Journal of Business Research 96 (2019) 250–263

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

SMEs' internationalisation: When does innovation matter?☆

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ARTICLE INFO

Keywords:
Goods innovation
Service innovation
Process innovation
SME internationalisation
Entrepreneurship
Exporting

ABSTRACT

The objective of this research is threefold: first, to investigate the role of goods, service, and process innovation on SMEs' internationalisation (i.e., exporting); second, to investigate the association between innovation's degree of novelty (radical innovation vs. incremental innovation) and SMEs' internationalisation; and, third, to examine the combined effect of different types of innovation and the degrees of novelty of innovation on firms' internationalisation and compare the findings with their individual effects. Data from 12,823 SMEs in the United Kingdom support the concept that innovative SMEs are more likely to export than non-innovative SMEs; however, the link between innovation and internationalisation differs according to the type of innovation introduced and the degree of novelty of the innovation. Of importance to managerial practice, the combined effects of different types and degrees of novelty of innovation are greater than their individual effects, creating a synergy or amplified effect.

1. Introduction

Recognition of the role of innovation in the internationalisation process of small and medium-sized firms (SMEs) has begun to attract research attention over the last few years (see, e.g., Esteve-Pérez & Rodríguez, 2013; García & Calantone, 2002; Higón & Driffield, 2010; Love, Roper, & Zhou, 2016). For example, Kyläheiko, Jantunen, Puumalainen, Saarenketo, and Tuppura (2011) propose that innovation and business internationalisation are strategic activities that are highly connected, while Williams and Shaw (2011) argue that successful internationalisation requires innovation. Many scholars believe that innovation assists firms in crossing borders by means of exporting, because, through innovation, firms can produce new competitive products that enable them to overcome the barriers to penetrating a foreign market (Becker & Egger, 2013; Cassiman, Golovko, & Martínez-Ros, 2010; Paul, Parthasarathy, & Gupta, 2017; Rodríguez & Rodríguez, 2005).

However, previous empirical studies report mixed evidence about the relationship between innovation and internationalisation. Some research suggests that there is a positive relationship between innovation and internationalisation (e.g., Golovko & Valentini, 2011; Roper & Love, 2002; Xie & Li, 2013). On the other hand, other studies either find a negative relationship between the two factors (e.g., Wakelin, 1998) or report a statistically insignificant effect of innovation on internationalisation (e.g., Sterlacchini, 1999). One possible reason for the mixed findings could be that most empirical studies measure innovation in terms of R&D, patents, and technological innovation (see, e.g., Lachenmaier & Wößmann, 2006; Martínez-Román & Romero, 2013); larger firms are more likely to be engaged in these representations of innovation, whereas smaller firms are more likely to undertake a softer type of innovation (Kleinknecht, 1987). As a result, empirical studies based on firm-level analysis are not conclusive, especially if the researcher examines the innovation–internationalisation link within SMEs (Higón & Driffield, 2010).

Furthermore, published studies often tend to focus on one type of innovation, as noted by Azar and Ciabuschi (2017). However, adopting a single type of innovation may only allow a partial investigation of the potential positive influences of innovation on firm performance (Damanpour & Aravind, 2011). Still, Lewandowska, Szymura-Tyc, and Golębiowski (2016) argue that empirical studies suggest that there is potentially complementarity between goods and process innovation; see also Oke, Burke, and Myers (2007). Advancing insights on these concepts, this research explicitly argues that combined measures of innovation can shed more light on the innovation and small business performance link.

The purpose of this research is to examine theorised differential

☆ Note: this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
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https://doi.org/10.1016/j.jbusres.2018.11.001
Received 11 September 2017; Received in revised form 31 October 2018; Accepted 2 November 2018

effects of innovation focus - goods, service, and process innovation - in relation to their potential individual and combined effects on SMEs' propensity to export as a proxy for internationalisation. Moreover, this research investigates those effects across the level of novelty of the innovation - comparing more radical/novel innovation and more incremental innovation - to determine the association between these types of innovation and SMEs' internationalisation. This research aims to provide new and possibly more refined evidence regarding the association between innovation and internationalisation after considering the possible combined effects of different types and degrees of novelty of innovation. To provide an overview of the results, this research finds empirical evidence that each type of innovation affects internationalisation differently; empirical studies and research should recognise that not all types of innovation are equal. Moreover, this research contributes to the previous literature by providing evidence regarding the effect of combining different types of innovation on internationalisation - a topic that is largely ignored in the existing literature (Chetty & Stangl, 2010; Higón & Driffield, 2010; Lewandowska et al., 2016). In addition, the results point towards the importance of introducing radical/novel innovation as an instrument to stimulate internationalisation and in turn firm performance.

The rest of the research is organised as follows. Section 2 discusses the existing literature regarding the relationship between innovation and SMEs' internationalisation and the logic behind the hypotheses presented. Section 3 describes the method, including the study design and measures, and the empirical results. Section 4 contains the discussion, limitations, and managerial and theoretical implications.

2. Conceptual background

2.1. Innovation and internationalisation

According to the Resource-Based View (RBV) theory, a firm is considered as a distinctive entity with a diverse bundle of intangible and tangible resources (Barney, 1991; Penrose, 1959). At the centre of the intangible resources, much emphasis is placed on firms' ability to innovate - explaining their internationalisation (Schoonhoven, Eisenhardt, & Lymman, 1990). Innovation, which is defined as "the implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organisational method in business practice" (OECD, 2005, p. 47), is considered as the tool that contributes to increasing firms' performance and competitive advantages (Castaño, Méndez, & Galindo, 2016). According to Onetti, Zucchella, Jones, and McDougall (2010), firms' success and survival in the global markets depend on the joint effect of innovation and internationalisation. The term internationalisation can be defined from different perspectives depending on the observed phenomena. For instance, Johanson and Vahlne (1977) imply that internationalisation is the process whereby a firm increases its international involvement in incremental stages (Paul et al., 2017). It is generally assumed that internationalisation and innovation are an alternative growth strategy that occurs in the case of innovation and incremental internationalisation (Johanson & Vahlne, 1977). On the other hand, Calof and Beamish (1995, p. 116) define internationalisation as "the process of adapting firms' operations (strategy, structure, resources, etc.) to international environment."

The term exporting, on the other hand, can be defined as the "outward international trade in goods and/or services, conducted either directly or through a third party" (Love & Roper, 2015, p. 29). According to Golovko and Valentini (2011), although different modes of internationalisation, such as foreign direct investment and exporting, are available to SMEs, exporting is still often their initial stage of internationalisation (Jones, 2001). Hence, this research uses exporting as a proxy for internationalisation. This research follows the previous literature in using export propensity as the operationalisation of internationalisation (e.g., Boehe, 2013; Ganotakis & Love, 2012; Idris & Saridakis, 2018) and defines export propensity as "whether a firm exports to foreign market" (Serra, Pointon, & Abdou, 2012, p. 2016).

The relationship between innovation and internationalisation is investigated in previous studies. For instance, Paul et al. (2017) imply that SMEs that have the ability to introduce product or service innovation will gain competitive advantages over their competitors and that these in turn will help their internationalisation process. In addition, it is indicated that globalisation and shorter product life cycles will lead entrepreneurs with new or innovative products and services to adopt internationalisation strategies despite being new firms (Castaño et al., 2016). Hence, for firms to compete internationally, they should have the ability to introduce innovative activities (Geldres-Weiss, Uribe-Bórquez, Coudounaris, & Monreal-Pérez, 2016). For instance, Autio, Sapienza, and Almeida (2000) suggest that innovative companies that use "cutting-edge" technology and internationalise their business can achieve higher performance. On the other hand, several researchers (e.g., Geldres-Weiss et al., 2016; Leonidou, Katsikeas, Palihawadana, & Spyropoulou, 2007; Pla-Barber & Alegre, 2007) emphasise the importance of adopting an innovation strategy for exporting firms. For instance, Pla-Barber and Alegre (2007) stress the important role of innovation in foreign markets, discussing the possibility that a single market may not support firms' innovative activities. Hence, internationalisation may act as a destination where innovative firms can gain economic advantages.

