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An examination of product innovation in low- and medium-technology industries: Cases from the UK packaged food sector

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ABSTRACT

This study deepens our knowledge of organisational routines and activities in the innovation process of low- and medium-technology (LMT) industries. To accomplish this, it explores how the innovation process in the packaged foods sector of the UK food industry depends on a learning- by-doing, by using and by interacting (DUI) mode of innovation including activities such as technology adaptation and the use of external firm sources. The empirical analysis is based on four case studies of new product innovation taken from a cross section of the packaged foods sector. Our findings support the view that LMT industries rely on non- formal Research and Development (R&D) activities such as firm interaction and shared experiences. We develop a set of propositions which help to explore evidence in practice of how these external sources influence the innovation process. Our research contributes to theory in the areas of innovation processes in low- and medium-technology (LMT) industries and DUI industrial modes of innovation.

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1. Introduction

Researchers have recognized the unique characteristics of innovation in the food industry since at least the early 1980s (Ettlie, 1983). Since this time much research has shed light on our understanding. Significant amongst these findings is the recognition that in low and medium technology (LMT) intensive industries the traditional science and technology model of innovation is not applicable and cannot explain continued product and process innovations (see Bush, 1945; Maclaurin, 1953; Arrow, 1962; Pavitt, 2001; Fitjar and Rodríguez-Pose, 2013). Further, in the classic article by Pavitt (1984, p. 343–373) he spelt out, in his typology of firms, that ‘LMT industries are characterised by process, organisational and marketing innovations, by weak internal innovation capabilities and by strong dependencies on the external provision of machines, equipment and software’. LMT sectors are central to economic growth. Whether measured in terms of output, capital invested or employment, they dominate the economies of highly developed as well as developing nations, providing more than ninety percent of output

in the European Union, the USA and Japan.¹ Given this dominant position within modern industrialised economies attempting to better understand the nature of innovation within this sector is of concern to policy makers and industrialists.

The role of low technology intensive firms and industries in modern economies is complex and frequently misunderstood (Robertson et al., 2009). This is partly due to Hatzichronoglou's (1997) widely used revision of the OECD classification of sectors and products, which only refers to high technology (defined as spending more than five per cent of revenues on R&D). This has contributed to an unfortunate tendency to understate the importance of technological change outside such R&D-intensive fields (Hirsch-Kreinsen et al., 2006; Robertson et al., 2009). Products and production processes in these industries may be highly complex and capital intensive. The food industry is frequently classified as a low tech intensive industry. Research in the area of low technology intensive industries shows a dominance of incremental, mostly process driven innovations where disruptive innovation activities are scarce. Research within the food and agriculture sector has demonstrated the importance of collaboration amongst

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¹ General treatments of the role of LMT firms and industries are given in von Tunzelmann and Acha (2005), Sandven et al. (2005) and Robertson and Patel (2007). Hirsch-Kreinsen et al. (2006) report on a European Commission study of LMT sectors.

Table 1
Overview of economic data indicators from the UK food industry.

Indicator	2014
Turnover	£80 billion
Exports	£12.6 billion (77% to EU)
Manufacturing	16% of all UK manufacturing; Over 6000 manufacturing firms, the largest sector in UK
Imports/exports	24 countries together accounted for 90% of UK food supply
Agriculture	Two thirds of all the UK's agricultural produce goes into UK food manufacturing
R&D	£1.1 billion on R&D (% of revenue on R&D is 0.014%)
Innovation and new products	8000 new product launches
Food manufacturing and processing	The sector consists of several smaller sub-sectors including meat and fish processing, poultry, frozen, ambient, chilled and prepared foods, dairy, soft drinks, bakery, brewing, distilling, fresh produce, milling and cereals, sweets and confectionery.
Employment numbers are dominated by:	Skilled trades' occupations; machine and transport operatives; and elementary occupations.
Education and training	The sector is less well qualified compared with the UK population. ^a Some industries in this sector have a high proportion (more than 65%) of low qualified workforce.

Sources: <http://www.focusmanagementconsultants.co.uk/food-industry-information>. National Guidance Research Forum: <http://www.guidance-research.org/future-trends/food>.

^a 52% of the UK Improve workforce has a Level 2 qualification or below. Around 15% of the workforce is qualified to Level 4 or higher.

members of the food provision system, and close network linkages (e.g. Kuhne et al., 2015; Karantininis et al., 2010; Devaux et al., 2009; Fritz and Schiefer, 2008; Menrad, 2004). Table 1 provides an overview of key economic data indicators which shows the food industry as the largest manufacturing sector and clearly characterises it as a low technology sector.

