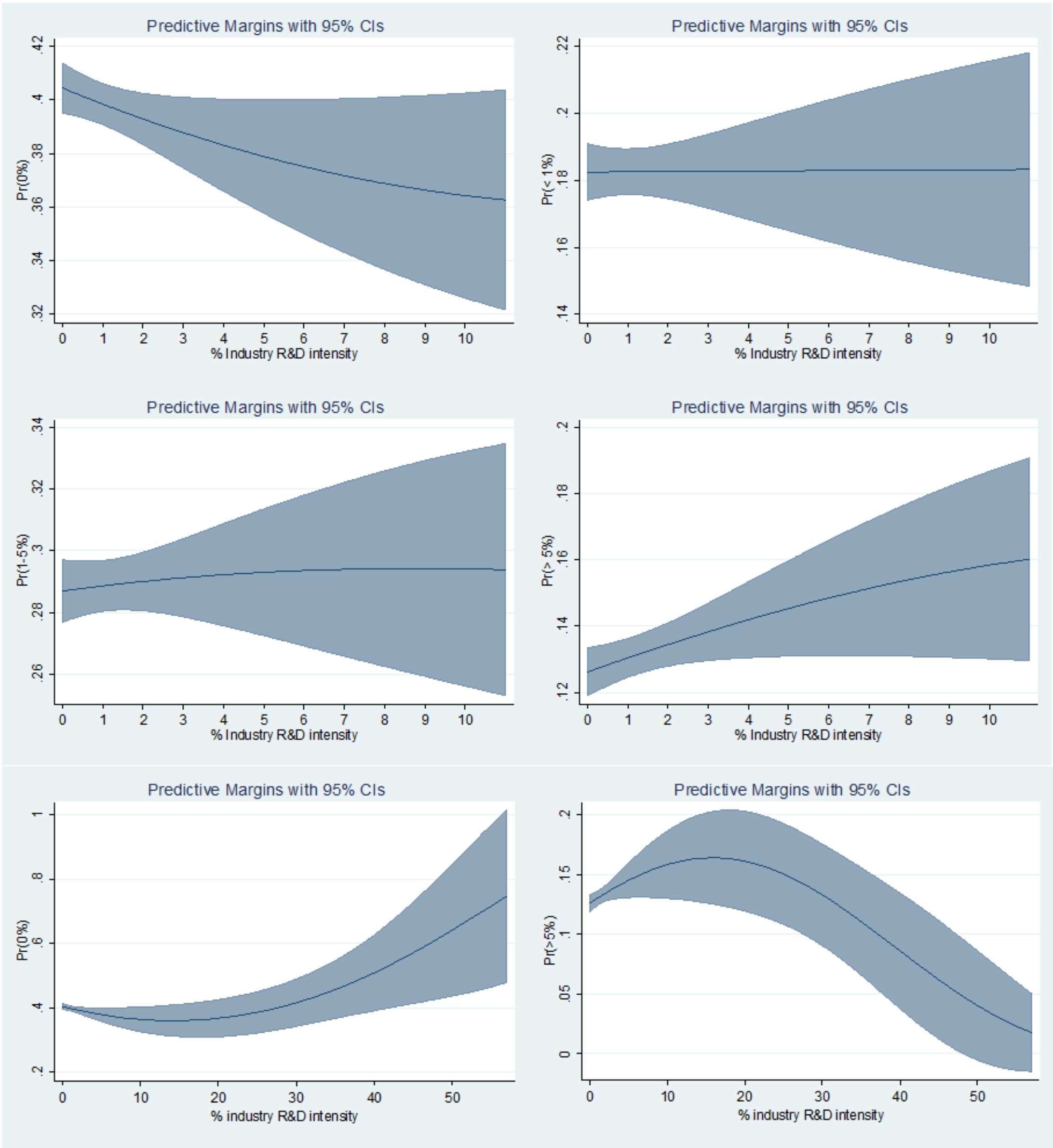
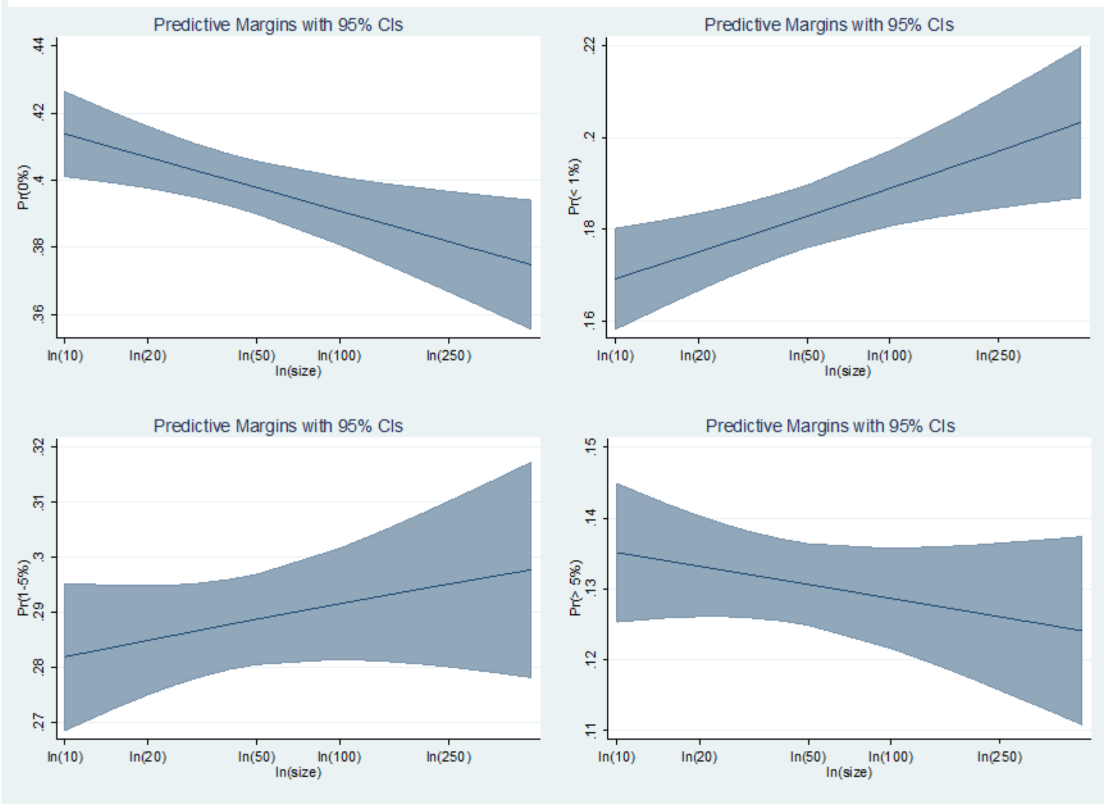


Figure 5 Predicted probabilities of the levels of design investment by organisational size



In order to better describe the relationship between industry R&D intensity and firms' commitment to design, we looked at the sectoral distribution of the 1% firms which operate in the most R&D-intensive industries (i.e. where the R&D intensity is higher than 20%, and where the probabilities to "use design as an integrated element for development work" or "invest more than 5% of total turnover in design" start to decline). These firms are concentrated in only two sectors at NACE 2-digit level, half of which comes from "NACE 72 Scientific research and development", the other half of which comes from "NACE 26 Manufacture of computer, electronic and optical products" – note the R&D intensities of industries are country-specific hence firms operating in the same industries do not necessarily have the same industry R&D intensity. That NACE72 companies are less likely to have a greater commitment to design is understandable, whereas the result for NACE26 companies is more surprising, given that design can be expected to enhance the usability of computers, electronics and optical equipment. A possibility could be that the design involved in this sector may be captured to a certain extent by software development and process improvement (e.g. Electronic Design Automation or Computer-Aided Design, which involves software tools that are used for optimising design process). In general, we conclude that the relationship between the industry R&D intensity and firms' commitment to design is positive. That is, H1 is partially supported.

Discussion, implications and limitations

The estimation of the two measures of design commitment in general suggests consistent results: (1) there exists a positive relationship between technological opportunities (the R&D intensity of industry) and the firms' commitment to design; (2) more differentiated demand is associated with greater design commitment; (3) the importance of design tends to increase with other functions within businesses, especially R&D and branding, which is probably motivated by the technological and market opportunities; (4) larger firms tend to integrate design into their businesses and spend a modest amount on it; (5) subsidiaries tend to put design on higher strategic footing and to invest a modest amount in it.

The finding about industry R&D intensity partially supports our hypothesis that design is favoured when technological opportunities are high. However, we found no evidence to support the existence of a valley of design commitment for those active in environments with moderate technological opportunities. We consider the reasons could be at least twofold. First, although we quantified the level of technological opportunities by industry R&D intensity, there might not be substantial difference between the alleged "mature industries" and the industries of "intermediate level of technological opportunities", or in most industries there might not be such distinct phases across "industry life cycles" with shifts from product innovation to process innovation and then back to product differentiation. The industries as classified by their resources, processes and output seem to be increasingly difficult to summarise, with a lot of variety happening in businesses included in the same industry codes. Technological opportunities could emerge anywhere and transmit anytime vertically from industries in the same value chain or horizontally from industries that would be considered irrelevant in a traditional sense, or indirectly from customers. Therefore, the conventional characterisation of industries as "mature" versus intermediate can be problematic. Second, technological opportunities could stem from the reconfiguration of established technologies with or without a significant attendance of emerging technologies (i.e. they do not require numerous new technologies), which may not necessarily require substantial investments in R&D – especially that part for adopting new technologies. Therefore, while heavy investments in R&D can suggest high technological opportunities (i.e. rich opportunities or heavy involvement of new technologies), a modest amount of R&D investment may signify small possibility to incorporate new technologies but not necessarily few opportunities to configure established technologies. This may be a limitation of the current study, albeit R&D

intensity is the best option available for measuring technological opportunities and has been widely used in existing literature.

While generally aligning with our hypotheses, our findings also indicate the absolute size of the differences in behaviours are small. At first sight these results may be disappointing. On the other hand they suggest that design is applicable across a wide range of contexts, and the results also generally indicate that design capabilities are rather accessible in the sense that they do not require substantial investments. Therefore, it is potentially a quality strategic asset for small independent businesses which possess relatively limited financial and other resources to innovate and compete in the market. For those which are actively engaged in R&D or branding, design could be an option to input into if the firm seeks to add additional value to their existing activities. Seeing that it is widely associated with innovation activities as well as its attendance to customer aspects, design is probably an indicator of "good business".

The current study certainly has limitations. It utilises cross-sectional data, and the analysis is therefore associative rather than supporting causal inferences. With regard to design it may be that this is not particularly well understood, and that future work is more precise about the types of design that respondents are being asked to report on. As outlined earlier, we consider there are at least three types.

With regard to the measures, the binary measure of patent intensity is only able to catch certain types of (i.e. patentable) technological activities for a small portion of businesses in the whole economy. This also applies to trademark and registered-design intensiveness for measuring demand heterogeneity. Therefore, the results generated are probably not so widely applicable. The other measure of demand heterogeneity is also not ideal in the sense that it reflects the company's response to demand rather than the demand per se; and by using this measure we assumed firms that reach further markets also serve closer markets – which applies to most companies but not all. However, this measure has its advantage as it does not define a product category hence does not assume that demand is bounded by existing choices for a given product category.

The analysis is based on pooled data extracted from the same survey which were conducted in two consecutive years. Ideally, the year of survey should be controlled in the models. However, in order to secure enough observations for each combination of all the categories of all variables of interest in the analysis, the models are only able to accommodate the relatively more relevant control variable. Therefore, country is controlled for in the models while the year of survey is not, given that the latter was not detected with the tendency to confound the relationship of interest in the preliminary analyses.

Future research could adopt a longitudinal research design which will allow for testing causal relationships. For a more practical inference of the relationships, continuous measures are ideal. It could also be interesting to examine innovation as the outcome of design sensing and seizing opportunities, possibly with path analysis or Structural Equation Modelling.

While it has limitations, the study has contributed to the knowledge about design capabilities in business scenarios.

References

Abernathy, W. J. & Utterback, J. M., 1978. Patterns of industrial innovation. *Technology Review,* 80(7), pp. 40-47.

Adner, R. & Levinthal, D., 2001. Demand heterogeneity and technology evolution: Implications for product and process innovation. *Management Science,* 47(5), pp. 611-733.

Adner, R. & Zemsky, P., 2006. A demand-based perspective on sustainable competitive advantage. *Strategic Management Journal,* 27(3), pp. 215-239.

Amburgey, T. L., Kelly, D. & Barnett, W. P., 1993. Resetting the clock: The dynamics of organizational change and failure. *Administrative Science Quarterly,* 38(1), pp. 51-73.

Arrow, K. J., 1962. Economic welfare and the allocation of resources for invention. In: *The Rate and Direction of Inventive Activity: Economic and Social Factors.* s.l.:Princeton University Press, pp. 609-626.

Awano, G., Franklin, M., Haskel, J. & Kastrinaki, Z., 2010. *Investing in innovation: Findings from the UK investment in intangible assets survey,* s.l.: National Endowment for Science, Technology and the Arts.

Baker, T., Miner, A. S. & Eesley, D. T., 2003. Improvising firms: Bricolage, account giving and improvisational competencies in the founding process. *Research Policy,* 32(2), pp. 255-276.

Banker, R. D., Khosla, I. & Sinha, K. K., 1998. Quality and competition. *Management Science,* 44(9), pp. 1179-1192.

Barron, D. N., West, E. & Hannan, M. T., 1994. A time to grow and a time to die: Growth and mortality of credit unions in New York City, 1914-1990. *American Journal of Sociology,* 100(2), pp. 381-421.

Bascavusoglu-Moreau, E. & Tether, B., 2011. *Registered designs & business performance–exploring the link,* s.l.: s.n.

Behrens, V. et al., 2017. *Innovation activities of firms in Germany-Results of the German CIS 2012 and 2014: Background report on the surveys of the Mannheim Innovation Panel Conducted in the Years 2013 to 2016,* s.l.: ZEW-Dokumentation.

BEIS, 2016. *UK innovation survey 2012 to 2014: Statistical annex [Data file],* London: Department for Business, Energy and Industrial Strategy.

BIS, 2012. *UK Innovation Survey 2011: Statistical annex [revised] [Data file],* London: Department for Business, Innovation and Skills.

BIS, 2014. *UK innovation survey 2010 to 2012: Annex [Data file],* London: Department for Business, Innovation and Skills.

Björklund, T., Maula, H., Soule, S. A. & Maula, J., 2020. Integrating design into organizations: The coevolution of design capabilities. *California Management Review,* 62(2), pp. 100-124.

Bloch, P. H., 1995. Seeking the ideal form: Product design and consumer response. *Journal of Marketing,* 59(3), pp. 16-29.

Bogers, M. & Horst, W., 2014. Collaborative prototyping: Cross-fertilization of knowledgein prototype-driven problem solving. *Journal of Product Innovation Management,* 31(4), pp. 744-764.

Breschi, S., Malerba, F. & Orsenigo, L., 2000. Technological regimes and Schumpeterian patterns of innovation. *The Economic Journal,* 110(463), p. 388–410.

Brown, T., 2008. Design thinking. *Harvard Business Review,* 86(6), pp. 84-92.

Bruce, M. & Bessant, J., 2002. *Design in business: Strategic Innovation through design.* s.l.:Pearson Education.

Camisón-Zornoza, C., Lapiedra-Alcamí, R., Segarra-Ciprés, M. & Boronat-Navarro, M., 2004. A meta-analysis of innovation and organizational size. *Organization Studies,* 25(3), pp. 331-361.

Candi, M. & Saemundsson, R. J., 2011. Exploring the relationship between aesthetic design as an element of new service development and performance. *Journal of Product Innovation Management,* 28(4), pp. 536-557.

Carlgren, L., Elmquist, M. & Rauth, I., 2014. Design thinking: Exploring values and effects from an innovation capability perspective. *The design journal,* 17(3), pp. 403-423.

Cereda, M., Crespi, G., Criscuolo, C. & Haskel, J., 2005. *Design and company performance: Evidence from the Community Innovation Survey,* s.l.: DTI Report.

Chandy, R. K. & Tellis, G. J., 2000. The incumbent's curse? Incumbency, size, and radical product innovation. *Journal of Marketing,* 64(3), pp. 1-17.

Chisnall, P. M., 1985. *Marketing: a behavioural analysis.* 2nd ed. Maidenhead: McGraw Hill.

Chitturi, R., Raghunathan, R. & Mahajan, V., 2008. Delight by design: The role of hedonic versus utilitarian benefits. *Journal of Marketing,* 72(3), pp. 48-63.

Chiva, R. & Alegre, J., 2009. Investment in design and firm performance: The mediating role of design management. *Journal of Product Innovation Management,* 26(4), pp. 424-440.

Ciriaci, D., 2011. *Design and European firms' innovative performance: A less costly innovation activity for European SMEs?,* s.l.: Joint Research Centre of the European Commission.

Cohen, W. M. & Levinthal, D. A., 1989. Innovation and learning: The two faces of R&D. *The Economic Journal,* 99(397), pp. 569-596.

Cohen, W. M. & Levinthal, D. A., 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly,* 35(1), pp. 128-152.

Creusen, M. E. H. & Schoormans, J. P. L., 2004. The different roles of product appearance in consumer choice. *Journal of Product Innovation Management,* 22(1), pp. 63-81.

Czarnitzki, D. & Thorwarth, S., 2012. The contribution of in-house and external design activities to product market performance. *Journal of Product Innovation Management,* 29(5), pp. 878-895.

Damanpour, F., 1992. Organizational size and innovation. *Organization Studies,* 13(3), pp. 375-402.

Damanpour, F., 1996. Organizational complexity and innovation: Developing and testing multiple contingency models. *Management Science,* 42(5), pp. 629-782.

Damanpour, F., 2010. An integration of research findings of effects of firm size and market competition on product and process innovations. *British Journal of Management,* 21(4), pp. 996-1010.

Day, G. S. & Wensley, R., 1988. Assessing advantage: a framework for diagnosing competitive superiority. *Journal of Marketing,* 52(2), pp. 1-20.

Dean, T. J., Brown, R. L. & Bamford, C. E., 1998. Differences in large and small firm responses to environmental context: Strategic implications from a comparative analysis of business formations. *Strategic Management Journal,* 19(8), pp. 709-728.

Delacroix, J. & Swaminathan, A., 1991. Cosmetic, speculative, and adaptive organizational change in the wine industry: A longitudinal study. *Administrative Science Quarterly,* 36(4), pp. 631-661.

Desai, P., Kekre, S., Radhakrishnan, S. & Srinivasan, K., 2001. Product differentiation and commonality in design: Balancing revenue and cost drivers. *Management Science,* 47(1), pp. 37-51.

Design Council, 2007. *The value of design factfinder report,* London: Design Council.

Design Council, 2009. *The design economy: The value of design to the UK,* London: Design Council.

Dickson, P. R. & Ginter, J. L., 1987. Market segmentation, product differentiation, and marketing strategy. *Journal of Marketing,* 51(2), pp. 1-10.

Dorst, K. & Cross, N., 2001. Creativity in the design process: Co-evolution of problem–solution. *Design Studies,* 22(5), p. 425–437.

Eisenhardt, K. M. & Martin, J. A., 2000. Dynamic capabilities: what are they?. *Strategic Management Journal,* 21(10-11), pp. 1105-1121.

Eisenman, M., 2013. Understanding aesthetic innovation in the context of technological evolution. *Academy of Management Review,* 38(3), pp. 332-351.

EPO & EUIPO, 2016. *Intellectual property rights intensive industries and economic performance in the European Union,* Munich & Alicante: EPO & EUIPO.

European Commision, 2016a. *Flash Eurobarometer 433: Innobarometer 2016 – EU business innovation trends [Data file],* Brussels: European Commision.

European Commission, 2009. *Flash Eurobarometer 267: Innobarometer 2009 analytical report,* Brussels: European Commission.

European Commission, 2013a. *Commission staff working document: Implementing an action plan for design-driven innovation,* Brussels: European Commission.

European Commission, 2013b. *Flash Eurobarometer 369: Investing in intangibles: economic assets and innovation drivers for growth,* Brussels: European Commission.

European Commission, 2015a. *Flash Eurobarometer 415: Innobarometer 2015 – the innovation trends at EU enterprises [Data file],* Brussels: European Commission.

European Commission, 2015b. *Flash Eurobarometer 415: Innobarometer 2015 – the innovation trends at EU enterprises,* Brussels: European Commission.

European Commission, 2016b. *Flash Eurobarometer 433: Innobarometer 2016 – EU business innovation trends,* Brussels: European Commission.

Eurostat, 2019a. *Cross-classification of gross fixed capital fromation by industry and by asset (flows).* [Online] Available at: https://ec.europa.eu/eurostat/data/database [Accessed 2nd August 2019].

Eurostat, 2019b. *National accounts aggregates by industry (up to NACE A*64).* [Online] Available at: https://ec.europa.eu/eurostat/data/database [Accessed 2nd August 2019].

Filippetti, A., 2011. Innovation modes and design as a source of innovation: a firm-level analysis. *European Journal of Innovation Management,* 14(1), pp. 5-26.

Filitza, R., Henkel, J. & S.Tether, B., 2015. Protecting aesthetic innovations? An exploration of the use of registered community designs. *Research Policy,* 44(6), pp. 1192-1206.

Freeman, J., Carroll, G. R. & Hannan, M. T., 1983. The liability of newness: Age dependence in organizational death rates. *American Sociological Review,* 48(5), pp. 692-710.

Galindo-Rueda, F., Haskel, J. & Pesole, A., 2010. *How much does the UK employ, spend and invest in design?,* s.l.: s.n.

Galindo-Rueda, F. & Millot, V., 2015. *Measuring Design and its Role in Innovation,* Paris: OECD Publishing.

Galindo-Rueda, F. & Verger, F., 2016. *OECD taxonomy of Economic activities based on R&D intensity,* Paris: OECD Publishing.

Geels, F. W., 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy,* 33(6-7), pp. 897-920.

Gemser, G. & Barczak, G., 2020. Designing the future: Past and future trajectories for design innovation research. *Journal of Product Innovation Management,* 37(5), pp. 454-471.

Gemser, G. & Leenders, M. A. A. M., 2001. How integrating industrial design in the product development process impacts on company performance. *Journal of Product Innovation Management,* 18(1), pp. 28-38.

Gorb, P. & Dumas, A., 1987. Silent design. *Design Studies,* 8(3), pp. 150-156.

Guan, J. & Ma, N., 2003. Innovative capability and export performance of Chinese firms. *Technovation,* 23(9), pp. 737-747.

Hamel, G. & Prahalad, C., 1994. Competing for the future. *Harvard Business Review,* 72(4), pp. 122-128.

Hannan, M. T. & Freeman, J., 1984. Structural inertia and organizational change. *American Sociological Review,* 49(2), pp. 149-164.

Hannan, M. T. & Freeman, J., 1984. Structural inertia and organizational change. *American Sociological Review,* 49(2), pp. 149-164.

Hargadon, A. B. & Douglas, Y., 2001. When innovations meet institutions: Edison and the design of the electric light. *Administrative Science Quarterly,* 46(3), pp. 476-501.

Helfat, C. E. et al., 2007. *Dynamic capabilities: Understanding strategic change in organizations.* Oxford: Blackwell Publishing.

Helfat, C. E. & Peteraf, M. A., 2003. The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal,* 24(10), pp. 997-1010.

Helfat, C. E. & Winter, S. G., 2011. Untangling dynamic and operational capabilities: Strategy for the (n)ever-changing world. *Strategic Management Journal,* 32(11), pp. 1243-1250.

Henderson, R. M. & Clark, K. B., 1990. Architectural innovation: The reconfiguration of existing. *Administrative Science Quarterly,* 35(1), pp. 9-30.

Hertenstein, J. H., Platt, M. B. & Veryzer, R. W., 2005. The impact of industrial design effectiveness on corporate financial performance. *Journal of Product Innovation Management,* 22(1), pp. 3-21.

Hitt, M. A., Hoskisson, R. E. & Ireland, R. D., 1990. Mergers and acquisitions and managerial commitment to innovation in M-form firms. *Strategic Management Journal,* Volume 11, pp. 29-47 .

Jensen, M. B., Johnson, B., Lorenz, E. & Lundvall, B. Å., 2007. Forms of knowledge and modes of innovation. *Research Policy,* Volume 36, p. 680–693.

Karjalainen, T. & Snelders, D., 2010. Designing visual recognition for the brand. *Journal of Product Innovation Management,* 27(1), pp. 6-22.

Katila, R. & Shane, S., 2005. When does lack of resources make new firms innovative?. *Academy of Management Journal,* 48(5), pp. 814-829.

Klevorick, A. K., Levin, R. C., Nelson, R. R. & G.Winter, S., 1995. On the sources and significance of interindustry differences in technological opportunities. *Research Policy,* 24(2), pp. 185-205.

Knight, E., Daymond, J. & Paroutis, S., 2020. Design-led strategy: How to bring design thinking into the art of strategic management. *California Management Review,* 62(2), pp. 30-52.

Kotler, P. & Keller, K., 2016. *Marketing management.* s.l.:Pearson Education.

Lawson, B. & Samson, D., 2001. Developing innovation capability in organisations: A dynamic capabilities approach. *International Journal of Innovation Management,* 5(3), pp. 377-400.

Levitt, B. & March, J. G., 1988. Organizational learning. *Annual Review of Sociology,* 14(1), pp. 319-338.

Luchs, M. G., Swan, K. S. & Creusen, M. E. H., 2015. Perspective: A review of marketing research on product design with directions for future research. *Journal of Product Innovation Management,* 33(3), pp. 320-341.

Malerba, F., 2002. Sectoral systems of innovation and production. *Research Policy,* 31(2), pp. 247-264.

March, J. G., 1991. Exploration and exploitation in organizational learning. *Organization Science,* 2(1), pp. 1-147.

Matthyssens, P. & Vandenbempt, K., 2008. Moving from basic offerings to value-added solutions: Strategies, barriers and alignment. *Industrial Marketing Management,* 37(3), pp. 316-328.

McCracken, G., 1986. Culture and consumption: A theoretical account of the structure and movement of the cultural meaning of consumer goods. *Journal of Consumer Research,* 13(1), pp. 71-84.