On the other hand, the linkage between innovation and exporting is investigated in previous research at the macro and the micro level. At the macro level, Cassiman and Martínez-Ros (2004) show that innovation is considered as an important measure of growth in a country and that exporting demonstrates the competitive advantages of a nation. However, at the micro level, the empirical evidence is inconsistent (e.g., Hagen, Denicolai, & Zucchella, 2014; Nguyen, Pham, Nguyen, & Nguyen, 2008). This section outlines the research and logic that result in a series of hypotheses on the relationship between SME innovation and SME internationalisation represented in Fig. 1.

To discuss the latter literature briefly, Harris and Li (2009) examine the relationship between R&D and exports for UK firms and find that this type of innovation plays an important role in firms' ability to overcome internationalisation barriers. While Golovko and Valentini (2011) find that innovation and exports affect each other positively in an effective circle, others report a negative relationship between innovation and exports. Wakelin (1998), for example, shows that innovative firms in the UK are less likely to undertake exporting activities than non-innovative firms. Moreover, some studies report a statistically insignificant relationship between innovation and exports (e.g., Sterlacchini, 1999). For example, Lefebvre, Lefebvre, and Bourgault (1998) find that there is no association between innovation, measured as investment in R&D, and exporting; however, it can be the case that this statistically insignificant relationship can be attributed to the fact that many SMEs might under-report their R&D measures and their innovation activities. Rodil, Vence, and Sánchez (2016) discover a positive relationship between innovation and exporting. In a more recent study, Azar and Ciabuschi (2017) find that, at the general level, adopting innovation is beneficial for export performance. The previous literature indicates that innovation is considered as a growth strategy for firms that seek to internationalise (e.g., Gunday, Ulusoy, Kilic, & Alpkan, 2011; Wang, Lu, & Chen, 2008).

Limited empirical research in the export literature considers the possible endogeneity of innovation with respect to exporting (Dohse & Niebuhr, 2018; Higón & Driffield, 2010). An example is the study by Lachenmaier and Wößmann (2006), which uses the instrumental variable approach to account for the possible endogeneity between exporting and innovation. Additionally, Nguyen et al. (2008) suggest that previous research that fails to take potential endogeneity into account may produce biased estimates of the association between innovation and exporting activity. To this end, Higón and Driffield (2010), using SME data from the UK, find larger estimated coefficients for goods

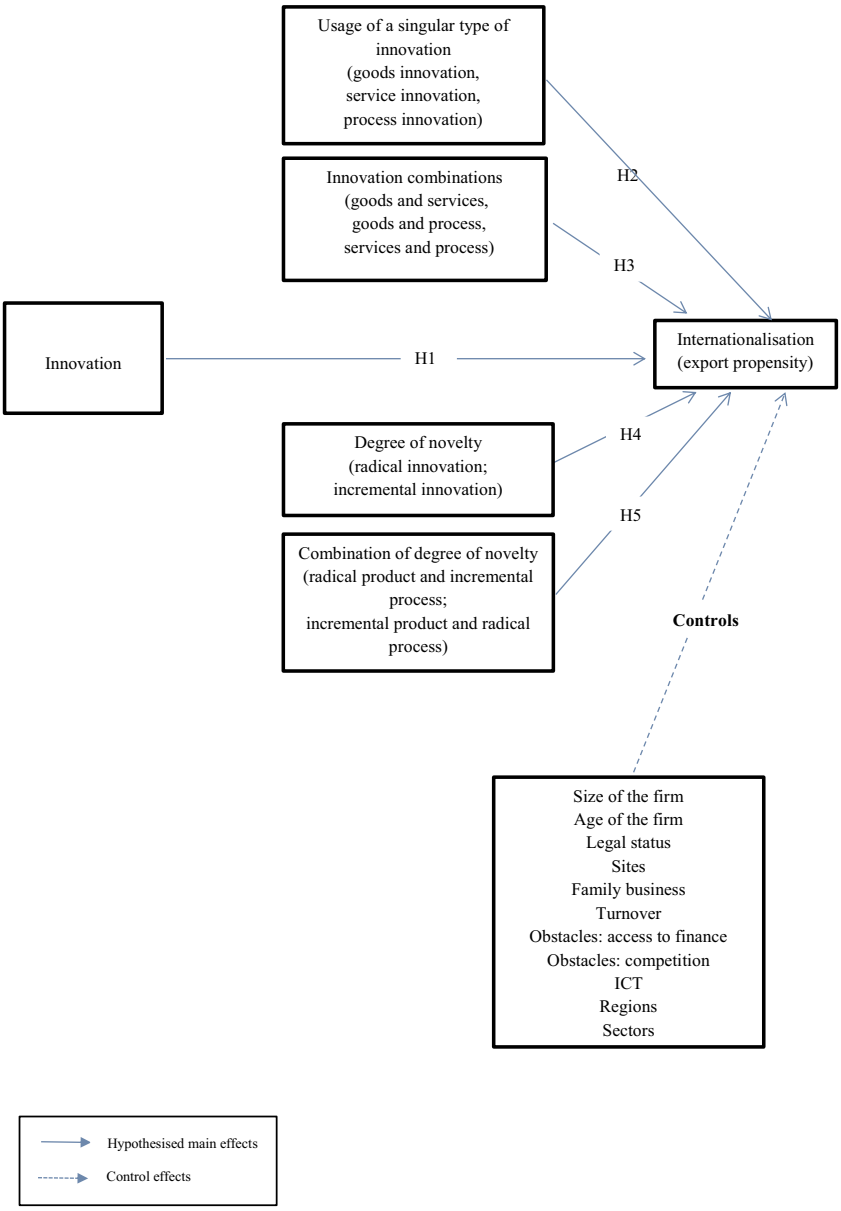

Fig. 1. The theorised model.

innovation than the ones reported ignoring endogeneity. Based on the collective results of the described literature, we believe that innovation permits global growth for SMEs, and thus we hypothesise that:

H_1. Innovative SMEs have a higher likelihood of internationalisation than non-innovative SMEs.

2.2. Innovation types and internationalisation

Vernon's (1966, 1971, 1979) Product Life Cycle (PLC) theory suggests that firms' internationalisation process follows a product life cycle. Firms first introduce new products into their domestic market to acquire knowledge regarding their performance and thereafter sell their products across borders in the form of exporting. According to Lecerf (2012), when firms have the ability to develop and launch new products or services or implement new processes through innovation, they will be superior to their competitors. Therefore, small firms that have the ability to produce new products/services or implement new ways of production will gain competitive advantages, which will enhance their internationalisation process. The more firms innovate, the larger their exporting activities will be (Lachenmaier & Wößmann, 2006). According to Paul et al. (2017), firms can gain competitive advantages from innovation when the foreign market needs a specific type of service or product innovation.