The food industry has traditionally experienced very low levels of investment in R&D yet has delivered both product and process innovation over a sustained period. Avermaete et al. (2004) argue within the food industry R&D financial effort is a poor indicator of innovation intensity due to specific features of its innovation pattern, such as process orientated and a reliance on technologies developed by upstream industries. In such environments innovation can be explained through learning by doing and the use of networks of interactions and extensive tacit knowledge (Lundvall, 1992; Nonaka and Hirotaka, 1995). Similarly, Jensen et al. (2007) characterised a learning by 'learning-by-doing, by-using, and by interacting' (DUI) mode of innovation where extensive on-the-job problem solving occurs and where firms interact and share experiences. More recently, Fitjar and Rodríguez-Pose (2013) developed a classification of DUI firm interactions in a study of firm level innovation in the food industry in Norway. They found that 'firms which engage in collaboration with external agents tend to be more innovative than firms that rely on their own resources for innovation' (Fitjar and Rodríguez-Pose, 2013, p. 137).

Our study focuses on food packaging innovations, which are of growing importance within the highly competitive food industry. This sector is characterised by high integration between the packaging and the product, which is not so in other product categories such as smart phones. Firms in the packaged foods sector are increasingly utilising packaging innovations to differentiate and improve the performance of their products (Wells et al., 2007; Mahalik and Nambiara, 2010). Consequently, it has been suggested that packaging is a 'priority issue' within new product development (NPD) (Koss, 2007, p. 132; Johnsson, 1998). A number of factors have contributed to this growing significance of packaging processes: (i) government and consumers concerns of the impact of packaging on the environment (Prendergast and Pitt, 1996; Thøgersen, 1999; Rundh, 2005); (ii) increased logistics costs (Rundh, 2005; Lockamy, 1995); and (iii) the expanding competition from retailer brands (Vazquez et al., 2003; Burt, 2000). Yet, packaging has received relatively little attention and theory in this area is underdeveloped. This research offers an empirical study on how firms manage packaging within their NPD activities. The case studies offer new insights into how packaging forms an integral part of the food product that is inseparable from the core product (e.g.

Simms and Trott, 2014; Wells et al., 2007; Rundh, 2005; Silayoi and Speece, 2004).

The purpose of this paper is to examine one industry sector, the packaged foods sector of the UK Food Industry, and examine product innovation and see whether DUI industrial modes of innovation offer a better understanding of innovation within this low technology intensive industry. A criticism of previous studies within LMT industries is their use of existing data sets from prior studies. Indeed, in a special issue on LMT in Research Policy (Robertson et al., 2009, p. 446) called for 'detailed studies of individual sectors to help to sort out the effects in practice'. Specifically we address the research question: how does the food supply chain use DUI to deliver product innovation in the UK packaged food sector?

Our findings are based on four in-depth product innovation case studies taken from a cross section of the packaged foods sector. This includes a large retailer; a food packaging supplier and a brand management company. We find evidence in practice of DUI modes of innovation. We uncover diffusion of technology from high tech sectors to the packaged food industry. We show new knowledge being created and illustrate the role of middle managers as agents of technology change. The paper contributes to the stream of literature on models of innovation and DUI mode of innovation (Jensen et al., 2007; Fitjar and Rodríguez-Pose, 2013; Aylen, 2013). Significantly, it also contributes to sector analysis in the packaged food industry by offering insight into product innovation management in low- and medium-technology (LMT) industries (Robertson et al., 2009). The paper is structured as follows. Firstly, we review the literature on LMT innovation, this section shows that LMT industries show a dominance of incremental, mostly process driven innovations. The next section of the paper describes our case study research design. After this the findings and analysis of the four cases are presented. Finally, the limitations of the article are discussed as well as conclusions and possible directions for future research.

2. Theoretical review

2.1. Innovation within low technology intensive industries

The North American view of innovation being driven by investments in science and technology has dominated policy making within innovation.² This view, however, does not explain

² Benoit Godin has written extensively on the intellectual history of innovation. His work provides a detailed account of the development of the category of innovation. In his papers "Innovation Studies: The development of a speciality I and II" (Godin, 2010) he explains how two traditions emerged. The first in the USA was

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