Minbaeva, D. et al., 2003. MNC knowledge transfer, subsidiary absorptive capacity, and HRM. *Journal of International Business Studies,* 34(6), p. 586–599.

Montresor, S. & Vezzani, A., 2020. Design centrality, design investments and innovation performance: An empirical analysis of European firms. *Industrial and Corporate Change,* 29(2), p. 351–374.

Moultrie, J. & Livesey, F., 2014. Measuring design investment in firms: Conceptual foundations and exploratory UK survey. *Research Policy,* 43(3), pp. 570-587.

Mugge, R. & Dahl, D. W., 2013. Seeking the ideal level of design newness: Consumer response to radical and incremental product design. *Journal of Product Innovation Management,* 30(S1), pp. 34-47.

Nomen, E., 2014. *Guidelines for collecting and interpreting design data: A proposal for a future Barcelona manual on design,* Barcelona: Barcelona Design Centre.

OECD and Eurostat, 2005. *Oslo Manual: Guidelines for collecting and interpreting innovation data,* Paris: OECD Publishing.

OECD and Eurostat, 2018. *Oslo Manual 2018: guidelines for collecting, reporting and using data on innovation,* Paris: OECD Publishing.

OECD, 2015. *Frascati Manual 2015: Guidelines for collecting and reporting data on research and experimental development,* Paris: OECD Publishing.

Peneder, M., 2010. Technological regimes and the variety of innovation behaviour: Creating integrated taxonomies of firms and sectors. *Research Policy,* 39(3), pp. 323-334.

Perks, H., Cooper, R. & Jones, C., 2005. Characterizing the role of design in new product development: An empirically derived taxonomy. *Journal of Product Innovation Management,* 22(2), pp. 111-127.

Peteraf, M., Stefano, G. D. & Verona, G., 2013. The elephant in the room of dynamic capabilities: Bringing two diverging conversations together. *Strategic Management Journal,* 34(12), pp. 1389-1410.

Prahalad, C. K. & Bettis, R. A., 1986. The dominant logic: A new linkage between diversity and performance. *Strategic Management Journal,* 7(6), pp. 485-501.

Priem, R. L., Li, S. & Carr, J. C., 2011. Insights and new directions from demand-side approaches to technology innovation, entrepreneurship, and strategic management research. *Journal of Management,* 38(1), pp. 346-374.

Rangan, V. K. & Bowman, G. T., 1992. Beating the commodity magnet. *Industrial Marketing Management,* 21(3), pp. 215-224.

Ravasi, D. & Lojacono, G., 2005. Managing design and designers for strategic renewal. *Long Range Planning,* 38(1), pp. 51-77.

Rindova, V. P. & Petkova, A. P., 2007. When is a new thing a good thing? Technological change, product form design, and perceptions of value for product innovations. *Organization Science,* 18(2), pp. 165-335.

Rosenbloom, R. S. & Christensen, C. M., 1994. Technological discontinuities, organizational capabilities, and strategic commitments. *Industrial and Corporate Change,* 3(3), p. 655–685.

Rothwell, R. & Gardiner, P., 1983. The role of design in product and process change. *Design Studies,* 4(3), pp. 161-169.

Roy, R., 1993. Case studies of creativity in innovative product development. *Design Studies,* 14(4), pp. 423-443.

Rubera, G., 2015. Design innovativeness and product sales' evolution. *Marketing Science,* 34(1), pp. 98-115.

Rubera, G. & Droge, C., 2013. Technology versus design innovation's effects on sales and Tobin's Q: The moderating role of branding strategy. *Journal of Product Innovation Management,* 30(3), pp. 448-464.

Simeone, L., Secundo, G. & Schiuma, G., 2017a. Adopting a design approach to translate needs and interests of stakeholders in academic entrepreneurship: The MIT Senseable City Lab case. *Technovation,* Volume 64-65, pp. 58-67.

Simeone, L., Secundo, G. & Schiuma, G., 2017b. Knowledge translation mechanisms in open innovation: The role of design in R&D projects. *Journal of Knowledge Management,* 21(6), pp. 1406-1429.

Sørensen, J. B. & Stuart, T. E., 2000. Aging, obsolescence, and organizational innovation. *Administrative Science Quarterly,* 45(1), pp. 81-112.

Sutton, J., 1998. *Technology and market structure.* s.l.:MIT Press.

Swan, K. S., Kotabe, M. & Allred, B. B., 2005. Exploring robust design capabilities, their role in creating global products, and their relationship to firm performance. *Journal of product innovation management,* 22(2), pp. 144-164.

Swink, M., 2000. Technological innovativeness as a moderator of new product design integration and top management support. *Journal of Product Innovation Management,* 17(3), pp. 208-220.

Talke, K., Salomo, S., Wieringa, J. E. & Lutz, A., 2009. What about design newness? Investigating the relevance of a neglected dimension of product innovativeness. *Journal of Product Innovation Management,* 26(6), pp. 601-615.

Teece, D. J., 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal,* 28(13), pp. 1319-1350.

Tushman, M. L. & Anderson, P., 1986. Technological discontinuities and organizational environments. *Administrative Science Quarterly,* 31(3), pp. 439-465.

Tynan, A. C. & Drayton, J., 1987. Market segmentation. *Journal of Marketing Management,* 2(3), pp. 301-335.

Utterback, J. M. & Abernathy, W. J., 1975. A dynamic model of process and product innovation. *Omega,* 3(6), pp. 639-656.

Utterback, J. et al., 2006. *Design-inspired innovation.* s.l.:World Scientific.

Verganti, R., 2009. *Design driven innovation: changing the rules of competition by radically innovating what things mean.* Boston: Harvard Business Press.

Verganti, R. & Dell'Era, C., 2014. Design-driven innovation: Meaning as a source of innovation. In: M. Dodgson, D. M. Gann & N. Phillips, eds. *The Oxford handbook of innovation management.* Oxford: Oxford University Press, pp. 139-162.

Veryzer, J. R. W., 1995. The place of product design and aesthetics in consumer research. *Advances in Consumer Research,* 22(1), pp. 641-645.

Veryzer, R. W., 2005. The roles of marketing and industrial design in discontinuous new product development. *Journal of Product Innovation Management,* 22(1), pp. 22-41.

Vinodrai, T., Gertler, M. S. & Lambert, R., 2007. Capturing design: Lessons from the United Kingdom and Canada. In: *Science, technology and innovation indicators in a changing world: Responding to policy needs.* Paris: OECD Publishing, pp. 65-86.

Von Stamm, B., 2003. *Managing innovation, design and creativity.* Chichester: Wiley.

Walsh, 1996. Design, innovation and the boundaries of the firm. *Research Policy,* 25(4), pp. 509-529.

Walsh, V., Roy, R., Bruce, M. & Potter, S., 1992. *Winning by design: Technology, product design and international competitiveness.* Oxford: Blackwell Publishers.

Wang, C. L. & Ahmed, P. K., 2007. Dynamic capabilities: A review and research agenda. *International Journal of Management Reviews,* 9(1), pp. 31-51.

Whicher, A., Swiatek, P. & Cawood, G., 2015. *Design Policy Monitor 2015: Reviewing innovation and design policies across Europe,* s.l.: Sharing Experience Europe.

Winter, S. G., 2003. Understanding dynamic capabilities. *Strategic Management Journal,* 24(10), pp. 991-995.

Appendix

NACE		Weighted average R&D intensity
72	Scientific research and development	32.917%
26	Manufacture of computer, electronic and optical products	20.676%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	14.444%
29	Manufacture of motor vehicles, trailers and semi-trailers	10.781%
30	Manufacture of other transport equipment	10.458%
27	Manufacture of electrical equipment	8.902%
28	Manufacture of machinery and equipment n.e.c.	7.055%
C	Manufacturing	6.522%
M	Professional, scientific and technical activities	5.768%
20	Manufacture of chemicals and chemical products	5.584%
19	Manufacture of coke and refined petroleum products	3.376%
N	Administrative and support service activities	3.288%
61	Telecommunications	2.952%
71	Architectural and engineering activities; technical testing and analysis	2.777%
62,63	Computer programming, consultancy, and information service activities	2.612%
J	Information and communication	2.539%
22	Manufacture of rubber and plastic products	2.513%
33	Repair and installation of machinery and equipment	2.073%
31,32	Manufacture of furniture; other manufacturing	1.974%
23	Manufacture of other non-metallic mineral products	1.952%
58	Publishing activities	1.903%
24	Manufacture of basic metals	1.895%
13,14,15	Manufacture of textiles, wearing apparel, leather and related products	1.671%
93	Sports activities and amusement and recreation activities	1.420%
74,75	Other professional, scientific and technical activities; veterinary activities	1.392%
10,11,12	Manufacture of food products; beverages and tobacco products	1.136%
25	Manufacture of fabricated metal products, except machinery and equipment	1.017%
90,91,92	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	0.888%
37,38,39	Sewerage, waste management, remediation activities	0.786%
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.782%
R	Arts, entertainment and recreation	0.746%
17	Manufacture of paper and paper products	0.678%
46	Wholesale trade, except of motor vehicles and motorcycles	0.655%
D	Electricity, gas, steam and air conditioning supply	0.607%
66	Activities auxiliary to financial services and insurance activities	0.597%
80,81,82	Security and investigation, service and landscape, office administrative and support activities	0.579%
69,70	Legal and accounting activities; activities of head offices; management consultancy activities	0.570%
K	Financial and insurance activities	0.445%
E	Water supply; sewerage, waste management and remediation activities	0.443%
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	0.411%
65	Insurance, reinsurance and pension funding, except compulsory social security	0.405%
64	Financial service activities, except insurance and pension funding	0.397%
18	Printing and reproduction of recorded media	0.395%
73	Advertising and market research	0.348%
77	Rental and leasing activities	0.297%
59,60	Motion picture, video, television programme production; programming and broadcasting activities	0.265%
36	Water collection, treatment and supply	0.231%
53	Postal and courier activities	0.215%
H	Transportation and storage	0.137%
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	0.134%
50	Water transport	0.117%
F	Construction	0.112%
79	Travel agency, tour operator reservation service and related activities	0.107%
49	Land transport and transport via pipelines	0.092%
47	Retail trade, except of motor vehicles and motorcycles	0.078%
78	Employment activities	0.074%
52	Warehousing and support activities for transportation	0.059%
51	Air transport	0.026%
I	Accommodation and food service activities	0.011%
L	Real estate activities	0.007%

CHAPTER 4

DESIGN AND GEOGRAPHICAL REACH AMONG PRODUCT INNOVATORS: AN ANALYSIS OF THE UK INNOVATION SURVEY 2017*

*The data is used under permission.
Source: Office for National Statistics, Northern Ireland. Department of Enterprise, Trade and Investment, Department for Business, Innovation and Skills. (2021). *UK Innovation Survey, 1994-2018: Secure Access*. [data collection]. *7th Edition.* UK Data Service. SN: 6699, http://doi.org/10.5255/UKDA-SN-6699-7
The use of these data does not imply the endorsement of the data owner or the UK Data Service at the UK Data Archive in relation to the interpretation or analysis of the data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Introduction

The ability to win customers at distance is the ability to do business with customers that are not geographically proximate to the company. These customers may be in another town, another region and/or in another country. In the latter case customers can be supplied by exporting from one country to another.[147] Such an ability potentially allows firms to grow larger and/or to become more efficient given the larger potential customer base hence greater potential sales. It may also allow firms to specialise in a narrow range of products which have geographically dispersed demand. In this paper we examine whether and to what extent design commitment is associated with innovating firms winning customers at distance in terms of geographical market reach and exporting.

Both innovation and wining customers at distance involves organisational learning, and the literature on organisational learning suggests that firms' search for new knowledge can be geographically constrained or bounded (von Hippel, 1994; 1998; Stuart & Podolny, 1996), and this can restrict a firm's ability and/or motivation to pursue new opportunities (Levinthal & March, 1993; Katila & Ahuja, 2002). Mechanisms to overcome such knowledge localisation can include alliances with geographically distant partners, employee mobility, external knowledge repository and mergers and acquisitions with or of geographically distant firms (Rosenkopf & Almeida, 2003; Mowery, et al., 1996; Wagner, et al., 2014; Capron, et al., 1998). The current study proposes that design also provides a mechanism to overcome the constraints of local search. In this paper, we consider design to be an organisational capability (or set of capabilities) that can enable firms to enhance their product quality and customer focus, thereby contributing to achieving competitive advantage potentially by recognising, developing and seizing market opportunities.

Selling goods or services directly to foreign buyers (i.e. exporting) evidently indicates an organisational ability to serve customers at distance. The relationship between innovation and exporting, both as an activity and in levels, has been substantially researched, including studies which have measured innovation directly (Basile, 2001; Cassiman, et al., 2010; Love & Mansury, 2009), through investments in R&D (Tomiura, 2007; Ito & Pucik, 1993; Esteve-Pe´rez & Rodrı´guez, 2013; Barrios, et al., 2003; Di Cintio, et al., 2017) and, much less frequently, conducting other innovation

[147] There are different means through which firms can serve foreign customers, among which this study focuses on exporting (Helpman, et al., 2004; Cassiman & Golovko, 2011).

related activities such as design (Sterlacchini, 1999; Nassimbeni, 2001; Gemser & Leenders, 2001; MacPherson, 2000).

Therefore, in addition to conceiving design capabilities as a mechanism to overcome the knowledge localisation of businesses, this paper aims to contribute to the innovation-exporting literature by addressing the question whether and to what extent design is associated with increased geographical reach of product innovators and greater sales in geographical distant markets. To do this, the study draws on a large scale survey of UK businesses. Specifically, it tests the relationship between the extent of product innovators' commitment to design, which is measured by investments in design and the utilisation of design skills, and (1) the geographical reach of their markets and (2) the value of their exports.

The paper contributes to the small extant literature on the relationship between design and exporting (Sterlacchini, 1999; Nassimbeni, 2001; Gemser & Leenders, 2001; MacPherson, 2000), but adds to this by also addressing geographical reach by including intra-national trade between regions, which to our knowledge has not previously been addressed in the literature.

In the following we first draw on existing literature to derive the hypotheses to be tested. We then introduce the data, measures and strategy used to test the hypotheses. The results of the analysis including descriptive statistics are then presented and discussed. Following this, the implications for management, policy development and future research are discussed. The limitations of the current study will also be acknowledged.

Conceptual background

This chapter contends that design, as an organisational capability, or set of capabilities, may assist companies in in winning customers at distance. We first discuss this conceptualisation, before also considering how the interactions between design (capabilities) and R&D and marketing capabilities may also help firms win customers at distance.

Following Helfat et al. (2007, p. 1), "a capability, whether operational or dynamic, is the ability to perform a particular task or activity". Capabilities also include the ability to coordinate or integrate tasks (Helfat & Peteraf, 2003). Firms are understood to perform, coordinate and integrate different sets of activities, with different levels of accomplishment or proficiency. The set of capabilities and associated levels of minimal proficiency that a firm will need in order to survive in even a static market will vary with the specific role, or roles, that the firm is engaged in (e.g., different capabilities are required for manufacturing and retailing furniture). This variety in capabilities, coupled with the different resource inputs[148] required to accomplish the role, can be understood as what makes firms different, especially between industries or sectors. Firms within the same industry or sector also differ, however; and this variation is also explained by firm-specific differences in both their endowments of resources (quantity and quality) and their differential (cap)abilities to utilise, coordinate and integrate these resources in order to both operate efficiently and generate marketable goods and services. Firms which can "make a living" in a static or unchanging environment can be understood as having adequate "ordinary capabilities" (Winter, 2003).

Ordinary capabilities are not sufficient, however, in the context of changing or dynamic environments, including environments with changing consumer preferences, technologies and/or regulatory regimes. "To survive and prosper under conditions of change, firms must develop the 'dynamic capabilities' [that] create, extend, and modify the ways in which they make their living (Helfat, et al., 2007, p. 1)".

Firms can both pro-actively seek to change their environment, by for example introducing highly novel innovations, or they may respond to changes in their environment, such as by introducing innovations mirroring the trends. Either way, the

148 In this conceptualisation, resources are considered stocks, some of which can be acquired in markets, while capabilities include the ability to utilise these resources effectively (Amit & Schoemaker, 1993).

concept of dynamic capability includes the capacity with which to identify the need or opportunity for change, formulate a response to such a need or opportunity, and implement a course of action (Helfat, et al., 2007, p. 2), such as new product development. Elsewhere, Teece (2007, p. 1319) argues that "dynamic capabilities can be disaggregated into three capacities: (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets".

In an alternative conceptualisation, Eisenhardt and Martin (2000, p. 1105) identify dynamic capabilities as certain processes or abilities, such as new product development, strategizing and alliancing that provide the firm with the ability to manipulate resources into value-creating strategies and therefore enable the firm to take advantage of changing environments.

A debate exists concerning the scope and content of dynamic capabilities (Barreto, 2009), with some arguing there are incompatibilities between the Eisenhardt and Martin (2000) view and the Teece (2007) view. Both of these views recognise the ability to innovate – that is the ability to introduce new and significantly changed products and processes – is likely to be based on dynamic capabilities, or a sub-set of these. Indeed, several authors have argued for the identification of innovation capabilities as a sub-set of dynamic capabilities which are particularly associated with the development and introduction of new products, processes and services (e.g., Lawson & Samson, 2001; Guan & Ma, 2003; Wang & Ahmed, 2007). For the purpose of this paper, we adopt the conceptualisation of innovation capabilities as a sub-set of dynamic capabilities (Lawson & Samson, 2001; Guan & Ma, 2003; Wang & Ahmed, 2007)

Innovation capabilities are here understood to be abilities that go beyond operational, day-to-day "earning a living" "ordinary capabilities" (Winter, 2003) in the sense that, for most firms, developing innovations is not an everyday activity.[149] Furthermore, as capabilities are capacities, they may exist but not be utilised, such that the possession of innovation capabilities need not result in the introduction of innovations.

149 We recognise that this is not always or necessarily the case. Where firms "make their living" from innovation, capabilities oriented to developing innovations should be considered "ordinary" or "everyday" (Helfat & Winter, 2011). Such firms include R&D enterprises and innovation consultancies. However, these are exceptional, and for the majority of firms it makes sense to separate, at least conceptually, their ordinary and innovation capabilities.

A standard measure of innovation is the introduction of "a new or improved product or process (or combination thereof) that differs significantly from the [firm's] previous products or processes..." (OECD and Eurostat, 2018, p. 20). This conceptualisation implies a novelty threshold below which products or processes can be changed, but not sufficiently to quality as innovations (see OECD and Eurostat, 2018, p. 78-80 for a discussion of these changes); for example, "3.67. Product introductions that only involve minor aesthetic changes, such as a change in colour or a minor change in shape, do not meet the requirement for a 'significant difference' and are therefore not product innovations." (OECD and Eurostat, 2018, p. 79).

Implementing changes to existing products and/or processes is presumably purposeful, meaning intended to have some effect. It implies abilities beyond maintaining the production of existing products; that is operational capabilities. Conceptually we distinguish these abilities to implement minor changes as "tweaking capabilities": that is, the capacity to purposefully slightly modify or alter products. "Tweaking capabilities" might, for example, be used to detect and respond to minor differences in customer preferences or fashions. While firms with "tweaking capabilities" may not be able to introduce new or significantly improved products or processes, it is likely that firms with higher-order "innovation capabilities" will also have lower-order "tweaking capabilities".[150]

Design (and) capabilities

Design can be considered to contribute to both a firm's "tweaking capabilities" and to its "innovation capabilities".[151]

The role of design, and the effective management of design, has been recognised as having the potential to contribute to corporate success since at least the 1980s, when Kotler and Rath (1984) identified design as a "powerful but neglected strategic tool", and Christopher Lorenz advocated design as "the new competitive weapon for strategy and global marketing" (Lorenz, 1986). Design, and design management in this mode, need not be directly related to innovation – i.e. the development and introduction of new and significantly improved products or processes; it may instead

150 Conceptually, "tweaking capabilities" therefore sit above "ordinary capabilities", which Winter (2003, p. 992) described as the capabilities exercised in the stationary process of the firm keeping "earning its living by producing and selling the same product, on the same scale and to the same customer population over time", but below "innovation capabilities" which enable the firm to introduce new or significantly changed products and/or processes.
151 To the extent that a firm's operational "ordinary capabilities" are based past design decisions, design has also contributed to these. However, as our focus is on current rather than past design investments we do not consider "ordinary capabilities" here.

be used to refresh products, perhaps postponing the need for innovations; it can be used to alter products to appeal to new or additional market segments, for example in relation to usability, or implementing minor changes in appearance (e.g., form-colour combinations); it can be used in conjunction with marketing to build an image of the firm, especially through branding (Cooper & Press, 1995). As none of these activities necessarily relates to innovation, we can consider them “tweaking capabilities” involving design as a means of identifying the possibilities and opportunities for change, and implementing these changes; such capabilities are likely to be unevenly distributed among firms, including firms in the same sector.

Although an implicit connection between design and innovation has been recognised since at least Herbert Simon (1969), who declared “everyone designs who devises course of action aimed at changing existing situations into preferred ones”, it is in the last thirty years or so that the explicit connection between design and innovation has been increasingly recognised (Walsh, et al., 1992; Bruce & Bessant, 2002; Von Stamm, 2003; Utterback, et al., 2006). This conceptualisation implies that design as an activity (or set of activities) contributes to the capacity to engage in innovation, or at least certain types of innovation. In this view, design-innovation capabilities can be considered a sub-component of a wider set of innovation capabilities.

There are at least three types of innovation in which the application of design capabilities play a leading role.[152] The first are “design-invention innovations”, which can be considered to involve the inventive use of ideas for form and function, coupled with established rather than new technologies, to produce novel products (and possibly processes) with outstandingly novel characteristics.[153] These are innovations in product form, and to some extent function; they involve the designer reconceptualising the product and are typically outcomes of the designers' imagination, rather than responses to marketing briefs. We can also conceptually distinguish these “design-invention innovations” from two other types of innovation in which design plays a leading role.

A second type of innovation in which design capabilities play a leading role is “user-centred (design) innovations” and especially those identified and subsequently

[152] In this section, we primarily consider design in relation to product innovations, and to a lesser extent process innovations. It should be appreciated that design can also apply to other forms of innovation, such as business model innovation, and marketing innovation. For reasons of brevity, we do not address these here.
[153] Examples here would include Marcel Breuer's tubular steel chairs, George Carwardine's Anglepoise lamps, James Dyson's Ballbarrow and Robert Law's “Trunki”, a ride on suitcase for children.

developed through user-centred design methods or “design thinking” (Brown, 2008). While “design thinking “has become increasingly prominent in recent years, it has essentially existed for at least fifty years (Dreyfuss, 1955; 1960) and relates to thinking about and addressing the user experience through ergonomics and human factors. This approach to designing (and new product development) starts with users and seeking to understand their needs, which are often latent – that is, not explicitly recognised and articulated by users, or potential users. Design research, which here includes observing users “in the wild”, typically uses ethnography and empathic research methods (Button, 2000; Leonard & Rayport, 1997). This research is used to gather insight and identify or uncover users’ (hidden) needs. The aim is to develop something that is “desirable” to the targeted user group, which, if successful, will typically result in a new or significantly improved product. As well as identifying “desirable” products or solutions, “design thinking” also involves ensuring new products are technically “feasible” and “viable” from the producer’s typically profit motivated perspective (Brown, 2008).

A third perspective on how design relates to innovation has been developed by Roberto Verganti and colleagues. This perspective argues that designing is closely connected to the communication of meanings, rather than enhancing product functionality. “Design-driven innovations” are therefore about innovating the reason why and the purpose for which people buy things (Verganti & Dell'Era, 2014, p. 142). While accepting that meanings cannot be imposed on buyers, or users, Verganti and colleagues argue: “firms can [intentionally] design several elements to encounter and stimulate meaningful interpretations by users; from product functionality to its design language (that is the set of signs, symbols and icons associated with a product – of which style is just one instance – that includes materials, sensory features such as sound, the user interface, etc.)”. They argue that more radical innovations in meaning can be achieved by “design-driven innovation”, which is “pushed by a firm’s vision about possible breakthrough meanings that people could love” (Verganti & Dell'Era, 2014, pp. 145-6). In other words, based on design-based research, insight and/or instinct, the firm conjectures that people will want and buy the products not because of their functionality, but rather because they have new meanings which resonate with them. Thus products are essentially a vehicle through which firms can express meanings which users literally buy-into.

Verganti and colleagues argue that the proposing of new meanings originates from processes including listening, engaging with “interpreters”, and understanding socio-cultural change (e.g. the changing reasons why people buy things) as well as understanding the technological opportunity space. Within these processes, designers, as a group of people, act (inter alia) as interpreters:

> Designers can support companies in the identification and interpretation of how people give meaning to things, and, most of all (which makes them different than anthropologists and sociologists), they can *envision* [emphasis in original] new possible meanings, new experiences that do not exist, mostly because their understanding of technology; their ability to investigate user needs and the evolution of socio-cultural models can support the scenario-building activities and consequently the development of radical innovation in product meaning (Verganti & Dell'Era, 2014, pp. 153-4).

The purpose of the above discussion is to illustrate means by which design can contribute, both as "tweaking capability", associated with minor changes to products and the product portfolio, and to a higher level "innovation capability". Both of these can then be connected to three central capacities identified by Teece (2007): (1) sensing and shaping, (2) seizing and (3) maintaining by enhancing, combining and/or protecting.

Our aim in presenting this table is to illustrate ways in which design can contribute (significantly) to each of the three capabilities which Teece identified as constituting to dynamic capabilities. The table should not be read as implying that design necessarily results in these outcomes, or that design alone can achieve these outcomes: other capabilities such as R&D and marketing may also be required, as well as other investments such as training and acquiring new equipment.

Table 59 How design can contribute to dynamic capabilities

	Non-innovation related design (Design as contributing to a **"tweaking capability"**)	**Design oriented to innovation** (Design as contributing to an **innovation capability**)
Sensing (and shaping) opportunities and threats	Sensing and detecting minor differences in user wants or needs, sufficient to warrant purposeful product alterations. Also detecting the lack of appetite for such changes is important.	Sensing opportunities for new and/or improved products and processes, and/or new meanings, through user-centred research and/or design-driven interpretation activities
Seizing opportunities	Includes introducing minor changes to products, insufficient to be considered innovations (e.g., refresh). Stretching brands.	Designing, developing and marketing new or improved products and processes, with new or changed functions and/or meanings*
Enhancing, combining, protecting, and, when necessary, reconfiguring the business	Design used primarily as a defensive ability; e.g., managing to stay relevant without needing to change fundamentally	Protection of new products and processes through IP rights and complementary assets. Possible reconfiguration of business to align with new meanings (e.g., "sustainable")

* e.g., designing and developing innovative products and/or processes that are (claimed to be) "clean", "green", "ethical", "responsible", etc.