Following Chetty and Stangl (2010), among others (e.g., Chiva, Ghauri, & Alegre, 2014; De Massis, Frattini, Pizzurno, & Cassia, 2015; Higón & Driffield, 2010; OECD, 2005, p. 48), product innovation[1] is defined in this research as the introduction of improved goods or services, for example to increase sales or improve customer service. In this research, process innovation is defined as the introduction of new methods of production that aim to decrease costs, increase quality, or improve services (Chetty & Stangl, 2010; Chiva et al., 2014; Higón & Driffield, 2010; OECD, 2005, p. 49).

A few studies begin to examine the different effects of various types of innovation on exports; according to Dohse and Niebuhr (2018), the results are still rather inconclusive. For instance, Higón and Driffield

[1] The term product innovation is used to cover both goods and service innovation (OECD, 1997, p. 31).

(2010) distinguish between product and process innovation activities. Their results imply that product and process innovation have equal effects on SMEs' internationalisation. However, once they control for product innovation effects, their results indicate no significant additional effect for process innovation. Likewise, Becker and Egger (2013) find that product innovation plays a more critical role in promoting firms' exporting activities than process innovation. Product innovation is viewed as a significant contributor to the propensity to export. On the one hand, Nguyen et al. (2008) find that product, process, and product modification innovations are significant in the internationalisation of SMEs in Vietnam. However, on the other hand, Damijan, Kostevc, and Polanec (2010) conclude that there is no association between product or process innovation and export propensity.

According to Cassiman et al. (2010), when firms are engaged in new product innovation, their export propensity may increase, because innovation can drive exports. Hence, product innovation enables owner-managers to take internationalisation decisions (Cassiman & Golovko, 2011). Lim, Sharkey, and Heinrichs (2006) suggest that the ability of a firm to introduce new products is a condition for firms to be involved in exporting, which enables them to reach international markets through differentiated products. In addition, it is noted that firms may combine product and process innovations to gain more competitive advantages (Lewandowska et al., 2016). For example, Martínez-Ros and Labeaga (2009) argue that manufacturing firms introduce new products when a new technological process is applied. In addition, firms that introduce new processes are more likely to introduce new products. Others argue that SMEs tend to focus their efforts more on product innovation than on process innovation to increase their profits and grow (e.g., Wolff & Pett, 2000). Product innovation is unquestionably the main determinant of the establishment of new firms (Drucker, 2014; Pedeliento, Bettinellim, Andreini, & Bergamaschi, 2018). However, it is argued that innovation should also be pursued beyond the product or the process itself, as described in the next paragraph.

Some researchers claim that process innovation that is based on new technological advancements is generally used to enhance product innovation (e.g., Lewandowska et al., 2016; Martínez-Ros, 1999; Martínez-Ros & Labeaga, 2009; Van Beers & Zand, 2014). Studies that take into account these complementarities between product and process innovation provide a useful insight but not a consistent picture. Maria and Ganau (2013), for example, suggest that, although the propensity to export is influenced by new product innovation, the export intensity is influenced more by process innovation; moreover, the recent study by Lewandowska et al. (2016) shows that there is a strong relationship between firms that introduce a combination of product-process innovation and new product exporting. Given the diverse findings of the extant research, we believe that it is likely that different types of innovations might have different effects on or associations with the level of SME internationalisation. Hence, we hypothesise that:

H_2. The likelihood of SME internationalisation differs according to the type of innovation.

H_3. A combination of different types of innovation has a stronger effect on the likelihood of SME internationalisation than a single type of innovation.

2.3. Degree of innovation novelty

Innovations can be differentiated based on their degree of novelty: (i) radical innovation and (ii) incremental innovation (e.g., Chiva et al., 2014; Daft & Becker, 1978; Forés & Camisón, 2016; Foster, 1986; Kocak, Carsrud, & Oflazoglu, 2017; Pavitt, 1991; Sheng & Chien, 2016; Tellis, Prabhu, & Chandy, 2009). Generally, radical innovation is defined as advancements in knowledge because of the development of new products and processes that are new to the market/industry (e.g., Cosh & Hughes, 1998; Freel & Harrison, 2006; Love et al., 2016; Tether, 2002; Van Beers & Zand, 2014). Incremental innovation is defined as a continuous improvement to products, processes, or services that are new to the firm only (e.g., Freel & Harrison, 2006; Tidd, Pavitt, & Bessant, 2011; Van Beers & Zand, 2014). While Tellis et al. (2009) find that the commercialisation of radical innovations translates into financial performance across nations, Sheng and Chien (2016) find that, for entrepreneurial ventures, which relate more directly to the focus of the present research, superior capability in a particular area leads to a focus on incremental innovation. In addition, Forés and Camisón (2016) find that the organisation size has a positive effect on incremental innovation performance but a negative non-significant effect on radical innovation performance. Given the combination of those findings, the specific relationship of SME innovation's novelty level and the extent of internationalisation need further examination.

Regarding innovation novelty, the *Oslo manual* (OECD, 2005, p. 58) introduces a classification regarding a product's degree of novelty: novel product innovation occurs when a firm introduces for “the very first time a new or improved product.” Even when products are not new globally, they could be new to the market in which the firm operates. This new to the market/industry innovation gives the firm a monopolistic power that is temporary, since new or improved products will not face immediate competition. On the other hand, incremental product innovation occurs when a firm implements a new or improved product or process that is new to the firm itself but has already been implemented in other firms. See also Blind, Petersen, and Riilloc (2017), Love et al. (2016), and Van Beers and Zand (2014).

Adopting radical innovation will improve a firm's competitive position by offering novel qualities and distinctive benefits for its customers. This in turn will result in increasing sales and an expanding market share (O'Connor & Rice, 2013; Sainio, Ritala, & Hurmelinna-Laukkanen, 2012; Tellis et al., 2009). While Bao, Chen, and Zhou (2012) argue that radical innovation enhances firms' performance and reshapes their competitive advantages, a question might arise regarding the extent to which these relationships apply to SMEs.

The previous literature provides mixed results regarding the dominant type of innovation among SMEs. For instance, Oke et al. (2007) argue that the previous research shows that SMEs generally undertake radical innovation more than large firms and introduce new products that increase their growth and foster their performance. Radical innovation clearly produces competitive advantages in SMEs (Laforet, 2008). It is indicated that radical innovation is characterised by knowledge intensity and uncertainty. Hence, firms need to adjust their strategies and make them more flexible in the development of this type of innovation. Simon, Elango, Houghton, and Savelli (2002) argue that SMEs tend to focus more on radical innovation than on incremental innovation, because this type of innovation generates high revenue for firms, which will enhance their performance.

In contrast, Oke et al. (2007) show that SMEs with “an ambitious to grow” tend to place more focus on incremental innovation than on radical innovation. Likewise, Martínez-Román and Romero (2013) imply that, since most small firms are engaged in a softer type of innovation than innovation based on R&D, small firms often introduce innovation that is incremental in nature rather than radical. Hence, these types of firms generally undertake small adjustments to their products or processes, which in some cases are only considered as an innovation to the firm itself. However, it can be argued that these types of innovations help small firms to compete in the marketplace and gain access to new international markets. Moreover, small firms have the ability to undertake radical innovation in their products, in some cases based on a new technology. Moreover, Tödtling and Kaufmann (2001) argue that incremental innovation is prevalent in small firms due to their limited resources. This type of innovation could be an important factor in fostering firms' growth in their own markets.

According to Forés and Camisón (2016), a firm's survival and generation of economic benefits can be explained by its ability to introduce both radical and incremental innovation. Previous empirical studies examine the

Table 1
Summary of the proposed hypotheses.

