The effect of outward and inward internationalisation on different types of innovation: evidence from UK SMEs

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Abstract

This paper empirically examines the effect of outward internationalisation, inward internationalisation activities and outward-inward internationalisation (i.e., exporting and importing) on different types of innovation undertaken by UK SMEs. Specifically, we differentiate between product innovation and process innovation and examine the potential effect that they can generate individually and in combination. The results show that both inward and outward internationalisation support product and process innovation in SMEs. However, such an effect is found to be stronger for the combined outward-inward internationalisation operations than for the single mode undertaken by SMEs. The results are found to be robust across the different types of innovation. However, sub-sample analysis shows that, although innovation responds to different internationalisation operations in micro and small firms, for medium-sized firms, only the combination of outward and inward internationalisation operations increases the probability of undertaking both innovations. Using the organisational learning theory, we argue that engaging in both internationalisation activities simultaneously enables firms to acquire a more diverse and richer set of knowledge and key information - through double loop learning, which is translated into increased levels of innovation. Hence, our results have important theoretical, managerial, and policy implications and stimulate the existing debate in the area.

Keywords: SMEs, outward internationalisation, inward internationalisation, learning, innovation, product innovation, process innovation.

1. Introduction

There has been increasing interest in understanding the role of internationalisation on firms' innovation. Existing research shows that both internationalisation and innovation contribute to firms' performance, productivity and growth (Prashantham, 2008; Halilem et al., 2014; Abubakar et al., 2019). Since internationalisation and innovation are interlinked, increasing attention is being directed to the specific channels through which international trade can affect firm innovation (Altomonte et al., 2014). To this end, the international business (IB) literature suggests that firms that are engaged in international activities are more likely to gain substantial competitive advantages through the interaction with their customers and suppliers and the competitive conditions of the foreign market in which they operate (Salomon & Shaver, 2005; Damijan & Kostevc, 2010). In addition, the organisational learning (OL) theory suggests that firms that are exposed to different economic environments and conditions can enhance their creativity and innovative activities to overcome the competition and strengthen their market share through the acquisition and leveraging of diverse sources of knowledge (cf. March, 1991; Argote, 2011; Puthusserry et al., 2020). It can be argued, therefore, that internationalisation in the form of imports and/or exports can serve as a learning opportunity for firms to gain more market and organisational knowledge, which in turn can trigger innovation (Kiriyama, 2012). Especially for smaller firms, since they face limitations in their internal resources as well as suffer from liabilities of smallness and newness compared with larger firms (Stinchcombe, 1965; Aldrich & Auster 1986; Gimenez-Fernandez et al., 2020). Thus, innovative activities may be affected more by knowledge factors that are external to the firm (Acs, 2002; Abubakar & Mitra, 2009; Abubakar et al., 2019).

Therefore, exposure to international markets can allow firms to develop and expand their set of capabilities and thus increase their likelihood of growth and enhance their dominance in the marketplace (Lu & Beamish, 2006; Prashantham, 2008; Zahra et al., 2018). For example, internationalised firms may be more likely to be exposed to new organisational ideas and methods of production, providing them with greater learning opportunities and knowledge tools to develop new skills and expand or improve existing organisational approaches that are not available in their domestic market (Hitt et al., 1997; Jones, 2001; Puthusserry et al., 2020). Although a great number of studies provide evidence regarding the positive effect of internationalisation on innovation (e.g., Kafouros et al., 2008; Lecerf, 2012), most of these studies concentrate on larger firms (e.g., Kafouros et al., 2008) rather than on SMEs (Abubakar et al., 2019). This is perhaps surprising, since previous research shows that SMEs that are involved in international activities are 'three times' more likely to introduce

products or services that are new to their sector than those SMEs that focus entirely on their domestic market (European Commission, 2010; Love & Roper, 2015). Although the available literature stresses the link between internationalisation and innovation, it is still in its infant stage regarding the individual and combined roles of outward and inward internationalisation activities on innovation.

Specifically, most of the previous studies focus either on the link between outward internationalisation and innovation (e.g., Salomon & Shaver, 2005; Love & Ganotakis, 2013; Golovko & Valentini, 2014; Olabisi, 2017; Fassio, 2018) or on the effect of inward internationalisation on innovation (e.g., Goldberg et al., 2010; Grosse & Fonseca, 2012; Kiriyama, 2012; Liu & Qiu, 2016; Chen et al., 2017) to determine how firms accumulate and implement knowledge (Hernández & Nieto, 2016). However, this literature ignores the potential effect on innovation that can be generated by combining the two forms of internationalisation activities. To address this gap, this paper investigates whether a combination of outward and inward internationalisation operations along with their individual effects can help SMEs to develop product and process innovations and, if so, to what extent. Theoretically, we draw insights from the OL theory (Senge, 1990; Argote, 2011; Gerschewski et al., 2018), and apply it to propose that the knowledge flow from international activities can stimulate SMEs' innovation (Zahra et al., 2009). In contrast to a large body of previous work, we do not treat innovation as an overall construct capturing different types of innovation together (Azari et al., 2017). In addition, instead of focusing on different types of innovation, separately, (e.g., Alegre et al., 2012; Bratti & Felice, 2012; D'Angelo et al., 2013; Boermans & Roelfsema, 2016; Martínez-Román et al., 2019, for product innovation; and Damijan & Kostevc, 2010, for process innovation; and Cassiman & Golovko, 2011; Monreal-Pérez et al., 2012, Damijan & Kostevc, 2015; Abubakar et al., 2019; Henly & Song, 2020; for product and process innovation, separately), we follow limited but growing recent research (e.g., Hullova et al., 2016; Saridakis et al., 2019) and consider a combination of different types of innovation (i.e., a combination of product and process) and their potential association with inward and outward internationalisation activities.