Thus, design can contribute to "tweaking capabilities" by detecting differences in users' tastes, preferences, needs and wants; to address these in product variations; and help to defend a firm's position in product markets, including by enabling it to stay relevant without the need for more substantial innovations. This ability may be sufficient for firms to compete against more innovative firms. This does not mean that such firms should not invest in developing innovation capabilities, because the scope for maintaining competitiveness by only tweaking existing products and processes will ultimately be limited (Winter, 2003).

Design for discovering opportunities for product and/or process innovation can take the form of user centred design research and interpretation activities with respect to both functions and meaning. Through these sensing activities, knowledge generated by design activities can enable firms to grasp the opportunities for innovation, in product functions, meanings and both (Noble & Kumar, 2010; Aaker, 1997). Design can also contribute to protecting innovative products and processes through knowledge of the appropriate use of Intellectual Property Rights, secrecy practices and the development of complementary assets such as branding; it can also possibly lead to a reconfiguration of the businesses to align with new meanings.

Design and winning customers at distance

Having outlined channels through which design can be considered to contribute to both "tweaking" and "innovation" capabilities, we now address the question why design might be expected to be associated with winning customers at greater distance, and possibly in greater sales volumes.

In the reasoning which follows, we continue to distinguish between design as a "tweaking capability" and as an "innovation capability". Partially for brevity, but also because as our evidence base does not permit such a granular analysis, we will often not distinguish the orientation of design activities (e.g., as user-centred or as interpreting/meaning oriented). A more granular conceptual and empirical analysis would be desirable in future research.

While it is possible that users' tastes and needs are universal and homogenous globally, such that a product introduced in one place will be equally attractive world-wide, such situations are rare. Indeed, even "global products" such as Coca-Cola are often slightly altered, in Coca-Cola's case because people in different parts of the world "perceive taste in very different ways"[154].

From the outset, we make two fundamental assumptions.

First, that customer preferences (needs, tastes, etc.) vary over geographical (and other, e.g. cultural) space and generally become more different, and thus differentiated, with increasing distance (Siqueira, et al., 2015; Ellis, 2007; Ghemawat, 2001).

Second that the challenge of understanding and addressing preferences increases with geographical and related distances, such as cultural distance (Sidhu, et al., 2007; Katila & Ahuja, 2002; Levinthal & March, 1993; Nachum, et al., 2008). This second assumption is underpinned by the concepts of opportunities, alertness and search.

It is widely accepted that knowledge, as opposed to information, is "sticky" to locations (von Hippel, 1994; 1998). In 1890 Marshall observed that within geographically bounded industrial districts "the mysteries of [a] trade become no mysteries; but are, as it were, in the air, and children learn many of them unconsciously. Good work is rightly appreciated [and] inventions and improvements in machinery… have their merits promptly discussed" (Marshall, 1890, p. 226). Here, Marshall highlights the

[154] https://www.coca-cola.co.uk/our-business/faqs/does-coca-cola-taste-different-in-different-countries

importance of tacit knowledge, which builds and develops through unconscious learning, and the circulation of ideas within the community of practice (Lave & Wenger, 1991) or social networks. In such a context, entrepreneurs can be alert to, or “tune-in” to, opportunities to introduce novelties, without necessarily engaging in deliberate search activities. They observe, listen, and often subconsciously decide what information to give heed to and what to ignore. To act on opportunities is to conjecture that this combination of intuition and judgement is correct.

With increasing distance, these advantages fall away. Direct observation and listening become difficult, even impossible without deliberate actions; the entrepreneur may not be a member of the community of practice and/or social network, and perhaps deliberately excluded: they may literally speak another language. The entrepreneur is therefore likely to be starved of information that is much more easily accessible within the locality (Cohen & Levinthal, 1990; Helfat, 1994; Martin & Mitchell, 1998; Stuart & Podolny, 1996); meanwhile relying on homogenous knowledge can generate organisational rigidity, and the returns to local search can decrease from some point (Katila & Ahuja, 2002); consequently, unless they can extend beyond local search, firms can become incapable of innovating and may ultimately be unable to adapt to changing or different environments (Levinthal & March, 1993). Also challenging is knowing what non-proximate information to pay attention to and what to ignore. Geographic distance increases the variety of information and knowledge encountered, and thus the complexity of integrating and managing knowledge (Grant, 1996) as well as the uncertainty of responding appropriately to new information (Heiner, 1986). This is not to say that these challenges of extending beyond local search cannot be overcome, but they require deliberate processes, including deliberate search and exploration.

Mechanisms to overcome the constraints of local search include forming alliances, and employing people in roles related to accessing and transferring external knowledge (Rosenkopf & Almeida, 2003; Mowery, et al., 1996; Wagner, et al., 2014; Capron, et al., 1998). We propose that design (including by employing designers) also provides a mechanism to overcome the constraints of local search.

As a “tweaking capability”, design is expected to sense and detect changes in user needs or wants related to minor changes in existing products, or the lack of appetite for such novelties. A product originally designed to be used in one country or in one community can be “tweaked” to make it more attractive to, or suitable for, users in another country or community. Exercising this capability includes absorbing and interpreting the relevant market knowledge sensitively and incorporating it into product alterations (e.g. the relative positions of the goods or services and their developers (i.e. brands) as compared to their (relatable) competitors) (Amaldoss & Jain, 2008).

This "tweaking" maybe functional (larger, smaller, etc.), but interpretation through design capability can and should also be sensitive to cultural differences across geographical space and distance (Moon, et al., 2013). Meanings are specific to socio-cultural contexts (Verganti & Dell'Era, 2014; Thompson, et al., 1994). Design practices can be used to recognise, interpret and address the cultural difference of meanings (Desmet & Hekkert, 2007). Neither this process nor the outcome is necessarily innovative, but the designed (adjusted) meanings should be more appropriate and aligned to the target customers. Further, the meanings customers assign to the products and brands could help developers achieve a desired position in the distant market (Friedmann & Lessig, 1987).

Meanwhile, this suggests design as a "tweaking capability" also signifies firms' capability to enhance and protect its assets, especially intangibles (e.g. product or brand image), in a different cultural setting. Moreover, research shows design helps firms to combine and integrate different product/service lines, functions, resources, actors of a value chain or environmental elements when necessary (Veryzer & Borja de Mozota, 2005; Liker, et al., 1999; Nambisan, 2002; Baldwin & Clark, 2000; Dangelico, et al., 2013) – again without necessarily engaging in innovation. This implies that designing, even as a non-innovative capability, may still contribute to businesses' capacity to adapt to changing operating, competitive and/or regulatory environments. In other words, design can enable (potentially with other capabilities and resources) companies to stay relevant without innovation, even in distant markets.

Design as a "cognitive and creative" ability and capacity (Teece, 2007, p. 1323) to understand users'/consumers' thinking and behaviours, as well as a creative activity per se, is embedded in a company's capability to discover and create opportunities (Teece, 2007; Nonaka & Toyama, 2007). It helps "define the manner by which the enterprise delivers value to customers, entices customers to pay for value and converts those payments to profit" (Teece, 2007, p. 1329).

Connecting to potential customers distributed over increasingly distant geographical space implies engaging with increased heterogeneity among customers. Even if customers have absolutely identical functional needs and ascribe absolutely identical meanings to products, the regulatory environment in which the product is being sold may differ (e.g. different environmental standards).[155] Understanding these difference requires deliberate learning, for which design can be effective.

Of course the functional and/or meaning-related needs of distant customers may not be able to be satisfied by the tweaking of existing products. Innovative products may be required to attract these customers. Furthermore, the firm might develop innovations that from the outset are intended to be attractive to a dispersed customer base (rather than a localised one). Both of these activities requires deliberate learning about the characteristics of these dispersed (potential) customers and the extent to which they differ from local customers, which can be addressed by undertaking activities including design.

There is evidence showing that design can be positively associated with firms' internationalisation (Aschhoff, et al., 2013; Ciriaci, 2011; Cereda, et al., 2005) including exporting (Danish Design Centre, 2003; Nassimbeni, 2001; Gemser & Leenders, 2001; MacPherson, 2000; Sterlacchini, 1999). Given that internationalisation (exporting) indicates firms reaching distant geographical markets, the positive relationship is likely to also be applicable as well to intra-national trade, which likewise can be viewed as reaching a distant market beyond the region where a firm is located, albeit to a less extent than selling to other countries.

In summary, we consider that design has the potential to assist businesses in overcoming constraints of localisation, as both a "tweaking capability" and an innovation capability, and that inputting more into design may therefore enhance the firm's ability to win customers at distance.

Hence, we propose that:

H1 Commitment to design is positively associated with (a) the geographical reach of product innovators, and (b) their sales in the geographically distant market.

Interactions between design and R&D

Research and development is the activity that is widely considered to underpin technological innovations. Research adds to the stock of knowledge (and especially scientific and technological knowledge), while experimental development derives new

[155] Another difference could be the intellectual property regime. The firm may need to design and develop complementary assets appropriate to a different context, particularly if IP rights are weaker or less enforceable.

application from new and existing (scientific and technological) knowledge. The majority of R&D undertaken by firms takes the form of experimental development.

In relation to winning customers at distance, it is not difficult to see that investments in R&D can result in the development of unique products for which there may, at least for a time, be no direct competitors. Any user which desires this specific product has no other option but to obtain it from the originator.

In less extreme circumstances we can also see that R&D can substitute for design as a mechanism for the development of innovations that dispersed users find attractive. R&D may for example engage in user-centred research (without explicitly using "design" or "design-methods") and use this knowledge to devise functionally superior products. R&D might be cleverly deployed to take account of heterogeneity among potential users, and therefore devise products which have a more universal appeal. It may not therefore be necessary to explicitly engage in design to develop products that appeal to distant customers.

This said, there are good reasons for thinking that R&D and design are likely to provide complementary inputs to innovation, which when combined, are more likely to result in appealing products than if design is excluded. In particular, design's role in communicating or "translating" unfamiliar technologies to users is recognised (Hargadon & Douglas, 2001; Eisenman, 2013), as is its contribution to adjusting the functionality to the needs of different users of user groups (Rothwell & Gardiner, 1983). More fundamentally, R&D is typically detached from the socio-cultural meanings of products, and without that input – from design or elsewhere – even technologically advanced products can flop.[156]

Overall, therefore, we consider that greater commitment to R&D is likely to indicate greater importance of design to enhance the firm's ability to win more distant customers.[157] Hence, it is hypothesised that

H2 Greater commitment to R&D has a positive impact on the relationship between design commitment and (a) the geographical reach of product innovators, and (b) their sales in the geographically distant market.

---

[156] As an example, the Segway human transporter.

[157] There may also be a degree of reverse causation here. By making products which have greater appeal, including appeal to more distant markets, the firm expands its customer base, which may make innovation products viable, because the (largely fixed) cost of R&D and other inputs is then spread over a larger volume of outputs.

Interactions between design and marketing

Arguments made in relation to R&D can also be made in relation to marketing. That is marketing can possibly substitute for design, or be complementary with design, in helping firms reach more distant markets.

As a substitute for design, and especially explicit design, marketing activities can include market research oriented to understanding the extent of demand, willingness to pay, sensitivity of product features to socio-cultural differences, and other factors. Market research typically involves more quantitative approaches, rather than the empathic methods of design, but it is also possible that user-focused design-research is subsumed into marketing. Marketing is also associated with raising awareness among potential buyers by drawing attention to the product through advertising and other means. It is certainly possible that such promotional activity will have some success, even if products are neither developed for, nor tweaked for, specific users groups in more distant locations. Hence, like R&D, it is certainly possible for firms to win distant customers by participating in marketing activities and without participating (explicitly) in design.

On the other hand, there are good reasons for considering that marketing and design can complement one another in helping the firm to win customers in more distant markets. Marketing contributes information and knowledge that is not normally within the remit of design, such as understanding market segments, and sensitivity of demand to pricing which sets the context for new product developments. Design then contributes by (1) understanding more specifically what it is that users want, both in relation to functions and meanings; and (2) converting this knowledge into “real products” with specific features. It is these “products” that are sold to consumers. Marketing steps back in through promotional activities, such as advertising that design may support, but which is not generally a design activity. Similarly marketing may develop a brand, supported by design, involving a portfolio of products intended to appeal to different segments of the market.

Overall, while it is certainly possible for firms to gain buyers at distance by utilising neither marketing nor design, given the nature of these activities it seems likely that utilising them will enhance the chances of appealing to distant buyers and, moreover, because these two activities bring complementary and mutually enhancing advantages, it seems likely that greater commitment to both will be especially advantageous. Hence, we hypotheses that:

H3 Greater commitment to marketing has a positive impact on the relationship between design commitment and (a) the geographical reach of product innovators and (b) their sales in the geographically distant market.

Methods

Data

The analysis draws on cross-sectional data from the UK Innovation Survey of 2017. The UK Innovation Survey (UKIS) is UK's version of the Community Innovation Surveys (CIS), which have been undertaken in European Union countries since 1992. These surveys are based on the OECD/European Commission "Oslo Manual" guidelines on the collection and interpretation of innovation data, four editions of which have been published (OECD and Eurostat, 1992; 1997; 2005; 2018).

The UK's versions of the CIS have departed from the Oslo Manual's guidelines in some aspects, and in particular in relation to design. Rather than asking about "other preparations" in relation to innovation investments, the UKIS has asked about "all forms of design". Prior to the 2011 survey, respondents were asked to exclude from design "design activities in the R&D phase of product development"; since UKIS 2011 respondents have not been asked to deduct design activities undertaken within R&D. This means that part of design is no longer hidden within R&D, although there is potentially some double counting.

The UKIS is now conducted every other year by the UK's statistical authority – the Office for National Statistics (ONS). It investigates innovation of UK businesses over the previous 3-year time period. For UKIS 2017, the respondents were asked about their innovation activities for the period from 1st January 2014 to 31st December 2016.

This study adopts the 2017 version of the survey as it is the most recent by the time the study is conducted. The UKIS is chosen as opposed to other surveys given that it explicitly requests for design data among a range of innovation activities and the total value of exports; the large sample also helps generate a robust analysis.

The UKIS is a voluntary survey, and the 2017 version was conducted mainly through an internet hosted questionnaire. 30,479 companies with at least 10 employees were invited to respond, and 13,194 (43%) provided usable responses. Since the recorded design is very low among non-product-innovators (i.e. 10% of non-product-innovators c.f. 32% product innovators employ the skills of object/service design; 6% of non-product-innovators cf. 35% innovators invest in design), the current study focuses on product innovators (i.e. those that introduced new or significantly improved goods or services during the previous 3 years), which had developed the innovative goods or services by themselves, or with other businesses or organisations. We exclude those that said their innovations were primarily developed by others. We also exclude businesses based in Northern Ireland because of the relative ease with which they can "export" across the land border to Ireland. We also excluded firms providing incomplete or inconsistent data[158].The analysed sample consists of 2,828 firms with a single observation from each.

Measures

Dependent variables

The analysis involves two dependent variables, the first of which measures "geographical reach".

The UKIS 2017 asks about the geographical markets where the business sold goods/services during the previous 3-years, which, from nearest to furthest, are "UK regional (within approximately 100 miles of this business)", "UK national", "European countries", and "all other countries". The respondents were asked to select all of the markets that applied, among which we selected the most distant as the dependent variables.

The other dependent variable is the (log transformed) estimate of total value of the business' exports in 2016.

Independent variables

Innovation related expenditures: The questionnaire requests the amount invested in each of the seven types of activities, "for the purpose of current or future innovation", which, in 2016 were: (a) internal R&D; (b) acquisition of R&D; (c) acquisition of advanced machinery, equipment and software; (d) acquisition of existing knowledge; (e) training; (f) all forms of design; and (g) market introduction of innovations.

Firms were also asked to indicate if they employed individuals in-house with the skills of designing objects or services, or acquired the skills form external sources, during the 3 years.

The analysis involves four independent variables:

[158] The current study only considers exporting as the approach of serving foreign customers.

(Natural logarithm of) design investment[159]: this measures the extent of commitment to design.

Design skills, which is available as a dichotomous variable indicating whether or not the firm employed individuals with the design skills in-house or acquired form external sources. This is an alternative measure of design commitment.

(Natural logarithm of) R&D investment, which is the sum of investments in internal and acquired R&D. This variable measures the extent of R&D commitment.

(Natural logarithm of) marketing investment, which is the investment in “market introduction of innovations”. This variable measures the extent of marketing commitment.

Control variables

A set of variables that may confound the relationship of interest is included in the analysis.

Breadth of innovative investments counts the number of investments in innovation activities that a company made other than design, R&D and marketing. This variable ranges from 0 to 3 (integers only); a higher score indicates broader innovative investments. The motivation for including this variable as a control is that when resources are finite, a firm’s commitment to one activity may depend on how many other activities it has also chosen to engage in. Given that some resources are fungible, firms may make certain investments to reconcile their needs; on the other hand, some resources are complementary, and thus companies may have broader innovative investments for the purpose of complementing focal innovation activities (Piening & Salge, 2015).

Apart from the strategic variables above, several structural variables are also controlled for.

Firm size, measured by natural logarithm of number of employees (Zahra, et al., 2000), indicates the extent of resources, is commonly considered as a factor that

[159] A negligible 0.001 is added to design investment and R&D investment before taking the logarithm to cover those firms without the corresponding investments. 0.001 is also added to exports before taking logarithm in order to distinguish those whose exports will become zero after log transformation if without adding the 0.001 from the unobserved exports of non-exporters.

influences companies' innovation (Camisón-Zornoza, et al., 2004) and exporting (Bernard, et al., 2012).

New firm, which identifies firms that were established during the past three years, is a dichotomous variable identifying very young firms (Coad, et al., 2016).

Subsidiary is a dichotomous variable, which is included because parent or sister companies may be able to provide resources or other types of support to subsidiaries which might affect its capability to serve more distant customers.

Industry dummies are included based on the Standard Industrial Classification (SIC) divisions.[160]

Regional dummies identifying the Standard Regions of Great Britain are also included as access to more distant markets may vary somewhat by region (Rosenkopf & Almeida, 2003; Jaffe, et al., 1993).

Analytical strategy

The analysis will be based on product innovators which in developed innovative products and which were based in Great Britain. Descriptive statistics will be reported before we enter into the tests of hypotheses.

The hypotheses with respect to furthest markets will be tested using Multinomial Logistic Regressions. Furthest market is a variable which consists of four ordered categories. Thus we initially sought to apply Ordered Logistic Regression and tested the assumption of "proportional odds". As this assumption was found not to hold and we therefore used Multinomial Logistic regression as an alternative method.

The estimation will begin with testing design investment and design skills in parallel, in two independent regressions, each of which has the full set of controls included. Afterwards, R&D and marketing investments and their interactions with design investment will be added to the regression of design investment.

In order to examine the hypotheses on the value of exports, a Heckman (1979) two-step approach will be adopted. With respect to exporting, the questionnaire requests estimation of total value of exports for 2016. This figure is not observed for those which did not export in that year. Therefore, many missing values of the dependent

[160] Due to their small number of observations, firms belonging the Industry Divisions B (mining) D (energy utilities) and E (water utilities) have been combined into a single category.

variable are not randomly missing,[161] but are rather a function of underlying factors. As the sample (which consists of self-reported exporters) is not randomly selected from the population, estimations based on this sample could be biased. In order to correct any such selection bias, a Heckman two-step procedure will be followed (Tavassoli, 2015; Piening & Salge, 2015; Spithoven & Teirlinck, 2015).

The first step is a "selection equation", which draws on the whole sample including both exporters and non-exporters. This equation will estimate whether or not firms export, a binary outcome variable, using a Probit model. In this step, a variable – the inverse Mill's ratio (lambda) - will be generated, which, if significantly different from, zero, indicates a selection bias; and, as a result, this variable will be added to the "outcome equation" in next step to accommodate the non-randomness of the sample. Step two estimates the (natural logarithm of) value of exports using linear regression, conditional on the firm having exports.

Regarding the independent variables, this two-step approach will also start with design investment and design skills in parallel, both with the full set of controls included. Afterwards, the same procedure will be repeated by adding R&D investment, marketing investment, and the interactions between these and design investment.

The Heckman two-stage procedure advises to include at least one variable in the selection equation which is omitted from the outcome equation (Puhani, 2000). This variable should also have a significant impact on the selection – in our case engaging in exporting, but not on the outcome equation – in our case the value of exports.

We identified such a variable by considering which types of firms might be less likely to export and related this to firms' motivation for innovating. Specifically, the UKIS 2017 asks respondents to rate the importance of 12 factors which could influence their decisions to engage in innovation activities. There are three factors relate to compliance (i.e., "improving health and safety", "reducing environmental impacts" and "meeting regulatory requirements (including standards)"). Meanwhile, another three related to expanding the business (i.e. "increasing range of goods or services", "entering new markets" and "increasing market share"). The two groups of reasons relate to different motivations[162], and we used the responses to these questions to identify those firms that were strongly motivated to introduce innovations for reasons

[161] More than 90% of the business in Great Britain were estimated not engaged in exporting in 2016 (Office for National Statistics, 2019).
[162] Which is confirmed by factor analysis.

of compliance but not to expand the business. Such compliance oriented innovators do not appear to be motivated to use innovation to expand their business, including through exporting and are therefore less likely to export. However, among those that have this orientation and which export it is not clear that this would have a negative impact on the value of their exports. Therefore, we include this variable in the selection equations as an “exclusion restriction” in the Heckman approach. It will be also included as a control in the Multinomial Logistic Regressions related to “furthest market”.

Results

Descriptive statistics

In our sample of product innovators, half were exporters, which, on average, achieved 30% of their total sales from exports. Three-quarters (76%) of the exporters served customers further than Europe; these “Rest of the World” exporters typically generated 36% of total sales by exporting, which substantially higher than that achieved by firms exporting only to Europe.

Of the product innovators, 33% employed the skills of object/service design. The share of firms with design skills is greater among those which reached a more distant market. 35% of the product innovators invested (explicitly) in design. The percentage of design investors is higher among exporters, but does not differ substantially between those whose furthest market was the EU as opposed to the Rest of the World. Nor does participation in design vary significantly between those whose furthest market was UK regional or the “rest of the UK”. This implies that design participation differs between exporters and non-exporters and not by “furthest market”. However, the value of design investments does tend to increase with the geographic distance of the firms’ furthest market. This said, spending on design is typically modest and is concentrated in a minority of businesses, with 90% of product innovators spending no more than £50k on design (this includes the 65% not spending on design). Even though, it is higher than the typical amount of spending on marketing (i.e. “market introduction of innovations”), which is also more concentrated, with 90% of product innovators investing £15k or less on marketing (which includes the 81% not spending on marketing).

Table 60 Strategic variables by exporting status (N=2828)

		Non-exporter	Exporter	Total
Design skills	No	61%	39%	67%
	Yes	31%	69%	33%
Design	No	71%	58%	65%
	Yes	29%	42%	35%
R&D	No	54%	21%	37%
	Yes	46%	79%	63%
Marketing	No	85%	76%	81%
	Yes	15%	24%	19%
Design investment (£k)	Mean	45.0	320.1	181.8
	SD	488.5	6218.9	4400.8
	25 percentile	0	0	0
	50 percentile	0	0	0
	75 percentile	0	20	5
	90 percentile	20	100	50
	Valid obs.	92%	95%	94%
R&D investment (£k)	Mean	288.2	1543.8	907.2
	SD	3561.0	13838.0	10059.2
	25 percentile	0	7	0
	50 percentile	0	100	16
	75 percentile	35	500	207
	90 percentile	240	1758	1000
	Valid obs.	91%	91%	91%
Marketing investment (£k)	Mean	7.5	36.8	22.0
	SD	71.1	210.8	157.4
	25 percentile	0	0	0
	50 percentile	0	0	0
	75 percentile	0	0	0
	90 percentile	2	45	15
	Valid obs.	95%	97%	96%
Breadth of innovative investments	0	28%	26%	27%
	1	42%	39%	41%
	2	24%	29%	27%
	3	5%	6%	5%
Exports/turnover	Mean	-	0.304	0.268
	SD	-	0.320	0.316
	Valid obs.	-	99.8%	56%

Table 61 Strategic variables by geographic markets (N=2828)

		Local	National	Europe	RoW	Total
Design skills	No	25%	36%	11%	29%	67%
	Yes	9%	23%	15%	53%	33%
Design	No	71%	71%	60%	58%	65%
	Yes	29%	29%	40%	42%	35%
R&D	No	64%	47%	26%	19%	37%
	Yes	36%	53%	74%	81%	63%
Marketing	No	85%	85%	81%	75%	81%
	Yes	15%	15%	19%	25%	19%
Design investment (£k)	Mean	50.7	41.4	35.7	415.2	181.8
	SD	519.8	468.4	128.2	7182.7	4400.8
	25 percentile	0	0	0	0	0
	50 percentile	0	0	0	0	0
	75 percentile	0	0	15	20	5
	90 percentile	15	25	79	133	50
	Valid obs.	92%	93%	95%	95%	94%
R&D investment (£k)	Mean	316.3	270.5	884.7	1769.1	907.2
	SD	5213.3	1896.9	5885.3	15652.4	10059.2
	25 percentile	0	0	0	12	0
	50 percentile	0	0	50	149	16
	75 percentile	3	81	250	639	207
	90 percentile	53	394	803	2014	1000
	Valid obs.	91%	90%	93%	91%	91%
Marketing investment (£k)	Mean	7.7	7.4	8.0	46.5	22.0
	SD	96.5	49.5	34.4	242.3	157.4
	25 percentile	0	0	0	0	0
	50 percentile	0	0	0	0	0
	75 percentile	0	0	0	0	0
	90 percentile	0	5	12	50	15
	Valid obs.	94%	96%	97%	97%	96%
Breadth of innovative investments	0	28%	28%	24%	27%	27%
	1	45%	41%	42%	38%	41%
	2	22%	26%	29%	29%	27%
	3	5%	5%	6%	6%	5%
Exports/turnover	Mean	-	-	0.146	0.358	0.268
	SD	-	-	0.248	0.323	0.316
	Valid obs.	-	-	100%	99.7%	56%

Product innovators serving different geographic markets also appear to vary with business structural characteristics (Table 62 and Table 63).