H1	Innovative SMEs have a higher likelihood of internationalisation than non-innovative SMEs.
H2	The likelihood of SME internationalisation differs according to the type of innovation.
H3	A combination of different types of innovation has a stronger effect on the likelihood of SME internationalisation than the effect of a single type of innovation.
H4	SMEs that introduce radical product/process innovation have a higher likelihood of internationalisation than SMEs that introduce incremental product/service innovation.
H5	Combining radical and incremental innovation has a stronger effect on the likelihood of SME internationalisation than the effect of a single radical innovation.

relationship between these types of innovation and exporting. For instance, Love et al.'s (2016, p. 816) recent study shows that innovation positively affects SMEs' exporting, whereby radical innovation is more associated with "inter-regional" exports and incremental innovation is more related to "intra-regional" exporting. Their results suggest that incremental product innovation helps SMEs to export more nationally in their home region while radical product innovation helps them to export internationally. They suggest that this can be explained by the fact that novel innovation can assist firms in overcoming the "liability of foreignness." According to Azar and Ciabuschi (2017), firms can increase their competitive advantages by developing radical innovation and by offering novel products to their customers. These, in turn, can affect their profitability, market share, and open foreign market opportunities. Zhou and Li (2012, p. 1090) suggest that "radical innovation reshapes the competitive landscape and creates new market opportunities." On the other hand, Chetty and Stangl (2010) propose that firms that introduce radical innovation are more likely to internationalise faster than firms that introduce incremental innovation.

A review of the extant literature reveals that radical and incremental innovations are considered as an important factor that fosters SMEs' internationalisation. However, the previous literature does not empirically test whether a combination of radical innovation and incremental innovation can have a stronger effect on SMEs' internationalisation. According to Khazanchi, Lewis, and Boyer (2007), process innovation often involves the creation of products or services that are new to the market. Firms often undertake "systems and reengineering activities to develop new products" (Oke et al., 2007, p. 738). For instance, to support the production of new radical or incremental products, firms' technologies and process should be modified, updated, or even replaced. We argue that a combination of radical and incremental innovation can have stronger effects on SMEs' internationalisation than undertaking a single radical innovation. Thus, we hypothesise that:

H_4. SMEs that introduce radical product/process innovation have a higher likelihood of internationalisation than SMEs that introduce incremental product/process innovation.

H_5. Combining radical and incremental innovation has a stronger effect on the likelihood of SME internationalisation than a single radical innovation.

A summary of the hypotheses examined in this research is presented in Table 1.[2]

3. Empirical analysis

3.1. Data and sample

We obtained data on 12,823 SMEs (out of approximately 15,500 contacted) from the 2015 UK Longitudinal Small Business Survey's (UKLSBS) first wave (Department for Business, Innovation and Skills (BIS), 2016a) - the most recent available survey of SME owner-managers in the United Kingdom. The telephone-based survey sample was constructed using a stratified sample of owner-managers of firms with up to 249 employees across the 4 nations in the UK: England, Scotland, Wales, and Northern Ireland. The stratified survey sample targets were set according to the size of the firm and, within these groups, according to the 2007 SIC sectors. In addition, for registered businesses with between 0 and 4 employees, an additional stratum was set based on the legal status of the firm. Detailed information regarding the survey methods, response rate, and instruments can be found in the Small Business Survey report (Department for Business, Innovation and Skills (BIS), 2016b). As discussed in BIS (2016a), the sample is sufficiently large to allow reporting on the findings with a high degree of statistical reliability.

Overall, the survey provides a wide range of information regarding firms' characteristics, such as the size of the firm (including firms with zero employees), legal status, sector, age of the firm, ownership of the firm, and perceived obstacles to achieving the firm's objectives. Regarding the key variables used in this study - exporting and innovation - the survey provides data on whether a firm exports goods and/or services outside the UK and whether a firm has introduced a significantly new or improved goods, service, or process innovation. Therefore, the survey provides rich information from a large representative sample of UK firms (BIS, 2016a, 2016b) that allows us to explore empirically the relationship between innovation and internationalisation.

3.2. Measurements

3.2.1. Dependent variable: Export propensity

In this study, similar to prior research, "export propensity" is the operationalisation of internationalisation (Boehe, 2013; Ganotakis & Love, 2012; Higón & Driffield, 2010; Idris & Saridakis, 2018; Nguyen et al., 2008). Export propensity is defined as whether a firm exports to a foreign market (Serra et al., 2012, p. 2016). The scale used to measure export propensity in the survey asks SME owner-managers: *"In the past 12 months, did your business export any goods and/or services outside the UK?"* The scale uses a binary format, taking the value of one if the firm sells outside the UK and zero if not. We note that 23% of SMEs indicated that they do export. Most of the exporters are medium-sized firms (32%) followed by small firms (27%). Only a small proportion of micro firms, however, are found to export (17%).[3] We test whether the differences in proportions are statistically significantly different from each other. The results show that, for micro, small, and medium-sized firms, the differences in proportions are statistically significantly different from each other.

3.2.2. Independent variables: types of innovation and degree of novelty

3.2.2.1. Type of innovation. Consistent with the related prior studies, innovation is measured here as the introduction of new goods, services, and processes as a proxy for a firm's innovation activities (Higón, 2011; Higón & Driffield, 2010; Nguyen et al., 2008; Rogers, 2004; Tether, 2002; Van Beers & Zand, 2014). The survey posed questions on each of the three forms, as described below.

"Goods innovation"[4] is measured through the dichotomous scale question: *"Has your business introduced any new or significantly improved goods in the last three years?"* Answers take the value of one if the firm

[2] We thank one of the anonymous reviewers for the suggestion to insert a summary hypothesis table.

[3] In this research, micro firms are defined as those firms with 0 to 9 employees, small firms are those with 10 to 49 employees, and medium-sized firms are those with 50 to 249 employees.

[4] Goods and service innovation are referred to as product innovation by the OECD (1997, p. 31), which can be defined as the "introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses" (OECD, 2005, p. 48).

has introduced goods innovation or zero otherwise. Regarding the descriptive statistics, we note that variance exists in the sample: 22% of the sample SMEs in the UK has introduced goods innovation during the past three years. In more detail, about 25% of small firms have introduced new goods in the last three years, followed by medium-sized firms (24%) and micro firms (20%, including firms with zero employees). We also test whether these differences are statistically significant. The results show that the difference between small and medium-sized firms is not statistically significant (prob. = 0.351).

"Service innovation"[4] is measured through the dichotomous scale question: *"Has your business introduced any new or significantly improved services in the last three years?"* Answers take the value of one if the firm has introduced service innovation or zero otherwise. We again note that variation exists in the sample: 36% of the sample SMEs in the UK has introduced service innovation during the past three years. Disaggregating by firm size, we find that 41% of medium-sized firms in the UK have introduced service innovation in the past three years, followed by 39% of small firms and 33% of micro firms. We test whether these differences are statistically significant different from each other; the results show that the difference in proportions for all firms are statistically different from each other.

"Processes innovation"[5] is measured through the dichotomous scale question: *"Has your business introduced any new or significantly improved processes for producing or supplying goods or services in the last three years?"* Answers take the value of one if the firm has introduced process innovation or zero otherwise. The data related to process innovation show that medium-sized firms recorded the highest percentage, 37%, followed by small and micro firms (32% and 21%, respectively). We test whether these differences are statistically significant different from each other, and the results show that the difference in proportions for all firms is statistically different from each other.

3.2.2.2. Degree of novelty of innovation. Consistent with the interest in differentiating between radical and incremental innovations (e.g., Blind et al., 2017; Love et al., 2016; Van Beers & Zand, 2014), the survey measures the degree of novelty of innovation by asking owner-managers the following question: *"Were any of these new or significantly improved goods/services/process innovations new to the market, or were they just new to your business?"* We create an index variable to capture whether the innovation was radical, incremental, or not innovative. Two index variables are created to indicate the degree of novelty for product innovation (i.e., goods/service) and the degree of novelty for process innovation. The survey here does not distinguish between goods and service innovation; therefore, we follow the OECD (1997, p. 31) in its reference to goods/service innovation as product innovation. The data show that 6% of SMEs in the UK have introduced novel process innovation in the last three years. We check whether the differences are statistically significant, the results showing that all the coefficients are statistically significantly different from each other. As regards the descriptive statistics, 17% of medium-sized firms introduced radical product innovation that was new to the market, while 13% of micro firms' product innovation was also new to the market. We test whether these differences are statistically significantly different from each other, and the results show that incremental product innovation is not statistically significantly different between small and medium-sized firms (prob. = 0.552).

3.2.3. Control variables

We control for several variables that affect SMEs' internationalisation according to the previous studies. First, we control for the size of the firm - measured by the natural logarithm of the number of employees - as previous empirical studies find a positive relationship between exporting and firm size (Roper & Love, 2002). Second, we control for the age of the firm - measured by the number of years for which the business has been in operation. Mixed results are reported by previous studies regarding the effect of firms' age on their internationalisation. For instance, Baldwin and Rafiquzzaman (1998) report a positive relationship between exporting and firms' age, while Higón and Driffield (2010) find a negative relationship between firms' age and exporting. Their results imply that firms that have been trading for less than four years are 16% less likely to export.

Third, we control for the number of sites on which the firm operates. As suggested by Roper and Love (2002), firms with more than one site are more likely to export, since multiple sites can enable firms to overcome their limited resources, which are required for exporting. Fourth, we also control for the legal status of the firm, since it is found in previous studies to affect business decisions such as internationalisation (Higón & Driffield, 2010). Fifth, we control for firms' productivity, which previous studies show to affect firms' internationalisation, and we follow Love et al. (2016) in controlling for productivity as measured by firms' turnover reported in bands.

Seventh, we control for the surrounding business environment - captured by the competition in the marketplace and obstacles to obtaining finance. The previous research finds that firms' exporting behaviour might be affected by the conditions in the domestic markets. For instance, Rammer and Schmiele (2009) find that competition in the domestic market is considered as one of the obstacles to firms' internationalisation process. Eighth, the model considers ICT use, which is also found to be an important identifying variable in terms of impacts on innovation (Higón & Driffield, 2010). Ninth, following Kingsley and Malecki (2004) and Rogers (2004), we control for whether the business has sought external advice/information. Tenth, we control for whether the firm is a family business. Last, we include sectoral and regional dummies.

More details on the variables' definition and measurements used in this study can be found in Table A1 in the Appendix. Table A2 in the Appendix contains the corresponding descriptive statistics and Table A3 contains the corresponding correlation matrix. Given the usage of single-item measurement of variables in the probit regression models, the composite reliability is 1.0 and the convergent reliability (average variance extracted) is also 1.0. Confirmatory factor analysis of the substantive variable items demonstrates discriminant validity. We attempt both to minimise the common method variance (CMV) up front and examine the potential for it afterwards following the guidelines of Hulland, Baumgartner, and Smith (2018) and Podsakoff, MacKenzie, Lee, and Podsakoff (2003); Podsakoff, MacKenzie, and Podsakoff (2012). Research design elements that reduce the CMV were included, and statistical design elements to identify potential CM (i.e., Harmon's single-factor test) do not produce evidence of CMV.

3.3. Methods and results

We conduct probit regression to examine the potential relationships between export propensity and innovation. Since the variable that we want to examine takes only two possible values (i.e., 1 if the firm exports and 0 otherwise), probit is an appropriate econometric technique that deals with problems associated with the linear probability model (for a discussion, please see Gujarati, 1995, pp. 552–570).[6] First, a latent variable that represents the propensity of a firm to export goods and/or services is defined (E_j^*). We cannot observe (E_j^*), but we can observe whether firm j exports through the following measurement equation:

$$E_j = \begin{cases} 0 & \text{if} \quad E_j^* \leq 0 \\ 1 & \text{if} \quad E_j^* > 0 \end{cases} \tag{1}$$

[5] Process innovation can be defined as "the implementation of a new or significantly improved production or delivery method" (OECD, 2005, p. 49).

[6] As a robustness check following a different modelling approach, we use the logit model. The logit model is another commonly used model whenever the dependent variable is binary. More specifically, logit uses the cumulative standard logistic distribution, whereas probit uses the cumulative standard distribution. However, the results from the logit analysis are similar to those reported from the probit model and therefore are not reported here.

Table 2
The association between innovation and export propensity – probit estimates.

Sample	All firms						
Probit regression	1	2	3	4	5	6	7
	ME	ME	ME	ME	ME	ME	ME
Innovation	0.086***						
	0.006						
Goods innovation		0.121***			0.105***		
		0.009			*0.010*		
Service innovation			0.053***		0.012		
			0.007		*0.007*		
Process innovation				0.061***	0.032***		
				0.008	*0.008*		
Innovation combination							
(Base category: no innovation)							
Goods innovation						0.189***	
						0.021	
Service innovation						0.049***	
						0.012	
Process innovation						0.030**	
						0.014	
Goods and service innovation						0.098***	
						0.018	
Goods and process innovation						0.026***	
						0.030	
Service and process innovation						0.079***	
						0.014	
All innovation						0.153***	
						0.016	
Innovative firms							
(Base category: process innovation)							
Goods innovation							0.181***
							0.028
Service innovation							0.015
							0.021
Goods and service innovation							0.075***
							0.026
Goods and process innovation							0.255***
							0.038
Service and process innovation							0.048**
							0.022
All innovation							0.135***
							0.024
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
log Likelihood	−5152.3014	−5132.5212	−5203.2066	−5198.5511	−5120.1371	−5097.828	−3011.0267
Chi 2 (degrees of freedom)	3405.49(44)	3445.05(44)	3303.68(44)	3312.99(44)	3469.82(46)	3514.44(50)	1897.24(49)
Obs.	12,823	12,823	12,823	12,823	12,823	12,823	6460

Notes: Marginal effects (ME) at the sample mean values of the regressors are reported. All models control for the variables mentioned previously (the results are available on request).
As a robustness check, we use the logit model. The results are similar and available on request. Values in *italics* are standard errors. *** $p < 0.01$, ** $p < 0.05$.

$$E_j^* = X_j b_j + I_j \delta + e_j, \quad e \sim N(0, \sigma^2) \tag{2}$$

where I is the indicator variable for whether the firm has introduced innovation (goods/service and process). X is the vector of firm characteristics for firm j. b and δ are the parameters to be estimated. The model is estimated by the maximum likelihood technique (Stock & Watson, 2012), and Table 2 shows the association between innovation and export propensity, while Table 3 presents the association between the degree of novelty and export propensity. In both tables, we report marginal effects (ME) at the sample mean values of the regressors.

In Table 2, we find that firms that introduced goods, service, or process innovation have a higher likelihood of exporting outside their home country. The results show that being an innovative SME increases the likelihood of internationalisation by 8.6 percentage points compared with being a non-innovative SME. To address the potential endogeneity between exporting and innovation, we also estimate the average treatment effect on the treated (ATT) by using the nearest-neighbour estimator. The results suggest that, for innovative firms, innovation causes the probability of exporting to be 15.4 percentage points higher than it would have been otherwise. The results show that innovation is positively and significantly related to SMEs' internationalisation, supporting H1, which states that innovative SMEs have a higher likelihood of internationalisation than non-innovative SMEs.