Larger firms, older firms, subsidiaries and goods innovators are more likely to export than their counterparts, especially to the rest of the world. With regard to industrial sectors, manufacturing, “information and communication” and “professional, scientific and technical services” show greater possibilities to export, also especially to the rest of the world; these sectors usually have more intensive R&D and design activities. Among the regions in Great Britain, West Midlands is generally the most prominent: businesses based in West Midlands and South East on average are more likely to export than not; and those based in North East, West Midlands, Easton, London, South East and Scotland are more likely to reach the rest of the world than the closer markets as their furthest market.

Table 62 Structural characteristics by exporting status (N=2828)

		Non-exporter	Exporter
Sizeband	10-49	58%	42%
	50-99	44%	56%
	100-249	43%	57%
	250+	49%	51%
Firm age	>3 years	49%	51%
	<=3 years	66%	34%
Ownership	Independent	62%	38%
	Subsidiary	42%	58%
Innovator	Goods-only	30%	70%
	Services-only	70%	30%
	Goods and services	46%	54%
SIC division	B/D/E – Mining, energy & water utilities	73%	27%
	C - Manufacturing	21%	79%
	F - Construction	88%	12%
	G - Wholesale and retail trade	55%	45%
	H - Transportation and storage	79%	21%
	I - Accommodation and food services	94%	6%
	J - Information and communication	40%	60%
	K - Financial and insurance activities	82%	18%
	L - Real estate activities	96%	4%
	M - Professional, scientific and technical	40%	60%
	N - Administrative and support services	79%	21%
Region	North East	50%	50%
	North West	52%	48%
	Yorkshire and The Humber	53%	47%
	East Midlands	53%	47%
	West Midlands	45%	55%
	Eastern	49%	51%
	London	50%	50%
	South East	47%	53%
	South West	54%	46%
	Wales	61%	39%
	Scotland	50%	50%
N		51%	49%

Table 63 Structural characteristics by geographic markets (N=2828)

		Local	National	Europe	RoW
Sizeband	10-49	26%	32%	12%	30%
	50-99	13%	31%	15%	41%
	100-249	16%	27%	11%	46%
	250+	15%	34%	11%	40%
Firm age	>3 years	18%	31%	13%	38%
	<=3 years	35%	31%	10%	24%
Ownership	Independent	30%	32%	12%	26%
	Subsidiary	11%	31%	13%	45%
Innovator	Goods-only	11%	19%	15%	55%
	Services-only	27%	42%	9%	21%
	Goods and services	17%	29%	14%	40%
SIC division	B/D/E – Mining, energy & water utilities	24%	49%	10%	16%
	C - Manufacturing	5%	16%	18%	62%
	F - Construction	33%	55%	2%	10%
	G - Wholesale and retail trades	24%	31%	15%	30%
	H - Transportation and storage	25%	54%	8%	13%
	I - Accommodation and food services	75%	19%	1%	5%
	J - Information and communication	6%	34%	18%	43%
	K - Financial and insurance activities	4%	78%	3%	16%
	L - Real estate activities	70%	26%	1%	3%
	M - Professional, scientific and technical	7%	32%	14%	46%
	N - Administrative and support services	37%	42%	8%	14%
Region	North East	20%	30%	12%	37%
	North West	14%	38%	14%	34%
	Yorkshire and The Humber	17%	36%	15%	32%
	East Midlands	18%	35%	16%	31%
	West Midlands	14%	31%	16%	39%
	Eastern	22%	28%	10%	41%
	London	23%	27%	12%	38%
	South East	20%	28%	13%	40%
	South West	22%	32%	12%	34%
	Wales	22%	39%	10%	29%
	Scotland	21%	28%	9%	42%
N		20%	31%	12%	37%

As suggested by the correlation matrix (Table 64)**Table 64 Correlation matrix** and contingency tables (Table 65), design, R&D, marketing and exporting are to some extents associated with each other. The association between design and R&D is stronger than that between design and marketing; among design, R&D and marketing, marketing has a relatively weaker association with exporting. Moreover, the value of exports has a relatively stronger correlation with firm size. Firm size is also correlated with the value of R&D investment but not with design or marketing investment.

Table 64 Correlation matrix

	Design investment	R&D investment	Marketing investment	Exports	Number of employees
Design investment	1.000				
R&D investment	0.305**	1.000			
Marketing investment	0.238**	0.225**	1.000		
Exports	0.103**	0.370**	0.069**	1.000	
Number of employees	0.017	0.198**	-0.010	0.514**	1.000

Note: Spearman’s correlation coefficient; **p<0.05. The minimums for investments in design, R&D and marketing as well as exports are zero.

Table 65 Contingency tables

		Design skills		Design		R&D		Marketing		
		No	Yes	No	Yes	No	Yes	No	Yes	Total
Design skills	No									67%
	Yes									33%
Design	No	49%	15%							65%
	Yes	18%	18%							35%
R&D	No	32%	6%	29%	8%					37%
	Yes	35%	27%	35%	27%					63%
Marketing	No	56%	25%	56%	25%	33%	48%			81%
	Yes	11%	9%	8%	11%	4%	15%			19%
Furthest market	Local	17%	3%	14%	6%	13%	7%	17%	3%	20%
	National	24%	8%	22%	9%	15%	17%	27%	5%	31%
	Europe	7%	5%	7%	5%	3%	9%	10%	2%	12%
	RoW	19%	18%	21%	16%	7%	30%	27%	9%	37%
Exporter	No	40%	10%	36%	15%	27%	24%	43%	8%	51%
	Yes	26%	23%	29%	21%	10%	39%	37%	12%	49%
Breadth of innovative investments	0	20%	8%	19%	8%	12%	15%	24%	4%	27%
	1	29%	11%	29%	11%	19%	22%	34%	6%	41%
	2	15%	12%	15%	12%	6%	21%	20%	7%	27%
	3	3%	3%	2%	4%	0%	5%	3%	2%	5%
New firm	No	59%	30%	57%	31%	33%	56%	72%	17%	89%
	Yes	8%	3%	7%	4%	5%	6%	9%	2%	11%
Subsidiary	No	31%	12%	28%	15%	18%	25%	35%	8%	43%
	Yes	35%	21%	36%	20%	19%	37%	45%	11%	57%
Innovator type	Goods only	18%	12%	18%	12%	9%	21%	23%	7%	30%
	Service only	33%	9%	31%	11%	22%	19%	36%	5%	41%
	Both	16%	12%	15%	13%	7%	22%	21%	7%	29%
Compliance-oriented	No	58%	31%	56%	32%	31%	57%	70%	18%	88%
	Yes	8%	4%	8%	4%	6%	6%	10%	2%	12%
Total		67%	33%	65%	35%	37%	63%	81%	19%	100%

		Furthest market				Exporter		Breadth of innovative investments				
		Local	National	Europe	RoW	No	Yes	0	1	2	3	Total
Exporter	No	20%	31%	-	-							51%
	Yes	-	-	12%	37%							49%
Breadth of innovative investments	0	5%	9%	3%	10%	14%	13%					27%
	1	9%	13%	5%	14%	22%	19%					41%
	2	4%	8%	4%	11%	12%	14%					27%
	3	1%	1%	1%	2%	2%	3%					5%
New firm	No	16%	28%	11%	34%	43%	45%	25%	36%	23%	4%	89%
	Yes	4%	4%	1%	3%	7%	4%	3%	4%	3%	1%	11%
Subsidiary	No	13%	14%	5%	11%	27%	17%	11%	19%	11%	2%	43%
	Yes	6%	18%	7%	25%	24%	33%	17%	22%	15%	3%	57%
Innovator type	Goods only	3%	6%	4%	17%	9%	21%	10%	12%	7%	1%	30%
	Service only	11%	17%	4%	9%	29%	13%	11%	19%	10%	1%	41%
	Both	5%	8%	4%	11%	13%	15%	6%	10%	10%	3%	29%
Compliance-oriented	No	16%	27%	12%	34%	42%	46%	24%	35%	24%	5%	88%
	Yes	3%	4%	1%	3%	8%	4%	3%	5%	3%	1%	12%
Total		20%	31%	12%	37%	51%	49%	27%	41%	27%	5%	100%

		New firm		Subsidiary		Innovator type			Compliance-oriented		
		No	Yes	No	Yes	Goods only	Service only	Both	No	Yes	Total
Subsidiary	No	37%	7%								43%
	Yes	52%	4%								57%
Innovator type	Goods only	28%	2%	10%	20%						30%
	Service only	36%	5%	20%	21%						41%
	Both	25%	4%	14%	15%						29%
Compliance -oriented	No	79%	9%	38%	50%	27%	35%	26%			88%
	Yes	10%	2%	6%	6%	3%	6%	3%			12%
Total		89%	11%	43%	57%	30%	41%	29%	88%	12%	100%

Note: N=2828 (except for “compliance oriented”, where N=2756); industrial division and region are omitted for brevity.

Regressions

Table 66 and Table 67 present the results of the Multinomial Logistic Regressions on geographic markets. Model (a), presented in Table 66, finds that relative to otherwise similar firms, product innovators with design skills are (on average) 12 percentage points more likely to reach customers in the Rest of the World. They are also 6 percentage points less likely to only serve customers within their own region; and are 7 percentage points less likely to reach national customers outside their region at the furthest. These findings align with our expectations that having design skills enhances a firm's ability to reach a more distant market. The exception is European countries; we do not find that having design skills is not associated with customers in European countries being the firm's furthest. However, many firms that have customers in Rest of the World also have customers in Europe, which perhaps indicates that having overcome any barriers to exporting, design then aids firms exporting to more distant markets.

Model (b) reports the results based on design investments rather than design skills. The results are essentially the same as with design skills: design investment is positively related to having customers in the rest of the world, while firms that invest more in design are less likely to serve only customers within their region and outside of the region within the UK. Again, however, there is no effect with regard to Europe as the firm's furthest market.

The effects of design investment also become largely non-significant when R&D and marketing investments are included (Model (c)). Moreover, contrary to our hypotheses, neither interaction is significant. With R&D and marketing investments included, firms reporting higher design investments are significantly less likely to have customer across the UK, while internationally the coefficients for the furthest market being Europe and the Rest of the World are both positive but (at 14% and 12% respectively) above the conventionally observed thresholds for statistical significance.

Perhaps unsurprisingly, Model (c) also indicates that larger firms are less likely to be confined to their regional markets, while new firms are more likely to be. Subsidiaries are less likely to be localised and more likely to have customer in the Rest of the World as the furthest market. Also notable is that among the three types of innovators, goods-only innovators are least likely to only serve customers within the country and are the most likely to reach customers in the rest of the world. This perhaps reflects the tradability of innovations: goods are more tradable than services, and goods without services are more tradable than goods-service combinations.

Table 66 Multinomial Logistic Regression - Model (a) and Model (b)

	Multinomial Logistic Regression on "furthest market"							
	Model (a)				Model (b)			
	Local	National	Europe	RoW	Local	National	Europe	RoW
Main predictors								
design skills (d)	-0.060***	-0.073***	0.014	0.119***				
ln(design)					-0.003**	-0.007***	0.002	0.008***
Controlled variables								
breadth of innov.								
0 (ref.)								
1	-0.005	-0.017	0.027	-0.004	-0.005	-0.018	0.030*	-0.008
2	-0.019	-0.009	0.022	0.006	-0.019	-0.006	0.019	0.006
3	0.013	-0.028	0.022	-0.007	0.012	-0.043	0.033	-0.002
ln(employment)	-0.020***	0.011*	-0.005	0.014**	-0.022***	0.009	-0.005	0.018***
new firm (d)	0.052***	0.016	-0.010	-0.058**	0.050**	0.023	-0.011	-0.062**
subsidiary (d)	-0.092***	-0.010	0.001	0.101***	-0.094***	-0.015	0.003	0.106***
innovator type								
goods-only (ref.)								
services-only	0.030	0.129***	-0.013	-0.146***	0.036*	0.128***	-0.008	-0.156***
goods & services	-0.010	0.069***	0.004	-0.063***	-0.011	0.072***	0.002	-0.063***
compliance-orient. (d)	0.045**	0.045*	-0.037**	-0.053**	0.045**	0.043	-0.034*	-0.054**
Model Chi-Square	1611				1483			
-2LL	5599				5268			
Pseudo R-Square								
Cox and Snell	0.44				0.44			
Nagelkerke	0.48				0.47			
McFadden	0.22				0.22			
N	2756				2582			

Note: "d" indicates dummy variables; "ref." indicates reference category. ***p<0.01, **p<0.05, *p<0.10. The reported are average marginal effects. The results for industrial division and region are omitted for brevity.

Table 67 Multinomial Logistic Regression - Model (c)

	Multinomial Logistic Regression on "furthest market"			
	Model (c)			
	Local	National	Europe	RoW
Main predictors				
ln(design)	0.000	-0.005**	0.002	0.003
ln(r&d)	-0.008***	-0.007***	0.000	0.015***
ln(marketing)	-0.002	-0.001	-0.003	0.007***
ln(design)*ln(r&d)				
ln(design)*ln(marketing)				
Controlled variables				
breadth of innov.				
0 (ref.)				
1	0.005	-0.024	0.033*	-0.013
2	0.000	0.009	0.023	-0.032
3	0.049	-0.015	0.048	-0.082**
ln(employment)	-0.015***	0.009	-0.005	0.011
new firm (d)	0.054***	0.015	-0.006	-0.063**
subsidiary (d)	-0.084***	-0.008	0.000	0.093***
innovator type				
goods-only (ref.)				
services-only	0.030	0.102***	-0.013	-0.119***
goods & services	0.009	0.062**	0.001	-0.073***
compliance-orient. (d)	0.036*	0.028	-0.028	-0.036
Model Chi-Square	1502			
-2LL	4624			
Pseudo R-Square				
Cox and Snell	0.47			
Nagelkerke	0.51			
McFadden	0.25			
N	2341			

Note: "d" indicates dummy variables; "ref." indicates reference category. ***p<0.01, **p<0.05, *p<0.10. The reported are average marginal effects. The interaction terms are not significant; and there are not marginal effects for interaction terms. The results for industrial division and region are omitted for brevity.

Table 68 presents results from Heckman procedure for the estimation of exports. The "exclusion restriction" and lambda are both significant, which suggests Heckman two-step method is valid for the estimation of the propensity to export and the extent of exporting.

Model (a) shows that product innovators with design skills are, on average, 14 percentage points more likely to be exporters. However, among exporters they do not export significantly more than those without design skills.

Before R&D and marketing investments are included, the value of design investment is positively associated with both the propensity to export and the value of exports (Model (b)).

With R&D and marketing included, Model (c) finds that design investment is still associated with a higher propensity to export, but not now with significantly higher export earnings. Figure 6 illustrates, on the basis of Model (c), the effects of design investment (log transformed) on the predicted probabilities of exporting among product innovators. Relative to a firm not investing in design, a £5k investment in design is estimated to increase the probability of exporting from 49.3% to 53.7%; while the probability of exporting for those investing £50k in design (the 90th percentile of the product innovators observed in the sample) is estimated to be 54.8%. This demonstrates that a modest investment in design appears to aid exporting, but also that there is a diminishing marginal effect of additional design investment.

Raising investment in R&D increases both the propensity to export and the value of exports, while raising marketing investment does not increase the propensity to export but does increase the value of exports. Neither interact significantly however with design investments, either in the propensity to export or in relation to the value of exports.

Perhaps surprisingly, model (c) does not find an association between firm size and the propensity to export among product innovators; there is, however, a strong association between firm size and the value of export sales: a 10% of increase in firm size is associated with roughly 7.8 % of increase in the value of exports for the businesses on average. Also notable here is that the propensity to participate in and spend more on R&D, marketing and design, which are included in this model, are related to firm size.

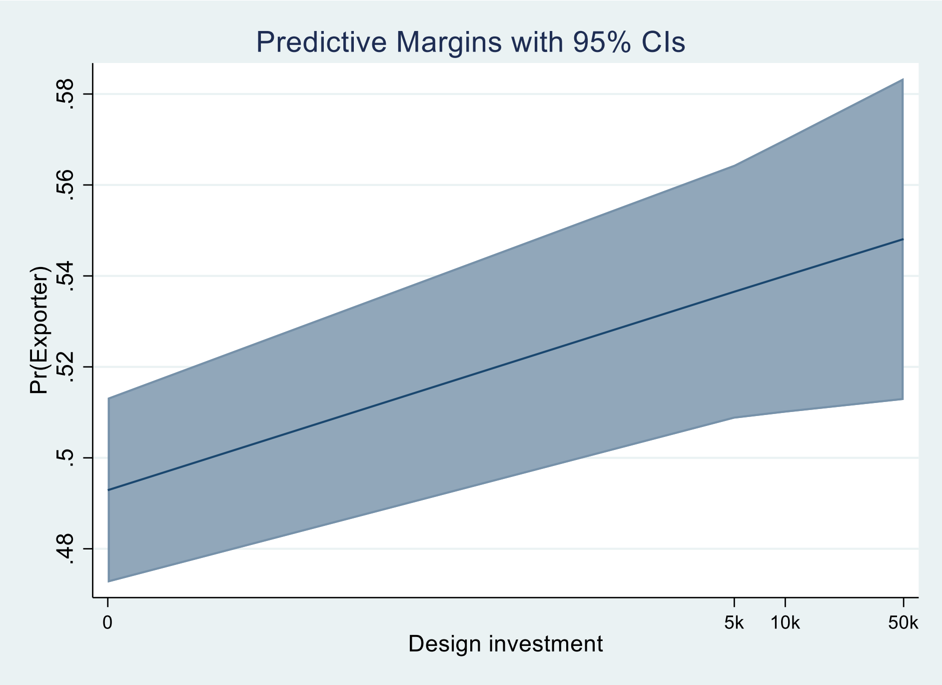
Ownership, firm age, innovator type and compliance-orientation all distinguish the probabilities to be export-active, and older firms, subsidiaries, and goods-only innovators all typically earned higher export sales.

Table 68 Heckman two-step estimation of exporting

	Heckman two-step estimation of exporting							
	Model (a)		Model (b)		Model (c)		Model (d)	
	Export prop.	Value of exports	Export prop.	Value of exports	Export prop.	Value of exports	Export prop.	Value of exports
Main predictors								
design skills (d)	0.136***	0.285						
ln(design)			0.010***	0.038**	0.005**	0.033		
ln(r&d)					0.015***	0.107***		
ln(marketing)					0.004	0.041**		
ln(design)*ln(r&d)						0.000		
ln(design)*ln(marketing)						0.001		
design (d)							0.036**	0.696**
r&d (d)							0.158***	0.740**
marketing (d)							0.042**	0.346
design (d)*r&d (d)								-0.626*
design (d)*marketing (d)								0.069
Controlled variables								
breadth of innov.								
0 (ref.)								
1	0.022	-0.017	0.023	-0.040	0.019	-0.039	0.021	0.002
2	0.028	0.113	0.025	0.043	-0.013	-0.234	0.004	0.036
3	0.019	0.328	0.030	0.229	-0.040	-0.171	-0.033	0.092
ln(employment)	0.009	0.845***	0.013**	0.843***	0.006	0.792***	0.011**	0.851***
new firm (d)	-0.071***	-0.567**	-0.076***	-0.685***	-0.073***	-0.870***	-0.068***	-0.621**
subsidiary (d)	0.104***	0.846***	0.109***	0.887***	0.093***	1.003***	0.103***	0.930***
innovator type								
goods-only (ref.)								
services-only	-0.158***	-0.830***	-0.165***	-0.957***	-0.133***	-0.909***	-0.144***	-0.846***
goods & services	-0.060***	-0.793***	-0.062***	-0.856***	-0.071***	-1.045***	-0.065***	-0.859***
Exclusion restriction								
compliance-orient. (d)	-0.086***		-0.085***		-0.060**		-0.071***	
Constant		2.929***		3.137***		3.302***		2.218***
Lambda	1.40*		1.55*		2.34***		1.75**	
Total obs.	2756		2582		2341		2756	
Uncensored obs.	1370		1301		1190		1370	
Wald Chi-Square	571***		499***		423***		555***	

Note: “d” indicates dummy variables; “ref.” indicates reference category. ***p<0.01, **p<0.05, *p<0.10. The figures reported for independent variables involved in selection equations (i.e. “export propensities” column) are average marginal effects. The interaction terms are not significant; and there are not marginal effects for interaction terms. The figures reported for independent variables involved in outcome equations (i.e. “value of exports” column) are estimated coefficients (which represent marginal effects). The results of industrial division and region are omitted for brevity.

Figure 6 Effect of design investment on the predicted probabilities of being an exporter (Model (c))

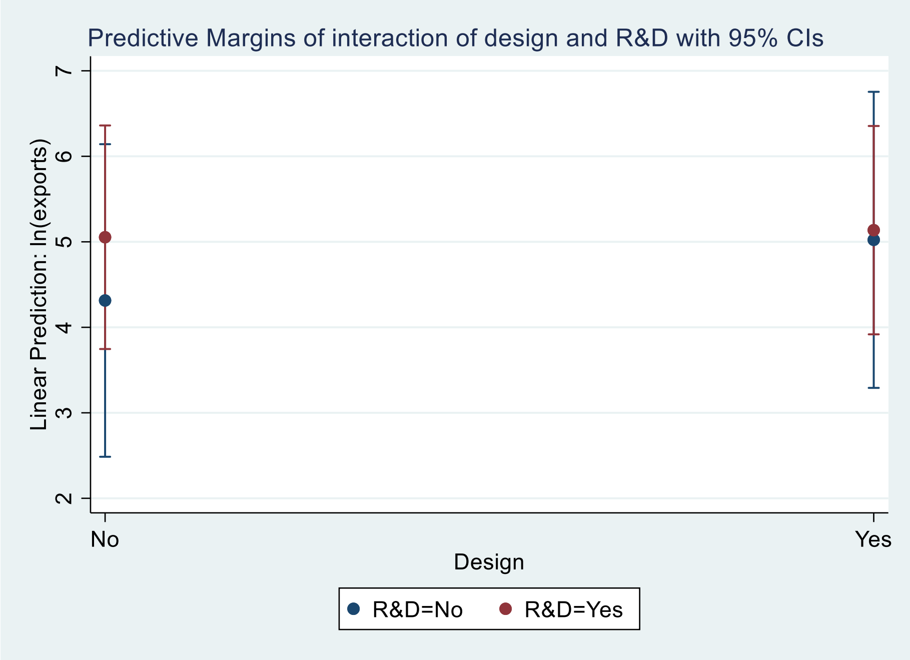


Given that Model (c) does not find value of exports is associated with value of design investment, we further examined if the value of exports can be distinguished by whether or not the firm invested in design, with participation in R&D and marketing also included as dummy variables rather than as values. This found (in Model (d)) that exports for those investing in design are double the exports of those investing in neither design nor R&D. This is a striking finding; it implies that modest investments in design can have an impact on exports. Also notable is that additional investments will have little or no additional effect. As illustrated by Figure 7, the average value of exports for product innovators investing in neither design nor R&D is nearly £75k; all else equal, while the value of exports is doubled (£152k and £157k respectively) for those investing only in design or only in R&D, and is marginally higher still for firms investing in both (i.e., £170k approximately). The absence of a substantial further increase from participating in both activities implies that design and R&D investments largely substitute for each other with respect to the value of exports.

Meanwhile, participating in marketing has a small positive impact on export propensity but does not significantly enhance the value of exports (the reverse of the findings from Model (c)), and there is again no significant interaction between participating in marketing and design in relation to the value of exports.

Those which invest in design are 3.6 percentage points more likely to export (i.e. 52.2% c.f. 48.6%). The interaction terms are not found with significant effect on the tendency to export.

Figure 7 Effect of the interaction between design and R&D participation on the value of exports (Model (d))



Before discussing the main findings of this paper, we briefly review the other findings of the regressions.

Among product innovators, smaller businesses are more likely to only serve their regional markets and less likely to reach markets further than Europe. However, once the value of investments in design, R&D and marketing are included in the models, smaller product innovators are not less likely to reach beyond Europe. The difference can be explained by the fact that smaller firms are less likely to invest in design, R&D and/or marketing. An interpretation of these results is that by investing in R&D, design and/or marketing smaller firms can overcome any inherent disadvantage of "smallness", particularly in relation to market reach and exporting.

Young companies are also more likely to only serve their regional markets and are less likely to export.

The opposite is the case for subsidiaries. Other things being equal, subsidiaries are more likely to achieve further market reach (and in particular have customers in the “rest of the world”), are more likely to export, and are likely to have higher export sales. We assume this is because subsidiaries are able to draw upon resources from their wider company groups, including possibly design, R&D and marketing resources and capabilities not directly undertaken by the subsidiaries themselves.

Another notable finding is that goods-only innovators are more likely to reach distant customers, are more likely to export and tend to have achieve higher export sales than service innovators, including both service-only innovators and those that introduced both goods and service innovations. These differences are likely to reflect the differences in tradability of goods and services. They may also reflect differences in strategy, in that firms that stick to a goods-only strategy will tend to look to expand their markets by selling products at greater distance, while an alternative strategy is to deepen relations with existing, generally more proximate customers by selling combinations of goods and services.

Finally, compliance-not growth-oriented companies are more likely to be oriented to regional markets and less likely to export; the latter in particular is in line with our expectations.

Discussion and implications

The focus of this paper was the relationship between design commitment and achieving greater geographical market reach, including exporting. We argued that design can help firms to understand non-local buyers, and to both “tweak” products to appeal to these, and help firms to develop innovation that are also appealing to distant customers. We also anticipated that while both R&D and marketing activities might substitute for design in helping firms to achieve these goals, there were also good reasons to expect that both R&D and design, and marketing and design, might be complements in helping companies to win customers at distance. Our results provide some support for these ideas.

First, firms that have design skills are found to be less likely to be confined to their regional markets, and are more likely to have distant customer, including in the rest of the world. The same is true before investments in R&D and marketing are taken into account, for firms that invest more in design. Similarly, before investments in R&D and marketing are taken into account, a greater design investment is associated with a higher propensity to export and greater export sales. However, once investments in R&D and marketing are taken into account, the effect of design investment on propensity to export becomes smaller (although it remains statistically significant) and neither of the interactions between R&D and design, and marketing and design were found to be significant; and the effect of design investment on export sales becomes non-significant. Even though, those investing in design, on average, are more likely to export and have greater export sales compared to those not investing in design, controlling R&D participation and marketing participation. These findings indicate that design investment can have a positive influence on firm’s geographical reach to customers, including helping them to export and win foreign customers. While it is true that the effect sizes are generally small, it is also true that the vast majority of the firms in our data set were spending very modest amounts on design, and therefore even modest investments in design can have this impact. Therefore, we consider that the results provide some support to Hypothesis 1(a) and 1(b), while they do not support Hypothesis 2(a), 2(b), 3(a) and 3(b).

The presence of absence of significant findings in an empirical study does not mean that the underlying theory is true or untrue and our findings should also be contextualised to the nature of the data examined in this paper, which, while being advantageous as a large “off the shelf” dataset which utilises a set of standard variables which are themselves based on standard definitions, has a number of limitations.

First, in relation to design skills, we only know whether or not the firm had or did not have people with design skills in the business, or access to people with such skills externally; we do not know anything about the depth of this resource. Nor do we know what they were working on. Second, in relation to investments in design, we only know how much firms spend on "all forms of design" in one year. Again, we do not know anything about what this money was spent on, and whether the firm's spending on design in this year was typical, or atypical, of other years. We also don't know whether or not there were design investments "hidden" within R&D and/or marketing. Third, the data-set is cross-sectional, and taken literally our analysis has sought to connect investments in design (R&D and marketing) in one year to reaching more distant buyers and engaging in export in the same year. Effectively, we are assuming that these investments and markets are unchanging rather than changing over time, which is somewhat at odds with a focus on innovation, which is about changing the status quo. It is also valid to acknowledge that the direction of causation may work differently from what we have argued, at least implicitly earlier. That is, rather than investments in design and innovation driving the firm towards serving more distant markets and exporting, it could be that having more distant customers and being engaged in export markets drives the firm to invest more in design and innovation. Particularly with regard to design, the reasoning remains the same however: investing in design helps firms to "tweak" their products and/or to innovate products that are intended to appeal to more distant customers.

These and other weaknesses of the present study could be addressed by undertaking a bespoke study on the relationships between design, the development of innovations, and winning distant customers, including through exporting. However, such a bespoke study would also raise a number of challenges, not least of which is resourcing it.

Notwithstanding the limitations of the empirical analysis in this study, we submit that the evidence presented here is sufficient to give practitioners a pause for thought. "What to do?" should of course be contextualised to the firm's own objectives and situation, but it would appear that generally modest investments in design (of the order of a few thousand to the low tens of thousands of pounds) can be beneficial, including to exporting. Perhaps unexpectedly, there is only a third of the product innovators in our study indicated that they had invested in design; and only a minority of firms that claimed to have developed and introduced product innovations considered that the skills of designers might be valuable in enhancing these innovations. To the majority of product innovators, therefore our message is simple: design does not necessarily require large investments to initiate, and could be favourable for reaching international customers; they could give design a try, through investing moderately in design, including by accessing people with design skills. This may entail additional investment over and above what the firm is currently spending on R&D and marketing, or could involve some reallocation from these activities to design.

References

Aaker, J. L., 1997. Dimensions of brand personality. *Journal of Marketing Research,* 34(3), pp. 347-356.

Amaldoss, W. & Jain, S., 2008. Research note – Trading up: A strategic analysis of reference group effects. *Marketing Science,* 27(5), pp. 755-947.

Aschhoff, B. et al., 2013. *Innovation in Germany - results of the Germany CIS 2006 to 2010,* Mannheim: ZEW.

Baldwin, C. Y. & Clark, K. B., 2000. *Design rules: The power of modularity.* s.l.:MIT Press.

Barreto, I., 2009. Dynamic capabilities: A review of past research and an agenda for the future. *Journal of Management,* 36(1), pp. 256-280.

Bernard, A. B., Jensen, B., Redding, S. J. & Schott, P. K., 2012. The empirics of firm heterogeneity and international trade. *Annual Review of Economics,* Volume 4, pp. 283-313.

Brown, T., 2008. Design thinking. *Harvard Business Review,* 86(6), pp. 84-92.

Bruce, M. & Bessant, J., 2002. *Design in business: Strategic Innovation through design.* s.l.:Pearson Education.

Button, G., 2000. The ethnographic tradition and design. *Design Studies,* 21(4), pp. 319-332.

Camisón-Zornoza, C., Lapiedra-Alcamí, R., Segarra-Ciprés, M. & Boronat-Navarro, M., 2004. A meta-analysis of innovation and organizational size. *Organization Studies,* 25(3), pp. 331-361.

Capron, L., Dussauge, P. & Mitchell, W., 1998. Resource redeployment following horizontal acquisitions in Europe and North America, 1988–1992. *Strategic Management Journal,* 19(7), pp. 631-661.

Cereda, M., Crespi, G., Criscuolo, C. & Haskel, J., 2005. *Design and company performance: Evidence from the Community Innovation Survey,* s.l.: DTI Report.

Ciriaci, D., 2011. *Design and European firms' innovative performance: A less costly innovation activity for European SMEs?,* s.l.: Joint Research Centre of the European Commission.

Coad, A., Segarra, A. & Teruel, M., 2016. Innovation and firm growth: Does firm age play a role?. *Research Policy,* 45(2), pp. 387-400.

Cohen, W. M. & Levinthal, D. A., 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly,* 35(1), pp. 128-152.

Cooper, R. & Press, M., 1995. *The design agenda; A guide to successful design management.* Chichester: Wiley.

Dangelico, R. M., Pontrandolfo, P. & Pujari, D., 2013. Developing sustainable new products in the textile and upholstered furniture industries: Role of external integrative capabilities. *Journal of Product Innovation Management,* 30(4), pp. 642-658.

Danish Design Centre, 2003. *The economic effects of design,* Copenhagen: s.n.

Desmet, P. & Hekkert, P., 2007. Framework of product experience. *International journal of design,* 1(1), pp. 57-66.

Dreyfuss, H., 1955. *Designing for people.* New York: Simon and Schuster.

Dreyfuss, H., 1960. *The measure of man: Human factors in design.* New York: Whitney Library of Design.

Eisenhardt, K. M. & Martin, J. A., 2000. Dynamic capabilities: what are they?. *Strategic Management Journal,* 21(10-11), pp. 1105-1121.

Eisenman, M., 2013. Understanding aesthetic innovation in the context of technological evolution. *Academy of Management Review,* 38(3), pp. 332-351.

Ellis, P. D., 2007. Distance, dependence and diversity of markets: Effects on market orientation. *Journal of International Business Studies,* Volume 38, p. 374–386.

Friedmann, R. & Lessig, P., 1987. Psychological meaning of products and product positioning. *Journal of Product Innovation Management,* 4(4), pp. 265-273.

Gemser, G. & Leenders, M. A. A. M., 2001. How integrating industrial design in the product development process impacts on company performance. *Journal of Product Innovation Management,* 18(1), pp. 28-38.

Ghemawat, P., 2001. Distance still matters. *Harvard Business Review,* 79(8), pp. 137-147.

Grant, R. M., 1996. Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science,* 7(4), pp. 359-467.

Guan, J. & Ma, N., 2003. Innovative capability and export performance of Chinese firms. *Technovation,* 23(9), pp. 737-747.

Hargadon, A. B. & Douglas, Y., 2001. When innovations meet institutions: Edison and the design of the electric light. *Administrative Science Quarterly,* 46(3), pp. 476-501.

Heckman, J. J., 1979. Sample selection bias as a specification error. *Econometrica,* 47(1), pp. 153-161.

Heiner, R. A., 1986. Uncertainty, signal detection experiments, and modeling behavior. In: R. N. Langlois, ed. *Economics as a process : essays in the new institutional economics.* Cambridge: Cambridge University Press, pp. 59-115.

Helfat, C. E., 1994. Firm-specificity in corporate applied R&D. *Organization Science,* 5(2), pp. 121-287.

Helfat, C. E. et al., 2007. *Dynamic capabilities: Understanding strategic change in organizations.* Oxford: Blackwell Publishing.

Helfat, C. E. & Peteraf, M. A., 2003. The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal,* 24(10), pp. 997-1010.

Jaffe, A. B., Trajtenberg, M. & Henderson, R., 1993. Geographic localization of knowledge spillovers as evidenced by patent citations. *Quarterly Journal of Economics,* 108(3), p. 577–598.

Katila, R. & Ahuja, G., 2002. Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal,* 45(6), pp. 1183-1194.

Kotler, P. & Rath, G. A., 1984. A powerful but neglected strategic tool.. *Journal of Business Strategy,* 5(2), pp. 16-21.

Lave, J. & Wenger, E., 1991. *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge university press.

Lawson, B. & Samson, D., 2001. Developing innovation capability in organisations: A dynamic capabilities approach. *International Journal of Innovation Management,* 5(3), pp. 377-400.

Leonard, D. & Rayport, J. F., 1997. Spark innovation through empathic design. *Harvard Business Review,* 75(6), pp. 102-113.

Levinthal, D. A. & March, J. G., 1993. The myopia of learning. *Strategic Management Journal,* 14(S2), pp. 95-112.

Liker, J. K., Collins, P. D. & Hull, F. M., 1999. Flexibility and standardization: Test of a contingency model of product design–manufacturing integration. *Journal of Product Innovation Management,* 16(3), pp. 248-267.

Lorenz, C., 1986. *The design dimension: Product strategy and the challenge of global marketing.* s.l.:Blackwell.

MacPherson, A., 2000. The role of international design orientation and market intelligence in the export performance of US machine tool companies. *R&D Management,* 30(2), pp. 167-176.

Marshall, A., 1890. *Principles of economics.* First ed. London: Macmillan.

Martin, X. & Mitchell, W., 1998. The influence of local search and performance heuristics on new design introduction in a new product market. *Research Policy,* 26(7-8), pp. 753-771.

Moon, H., Miller, D. R. & Kim, S. H., 2013. Product design innovation and customer value: Cross-cultural research in the United States and Korea. *Journal of Product Innovation Management,* 30(1), pp. 31-43.

Mowery, D. C., Oxley, J. E. & Silverman, B. S., 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal,* 17(S2), pp. 77-91.

Nachum, L., Zaheer, S. & Gross, S., 2008. Does it matter where countries are? Proximity to knowledge, markets and resources, and MNE location choices. *Management Science,* 54(7), p. 252–1265.

Nambisan, S., 2002. Complementary product integration by high-technology new ventures: The role of initial technology strategy. *Management Science,* 48(3), pp. 313-452.

Nassimbeni, G., 2001. Technology, innovation capacity, and the export attitude of small manufacturing firms: a logit / tobit model. *Research Policy,* 30(2), pp. 245-262.

Noble, C. H. & Kumar, M., 2010. Exploring the appeal of product design: A grounded, value-based model of key design elements and relationships. *Journal of Product Innovation Management,* 27(5), pp. 640-657.

Nonaka, I. & Toyama, R., 2007. Strategic management as distributed practical wisdom (phronesis). *Industrial and Corporate Change,* 16(3), pp. 371-394.

OECD and Eurostat, 1992. *Oslo manual: OECD proposed guidelines for collecting and interpreting technological innovation data,* Paris: OECD Publishing.

OECD and Eurostat, 1997. *Oslo manual: the measurement of scientific and technological activities: proposed guidelines for collecting and interpreting technological innovation data,* Paris: OECD Publishing.

OECD and Eurostat, 2005. *Oslo manual: Guidelines for collecting and interpreting innovation data.,* Paris: OECD Publishing.

OECD and Eurostat, 2018. *Oslo Manual 2018: guidelines for collecting, reporting and using data on innovation,* Paris: OECD Publishing.

Piening, E. P. & Salge, T. O., 2015. Understanding the antecedents, contingencies, and performance implications of process innovation: A dynamic capabilities perspective. *Journal of Product Innovation Management,* 32(1), pp. 80-97.

Puhani, P., 2000. The Heckman correction for sample selection and its critique. *Journal of Economic Surveys,* 14(1), pp. 53-68.

Rosenkopf, L. & Almeida, P., 2003. Overcoming local search through alliances and mobility. *Management Science,* 49(6), pp. 683-837.

Rothwell, R. & Gardiner, P., 1983. The role of design in product and process change. *Design Studies,* 4(3), pp. 161-169.

Sidhu, J. S., Commandeur, H. R. & Volberda, H. W., 2007. The multifaceted nature of exploration and exploitation: Value of supply, demand, and spatial search for innovation. *Organization Science,* 18(1), pp. 1-164.

Simon, H. A., 1969. *The sciences of the artificial.* s.l.:The MIT Press.

Siqueira, A. C. O., Priem, R. L. & Parente, R. C., 2015. Demand-side perspectives in international business: themes and future directions. *Journal of International Management,* 21(4), pp. 261-266.

Spithoven, A. & Teirlinck, P., 2015. Internal capabilities, network resources and appropriation mechanisms as determinants of R&D outsourcing. *Research Policy,* 44(3), pp. 711-725.

Sterlacchini, A., 1999. Do innovative activities matter to small firms in non-R&D-intensive industries? An application to export performance. *Research Policy,* 28(8), pp. 819-832.

Stuart, T. E. & Podolny, J. M., 1996. Local search and the evolution of technological capabilities. *Strategic Management Journal,* 17(S1), pp. 21-38.

Tavassoli, S., 2015. Innovation determinants over industry life cycle. *Technological Forecasting and Social Change,* Volume 91, pp. 18-32.

Teece, D. J., 2007. Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal,* 28(13), pp. 1319-1350.

Thompson, C. J., Pollio, H. R. & Locander, W. B., 1994. The spoken and the unspoken: A hermeneutic approach to understanding the cultural viewpoints that underlie consumers' expressed meanings. *Journal of Consumer Research,* 21(3), p. 432–452.

Utterback, J. et al., 2006. *Design-inspired innovation.* s.l.:World Scientific.

Verganti, R., 2009. *Design driven innovation: changing the rules of competition by radically innovating what things mean.* Boston: Harvard Business Press.

Verganti, R. & Dell'Era, C., 2014. Design-driven innovation: Meaning as a source of innovation. In: M. Dodgson, D. M. Gann & N. Phillips, eds. *The Oxford handbook of innovation management.* Oxford: Oxford University Press, pp. 139-162.

Veryzer, R. W. & Borja de Mozota, B., 2005. The Impact of The impact of user-oriented design on new product development: An examination of fundamental relationships. *Journal of Product Innovation Management,* 22(2), pp. 128-143.

von Hippel, E., 1994. "Sticky information" and the locus of problem solving: implications for innovation. *Management Science,* 40(4), pp. 429-439.

von Hipple, E., 1998. Economics of product development by users: The impact of "sticky" local information. *Management Science,* 44(5), pp. 629-644.

Von Stamm, B., 2003. *Managing innovation, design and creativity.* Chichester: Wiley.

Wagner, S., Hoisl, K. & Thoma, G., 2014. Overcoming localization of knowledge — the role of professional service firms. *Strategic Management Journal,* 35(11), pp. 1671-1688.

Walsh, V., Roy, R., Bruce, M. & Potter, S., 1992. *Winning by design: Technology, product design and international competitiveness.* Oxford: Blackwell Publishers.

Wang, C. L. & Ahmed, P. K., 2007. Dynamic capabilities: A review and research agenda. *International Journal of Management Reviews,* 9(1), pp. 31-51.

Winter, S. G., 2003. Understanding dynamic capabilities. *Strategic Management Journal,* 24(10), pp. 991-995.

Zahra, S. A., Ireland, R. D. & Hitt, M. A., 2000. International expansion by new venture firms: International diversity, mode of market entry, technological learning, and performance. *Academy of Management Journal,* 43(5), pp. 925-950.

CHAPTER 5

DESIGN AND EXPORTING BY UK CREATIVE INDUSTRIES: INSIGHTS FROM THE R&D IN CREATIVE INDUSTRIES SURVEY 2020*

*This paper contains an analysis of data that is used under permission.
Source: Department for Digital, Culture, Media and Sport
https://www.gov.uk/government/publications/rd-in-the-creative-industries-survey

Introduction

The creative industries are increasingly recognised as meaningful contributors to the economy nationally and internationally. According to a United Nations report on international trade in creative industries prior to the COVID-19 pandemic (UNCTAD, 2018), the global market for creative goods witnessed a rapid growth between 2002 and 2015 with its value more than doubled from US$208 billion to US$509 billion; despite the financial crises, its trade performance was generally consistent during the same period of time at an average growth rate above 7 percent, with (1) increased participation from "developing economies", (2) the European Union (as the world's largest exporter of creative goods) doubling the value of creative goods exported from US$85 in 2002 to US$171 in 2015, and (3) the UK exporting nearly US$26 million of creative goods in 2015 – which was the 4th among "developed economies", following the US, France and Italy; meanwhile, the annual growth of trade in creative services between 2011 and 2015 for developed economies (4.3% on average) was more than twice that of all services, which therefore raised the share of creative services in their trade of all services from 17.3% to 18.9% during that period of time.

The creative industries were first defined in the UK by the Blair Government's 2001 Creative Industries Mapping Document, which identified them as "those industries which have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property" (DCMS, 2001). The Department for Digital, Culture, Media and Sport (DCMS) further identified nine sub-sectors within the Creative Industries: (1) advertising and marketing; (2) architecture; (3) crafts; (4) design – product, graphic and fashion design; (5) film, TV, video, radio and photography; (6) IT, software and computer services; (7) publishing; (8) museums, galleries and libraries; (9) music, performing and visual arts[163].

In line with the DCMS's most recent statistical analysis (DCMS, 2019b), the Creative Industries (CIs) exported £32.8 billion by value of services and £13.5 billion by value of goods in 2017, that is 11.8% of all UK services exports by value and 3.9% of all UK goods exports by value. In terms of growth, the value of services that the Creative

[163] The creative industries are those with "creative intensity" above a certain threshold. The "creative intensity" is measured by the proportion of creative jobs in each industry. For more details please refer to the Creative Industries Economic Estimates Methodology: https://www.gov.uk/government/publications/creative-industries-economic-estimates-methodology.

Industries exported was 21.1% higher in 2017 than 2016; and it doubled (i.e. grew 122.6%) between 2010 and 2017 – dramatically faster than total UK export of services, which increased 12.9% between 2016 and 2017 and 59.1% between 2010 and 2017. By comparison, the growth in the value of goods exports generated by these industries has been smaller[164], increasing by about 1.8% between 2016 and 2017, and 24.2% from 2010 to 2017; the total UK export of goods rose 12.5% and 26% during the corresponding periods of time.

While the creative exports have been experiencing rapid growth, little is known about the characteristics of exporters in the creative industries sector, and how these differ from non-exporters. This study aims to examine some of the factors that differentiate exporters in the CIs. Utilising the UK "R&D in Creative Industries Survey 2020", the study is particularly interested in the link between innovation related activities, including R&D and design, and exporting. The link between R&D and exporting has been subject to substantial analysis, and many studies have demonstrated that R&D is associated with exporting; by contrast, the relevance of design to exporting has yet to be extensively addressed. Therefore, this study aims to contribute to not only the literature on exporting in the Creative Industries, but also the studies on the relationship between design and exporting.

The paper will first address the characteristics of the creative industries and draw on literature about the heterogeneity of firms' exporting behaviours. Hypotheses will be developed on the expected determinants of exporting. We then discuss the data and the analytical strategies used. Descriptive statistics are then reported before the main multivariate analysis. This is followed by a discussion of key findings and implications to businesses and policy development at the end.

Conceptual background

This section will develop hypotheses drawing on existing literature on factors that are associated with exporting, paying particular attention to the nature of creative industries.

[164] Note the estimates of goods and services are based on different data sources. The data on the former were gathered from HMRC's Intrastat survey and Customs export entries (under the cross-border principle of trade); the latter came from the ONS International Trade in Services dataset, the data of which were collected through survey (under the change of ownership principle of trade). For more details please refer to the reference.

The nature of creative industries

While statistics indicate considerable exporting by the UK's Creative Industries, they may under-report the true extent of exporting for a number of reasons. These might be reflected in some of the characteristics of these industries.

Creative output and its tradability

Creative products are often unique and not reproducible in some cases. Instead of a dichotomy of goods and services or tangibles and intangibles, the forms of creative output can be more complex: tangible goods (e.g. crafts), intangible goods (e.g. films and music), services (e.g. advertising, architecture and product design) and intangible assets (including those protectable by Intellectual Property Rights) (Hill, 1999; Eaton & Kortum, 2019).

Different types of output have varying extents of tradability and ease or difficulty of tracking trade. Tangible goods are typically both tradable and trackable; services have traditionally been regarded as non-tradable, but this is evidently not the case; they are increasingly traded, in part due to digitalisation, the development of technologies and changes in regulation (Egger, et al., 2012).

Jensen and Kletzer (2005) have distinguished between (potentially) tradable and non-tradable "service industries" and occupations using Ellison and Glaeser (1999) and Gini coefficients, recognizing that tradable services exhibit geographical concentration and that services which are traded within a country are "potentially" tradable internationally.[165] Among the CIs which could be identified from their study (Table 69), film, music and software are among the most tradable in the US. These CIs typically produce intangible, digital products; in addition, creative business services including architecture, design, computer and advertising services are considered tradable, but less so. See Fazio (2021) for a review of the tradability of creative services.

[165] Albeit notably, differences in cross-country regulations may put barriers to trading goods or services that are tradable in principle. That is, the observed "tradability" may not entirely reflects the tradability as determined by the nature of the goods or services per se.

Table 69 Tradability of creative services and occupations

2-digit NAICS	Industry			Gini coefficient class
51	Motion pictures and video industries			3
51	Sound recording industries			3
51	Software publishing			3
51	Publishing, except newspapers and software			2
54	Architectural, engineering, and related services			2
54	Specialized design services			2
54	Computer systems design and related services			2
54	Advertising and related services			2
71	Museums, art galleries, historical sites, and similar institutions			2
71	Independent artists, performing arts, spectator sports, etc.			2
51	Newspaper publishers			1
51	Radio and television broadcasting and cable			1
51	Libraries and archives			1
2-digit SOC	**Occupation**	**Gini class1**	**Gini class 2**	**Gini class 3**
15	Computer/mathematical	0	73.07	26.93
17	Architecture/engineering	36.04	58.31	5.65
27	Arts, design, entertainment	17.13	75.02	7.85

Source: Jensen and Kletzer (2005)
Note: this table presents the industries extracted from the study that are close to the CIs and their tradability – class 3 to 1 indicate tradability from highest to none; the table also shows the percentage of employment that falls into each class, for the relevant occupations.

While technologies have also had transformative effects on the tradability of intangible goods (Waldfogel, 2017), they also pose challenges to tracing the flow of these goods, including through international trade. Illicit copying further hampers monitoring the flow of creative goods and services. Digital files of music, photographs or videos can be shared on digital platforms and "traded" to wherever in the world those platforms are accessible yet the flow of this is difficult if not impossible to monitor.

These sub-sector variations in tradability and traceability may be reflected in the varied (recorded) degrees of export engagement.

As suggested by Table 70, 15% of the businesses in the UK CIs export, compared to 10% of the total UK non-financial business economy; that is, overall, they are 50% more likely to be engaged in exporting than non-financial businesses as a whole. Almost half of publishers sell in overseas market, while quarter of the businesses in advertising, crafts or "music, performing and visual arts" also export. At the other end of the spectrum, not more than 10% of companies in architecture, "IT, software and computer services" and "museums, galleries and libraries" trade internationally. "Design and designer fashion" and "film, TV, video, radio and photography" are in the middle, at around 15% of firms having international sales.

In terms of what is exported, the CIs predominantly export services except for the "publishing", "music, performing and visual arts", "museums, galleries and libraries" and “crafts” sub-sectors. “Architecture” and “IT, software and computer services” are especially service exporters, with few exports of goods; “advertising and marketing”, “design and designer fashion”, and “film, TV, video, radio and photography” also export mainly services. Services exports are critical for the GVA of “film etc.”, where they account for nearly half of the industry’s GVA (c.f. 4% for goods exports), which is the largest among the CIs. This is followed by “IT, software and computer services”, with more than two-fifth of the industry’s GVA being due to service exports. This is generated by less than 10% of the businesses in this sub-sector, which accounts for more than half of the value that the CIs contribute to the UK’s total exports of services – the IT sector is the biggest subsector and exporter among the CIs.

Although the specific extents may vary, most of the CIs are tradable.

Table 70 Estimates of 2017 exports of services and goods by sub-sectors of creative industries

	Total firms (k)	GVA (£m)	# of exporters (k) (% of total firms)*	Services			Goods		
				Exports (£m)	% of GVA*	% of total UK services exports	Exports (£m)	% of GVA*	% of total UK goods exports
Adv & mkt	24.0	13024	5.5 (22.9)	3949	30.3	1.4	N/A	N/A	N/A
Architecture	16.0	3833	0.6 (3.8)	635	16.6	0.2	13[166]	0.3	0.0
Crafts	1.2	292	0.3 (25.0)	-	-	-	4848	1662.4	1.4
Design	23.1	3889	3.3 (14.3)	461	11.9	0.2	N/A	N/A	N/A
Film etc.	32.2	16323	5.3 (16.5)	7734	47.4	2.8	650	4.0	0.2
IT	144.2	39725	12.4 (8.6)	16919	42.6	6.1	7	0.0	0.0
Publishing	10.7	11186	4.9 (45.8)	1983	17.7	0.7	2761	24.7	0.8
Museums etc.	1.0	1452	0.1 (10.0)	-	-	-	878	60.5	0.3
Music etc.	34.6	9315	9.3 (26.9)	1065	11.4	0.4	4301	46.2	1.3
CIs total	287.0	99038	41.7 (14.5)	32764	33.1	11.8	13459	13.6	3.9
UK total	2382.4	1796297	235.8(9.9)	277039	15.4	100	342391	19.1	100

Source: DCMS Sectors Economic Estimates 2017: Trade (DCMS, 2019b), GVA (DCMS, 2019c) and Business Demographics (DCMS, 2019d)
Note: "-" indicates figure suppressed due to disclosiveness; "N/A" indicates no goods associated with the sub-sectors; “*” indicates authors’ calculation.