Moreover, when differentiating between different types of innovation, the results show that the coefficients of goods, service, and process innovations are all positive and statistically significant in the internationalisation equation. In models (2)–(4) in Table 2, we include one of the types of innovation at a time. Specifically, we find that goods innovation introduced by SMEs increases their probability of exporting by 12 percentage points compared with SMEs that have not introduced goods innovation in the last 3 years. We also find that both service and process innovation increase the likelihood of internationalisation but that the magnitude of the effect is nearly half that of goods innovation.

According to the results, goods innovation has a stronger effect on SMEs' internationalisation than service and process innovation. Similarly, when all three types of innovation are included in the model simultaneously, we still find that goods innovation has a stronger association with internationalisation (see model 5, Table 2). In this model, the service innovation coefficient loses its statistical significance, and the coefficient of process innovation decreases significantly in magnitude. Overall, the results support H2, which states that the likelihood of SME internationalisation differs according to the type of innovation.

Table 3
The association between the degree of novelty and the export propensity – probit estimates.

Sample	All Firms				
Probit regression	1	2	3	4	5
	ME	ME	ME	ME	ME
Degree of novelty					
(Base category: no innovation)					
Radical product	0.180***		0.162***		
	0.013		*0.014*		
Incremental product	0.065***		0.057***		
	0.008		*0.008*		
Degree of novelty					
(Base category: no innovation)					
Radical process		0.133***	0.050***		
		0.018	*0.016*		
Incremental process		0.043***	0.022***		
		0.008	0.008		
Degree of novelty					
(Base category: no innovation)					
Combined radical innovation only				0.236***	
				0.025	
Combined incremental innovation only				0.089***	
				0.013	
Radical product and incremental process innovation				0.196***	
				0.027	
Incremental product and radical process innovation				0.113***	
				0.038	
Radical product innovation only				0.173***	
				0.018	
Incremental product innovation only				0.059***	
				0.011	
Radical process innovation only				0.083**	
				0.042	
Incremental process innovation only				0.021	
				0.015	
Degree of novelty					
(Base category: combined incremental innovation)					
Combined radical innovation only					0.144***
					0.027
Radical product and incremental process innovation					0.104***
					0.029
Incremental product and radical process innovation					0.020
					0.039
Radical product innovation only					0.084***
					0.021
Incremental product innovation only					−0.031**
					0.015
Radical process innovation only					−0.004
					0.043
Incremental process innovation only					−0.069***
					0.018
Controls	Yes	Yes	Yes	Yes	Yes
log Likelihood	−5102.8956	−5186.4677	−5095.385	−5094.8857	−3011.7471
Chi 2 (degrees of freedom)	3504.3(45)	3337.16(45)	3519.32(47)	3520.32(51)	1895.8(50)
Obs.	12,823	12,823	12,823	12,823	6460

Notes: Marginal effects (ME) at the sample mean values of the regressors are reported. All models control for the variables mentioned previously (the results are available on request).
As a robustness check, we use the logit model. The results are similar and available on request. Values in *italics* are standard errors.
** $p < 0.05$.
*** $p < 0.01$

In model (6), Table 2, we examine the association of combining different types of innovation and SMEs' internationalisation. The results suggest that SMEs that introduce a combination of goods and process innovation and service and process innovation are 2.6% and 7.9% more likely to export than non-innovative SMEs, respectively. The results also show that SMEs that introduce a combination of goods and service innovation are 9.8% more likely to export than non-innovative SMEs. Moreover, the results show that introducing all three types of innovation (i.e., goods, service, and process) increases SMEs' likelihood of internationalisation by 15.3%. The MEs of these combined innovation measures are generally higher than those from a single type of innovation, with the exception of goods innovation only. Using the Wald test (see Judge, Griffiths, Hill, Lütkepohl, & Lee, 1985), we test whether these coefficients are statistically different from each other; the results show that the coefficients of goods innovation and all types of innovation ($x^2(1) = 1.90$, prob. $= 0.167$), service, and process innovation ($x^2(1) = 1.19$, prob $= 0.275$) are not different from each other. Similarly, the coefficients of the combined goods and service innovation and the combined service and process innovation are not different from each other ($x^2(1) = 0.80$, prob. $= 0.371$). Overall, the results tend to support *H3*, which proposes that introducing a combination of innovation types has a stronger effect on internationalisation. We also estimate a model that allows multiple nominal-level treatments; the results are consistent with the results presented in model 6 of Table 2. However, the coefficients are found to be smaller in magnitude, with the coefficient of service innovation halved and becoming statistically significant at the 10% level.

We also examine the association of combining different types of innovation and SMEs' internationalisation compared with introducing process innovation by restricting the sample to innovative SMEs (see model 7, Table 2). The results show that innovative SMEs that introduce a combination of goods and process innovation and goods and service innovation are 25.5% and 7.5% more likely to export than innovative SMEs that undertake only process innovation, respectively. The results also show that introducing all types of innovation (i.e., goods, service, and process) or introducing goods innovation alone is strongly associated with SMEs' internationalisation compared with introducing process innovation (14% and 18%, respectively). We test whether these coefficients are statistically significantly different from each other; the results from the Wald test show that the coefficients of goods innovation and all types of innovation are not statistically significantly different from each other ($x^2(1) = 2.68$, prob. $= 0.101$). Likewise, the coefficients of the combined products and service innovation and the combined service and process innovation are not different from each other ($x^2(1) = 1.25$, prob. $= 0.263$).

Table 3 presents the association between the degree of novelty of innovation and the export propensity. Specifically, the results show that introducing radical product (i.e., goods/service) innovation increases SMEs' export propensity by 18% compared with SMEs that did not introduce product innovation. In addition, the results show that incremental product innovation that is new to the business only increases SMEs' internationalisation by 6.5%. Similar conclusions can be obtained for radical process and incremental process innovation (13% and 4.3%, respectively) (model 2, Table 3). Similarly, when all four types of the degree of novelty of innovation are included in the model simultaneously (model 3, Table 3), we still find that radical product innovation has the stronger association with internationalisation (see model 3). Hence, H4, which implies that there is a positive and significant relationship between radical innovation and SMEs' internationalisation, is supported. In model (3, Table 3), we also test if these variables are statistically significantly different from each other using the Wald test. The results show that incremental product and radical process innovation are not statistically different from each other ($x^2(1) = 0.27$, prob. $= 0.600$).

We also test for the association of the combination between radical innovation and incremental innovation on SMEs' internationalisation. The results in Table 3, in model (4), show that SMEs that introduce radical innovation are 24% more likely to export than non-innovative SMEs. In addition, the results imply that SMEs that introduce a combination of radical product and incremental process innovation are 19.6% more likely to export than non-innovative SMEs. In addition, SMEs that introduce only radical product innovation are 17.3% more likely to export than non-innovative SMEs. When radical and incremental innovations are combined, the magnitude of the ME varies from 0.113 to 0.196. The magnitudes of these effects are found to be large but generally do not suggest that combining radical and incremental innovation has a stronger effect on internationalisation than introducing radical innovation only. We carry out a test of equality of the degree of novelty coefficients. The results from the Wald test suggest that the coefficients of radical innovation and the combined radical product and incremental process innovations are not statistically significantly different from each other ($x^2(1) = 1.35$, prob. $= 0.244$). Hence, H5 is rejected.