Prevalence of micro businesses and freelancers

The Creative Industries are characterised by a relatively higher proportion of micro businesses, i.e. those with fewer than ten employees (94.7% c.f. 89. 3% for “UK non-financial business economy” as a whole in 2018) (DCMS, 2020), as well as self-employment (33.3% c.f. 16.1% for “all UK Sectors” in 2018) (DCMS, 2019a).

While a small size may be beneficial to discretion and manifestation of creativity within an organisation, it may constrain a firm’s ability to export (in line with the “self-

[166] The goods associated with Architecture include “plans and drawings for architectural, engineering, industrial, commercial, topographical or similar purposes, being originals drawn by hand; handwritten texts; photographic reproductions on sensitised paper and carbon copies of the foregoing” (DCMS, 2016). For goods associated with other creative industries please also refer to the reference.

selection" hypothesis (Bernard & Jensen, 1999; Melitz, 2003)). Small firms compared to their larger counterparts are more resource constrained, and therefore less able to conduct and/or manage some activities (including innovation, IP protection, bidding, etc.) in a strategic and systematic way. They are typically less proficient at "absorptive capacity" – "an ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990), which influences a firm's engagement in exporting (Harris & Li, 2009).

As exporters are commonly larger than their counterparts, the CIs as a whole may be expected to be less likely to participate in exporting. Nonetheless, contrary to this conjecture, businesses in the CIs are in fact observed even more engaged in exporting than typical firms in the UK; which implies the disadvantages caused by a limited firm size could be probably neutralised by the positive effects of other characteristics of a typical creative business, e.g. creativity and more tradable forms of output.

Not-for-profit organisations and private firms

Cultural activities are conducted by both companies and not-for-profit organisations (NPO). In accordance with DCMS's definitions (2016), the UK Creative Industries overlap with the UK Cultural Sector in 4 areas (i.e. "crafts", "film, TV, video, radio and photography", "museums, galleries and libraries" and "music, performing and visual arts"), which account for half of the CIs recorded under 4-digit Standard Industrial Classification (SIC) codes, one-fourth of the businesses in the CIs, and one-third of the exporters from the CIs.

Therefore, while "non-profit arts and cultural heritage" as well as more commercial activities are involved (Goto, 2017) in trading, non-profit organisations (NPO) and private businesses are considered distinct in terms of their strategic activities and motivation of exporting. In contrast to NPOs/charities, companies have higher incentives to export, and should have higher propensities to conduct and invest in innovation and/or other activities (including exporting) that are more likely to return commercial benefit; they are therefore both more likely to export and to export more.

R&D, design and other innovation inputs in creative industries

An analysis of the UK Innovation Survey 2015 (Gkypali & Roper, 2018) found that the participation of innovation activities in the Creative Industries is similar to that of manufacturing firms, and considerably higher than that of services (Table 71**Error! Reference source not found.**).

Table 71 Participation in innovation activities - creative industries, manufacturing and services

	Creative Industries	Manufacturing	Services
In-house R&D	35%	38%	16%
External R&D	10%	11%	5%
Capital acquisition	45%	44%	34%
External knowledge acquisition	6%	7%	4%
Training investment	25%	21%	14%
Design investment	21%	26%	10%
Market introduction of innovation	31%	29%	20%

Source: Gkypali and Roper (2018) based on the UK Innovation Survey 2015

Among these conventional activities that businesses could undertake in pursuit of innovation, Research and Development activities consist of systematically undertaken creative work (OECD, 2015); while design activities are commonly recognised as being creative (OECD and Eurostat, 2018).

A recent DCMS-commissioned survey on R&D in the Creative Industries (Bird, et al., 2020) found more than half (55%) of the organisations in these industries reported they were engaged in R&D (as defined in the OECD's Frascati Manual)[167] with a £30k mean investment.

As displayed in Figure 8 and Figure 9, the DCMS survey found that among "IT, software and computer services" nearly 70% of the respondents claimed to be engaged in R&D, and they also had the highest median R&D intensity among R&D performers[168] (i.e. R&D investment divided by total sales, 7.5%) among the CIs. This is followed by "crafts" and "film, TV, video, radio & photography", among which more than half of claimed to undertake R&D, and at typically relatively high intensities. "Architecture", "publishing" and "music, performing and visual arts" all reach two-fifth participating in R&D, among which architecture firms typically had relatively higher R&D intensities than firms in the other two industries. "Museums, galleries and libraries" had the lowest participation in R&D as well as R&D intensity.

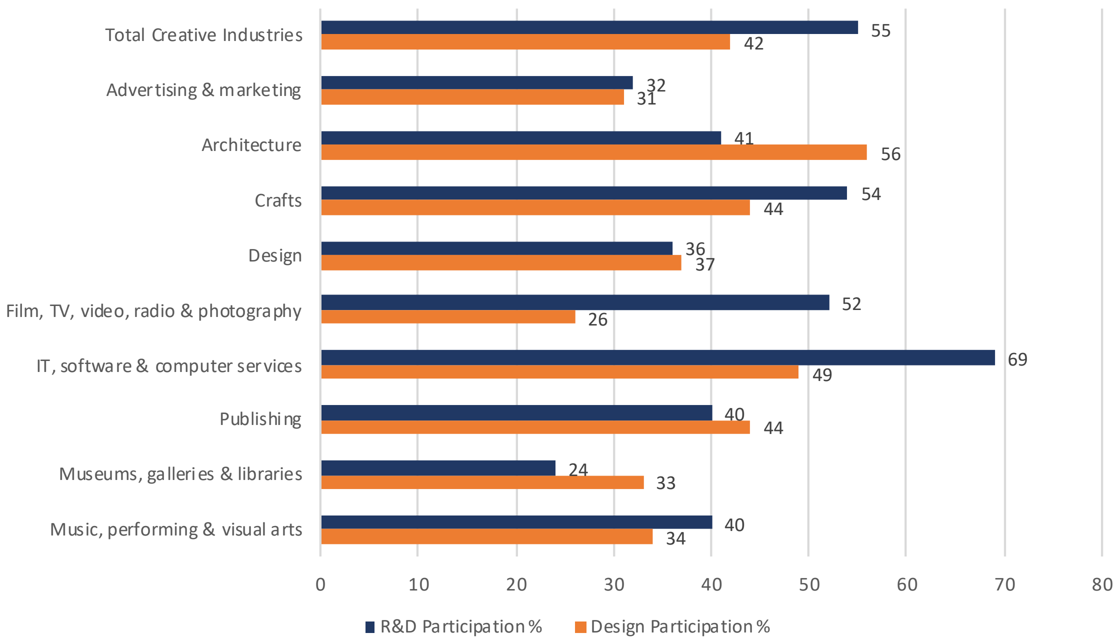
In addition to R&D, there are a number of other innovation activities the creative businesses could engage in, among which "any type of design" is the third most prevalent, with 42% of creative businesses having engaged in this (following 71% on

[167] A revised definition of R&D was proposed aiming to cover "all knowledge domains" (OECD, 2015) including those in relation to the Creative Industries.
[168] R&D intensity is calculated for those which reported R&D investments and total sales.

"computer hardware or software" and 49% on "licenses for technology or product/services"), for which the median of design intensity[169] (i.e. design investment divided by total sales) is 3.3%. By comparison, the proportions of creative firms engaging in "changes to marketing methods or product launch advertising", "training related specifically to developing new products/services", "market research" or "advanced machinery and equipment" range between 11% and 24%, substantially lower than the proportion investing in design.

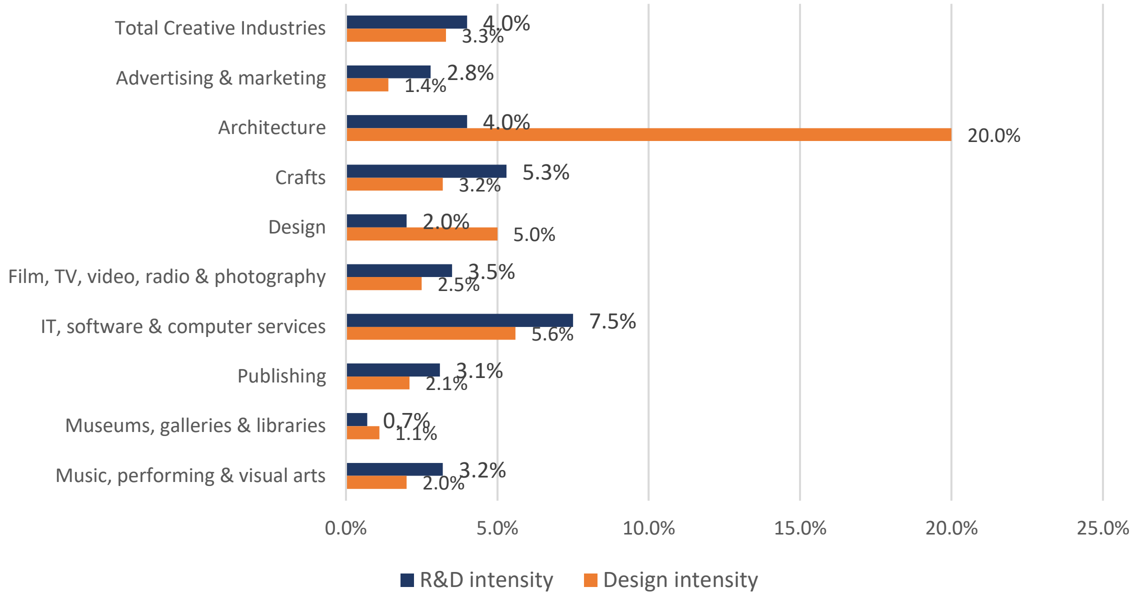
Design investment was especially widespread in "architecture" (Bird, et al., 2020). "IT, software and computer services" demonstrated once again its extensive interest, this time in design. Surprisingly, "design" companies reported less participation in design investment (albeit being the third highest sector in terms of design intensity), below that of "publishing" or "crafts", and even the average for all the CIs. While "architecture" had the highest design intensity (i.e. 20%), most creative industries reported a design intensity of less than 2.5%.

Figure 8 R&D and design participation by sub-sector from R&D in Creative Industries Survey 2020



[169] Design intensity is calculated for those which reported design investments and total sales.

Figure 9 R&D and design intensity by sub-sector from R&D in Creative Industries Survey 2020



Variances of export and the associated activities

What causes variations in exporting behaviours and performance within the creative industries? There is little creative industries specific literature on this, but we can draw on what is understood about exporting and non-exporting firms more generally.

Which firms export?

It is well-documented in international trade literature that export has occurred in a small proportion of businesses across economies; it is not random but in relation to higher productivity and wages, higher skill and capital intensity, and larger firm size (see Bernard et al. (2012) for a review of empirical evidence). Nevertheless, there are debates on whether higher productivity leads to exporting or whether exporting improves productivity.

The “self-selection” hypothesis considers that better performance leads to exporting (Bernard & Jensen, 1999). When exposed to opportunities to export, the most proficient firms, which are also the most productive, will be able to export and benefit from this, given the costs and barriers of entry into export market; some proficient/productive firms will remain domestic; and the least productive firms will exit the market (Melitz, 2003).

Reverse causation contends alternatively that higher productivity is at least in part the consequence of export participation. Baldwin and Gu (2004) identified three main mechanisms that this may involve (using a longitudinal sample of Canadian manufacturing plants): (1) learning by exporting – knowledge, information and international best practices could be obtained through export participation and thus enhance capabilities for survival and growth; (2) exposure to international competition – foreign competition creates additional incentive to be more productive and competitive; and (3) exploitation of scale economies enabled by increased product specialisation, technology use or innovation – productivity grows as a result of innovation, reduced product diversification (i.e. specialisation is elevated) or better command of technology, after entry into export market to take advantage of economies of scale[170].

Nonetheless and notably, as also implied by Baldwin and Gu’s discussion (2004), the validity of these mechanisms seems to be subject to the intensity of competition or

[170] There is also a cost spreading benefit. The margin cost of providing the same product to export markets as has been developed for domestic markets is presumably low.

level of technological advance of the domestic economy that is relative to the destination economy. For example, among the attempts to test whether growth of productivity is encouraged by exporting, Bernard and Jensen (2004) did not find evidence in the US manufacturing plants, nor did Arnold and Hussinger (2005) for German manufacturing firms; and Delgado, et al. (2002) found evidence "rather weak, and limited to younger exporters" in Spain – empirical evidence mostly support the "self-selection" hypothesis (in industrialised economies) (see Wagner (2007) for a review).

Conceptually, instead of a unidirectional causation, we consider it is more likely to be that productivity and exporting jointly determine each other in reality. That is, the two aforementioned mechanisms probably work concurrently.

Innovation and exporting

Firms' productivity is related to a number of factors including their innovation activities (Griffith, et al., 2006; Griliches, 1998; Foster, et al., 2008). Therefore, innovation could be connected with exporting through its association with productivity (Cassiman & Golovko, 2011; Cassiman, et al., 2010; Lileeva & Trefler, 2010; Costantini & Melitz, 2008).

A firm's innovative output (e.g. introduction of new/improved products/services, and/or intellectual properties such as patents, trademarks and registered designs) is partially determined by its inputs to innovation. At the same time, a firm's other strategic decisions and activities, such as exporting could influence both whether the company invests in innovation and how much it invests in innovation. Furthermore, these other activities can impact on the effectiveness/efficiency of the inputs and hence the innovative output. Thus, it can be argued that innovation and export "reinforce each other in a dynamic virtuous circle" (Golovko & Valentini, 2011). That is, they are probably both the cause and consequence of each other – innovation and exporting may co-determine each other in the sense that innovation empowers companies to join or flourish in export markets, while exposure to export market enhances innovation activities and/or outcomes.

Existing empirical studies – R&D/design and exporting

Given their basis in "individual creativity" (DCMS, 2001), compared to otherwise similar firms, businesses in the CIs compared to otherwise similar firms can be expected to place emphasis on building and mobilising creative capabilities and resources, which are typically of R&D and design activities (OECD and Eurostat, 2018). Therefore, R&D and design can be expected to be at least as relevant to the exporting of creative industries firms as those in other industries. Specifically, R&D and/or design activities can channel creativity into products and services that appeal to target customers, including those in international markets.

Studies have identified associations between export and "innovation", mostly as new product/process introduction (Wakelin, 1998a; Basile, 2001; Cassiman, et al., 2010)[171] or R&D (Aw, et al., 2008; Harris & Li, 2009), typically in context of manufacturing.

Non-R&D inputs into innovation have been largely neglected. The issue of understanding innovation entirely through R&D (which is treated as an exogenous variable) concerns: (1) this activity may not be systematically documented in micro and small firms; (2) even if it is true that innovations are "the product" of R&D, they do not necessarily occur without other innovative inputs (which implies that the effects of R&D may have been overestimated if these other inputs are not taken into account); (3) R&D is concentrated in a relatively small percentage of industries across the economy, and within these industries a few companies.

In contrast to the extensive evidence on R&D (Tomiura, 2007; Ito & Pucik, 1993; Esteve-Pe´rez & Rodrı´guez, 2013; Barrios, et al., 2003; Di Cintio, et al., 2017), relatively scarce research has addressed design's association with exporting.

Sterlacchini (1999) has considered the relationship between innovation and export in non-R&D intensive industries, where unusually, design was included as an indicator of innovation – "the ratio of expenditure on design, engineering and trial production to sales"; and this variable was found to have a positive association with export performance. Later, Nassimbeni (2001) found "design technologies" (as the only one among the seven "technology levers") and "new design" (as one of the three dimensions of product innovation) could help discriminate between exporters and non-exporters among small Italian manufacturing firms. Meanwhile, Gemser and Leenders (2001) have examined whether firm-level (industrial) design intensity is associated with the export sales (in percentage of turnover) of Dutch firms they found evidence for this association in one industry (precision instruments) but not in another (furniture). Also notable is that a study on the US machine tool companies indicated

[171] Basile (2001) conceptualised product/process innovations as indicators of "R&D strategies".

that a foreign-demand-oriented design strategy can lead to stronger export results (MacPherson, 2000).

In a recent report by Roper (2018) on the relationship between design investment, innovation and productivity (based on the UK Innovation Survey), engagement in design and engagement in exporting were both found to be linked to product/service innovation – in SMEs but not large firms, regardless of being R&D or non-R&D performers, within manufacturing or non-manufacturing industries.

A survey conducted in Denmark (Danish Design Centre, 2003) suggested that export intensity (i.e. share of turnover from exports) rises as the complexity of design use within companies is elevated from “non-design”, “design as styling”, “design as process” to “design as innovation”; the export intensity of the most complex design users is twice that of the least complex design users. Notably, a higher export intensity linked to design use was found in “production”, whereas a negligible difference of such was observed in “commerce/service”. Classified by no/external/in-house/both design employment, the first group of companies is linked to an export intensity that is higher than the second group but lower than the third group; while the last group has the highest export intensity that is twice and nearly twice that of the second and first group.

The association between design and exporting is arguably supported by the findings of other surveys that design is positively linked to firms’ internationalisation (Cereda, et al., 2005; Ciriaci, 2011; Aschhoff, et al., 2013). Nevertheless, in general, existing evidence on this relationship is insufficiently developed, especially given (1) the lack of evidence on design explicitly rather than that merged with other preparation of development/innovation (Sterlacchini, 1999; Aschhoff, et al., 2013); (2) the lack of precision for the identification of exporting, as opposed to internationalisation of market (Ciriaci, 2011) or innovation activities (Aschhoff, et al., 2013) – which are arguably in favour of the association between design and exporting; (3) the concentration in one or two manufacturing industries (Gemser & Leenders, 2001; MacPherson, 2000), which are not necessarily representative of all industrial sectors; and (4) the report of relevant evidence is not only relatively scarce in terms of quantity of literature, but has also made little progress in recent years (to the best of our knowledge).

In summary, as indicated by the literature reviewed above, most of the CIs are tradable (to varying extents); they are as likely to be engaged in a series of innovation activities as manufacturing, among which R&D and design, notably, comprise “creative work”; and R&D or design can be associated with firms’ exporting (as evidenced mostly in manufacturing industries; although a positive relationship may sometimes depend on firm size, sub-sectors and/or how exporting/R&D/design is measured). Therefore, we expect that exporters in the creative industries share similar characteristics with typical exporters in respect of engagement in innovation activities, especially R&D and design; and therefore, it is proposed in this paper that:

H1 R&D engagement is positively associated with exporting among firms in the Creative Industries.

H2 Design engagement is positively associated with exporting among firms in the Creative Industries.

H3 The exporting of the firms in the Creative Industries varies with the tradability of their activities.

Methods

Data

To explore exporting among Creative Industry organisations, this study uses the data collected through the DCMS-commissioned survey that was carried out by OMB Research in early 2020,[172] almost entirely (97%) before the UK entered into its first COVID-19 "lockdown". This is the same dataset that is examined in the aforementioned report by Bird and colleagues (2020).

Disproportionate stratified random sampling was applied – the sample, which consists of private companies, charities and not-for-profit organisations (i.e. excluding public sector organisations) was sourced from Dun & Bradstreet, and stratified by number of employees and sub-sectors of the Creative Industries such that larger businesses and some sub-sectors were intentionally over-sampled in order for them to be sufficiently represented. A total number of 625 interviews were conducted with all respondents being someone with significant responsibility for running the business or organization. Interviewing was conducted using Computer Assisted Telephone Interviewing.

Measures

Dependent variables

With regard to exporting, the survey asked if the organization had any sales outside of the UK in the last 12 months (i.e. export dummy), and the percentage of these sales within its total sales (which in combination of annual turnover gives the approximate value of these exports). Whether export, and value of exports are our key variables of interest.

Independent variables

In respect to R&D engagement, the survey asked whether the organisation had undertaken R&D over the last year (i.e. R&D dummy), and how much had been invested in R&D in the last year (i.e. value of R&D investment). The survey also asked respondents whether their organization had undertaken, in the last 12 months, basic

[172] From 13th February to 31th March

research (“work undertaken primarily to acquire new knowledge without a specific application in mind”), applied research (“work undertaken to acquire new knowledge with a specific application in mind) and/or experimental development (“work drawing on knowledge gained from research or practical experience, for the purpose of creating new or improved products or processes”). Dummy variables for each of these were coded. Furthermore, the survey asked about more narrowly defined R&D activities that have been recognized by the HM Revenue and Custom (HMRC)’s R&D tax relief scheme, namely, “activities which aim to advance science or technology by resolving scientific or technological uncertainties” (i.e. HMRC-defined R&D dummy). Respondents were informed that: “An advance in science or technology means an advance in overall knowledge or capability in a field of science or technology. The purpose of this may be, for example, to introduce a new product, service or process, or to significantly improve an existing product, service or process.”

Regarding design engagement, the survey asked if the organisation had invested in “any type of design” “for the purposes of current or future new product or service development, over the last year”, as well as the estimate of spending on any forms of design in the last 12 months (i.e. value of design investment).

In addition to design, the same engagement question was also asked in relation to six other innovation activities: (1) advanced machinery and equipment, (2) computer hardware or software, (3) licenses for technology or products/services, (4) training related specifically to developing new products or services, (5) market research, and/or (6) changes to marketing methods or product launch advertising. These six dummy variables will also be included as they may confound the effects of design and/or R&D. The value of investments in these activities was not asked for.

The variances of tradability within the CIs are expected to be captured by sub-sector indicators.

Other structural variables will be added into the models as well. Organistional size is measured by (the natural logarithm of) the number of employees. Firm age is measured by a five-category variable. Nature of organisation is indicated by a binary variable which separates private companies and charities/ not-for-profit organisations[173]. Regional dummies are included to control for the potential influence of regional inequalities in exporting.

[173] There is no public sector organisation involved in the sample.

Analytical approach

The analysis will start by reporting and discussing the descriptive statistics of the sample, and then move on to regressions.

Since most organisations do not export, and exports are concentrated among exporters – this study applies a "two-stage approach" (Dosi, et al., 2015; Roper & Love, 2002; Sterlacchini, 1999; Wakelin, 1998a) to examine mainly the association between R&D/design and exporting. Stage one estimates a dummy variable that indicates whether or not a firm exports, using Probit Regressions; and stage two estimates the value of exports (natural logarithm)[174], conditional on being an exporter, using OLS estimation. The independent variables that are regressed on export dummy are also examined on value of exports, albeit it is recognised that variables which are associated with entry into exporting do not necessarily influence their subsequent exporting performance, and vice versa (Harris and Li, 2009).

To begin with the Probit Regressions, the first regression tests the propensity to export using merely structural characteristics. The second regression examines the association between export dummy and participation in R&D or design, controlling participation in the 6 other innovation related activities. Taking advantage of the disaggregation of R&D in this survey, three dummy variables that indicate respectively the three specific components of R&D are included in the second regression instead of the "R&D dummy", while other variables remain. Likewise, the HMRC-defined R&D is also tested in the third regression. For all these regressions – organisational size, age, nature of organisation, sub-sectors and regions are included.

The same set-up is then applied to the estimation of value of exports (conditional on being an exporter).

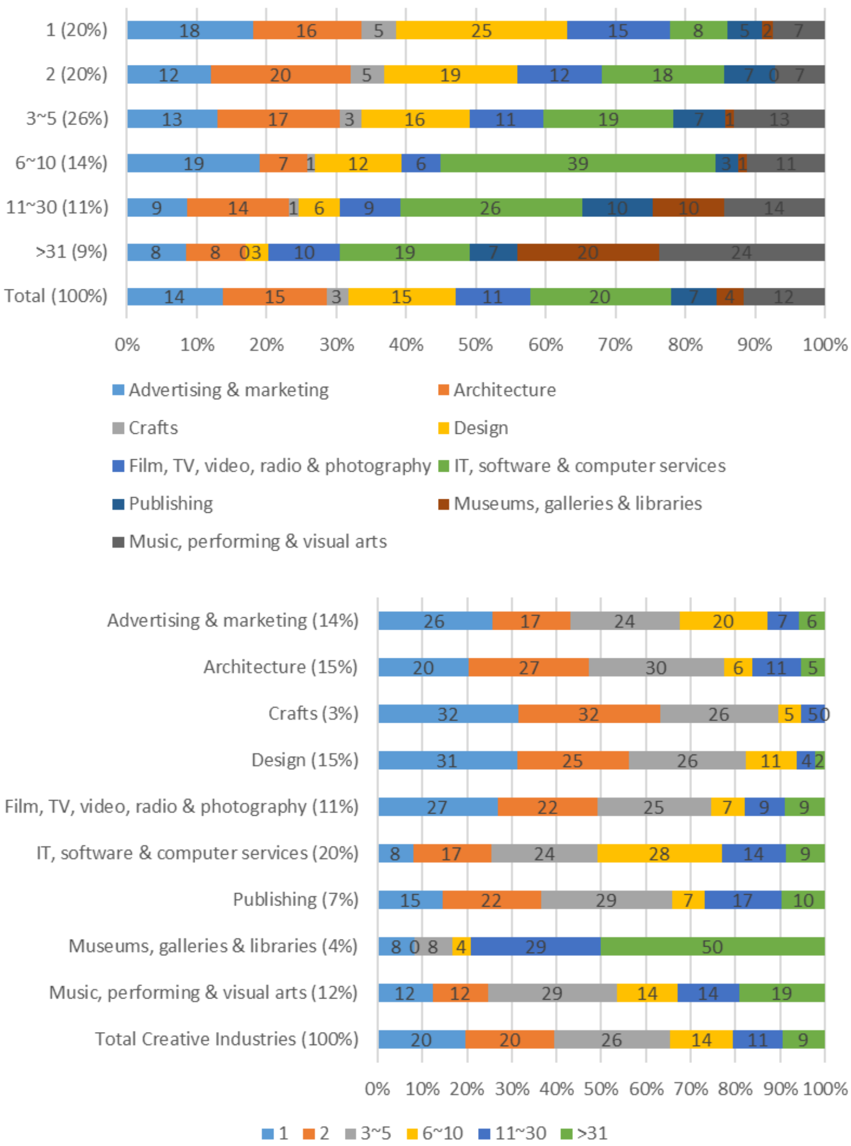
[174] The log transformed value of exports meets the assumption of normal distribution and uniform variance for the dependent variable of a linear regression using OLS approach.

Results

Descriptive statistics

The distribution of sample by sub-sectors and size is as illustrated in Figure 10. The most common size of the organisations is between three to five people; one and two-person organisations account for 40% of the sample, and they are more frequent in “crafts”, “design” and “film, TV, video, radio & photography”. “IT, software and computer services” represents the largest part (20%) of the sample and they most frequently have six to ten employees. “Crafts”, “museums, galleries and libraries” and “publishing” account for the smallest portions of the sample.