Moreover, when restricting the sample to only innovative SMEs (model 5, Table 3), the results show that SMEs that introduced radical innovation are 14% more likely to export than those that introduced only incremental innovation. Similar results are obtained for combining radical product and incremental process innovation (10.4%). The results also show that, compared with incremental innovation, introducing radical product innovation increases SMEs' likelihood of internationalisation by 8.4%. We also perform the Wald test on the equality of these coefficients. The results show that the coefficients of radical innovation and the combined radical product and incremental process innovations are not statistically significantly different from each other ($x^2(1) = 1.32$, prob. $= 2.50$). Moreover, we find that the coefficients of the combined radical product and incremental process innovation and radical goods/service innovation are not statistically significantly different from each other ($x^2(1) = 0.41$, prob. $= 0.524$). The multiple nominal-level treatment model also supports the findings reported in model 5 of Table 3.

4. Discussion, limitations, and implications

This article contributes important insights into (1) the individual role of goods, service, and process innovations on SMEs internationalisation and (2) the relationship between the degree of novelty of innovation and SMEs internationalisation. In detail, this research compares the internationalisation of SMEs focused on a singular source of innovation (of goods, services, or process innovations) with SMEs that combine together two or three different types of innovation and degrees of novelty of innovation. The empirical analysis of 12,823 SMEs in the UK shows that while innovative SMEs are more likely to internationalise (i.e., export) than non-innovative SMEs, the association between innovation and internationalisation differs according to the type of innovation introduced and the degree of novelty of innovation. In this section, we discuss the contribution of the finding to the literature, limitations, policy implications, and directions for future research.

Our findings contribute to the existing IB literature (e.g., Cassiman & Golovko, 2011; Castaño et al., 2016; Di Maria & Ganau, 2013; Golovko & Valentini, 2011; Hagen et al., 2014; Higón & Driffield, 2010; Lewandowska et al., 2016; Love et al., 2016) and small business literature (e.g., De Massis, Audretsch, Uhlaner, & Kammerlander, 2018; Higón & Driffield, 2010; Lachenmaier & Wößmann, 2006) regarding the role of innovation in SMEs' internationalisation. Most of the literature, as noted earlier (e.g., Golovko & Valentini, 2011; Higón & Driffield, 2010; Roper & Love, 2002; Xie & Li, 2013), suggests a positive association between innovation and internationalisation. However, the previous literature fails to recognise the effect of each type of innovation on SMEs' internationalisation (Azar & Ciabuschi, 2017). Using data from the first wave of the UKLSBS (BIS, 2016a), this article extends the current literature by providing empirical evidence regarding the role of each type of innovation undertaken by SMEs in their exporting. In addition, this research takes into consideration the effect of combining different types of innovation on internationalisation. This article also adds to the previous literature by providing empirical evidence regarding the role of radical innovation in SMEs' internationalisation. In sum, the first objective of this research was to provide new empirical evidence regarding the role of goods, service, and process innovation in SMEs' exporting. The study exceeded this objective by examining the combined effect of these types of innovation on firms' export propensity. The second objective was to provide empirical evidence on the association between innovations' degree of novelty and SMEs' internationalisation. Similarly, it examined the combined effects of different degrees of novelty of innovation and compared the findings with their individual effects.

Consistent with the previous literature (e.g., Cassiman & Golovko, 2011; Harris & Li, 2009; Higón & Driffield, 2010; Roper & Love, 2002), the results show that innovative SMEs are more likely to export than non-innovative SMEs. In addition, the findings reveal that goods innovation is more strongly associated with the propensity to export than service innovation or process innovation. When differentiating between different degrees of novelty, the results show that SMEs that introduce radical innovation that is new to the market/industry are more likely to export than non-innovative SMEs. Moreover, the results show that combining radical and incremental innovation increases the likelihood of SMEs exporting. In addition, the results suggest that SMEs that introduce incremental innovation are more likely to export than non-innovative SMEs; however, the magnitudes of the effects of radical innovation and the combined radical and incremental innovation are larger than that of incremental innovation alone.

4.1. Limitations

A limitation of this study is that the data are self-reported and thus potential inflation bias may be problematic, as firms may misinterpret

what innovation or a new product or process is. While there do not appear to have been significant issues in overestimating innovation in the sample, the design of future innovation surveys should also include objective measures whereby any potential differences between subjective and objective measures can be investigated and controlled for in the model. Furthermore, the analysis did not distinguish among the constituent countries of the United Kingdom. Future research might focus on each constituent individually, namely England, Scotland, Wales, and Northern Ireland. This would be in line with Janger, Schubert, Andries, Rammer, and Hoskens (2017), who proposed the measurement of innovation on the country level. Future research could also be of a comparative nature, contrasting the situation in England, Scotland, Wales, and Northern Ireland. It might also compare innovation in the British Isles with that in Germany - globally recognised for innovation (De Massis et al., 2018) - and elsewhere on the European continent and beyond.

Future research might also investigate the impact of human capital on innovation and determine whether a primary motivation to innovate is the desire to internationalise - perhaps adapting concepts from Huggins, Prokop, and Thompson (2017), who examine human capital and growth motivation - or it might focus on the impact of marketing innovation (see Gupta, Malhotra, Czinkota, & Foroudi, 2016; Windahl, 2017) on internationalisation. Finally, future research might contribute to a capability theory, as pioneered by Teece (2017).

4.2. Managerial, policy, and theoretical implications

The results have clear implications for owner-managers of small firms and decision making. For example, goods innovation can be viewed as an enabler and facilitator of internationalisation. In addition, by introducing a combination of different types of innovation rather than most single types of innovation, owner-managers can improve the likelihood of internationalisation. However, if owner-managers introduce a single type of innovation strategy, then goods innovation is likely to be more strongly associated with internationalisation. Moreover, the findings show the importance of introducing radical innovation that is new to the market for internationalisation.

Furthermore, the findings translate into important policy implications. Given that we find innovative SMEs to be more likely to export than non-innovative SMEs, it can be argued that innovations are in the national interest in that they contribute to a country's balance of payments. However, it is important to note that not all innovation is equal. The findings indicate that goods innovation is more strongly associated with the propensity to export than other types of innovation, such as process innovation or service innovation. In this case, governments should be lobbied to promote goods innovation rather than all innovation. It is also valuable to know that SMEs that introduce radical innovation are more likely to export than non-innovative SMEs. Given this finding, the government policy should not be spending to promote product innovation across the board. Rather, a better use of public funds would be to focus on encouraging radical innovation.

Moreover, considering that combining radical and incremental innovation increases the likelihood of SMEs exporting and that the magnitudes of the effects of radical innovation and combined radical and incremental innovation are higher than that of incremental innovation alone, the public policy might consider match making firms with complementary skills. Synergy may yield better results.

Finally, in terms of theory, the results imply that future research should not limit its examination and investigation to a single type of innovation (e.g., Alegre, Pla-Barber, Chiva, & Villar, 2012; Cassiman & Golovko, 2011; D'Angelo, Majocchi, Zucchella, & Buck, 2013, for product innovation; and Golovko & Valentini, 2011; Monreal-Pérez, Aragón-Sánchez, & Sánchez-Marín, 2012, for process innovation). However, information on different types of innovation and their effect on SMEs will yield different results. Scholars and researchers should recognise the potential effect of each type of innovation and its degree of novelty (i.e., goods, service, and process) when measuring innovation.

Appendices

Table A1
Variable definitions used in this study.