Figure 10 Sample descriptives - size band by sub-sector (%)



In terms of the three key variables of interest: above 40% of the sample claimed they had exported, while similar proportions had engaged in both R&D and design. Around 30% of the sample reported the exact value of their exports, R&D investments and design investments (Table 72)[175]. Among those whose value of exports/R&D investment/design investment could be identified, more than 60% reported zero; the distribution of exports/R&D investments/design investments is positively skewed, which indicates they are more concentrated at lower values (Table 73).

Table 72 Number and percentage of valid cases for the dichotomous and continuous measures of export, R&D and design

		Export		Design		R&D	
Participation	No	358	(57%)	369	(59%)	339	(54%)
	Yes	263	(42%)	256	(41%)	280	(45%)
	Missing	4	(1%)	0	(0%)	6	(1%)
	Total	625	(100%)	625	(100%)	625	(100%)
Value	0	358	(57%)	369	(59%)	339	(54%)
	>0	183	(29%)	207	(33%)	225	(36%)
	Missing	84	(13%)	49	(8%)	61	(10%)
	Total	625	(100%)	625	(100%)	625	(100%)

Table 73 Value of exports, design investment and R&D investment

		Value of exports	Value of design investment	Value of R&D investment
N	Valid	541	576	564
	Zero (% of valid)	358(66%)	369(64%)	339(60%)
	Missing (% of total)	84(13%)	49(8%)	61(10%)
Mean		199181	45389	19472
Median		0	0	0
Mode		0	0	0
Std. deviation		1252201	388292	68384
Skewness (S.E.)		10.28(0.11)	13.39(0.10)	6.87(0.10)
Kurtosis (S.E.)		118.24(0.21)	192.30 (0.20)	63.44(0.21)
Percentiles	25	0	0	0
	50	0	0	0
	75	7100	4000	5000

The cross-tabulation between size-band and exporting status (Table 74) suggests that the propensity to export increase with organizational size, although not continuously, and peaks among organisations with 6 to 10 workers. Table 74 also shows that publishing organizations were the most likely to export, while architecture and "museums, galleries & libraries" were the least. This is considered in relation to the tradability of these sectors. The propensity to export also increases with

[175] The missing value of exports are mainly due to missing turnover. Some of the cases with missing value of design or R&D investments were able to give an interval of the corresponding spending. We therefore recoded these missing values as the median spending of the observed cases falling into the corresponding interval.

organizational age, at least initially; after a decade further longevity does not appear to have an impact on exporting.

Table 75 indicates that those which had introduced innovations or which had engaged in innovation activities demonstrate a greater tendency to export than non-innovators. The difference in export engagement is especially marked for participation in R&D activities, design or market research. The percentage of export participation is also higher among those that invested in changing their marketing methods, training (as an indicator of skills) or machinery and equipment (as an indicator of capital investment) than those which do not. However, each of these differences are smaller than those related to R&D, design or market research.

Furthermore, regardless of exporter status, the organisations typically invested more in design than R&D, although the amount of design investment is also more divergent than the value of R&D investment. Likewise, exporters on average invest more in R&D or design than non-exporters, but the values of their investments in these two activities appear to be more variable.

By contrast, computer hardware or software and licensing are the exceptions, with organisations investing in these being no more likely to export than non-investors.

Table 74 Organisational characteristics by exporter status

		Exporter		Total
		No	Yes	(Col %)
Size band	1	70%	30%	20%
	2	61%	39%	20%
	3~5	54%	46%	26%
	6~10	43%	57%	14%
	11~30	55%	45%	11%
	> 31	61%	39%	9%
Age	<2 years	60%	40%	2%
	2-5 years	62%	38%	7%
	6-10 years	53%	47%	20%
	11-20 years	58%	42%	34%
	> 20 years	58%	42%	37%
Nature of organisation	Charity/voluntary sector/NPO	74%	26%	11%
	Private company	56%	44%	89%
Sub-sector	Advertising & marketing	48%	52%	14%
	Architecture	87%	13%	15%
	Crafts	47%	53%	3%
	Design	56%	44%	15%
	Film, TV, video, radio & photography	54%	46%	11%
	IT, software & computer services	55%	45%	20%
	Publishing	25%	75%	7%
	Museums, galleries & libraries	71%	29%	4%
	Music, performing & visual arts	59%	41%	12%

Table 75 Innovation activities by exporter status

		Exporter		Total
		No	Yes	(Col%)
Innovator	Non-innovator	67%	33%	54%
	New-to-the-business	53%	47%	22%
	New-to-the-market	44%	56%	24%
R&D	No	66%	34%	55%
	Yes	48%	52%	45%
Basic research	No	60%	40%	79%
	Yes	51%	49%	21%
Applied research	No	65%	35%	64%
	Yes	48%	52%	36%
Experimental development	No	64%	36%	69%
	Yes	46%	54%	31%
HMRC-defined R&D	No	59%	41%	87%
	Yes	48%	53%	13%
Machinery	No	58%	42%	79%
	Yes	55%	45%	21%
Computer hardware/ software	No	59%	41%	34%
	Yes	57%	43%	66%
Licensing	No	59%	41%	51%
	Yes	56%	44%	49%
Training	No	59%	41%	74%
	Yes	53%	47%	26%
Any type of design	No	63%	37%	59%
	Yes	50%	50%	41%
Market research	No	62%	38%	74%
	Yes	47%	53%	26%
Marketing methods	No	60%	40%	66%
	Yes	52%	48%	34%
Value of R&D investment	Mean	13973	27333	
	Std. deviation	65176	72387	
	Skewness (S.E.)	9.34(0.13)	4.39(0.16)	
	Kurtosis (S.E.)	110.40(0.27)	21.91(0.32)	
Value of design investment	Mean	27341	70638	
	Std. deviation	255732	518708	
	Skewness (S.E.)	16.48(0.13)	10.65(0.16)	
	Kurtosis (S.E.)	286.22(0.27)	120.13(0.31)	

Meanwhile, for a better understanding of how engagement in exporting relates to engaging in design and R&D, a cross-tabulation of the three dummy variables is conducted and illustrated by Figure 11. This shows considerable co-occurrence of R&D, design and exporting. While R&D and design performers constitute almost 60% and 50% of the exporters respectively, nearly 40% of the exporters undertake both design and R&D. This suggests there may be some complementarity between design and R&D on exporting. This will also be examined in the next section.

The value of design investments, R&D investments and exports are also to some extent correlated with each other (Table 76).

The frequency distributions of more variables are shown in Table 77.

While some associations are (as expected) relatively high, none is so high as to preclude inclusion in the same statistical model.

Figure 11 Percentage of combined participation of export, R&D and design

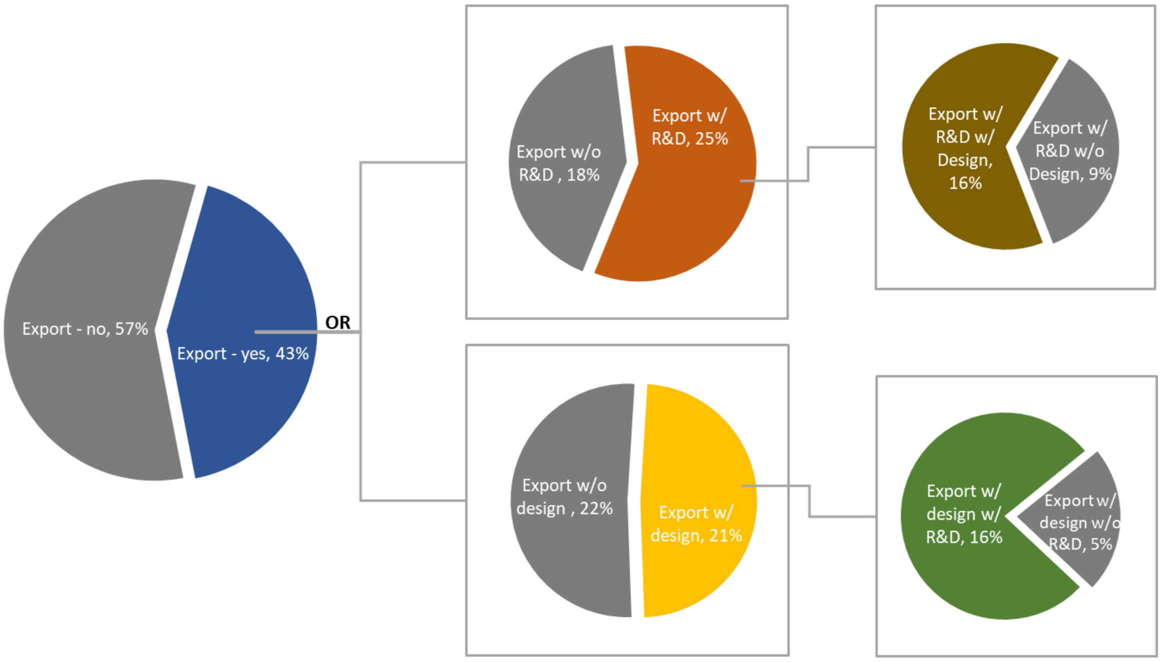


Table 76 Correlation matrix

	Design investment	R&D investment	Exports	Number of employees
Design investment	1.000			
R&D investment	0.435**	1.000		
Exports	0.209**	0.290**	1.000	
Number of employees	0.170**	0.235**	0.166**	1.000

Note: Spearman’s correlation coefficient; **p<0.05. The minimums for investments in design and R&D as well as exports are zero.

Table 77 Contingency tables

		Exporter		R&D		Basic research		Applied research		Experimental development		HMRC-defined R&D		
		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Total
Exporter	No													58%
	Yes													42%
R&D	No	36%	19%											55%
	Yes	22%	24%											45%
Basic research	No	48%	31%	54%	25%									79%
	Yes	11%	10%	1%	20%									21%
Applied research	No	41%	23%	54%	9%	58%	5%							64%
	Yes	17%	19%	1%	35%	21%	15%							36%
Experimental development	No	44%	25%	54%	15%	62%	7%	59%	10%					69%
	Yes	14%	17%	1%	30%	17%	14%	5%	26%					31%
HMRC-defined R&D	No	52%	35%	52%	35%	71%	16%	60%	28%	65%	23%			87%
	Yes	6%	7%	3%	10%	8%	5%	4%	9%	4%	8%			13%
Machinery	No	46%	33%	45%	34%	65%	14%	52%	27%	56%	23%	70%	9%	79%
	Yes	11%	9%	10%	11%	14%	7%	12%	9%	13%	8%	17%	4%	21%
Computer hardware/software	No	20%	14%	22%	12%	28%	6%	24%	9%	26%	8%	32%	2%	34%
	Yes	38%	29%	33%	34%	51%	15%	40%	27%	43%	23%	56%	11%	66%
Licensing	No	30%	21%	32%	19%	43%	8%	36%	15%	39%	12%	46%	5%	51%
	Yes	28%	22%	23%	26%	37%	12%	27%	21%	30%	19%	41%	8%	49%
Training	No	44%	30%	47%	27%	62%	12%	53%	21%	56%	19%	68%	6%	74%
	Yes	14%	12%	8%	18%	17%	9%	11%	15%	13%	12%	19%	6%	26%
Any type of design	No	37%	22%	41%	18%	50%	9%	46%	14%	48%	11%	54%	5%	59%
	Yes	20%	21%	14%	27%	29%	12%	18%	23%	21%	20%	33%	8%	41%
Market research	No	45%	28%	47%	27%	63%	11%	53%	21%	57%	17%	67%	7%	74%
	Yes	12%	14%	8%	18%	16%	9%	11%	15%	12%	14%	20%	6%	26%
Marketing methods	No	40%	26%	40%	26%	56%	11%	46%	21%	49%	17%	59%	7%	66%
	Yes	18%	16%	15%	19%	23%	10%	18%	16%	20%	14%	28%	6%	34%
Total		58%	42%	55%	45%	79%	21%	64%	36%	69%	31%	87%	13%	100%

		Machinery		Computer hardware/ software		Licensing		Training		Any type of design		Market research		Marketing methods.		
		No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Total
Computer hardware/software	No	30%	4%													34%
	Yes	50%	17%													66%
Licensing	No	43%	8%	28%	23%											51%
	Yes	37%	12%	6%	43%											49%
Training	No	61%	13%	29%	45%	43%	31%									74%
	Yes	18%	8%	5%	21%	8%	18%									26%
Any type of design	No	48%	11%	25%	34%	36%	23%	48%	11%							59%
	Yes	31%	10%	9%	32%	15%	26%	26%	15%							41%
Market research	No	61%	13%	28%	46%	40%	34%	59%	15%	49%	24%					74%
	Yes	19%	7%	6%	20%	11%	15%	15%	11%	10%	16%					26%
Marketing methods	No	55%	11%	26%	40%	37%	29%	52%	14%	45%	22%	56%	10%			66%
	Yes	24%	9%	7%	26%	13%	20%	22%	12%	14%	19%	18%	16%			34%
Total		79%	21%	34%	66%	51%	49%	74%	26%	59%	41%	74%	26%	66%	34%	100%

Note: N=621 except for R&D (N=616), basic research (N=610), applied research (N=608), experimental development (N=609) and HMRC-defined R&D (N=615). Structural variables are omitted for brevity.

Regressions

The results of Pobit regressions are reported in Table 78 and Table 79.

Column (1) indicates that larger organisations have greater propensities to export, all else equal.[176] For instance, the propensity is 10 percentage points higher for a 10-employee organisation than a one-person establishment (Figure 12). Age of the organisation is not found influence export propensity with other structural factors being controlled. By sector, publishing and architecture has the highest and lowest

[176] A curvilinear relationship between organisational size and export propensity was tested by including the number of employees and its quadratic term, which was not found significant.

propensity to export respectively which reflect differences in the tradability of these activities.

As indicated by column (2) and (3), participating in R&D activities is positively associated with a higher probability of being an exporter, within which applied research is most strongly associated with it. The R&D as defined by the HMRC also has a positive association with exporting (see column (4)). Meanwhile, among the 7 non-R&D innovative investments identified, only design demonstrates a significant positive connection to export participation.

Therefore, we tested further the pairwise interaction between R&D (applied research), HMRC-defined R&D and design by using 5 different groups of mutually exclusive dummy variables that indicate participation in these activities (i.e. regression A(5)-(9)). Furthermore, in order to understand if exporters invest differently in design or R&D, the value of these two investments (natural logarithms)[177] are tested (i.e. regression A(10)).

Table 79 suggests that when R&D (applied research) is controlled, the HMRC-defined R&D solely does not have significant effect on export participation (see column (5) and (6)). Moreover, design and R&D (applied research) in combination suggest a greater possibility to export than undertaking neither of them, or undertaking only one or other of them (see column (7) and (8)). The combination of HMRC-defined R&D and design also shows a higher propensity to export than engaging in neither or only one of them (see column (9)). Further, among those for which the value of investments in design or R&D can be identified (including those without such investments), there is a positive relationship between the value of design investment and the propensity to export, as well as between the value of R&D investment and export propensity (see column (10)). As illustrated by Figure 13, the probability of being an exporter rises by 7 percentage points from 38% to 45% when design investment increases from zero to £1,000; and the same investment in R&D is accompanied by around a 12-percentage-point increase (from 35% to 47%) in the probability.

[177] A negligible 1 is added to the value of design and R&D investment before taking the logarithms in order to include organisations not investing in these activities. Moreover, the transformation of the investments conforms to our assumption that an investment difference in a lower interval (e.g. £10k and £20k) will be more sensitive to the same amount of investment difference in a higher interval (e.g. £100k and £110K).

In terms of structural characteristics, larger organisations are found to be more likely to export (to varying significance levels) as estimated by most regressions in Table 78 and Table 79, except regression A(10). However, once investments in design and R&D are controlled for, the magnitude of which will typically be related to size, the significance of size as a direct influence on exporting drops out. This implies that for those which are not engaged in R&D or design, organisational size does not influence the probability to export. Not surprisingly, the tendency to engage in exporting is greater among private companies than in charities and not-for-profit organisations. In addition, export participation is not found distinguished by firm age. Meanwhile, there are some sub-sector variances. Compared to average CIs, publishers are much more likely to be exporting (i.e. more than 35 percentage points higher probability), architecture is much less likely to do so (i.e. more than 30 percentage points lower probability). “Advertising & marketing” and “music, performing & visual arts” also show higher propensities to export than the rest of the sectors.

The estimation of the value of exports (Table 80), which is conditional on being an exporter, does not find the export values are associated with R&D. Therefore, its interaction with design is not tested. However, we still control the value of R&D investment while examining the relationship between the value of design investment and the value of exports. Regression B(5) finds there is 1% increase in the value of exports when design investment increases by 10%. Meanwhile, the value of exports is higher for larger organisations.[178] That is, although smaller organisations are not significantly less likely to export than their larger counterparts when the value of design investment is controlled, the later achieve higher value of exports. Perhaps surprisingly, the value of exports is not found vary significantly among exporters in the different CI sectors.

[178] A curvilinear relationship between organisational size and the value of exports was tested by including the number of employees and its quadratic term, which was not found significant.

Table 78 Probit regression (1)-(4) on exporter status

	A: Probit regressions – exporter status			
	(1)	(2)	(3)	(4)
R&D participation				
R&D dummy		0.135***		
Disaggregate R&D (dummy variables)				
Basic research			-0.015	
Applied research			0.094*	
Experimental development			0.079	
HMRC-defined R&D participation				
HMRC-R&D dummy				0.112*
Investments for new products/services development (dummy variables)				
Advanced machinery & equip.		0.055	0.064	0.055
Computer hardware or software		-0.002	0.000	-0.008
Licenses for tech. or prod./serv.		-0.042	-0.046	-0.045
Training related to NP(S)D		-0.010	-0.006	0.006
Any type of design		0.127***	0.122***	0.153***
Market research		0.036	0.031	0.039
Mkt metho./prod. launch advert.		-0.028	-0.032	-0.021
Organisational size				
ln(NO. of employees)	0.049***	0.032**	0.030*	0.034**
Firm age (ref. >20 years)				
< 2 years	0.046	0.058	0.043	0.056
2-5 years	-0.044	-0.051	-0.052	-0.066
6-10 years	0.015	-0.008	-0.010	-0.001
11-20 years	-0.033	-0.042	-0.046	-0.035
Nature of organisation (ref. charity/voluntary sector/NPO)				
Private company	0.335***	0.337***	0.332***	0.336***
Sub-sectors (ref. IT, software or computer services)				
Advertising & marketing	0.086	0.171***	0.192***	0.136**
Architecture	-0.350***	-0.333***	-0.317***	-0.374***
Crafts	0.097	0.110	0.096	0.081
Design	0.030	0.084	0.092	0.064
Film, TV, video, radio, & photo.	0.057	0.108	0.123*	0.084
Publishing	0.319***	0.368***	0.378***	0.345***
Museums, galleries & libraries	-0.005	0.092	0.076	0.051
Music, performing & visual arts	0.076	0.115	0.134*	0.093
Model Chi-Square	104	133	129	127
Log likelihood	-370	-352	-345	-354
Pseudo R^2 (McFadden)	0.12	0.16	0.16	0.15
N	620	615	605	614

Note: The reported are average marginal effects. ***p<0.01, **p<0.05, *p<0.1. “ref.” indicates reference category. Region is controlled but not presented in the table for brevity.

Figure 12 Predicted probabilities of exporting by organisational size, as estimated by Probit regression (1)

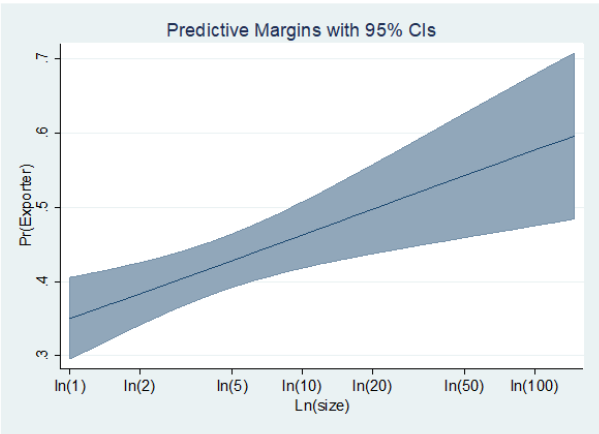


Table 79 Probit regression (5)-(10) on exporter status

	A: Probit regressions – exporter status					
	(5)	(6)	(7)	(8)	(9)	(10)
Combined participation of R&D & HMRC defined R&D (c.f. neither)						
R&D only	0.129***					
HMRC-R&D only	0.200					
Both R&D & HMRC-R&D	0.194***					
Combined participation of applied research & HMRC defined R&D (ref. neither)						
Applied research only		0.133***				
HMRC-R&D only		0.095				
Both App. Res. & HMRC-R&D		0.209***				
Combined participation of design & R&D (ref. neither)						
Design only			0.046			
R&D only			0.074			
Both design & R&D			0.267***			
Combined participation of design & applied research (ref. neither)						
Design only				0.133**		
Applied research only				0.146**		
Both design & applied research				0.267***		
Combined participation of design & HMRC-defined R&D (ref. neither)						
Design only					0.161***	
HMRC-R&D only					0.144#	
Both design & HMRC-R&D					0.250***	
Value of design/R&D investment						
ln(design)						0.010**
ln(R&D)						0.018***
Investments for new products/services development (dummy variables)						
Advanced machinery & equip.	0.056	0.059	0.057	0.062	0.053	0.061
Computer hardware or software	-0.006	-0.004	0.000	0.001	-0.009	-0.017
Licenses for tech. or prod./serv.	-0.044	-0.049	-0.042	-0.046	-0.046	-0.019
Training related to NP(S)D	-0.017	-0.013	-0.019	-0.007	0.005	-0.034
Any type of design	0.126***	0.126***				
Market research	0.022	0.020	0.036	0.032	0.040	0.026
Mkt metho./prod. launch advert.	-0.024	-0.029	-0.018	-0.031	-0.022	0.008
Organisational size						
ln(NO. of employees)	0.032**	0.029*	0.032**	0.030*	0.034**	0.027
Firm age (c.f. >20 years)						
< 2 years	0.070	0.057	0.058	0.047	0.056	0.042
2-5 years	-0.059	-0.066	-0.054	-0.058	-0.067	-0.059
6-10 years	-0.006	-0.002	-0.008	-0.007	0.000	-0.009
11-20 years	-0.042	-0.042	-0.044	-0.045	-0.034	-0.061
Nature of organisation (ref. charity/voluntary sector/NPO)						
Private company	0.340***	0.325***	0.329***	0.328***	0.336***	0.340***
Sub-sectors (ref. IT, software or computer services)						
Advertising & marketing	0.175***	0.186***	0.167***	0.180***	0.138**	0.219***
Architecture	-0.343***	-0.339***	-0.332***	-0.333***	-0.373***	-0.348***
Crafts	0.094	0.095	0.103	0.096	0.081	0.094
Design	0.095	0.099	0.084	0.086	0.065	0.086
Film, TV, video, radio, & photo.	0.091	0.117*	0.103	0.122*	0.084	0.141**
Publishing	0.368***	0.375***	0.366***	0.371***	0.349***	0.370***
Museums, galleries & libraries	0.090	0.073	0.066	0.066	0.050	0.111
Music, performing & visual arts	0.124	0.132*	0.110	0.124*	0.093	0.153**
Model Chi-Square	134	129	137	129	127	123
Log likelihood	-348	-344	-350	-347	-354	-298
Pseudo R^2 (McFadden)	0.16	0.16	0.16	0.16	0.15	0.17
N	610	602	615	607	614	528

Note: The reported are average marginal effects; ***p<0.01, **p<0.05, *p<0.1, #p=0.1. "ref." indicates reference category. Region is controlled but not presented in the table for brevity.

Figure 13 Predicted probabilities of exporting by value of design or R&D investment, as estimated by Probit regression (10)

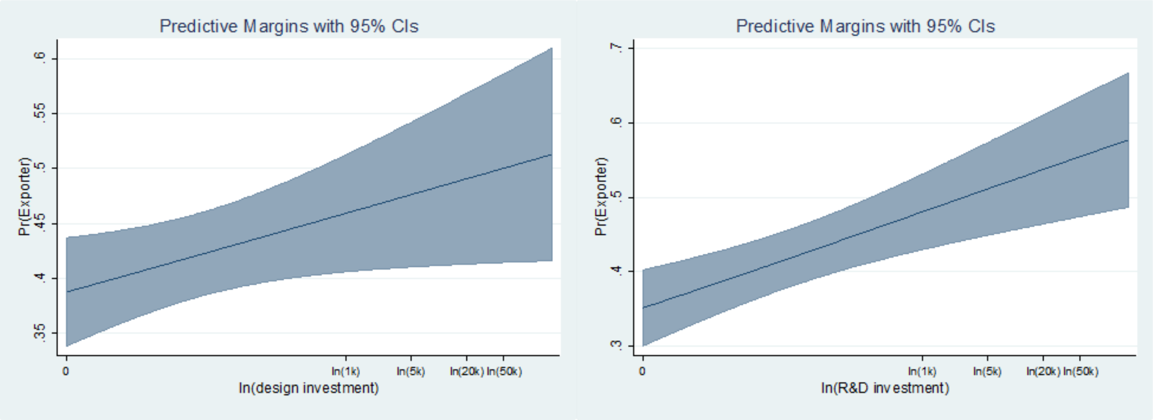


Table 80 Linear regression on value of exports

	B: Linear regressions – ln(export value), export value>0				
	(1)	(2)	(3)	(4)	(5)
R&D participation					
R&D dummy		0.074			
Disaggregate R&D (dummy variables)					
Basic research			-0.236		
Applied research			0.000		
Experimental development			-0.071		
HMRC-defined R&D participation					
HMRC-R&D dummy				-0.097	
Value of design/R&D investment					
ln(design)					0.108**
ln(R&D)					0.030
Investments for new products/services development (dummy variables)					
Advanced machinery & equip.		-0.097	-0.111	-0.113	-0.145
Computer hardware or software		0.327	0.331	0.330	0.218
Licenses for tech. or prod./serv.		-0.521	-0.618	-0.513	-0.695
Training related to NP(S)D		0.300	0.347	0.406	0.272
Any type of design		0.797**	0.947**	0.814**	
Market research		-0.136	-0.076	-0.116	-0.154
Mkt metho./prod. launch advert.		-0.350	-0.331	-0.317	-0.581
Organisational size					
ln(NO. of employees)	1.140***	1.112***	1.113***	1.078***	1.062***
Firm age (ref. >20 years)					
< 2 years	1.027	1.507	1.657	1.493	1.860
2-5 years	0.155	0.360	0.299	0.290	0.499
6-10 years	0.574	0.385	0.397	0.444	0.541
11-20 years	0.641	0.616	0.566	0.632	0.590
Nature of organisation (ref. charity/voluntary sector/NPO)					
Private company	1.526*	1.829**	1.857**	1.759**	1.802**
Sub-sectors (ref. IT, software or computer services)					
Advertising & marketing	0.087	0.398	0.317	0.324	0.757
Architecture	0.693	0.409	0.219	0.452	0.750
Crafts	0.383	0.444	0.388	0.406	0.487
Design	-0.260	-0.001	-0.108	-0.057	0.406
Film, TV, video, radio, & photo.	-0.090	0.208	0.414	0.161	0.457
Publishing	-0.473	-0.295	-0.373	-0.179	-0.022
Museums, galleries & libraries	-1.785	-1.063	-1.261	-1.153	-0.769
Music, performing & visual arts	0.052	0.251	0.191	0.180	0.535
Constant	7.440***	6.597***	6.815***	6.799***	6.365***
R^2	0.39	0.43	0.44	0.42	0.43
N	183	181	177	183	160

Note: The reported are coefficients. ***p<0.01, **p<0.05, *p<0.1. "ref." indicates reference category. Region is controlled but not presented in the table for brevity. Among exporters, there is a bias in the reporting of turnover such that organisations that are 2-5-year-old, and that are active in architecture and the museums/galleries/libraries sector were significantly less likely (at the 5% level or higher) to report their turnovers in the previous year; therefore they are less likely to be assigned a value figure for their exports. As such, the results may be less generalizable to organisations with these characteristic than other creative industry organisations.