Variable	Definition
Export propensity	Whether the firm sells goods and/or services outside the UK (coded 1) or not.
Innovation	Dummy variable = 1 if the firm has introduced goods, service, or process innovation.
Goods innovation	Dummy variable = 1 if the firm has introduced new goods.
Service innovation	Dummy variable = 1 if the firm has introduced new services.
Process innovation	Dummy variable = 1 if the firm has introduced new processes.
Innovation combination	Dummy variable = 1 if the firm has introduced goods innovation.
	Dummy variable = 1 if the firm has introduced service innovation.
	Dummy variable = 1 if the firm has introduced process innovation.
	Dummy variable = 1 if the firm has introduced goods innovation and service innovation.
	Dummy variable = 1 if the firm has introduced goods innovation and process innovation.
	Dummy variable = 1 if the firm has introduced service innovation and process innovation.
	Dummy variable = 1 if the firm has introduced goods innovation, service innovation, and process innovation.
Degree of novelty of product innovation	Dummy variable = 1 if the product (i.e., goods/service) innovation is new to the market.
	Dummy variable = 1 if the product (i.e., goods/service) innovation is new to the firm.
Degree of novelty of process innovation	Dummy variable = 1 if the process innovation is new to the market.
	Dummy variable = 1 if the process innovation is new to the firm.
Degree of novelty	Dummy variable = 1 if the firm has introduced radical innovation.
	Dummy variable = 1 if the firm has introduced incremental innovation.
	Dummy variable = 1 if the firm has introduced radical product (i.e., goods/service) and incremental process innovation.
	Dummy variable = 1 if the firm has introduced incremental product (i.e., goods/service) and radical process innovation.
	Dummy variable = 1 if the firm has introduced radical product (i.e., goods/service) innovation only.
	Dummy variable = 1 if the firm has introduced incremental product (i.e., goods/service) innovation only.
	Dummy variable = 1 if the firm has introduced radical process innovation only.
	Dummy variable = 1 if the firm has introduced incremental process innovation.
Size of the firm	ln(1 + number of employees).
Age of the firm	Broken down into age bands (0–5 years = 1, 6–10 years = 2, 11–20 years = 3, and > 20 years = 4). Dummy variables are created for each category.
Legal status	Legal status of the business (sole proprietorship = 1, company = 2, and partnership = 3). Dummy variables are created for each category.
Sites	Number of sites the business has (1 site = 1, 2 sites = 2, 3 sites = 3, 4–10 sites = 4, and 11+ sites = 5). Dummy variables are created for each category.

(continued on next page)

Table A1 (*continued*)

Variable	Definition
Family business	Dummy variable = 1 if the business is a family business.
Turnover	Broken down into turnover bands (1 = less than £82,000, 2 = £82,000–£99,999, 3 = £100,000–£249,000, 4 = £250,000–£499,000, 5 = £500,000–£999,999, 6 = £1 m–£1.99 m, 7 = £2 m–£2.8 m, 8 = £2.81 m–£4.99 m, 9 = £5 m–£9.99 m, 10 = £10 m–£14.99 m, 11 = £15 m–£24.99 m, and 12 = £25 m or more). Dummy variables are created for each category.
Business environment – finance	Dummy variable = 1 if the major obstacle for the business is obtaining finance.
Business environment – competition	Dummy variable = 1 if the major obstacle for the business is competition in the local market.
External advice/information	Dummy variable = 1 if the firm sought external advice/information.
ICT	Dummy variable = 1 if the firm used ICT.
Regions	Location of the business (England = 1, Scotland = 2, Wales = 3, and Northern Ireland = 4). Dummy variables are created for each category.
Sectors	2007 SIC (1-digit) classification. Dummy variables are created for each category.

Table A2
Descriptive statistics.

Variable	All firms	Exporting firms	Non-exporting firms
Innovation	50.370	30.247	69.752
Goods innovation	20.054	39.540	60.459
Service innovation	35.795	27.385	72.614
Process innovation	26.896	32.908	67.091
Innovation combination			
No innovation	49.621	14.867	85.132
Goods innovation	5.287	43.657	56.342
Service innovation	12.368	19.735	80.264
Process innovation	6.878	24.489	75.510
Goods and service innovation	5.825	28.112	71.887
Goods and process innovation	2.417	59.677	40.322
Service and process innovation	9.061	26.333	73.666
All innovation (goods, service, and process innovation)	8.539	39.086	60.913
Degree of novelty of the product (i.e., goods/services)			
No innovation	56.500	16.038	83.961
Radical product innovation	13.998	44.233	55.766
Incremental product innovation	29.501	24.953	75.046
Degree of novelty of the process			
No innovation	73.103	18.828	81.171
Radical process innovation	5.872	41.965	58.034
Incremental process innovation	21.024	30.378	69.621
Degree of novelty			
No innovation	49.621	14.864	85.132
Combined radical innovation only	3.782	48.453	51.546
Combined incremental innovation only	11.814	29.108	70.891
Radical product and incremental process innovation	3.212	46.844	53.155
Incremental product and radical process innovation	1.208	32.258	67.741
Radical product innovation only	7.003	40.757	59.242
Incremental product innovation only	16.478	21.438	78.561
Radical process innovation only	0.881	27.433	72.566
Incremental process innovation only	5.997	24.057	75.942

n_{SMEs} = 12,823; n_{micro} = 7031; n_{small} = 3313; n_{medium} = 2479.

Table A3
Correlation between the key explanatory variables and the dependent variable (export) by firm size.

Variable	All firms	Micro	Small	Medium
Innovation	0.183*	0.172*	0.172*	0.159*
Goods innovation	0.215*	0.169*	0.234*	0.263*
Service innovation	0.085*	0.123*	0.044*	0.011
Process innovation	0.149*	0.116*	0.145*	0.139*
Innovation combination				
No innovation	−0.183*	−0.172*	−0.172*	−0.159*
Goods innovation	0.118*	0.097*	0.133*	0.151*
Service innovation	−0.025*	0.008	−0.053*	−0.074*
Process innovation	0.012	−0.002	0.009	0.007
Goods and service innovation	0.032*	0.056*	0.023	0.004
Goods and process innovation	0.139*	0.058*	0.178*	0.183*
Service and process innovation	0.028*	0.061*	−0.004	−0.036

(*continued on next page*)

Table A3 (*continued*)

Variable	All firms	Micro	Small	Medium
All innovation (goods, service, and process innovation)	0.120*	0.100*	0.111*	0.138*
Degree of novelty of the product (i.e., goods/service)				
No innovation	−0.179*	−0.176*	−0.166*	−0.151*
Radical product	0.208*	0.191*	0.227*	0.203*
Incremental product	0.036*	0.051*	0.006	−0.001
Degree of novelty of the process				
No innovation	−0.149*	−0.116*	−0.145*	−0.139*
Radical process innovation	0.115*	0.103*	0.124*	0.104*
Incremental process innovation	0.095*	0.068*	0.087*	0.085*
Degree of novelty				
No innovation	−0.183*	−0.172*	−0.172*	−0.159*
Combined radical innovation only	0.122*	0.109*	0.119*	0.131*
Combined incremental innovation only	0.056*	0.060*	0.034*	0.028
Radical product and incremental process innovation	0.105*	0.063*	0.124*	0.116*
Incremental product and radical process innovation	0.025*	0.021	0.048*	−0.009
Radical product innovation only	0.119*	0.134*	0.132*	0.084*
Incremental product innovation only	−0.012	0.008	−0.041*	−0.025
Radical process innovation only	0.010	0.010	0.012	0.001
Incremental process only	0.008	−0.007	0.005	0.007

n_{SMEs} = 12,823; n_{micro} = 7031; n_{small} = 3313; n_{medium} = 2479

* $p < 0.05$.

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