Discussion and concluding remarks

Consistent with existing evidence for industries in general, the analysis here finds organisational size positively associated with both the propensity to export and the value of exports among creative industry organisations. Organisational age is not however found to affect exporting. Smaller organisations in the CIs are less likely to export unless they invest as much as their larger counterparts in design or R&D. Size related constraints may limit the ability of small organization to export, especially in the short-run. However, all else equal, greater investment in design is associated with higher export sales. The value of exports is not found to be related to the subsector of activity but the propensity to export is. Publishing businesses are the most likely to sell overseas, followed by “advertising and marketing” businesses; architecture firms are the least likely to export among the CIs. These sub-sectoral differences reflect differences in tradability. Therefore, H3 is partially supported.

Design investments are positively associated with both the propensity to participate in exporting and the value of exports. These results support H2 and add to empirical evidence of the relationship between design and exporting. Meanwhile, H1 is partially supported: R&D investments are positively associated with the propensity to be an exporter, although they are not found to be related to the value of exports for those that export.

While substantial existing evidence has pointed to a positive relationship between R&D and exporting (which have been measured in various ways), the analysis here does not find R&D investments to be associated with the value of exports among exporter in the CIs. The absence of a link between R&D investments and the value of exports in some part of the economy probably provides circumstantial evidence to the argument that R&D input should not be regarded as the “panacea” for innovation (measurement) – non-R&D innovation inputs as well as their relationship with exporting can be also worthy of note. They could potentially help unlock unrecognised innovation capabilities and/or mechanisms of growth for businesses in an increasingly diversified economy. On the other hand, as noted under Table 80, due to that the respondents within certain age group and industries in the CIs (which account for a small part of the population) are less likely to report turnover based on which we captured the value of exports, they are relatively underrepresented in the corresponding sample, which might result in less precise estimates within these groups. While this is a limitation of the study, achieving a truly representative sample is typically difficult in practice.

Investing in design and R&D (within which applied research) are both associated with export participation. Investing in both applied research and design is particularly strongly associated with export participation, more so than engaging in only one of these activities, implying that there may be a complementarity. However, it is important to recognise that the analysis here is associative rather than causal. We cannot say that investing (more) in design and applied research necessarily leads to entry into export market. We can say that organisations investing in both of these activities (and investing slightly more) are more likely to export than otherwise similar organisations. This finding is perhaps unsurprising given that these investments are more likely to be recovered by serving larger markets, which exporting implies. On the one hand, design and R&D (within which applied research emphasises on the work undertaken with a specific application in mind) both comprise creative work, the combination of which seems to be especially likely to generate differentiated goods or services that appeal to different customer groups such as those in different geographical markets. On the other hand, exporters compared to their counterparts may be more demanding of and more capable to create the synergies (Haskel & Westlake, 2017) of various inputs, including that between design and applied research.

This study does not find that investment in skill (through training) or capital equipment is associated with exporting by creative industry organisations. These are measures of investments, and therefore flows, rather than measures of skill and capital endowments; that are of stocks. Because of a lack of data we do not know if skill or capital endowments are associated with exporting in the CIs. Moreover, in the Creative Industries, learning-by-doing is probably more common than formal training; to some extent this can be captured by organisational age.

In terms of guidance to practitioners, the analysis suggests that those who want to export:

(1) are encouraged to think about the tradability of their activities, and possible seek to enhance their tradability by considering how their goods and services are packaged and delivered.
(2) can consider investing, and investing more, in design and applied research. Although our analysis does not identify what design activities or applied research activities should be undertaken, it is clear that if the goal is to export

then design and research activities related to targeted overseas markets would be wise. Further, it would appear there are benefits to do both design and applied research, rather than one or the other. The good news is that large investments are not required: modest investments in design and R&D can pay off significantly.

In relation to policy development, our analysis suggests that if the policy goal is to expand both the number of UK creative industry firms engaged in exporting and the value of those exports then:

(1) focus on the more tradable sub-sectors and reducing the barriers to trade in the less tradable sub-sectors (e.g. regulatory differences limiting the ability of architects to export)

(2) not to neglect design. The UK now has an ambitious target to increase investment in R&D as a proportion of GDP to 2.4% by 2027 (from around 1.7%) (ONS, 2021). The analysis here indicates that while R&D is associated with the propensity to export, so is design, and indeed the "winning combination" seems to be a combination of R&D and design. Again the good news is that modest investment in design can be highly beneficial. There is a danger that in seeking to deliver on this ambitious target for R&D investments, investment in other intangible activities and assets, such as design, will be starved due to a crowding out effect. Policymakers are urged to understand what other investments would complement the additional investment in R&D so that the overall investment has the maximum benefit to the UK economy and society.

(3) not to neglect micro businesses. Most UK businesses are micro businesses, and we can see from this and other analyses that some of these at least have the capacity to export, as well as engage in innovation activities. This is particularly true of micro enterprises in the Creative Industries.

References

Arnold, J. M. & Hussinger, K., 2005. Export behavior and firm productivity in German manufacturing: a firm-level analysis. *Review of World Economics,* 141(2), pp. 219-243.

Aschhoff, B. et al., 2013. *Innovation in Germany - results of the Germany CIS 2006 to 2010,* Mannheim: ZEW.

Aw, B. Y., Roberts, M. J. & Xu, D. Y., 2008. R&D investments, exporting, and the evolution of firm productivity. *American Economic Review,* 98(2), pp. 451-456.

Baldwin, J. R. & Gu, W., 2004. Trade liberalization: export-market participation, productivity growth, and innovation. *Oxford Review of Economic Policy,* 20(3), pp. 372-392.

Barrios, S., Görg, H. & Strobl, E., 2003. Explaining firms' export behaviour: R&D, spillovers and the destination market. *Oxford Bulletin of Economics and Statistics,* 65(4), pp. 475-496.

Basile, R., 2001. Export behaviour of Italian manufacturing firms over the nineties: the role of innovation. *Research Policy,* 30(8), pp. 1185-1201.

Bernard, A. B. & Jensen, J. B., 1999. Exceptional exporter performance: cause, effect, or both?. *Journal of International Economics,* 47(1), pp. 1-25.

Bernard, A. B. & Jensen, J. B., 2004. Exporting and productivity in the USA. *Oxford Review of Economic Policy,* 20(3), pp. 343-357.

Bernard, A. B., Jensen, J. B., Redding, S. J. & Schott, P. K., 2012. The empirics of firm heterogeneity and international trade. *Annual Review of Economics,* 4(1), pp. 283-313.

Bird, G., Gorry, H., Roper, S. & Love, J., 2020. *R&D in creative industries survey - 2020: research report,* Kent: OMB Research Limited.

Cassiman, B. & Golovko, E., 2011. Innovation and internationalization through exports. *Journal of International Business Studies,* 42(1), pp. 56-75.

Cassiman, B., Golovko, E. & Martinez-Ros, E., 2010. Innovation, exports and productivity. *International Journal of Industrial Organization,* 28(4), pp. 372-376.

Cereda, M., Crespi, G., Criscuolo, C. & Haskel, J., 2005. *Design and company performance: Evidence from the Community Innovation Survey,* s.l.: DTI Report.

Ciriaci, D., 2011. *Design and European firms' innovative performance: A less costly innovation activity for European SMEs?,* s.l.: Joint Research Centre of the European Commission.

Cohen, W. M. & Levinthal, D. A., 1990. Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly,* 35(1), pp. 128-152.

Costantini, J. A. & Melitz, M. J., 2008. The dynamics of firm-level adjustment to trade liberalization. In: E. Helpman, D. Marin & T. Verdier, eds. *The organization of firms in a global economy.* Cambridge, Mass.: Harvard University Press, pp. 107-141.

Danish Design Centre, 2003. *The economic effects of design,* Copenhagen: s.n.

DCMS, 2001. *DCMS, 2001. Creative Industries Mapping Documents 2001.* [Online]
Available at: https://www.gov.uk/government/publications/creative-industries-mapping-documents-2001
[Accessed 11 September 2020].

DCMS, 2016. *DCMS Sectors Economic Estimates Methodology.* [Online]
Available at: https://www.gov.uk/government/publications/dcms-sectors-economic-estimates-methodology#history
[Accessed 12 October 2020].

DCMS, 2019a. *DCMS Sectors Economic Estimates 2018: Employment.* [Online]
Available at: https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2018-employment
[Accessed 14 September 2020].

DCMS, 2019b. *DCMS Sectors Economic Estimates 2017: Trade.* [Online]
Available at: https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2017-trade
[Accessed 11 September 2020].

DCMS, 2019c. *DCMS Sectors Economic Estimates 2017: GVA.* [Online]
Available at: https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2017-gva
[Accessed 11 September 2020].

DCMS, 2019d. *DCMS Sectors Economic Estimates 2017: Business Demographics.* [Online]
Available at: https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2017-business-demographics
[Accessed 11 September 2020].

DCMS, 2020. *DCMS Sectors Economic Estimates 2018: Business Demographics.* [Online]
Available at: https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2018-business-demographics
[Accessed 14 September 2020].

Delgado, M. A., Fariñas, J. C. & Ruano, S., 2002. Firm productivity and export markets: a non-parametric approach. *Journal of International Economics,* 57(2), pp. 397-422.

Di Cintio, M., Ghosh, S. & Grassi, E., 2017. Firm growth, R&D expenditures and exports: an empirical analysis of italian SMEs. *Research Policy,* 46(4), pp. 836-852.

Dosi, G., Grazzi, M. & Moschella, D., 2015. Technology and costs in international competitiveness: from countries and sectors to firms. *Research Policy,* 44(10), pp. 1795-1814.

Eaton, J. & Kortum, S., 2019. Trade in goods and trade in services. In: *World trade evolution: growth, productivity and employment.* New York: Routledge, pp. 82-125.

Egger, P. H., Larch, M. & Staub, K. E., 2012. *Trade preferences and bilateral trade in goods and services: a structural approach,* s.l.: CEPR Discussion Paper No. DP9051.

Ellison, G. & Glaeser, E. L., 1999. The geographic concentration of industry: does natural advantage explain agglomeration?. *American Economic Review,* 89(2), pp. 311-316.

Esteve-Pe´rez, S. & Rodrı´guez, D., 2013. The dynamics of exports and R&D in SMEs. *Small Business Economics,* 41(1), pp. 219-240.

Fazio, G., 2021. *A review of creative trade in the economics literature,* London: Nesta.

Foster, L., Haltiwanger, J. & Syverson, C., 2008. Reallocation, firm turnover, and efficiency: selection on productivity or profitability?. *American Economic Review,* 98(1), pp. 394-425.

Gemser, G. & Leenders, M. A. A. M., 2001. How integrating industrial design in the product development process impacts on company performance. *Journal of Product Innovation Management,* 18(1), pp. 28-38.

Gkypali, A. & Roper, R. S., 2018. *What can we learn about the innovation performance of the creative industries from the UK Innovation Survey?.* [Online] Available at: https://media.nesta.org.uk/documents/Creative_industries_innovation_analysis.pdf [Accessed 16 September 2020].

Golovko, E. & Valentini, G., 2011. Exploring the complementarity between innovation and export for SME's growth. *Journal of International Business Studies,* 42(3), pp. 362-380.

Goto, K., 2017. Defining creative industries. In: S. Hemels & K. Goto, eds. *Tax incentives for the creative industries.* Singapore: Springer, pp. 11-20.

Griffith, R., Huergo, E., Mairesse, J. & Peters, B., 2006. Innovation and productivity across four European countries. *Oxford Review of Economic Policy,* 22(4), pp. 483-498.

Griliches, Z., 1998. *R&D and productivity: the econometric evidence.* Chicago: The University of Chicago Press.

Harris, R. & Li, Q. C., 2009. Exporting, R&D, and absorptive capacity in UK establishments. *Oxford Economic Papers,* 61(1), pp. 74-103.

Haskel, J. & Westlake, S., 2017. *Capitalism without capital.* s.l.:Princeton University Press.

Hill, P., 1999. Tangibles, intangibles and services: a new taxonomy for the classification of output. *The Canadian Journal of Economics / Revue canadienne d'Economique,* 32(2), pp. 426-446.

Ito, K. & Pucik, V., 1993. R&D spending, domestic competition, and export performance of Japanese manufacturing firms. *Strategic Management Journal,* 14(1), pp. 61-75.

Jensen, J. B. & Kletzer, L. G., 2005. Tradable services: understanding the scope and impact of services offshoring. *Brookings Trade Forum,* pp. 75-116.

Lileeva, A. & Trefler, D., 2010. Improved access to foreign markets raises plant-level productivity...for some plants. *The Quarterly Journal of Economics,* 125(3), p. 1051–1099.

MacPherson, A., 2000. The role of international design orientation and market intelligence in the export performance of US machine tool companies. *R&D Management,* 30(2), pp. 167-176.

Melitz, M. J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica,* 71(6), pp. 1695-1725.

Miles, I. & Green, L., 2008. *Hidden innovation in the creative industries,* London: NESTA.

Nassimbeni, G., 2001. Technology, innovation capacity, and the export attitude of small manufacturing firms: a logit / tobit model. *Research Policy,* 30(2), pp. 245-262.

OECD and Eurostat, 2018. *Oslo Manual 2018: guidelines for collecting, reporting and using data on innovation,* Paris: OECD Publishing.

OECD, 2015. *Frascati Manual 2015: Guidelines for collecting and reporting data on research and experimental development,* Paris: OECD Publishing.

ONS, 2021. *Gross domestic expenditure on research and development, UK: 2019.* [Online]
Available at: https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/latest
[Accessed 15 August 2021].

Roper, S., 2018. *Exploring the links between design investment, innovation and productivity,* s.l.: Enterprise Research Centre.

Roper, S. & Love, J. H., 2002. Innovation and export performance: evidence from the UK and Germany manufacturing plants. *Research Policy,* 31(7), pp. 1087-1102.

Sterlacchini, A., 1999. Do innovative activities matter to small firms in non-R&D-intensive industries? An application to export performance. *Research Policy,* 28(8), pp. 819-832.

Tomiura, E., 2007. Effects of R&D and networking on the export decision of Japanese firms. *Research Policy,* 36(5), pp. 758-767.

UNCTAD, 2018. *Creative economy outlook: Trends in international trade in creative industries,* s.l.: United Nations.

Wagner, J., 2007. Exports and productivity: a survey of the evidence from firm-level data. *The World Economy,* 30(1), pp. 60-82.

Wakelin, K., 1998a. Innovation and export behaviour at the firm level. *Research Policy,* 26(7-8), pp. 829-841.

Waldfogel, J., 2017. How digitization has created a golden age of music, movies, books, and television. *Journal of Economic Perspectives,* 31(3), pp. 195-214.

CHAPTER 6

CONCLUSIONS

This concluding chapter summarises the main findings of the thesis, provides advice on future practices and policymaking and discusses the limitations of the thesis, based on which future research is proposed.

Overview of main findings

The aim of the thesis was to make contribution to understanding design's utilisation among firms, particularly its determinants and performance implications, especially in context of innovation.

The contributions of the thesis are based on the analyses of large datasets in three essentially "stand-alone" papers each of which contributes to advancing the understanding of the utilisation of design among firms.

With regard to firms' engagement in design, consistent with the findings of prior literature (as suggested by Chapter 2), Chapter 3 has found that the majority of firms do not engage in design activities (or at least do not recognise that they do) and among those that do the value of design investments is typically low.

In relation to the factors that are associated with the extent of businesses' commitment to design, Chapter 3 suggests that larger businesses and those which are part of a business group tend to be more committed to design even they typically invest only modest amounts in design activities.

Engaging in, or being more committed to design, does seem to be associated with "good businesses". The review of empirical studies (Chapter 2) and the examination of factors associated with businesses' commitment to design (Chapter 3) both demonstrate that those with design activities tend to engage in a broad range of innovation activities. Specifically, the analysis in Chapter 3 shows that design-active firms tend to be making greater investments in R&D, branding, software development and process improvements. This is also consistent with existing evidence, as reviewed in Chapter 2. Especially, the extent of design commitment has strong associations with that of R&D and branding commitment within companies, which is likely because these activities are mutually supportive in helping firms to seize technological opportunities and exploiting differentiated demand in the market – consistent with the findings that design commitment is greater in contexts where there are more intensive R&D activities and where the demand is more differentiated.

Chapter 4 and 5 have shown design associated with market opportunities in the sense that firms investing in design and with greater investments in design are less likely to be confined to their regional markets and are more likely to reach more distant customers, including those in export markets. Although the value of exports may not necessarily increase with design investment, those spending on design typically have greater exports by value than their counterparts. The associations between design and the geographical reach of businesses, and their value of exports, may depend on industrial divisions, where the extent to which the output is inherently tradable could differ.

Therefore, these findings imply that engaging in design and committing more fully to design are related to building and maintaining design capabilities that contribute to an organisation's ability or capacity to "sense/shape and seize opportunities" (for example, as demonstrated in this thesis, technological opportunities and market opportunities). Therefore, conceptualising design as a set of organisational capabilities is helpful in unfolding the multiple influences of design as opposed to treating it as an ad-hoc activity.

Design and other innovation activities

Design commitment is strongly associated with R&D commitment within firms (as shown in Chapter 3). There are sound reasons to anticipate that they strengthen each other in helping firms seize opportunities in a distant market. Although it was not observed (in Chapter 4) among product innovators that design commitment and R&D commitment jointly influence the companies' geographical reach; and they can be substitutive for increasing the value of exports

Specifically in relation to the Creative Industries (in Chapter 5), it has been found that investing in design and R&D in combination increases the probability to export; and the more the companies spend on these two activities the more they are likely to export. On the one hand, these findings imply that the combined effect of design and R&D on reaching distant customers may depend on industrial contexts; on the other hand, they invoke questions about the role of innovation in the relationship between firms' design and geographical reach, and their earning power in the export market.

Likewise, design commitment has a strong association with branding commitment (as shown in Chapter 3). However, probably surprisingly, marketing investments did not appear (in Chapter 4) to be a robust indicator for firms' geographical reach, including export markets. Significant interactions between design and marketing in enhancing the ability to reach distant markets were also not found.

The association (as detected in Chapter 3) between design commitment and software development commitment, on the one hand, and between design commitment and process improvement commitment, on the other, is possibly a reflection of the importance of design for process optimisation.

Sectoral differences, technological/market environment

Consistent with existing evidence, Chapter 3 has suggested that firms' commitment to design can depend on their business environments. Design has been more recognised in contexts where there are more intensive technological activities and where the demand is more differentiated. The tradability of goods in particular can be enhanced by design (Chapter 5); the conventional taxonomy of economic activities is likely to point to manufacturing sectors as being where design is more widely used. However, Chapter 3 also shows that design is to some extent related to process improvements and software development.

However, since tradability differs fundamentally among industrial divisions, firms' geographical reach still varies with the industrial codes they belong to, all else being equal including the inputs in design and R&D (as suggested by the findings of Chapter 5).[179]

Firm size and ownership

It is not surprising to observe that compared to their counterparts, larger firms and subsidiaries can be more likely to engage in design (Chapter 3) and to reach distant customers (evidence for subsidiaries found in Chapter 4; evidence for larger firms found in Chapter 5). However, since those which engage in design commonly invest only a modest amount in it, smaller firms are not necessarily excluded from utilising design – if they are interested in or at least aware of the benefits of such expenditure. Although those that invest in design tend to spend on other innovation activities (Chapter 3), design has identifiable impacts separate from those other inputs – this thesis has found an association between design and exporting which is independent from the association between R&D and exporting (in Chapter 4 and 5). Therefore,

[179] Chapter 4 also found firms' geographical market reach to be different in different industrial sectors.

design can be an accessible and valuable asset to smaller businesses and those which are more resource-constrained.

Implications for practitioners

The findings have implications for companies as follows:

Smaller businesses and those with limited resources can consider investing in design (including by employing designers directly or via consultancies). Building design capabilities does not appear to be highly costly (most firms engaged in design spend modestly on it) and are typically cost-effective (e.g. through aiding the development of innovations or reaching more distant markets, both of which are associated with increased revenues and profitability).

For companies active in R&D and/or marketing (branding) anticipating complementary input to their extant activities, design has the potential to improve the overall returns at marginal cost. That is, on top of the existing investments, investing in design could probably produce greater returns than spending the same amount on additional R&D and/or marketing (branding). Specifically, this could involve investing directly in product or process design, employing designers, employing individuals with design skills, and training existing employees (especially the R&D team) for design thinking.

Likewise, for companies engaged in design activities, investing (more) in marketing, especially branding and/or market research, can be helpful.

We recognise that these recommendations draw from associations rather than causal analysis. Firms are not guaranteed to achieve these benefits by following the advice.

Implications for policymakers

In relation to policy-making, this research suggests:

It is necessary to recognise the value of design to businesses, innovation and the economy. Design is partially related to R&D and innovation, both within companies and at the industry level.

In high-technology sectors in particular there is evidence of benefits from being more committed to design (i.e. investing and investing more in design or utilising design as an integral element of development work) but there is some danger that design in these context is overshadowed by R&D, with policy makers focusing only on R&D and neglecting to support design. Our analysis indicates this would be sub-optimal, and that policies should support both R&D and design in high-tech sectors (although not necessarily to the same extent).

Policies that aim at expanding the number of exporters and the value of exports should encourage firms to develop design capacities. These policies are likely to be most effective in sectors in which outputs are highly tradable. .

Facilitating the design capabilities of micro and small businesses can help them overcome the "inherent disadvantages" in relation to smallness hence enhance their abilities to innovate and export, and therefore increase the shares of innovators and exporters in the economy.

On the businesses' side, policies may seek to create opportunities for, and encourage and help them exploit the potential of design through approaches including hiring individuals with design skills, who may not necessarily be "designers". With respect to the talents' side, policies can consider increasing investment in design education, including both design and non-design programmes at different levels, paying attention to future designers' ability to work in cross-functional contexts, and cultivating design mind-set for non-designers, which underscores human-centred thinking.

Limitations and future research directions

A challenge to advancing understanding firms' engagement or commitment to design is measurement. Firms do not always understand design consistently, and surveys measure design inconsistently. The generalisability of the results in this thesis relates to the measures available for each of the studies. It has further been affected by the cross-sectional nature of the datasets (such that, for example, reverse causality cannot be examined). In addition, by using cross-sectional data, the studies implicitly assume that the values of the independent and dependent variables are fixed and unchanging over time, which might not reflect reality. These are some drawbacks of using secondary data, which could be addressed by conducting a bespoke survey. However, doing so would pose other challenges, not least of which is recruiting respondents.

In future research it would be beneficial to break down design into various design activities, and improve its measurement. The aim will be to categorise design in some more effective ways so that we will be able to identify the locus and timing for (potentially different types of) design activities, and thus approach a more precise understanding of what design is, the value of design, and how to utilise design-related resources and capabilities timely and sustainably, and therefore help businesses survive and thrive in some challenging contexts.

It would also be interesting to look at directions of causation (such as between design and exporting), and if R&D and/or innovation mediate(s) between design and the other object of interest (such as exporting).

By examining the causation between design and a specific variable, we could potentially understand if and when design tends to be used as a prospective strategic input and when in a responsive move. If design is more of the "cause", companies could probably continuously make some investments in design in the long term, and recognise it as a sustainable supply to their competence (e.g. an intangible asset in which the investments build up the "innovative property" and therefore knowledge capital of a business).

By examining the extent to which the impact of design is achieved through R&D and/or innovation, we could separate design from R&D and innovation (i.e. "tweaking design" or "innovative design", as discussed in Chapter 3 and 4) and therefore have a better understanding of when and how design benefits businesses.

One of the reasons why causation and disaggregation matter is that design can become embedded in the culture of an organisation; it is invisible and has a profound influence within the business. This also potentially helps explain why the effect size of design has often been found to be relatively small, and why design has often been underestimated. A longitudinal study would be needed to confirm such long-term effects.

Another direction of future research could be to investigate design in relation to a process as opposed to product. The process may end up with a product design, but the focus will be the design used in the process. Given that the "visualised" benefit of design to customers seems to remain what more commonly understood and implemented in practice, and what is typically labelled and equated with the value of design, this research direction could potentially uncover more of the "behind the scenes" contribution of design. Similar to "latent demand", there might exist "latent design”. Research in this direction could possibly aim to identify this “latent design” and could focus on the impact of “latent design” on businesses activities and performances.