Such an approach provides a comprehensive and holistic understanding about the impact of inward-outward internationalisation activities and their effect on different types of innovation. The international process view and internationalisation studies primarily focus has been on firms' outward activities in the development of market knowledge (cf. Johanson & Vahlne, 1977, 1990), whereas scholars have also suggested that other sources of knowledge can be important for value creations (e.g., Jones, 2001; Forsgren, 2002; Puthusserry et al.,

2020). In such a context examining the connections between outward-inward internationalisation activities and their potential impact on firm-level outcomes such as innovation has significant implications for developing a much fine-grained understanding of firms' internationalisation process. Therefore, the examination of both inward and outward internationalisation activities provide novel and systematic understanding about the coordination, generation and exploitation of different sources of knowledge by firms for different types of innovation.

In order to address the above gaps, we leverage data from the UK Small Business Survey (BEIS, 2018), conducted between August 2016 and January 2017 by BMG Research Ltd. The survey is a large-scale telephone survey conducted with 9,248 small business owner-managers (those with up to 249 employees) in the United Kingdom. By utilising such a large-scale data set, the aim is to provide a complete picture of the effects of different internationalisation operations on innovation for SMEs (e.g., Seker, 2009; Hernández & Nieto, 2016) by focusing on the SMEs originating from the UK. Moreover, the use of a large-scale data set allows us to examine the differences between larger-sized SMEs and smaller ones, which can be hidden when data is aggregated into a single size category (Idris & Saridakis, 2018). Such a fine-grained systematic analysis is rare in the extant internationalisation research (cf. Bagheri et al., 2019).

Importantly, this work contributes to three distinctive streams of literature - the international business (IB) literature (e.g., Damijan & Kostevc, 2010; Nieto & Rodríguez, 2011; Grosse & Fonseca, 2012; Hernández & Nieto, 2016; Abubakar et al., 2019; Bagheri et al., 2019), the small business (SB) literature (e.g., Andersson & Lööf, 2009, 2012; Hernández & Nieto, 2016), the OL and international knowledge literatures (e.g., Argote, 2011; Chiva et al., 2014; Gerschewski et al., 2018) - in three important ways.

First, we add to the previous IB literature by examining the effect of outward-inward internationalisation operations simultaneously on SMEs' different types of innovation. In other words, our paper extends the extant studies that highlight the importance of taking into account the complementarities that may arise from different international activities (Bertrand, 2011; Hernández & Nieto, 2016). However, existing studies have predominately focused on outward internationalisation and ignored the role of inward activities on the development of innovative capabilities that are vital for developing competitive advantages in foreign markets (e.g., Cavusgil, 1998; Eriksson et al., 2000; Johanson & Vahlne, 1977, 1990; Bagheri et al., 2019). In this way, the paper extends the typical examination of the effect of either outward (e.g., Lileeva & Trefler, 2010; Ganotakis & Love, 2011; Bratti & Felice, 2012) or inward (e.g.,

Anderson & Lööf, 2009; Filippetti et al., 2012; Shahabadi & Havaj; 2012) international operations on innovation. Studies such as ours, which integrate both inward and outward internationalisation and simultaneously examine their effect on product and process innovations, are relatively rare (cf. Bagheri et al., 2019). Second, we contribute to the literature on international knowledge spillover, which suggests that the flow of knowledge is facilitated by participating in international trade activities. However, we extend the typical examination that either exporting or importing can increase firm's accumulation of knowledge. Our results clearly suggest that undertaking both types of internationalisation activities, simultaneously, may allow firms to increase their knowledge and access to information, thereby enhancing their absorptive capacity (Yao et al., 2013), which is ultimately related to firms' performance (George et al., 2001). In this context, our study provides novel insights about the different sources of knowledge - again highlighting that both outward and inward internationalisation activities can enable SMEs to acquire and internalise knowledge, which in turn facilitate their absorptive capacity (Hernández & Nieto, 2016), and support their international operations. Beside SMEs, large firms from emerging markets are also expanding abroad by learning from inward activities and developing their capabilities that are conducive for expansion into foreign markets (cf. Li et al., 2017). Third, we contribute to the OL theory by providing support to the view that it is important for firms to acquire and share knowledge with international firms due to the demands of globalisation (Levitt & March, 1988; Argote & Miron-Spektor, 2011; Hernández & Nieto, 2016). By exploring and exploiting different sources of knowledge, small resource-constrained firms can generate both product and process innovation through double loop learning (Argyris & Schon, 1978; Huber, 1991; March, 1991; Fletcher, 2009; Argote, 2011). Prior international process studies focus on incremental learning approaches where firms can develop competitive advantage by engaging in outward international activities through the accumulation of market knowledge (Johanson & Valhne, 1977, 1990). The findings of this study contribute to the process based view of internationalisation by bringing in multidimensional - holistic view of learning through inward-outward activities and their impact on different types of innovation. Small resource constrained firms can experiment and develop experiential learning through various sources while expanding into different markets through outward activities (cf. Zahra et al. 2018; Puthusserry et al., 2020), and can also enhance their learning through networking and developing connections with international sources of knowledge (through suppliers) by pursuing inward internationalisation activities. The connections between outward-inward internationalisation and the development of innovative capabilities by internationalising SMEs can be vital for developing a complete picture of firms'

internationalisation process, which so far has received limited scholarly attention (cf. Cavusgil, 1998; Bagheri et al., 2019; Eriksson et al., 2000; Westney, 2020). By examining both activities and their connections with innovation suggest that internationalising SMEs could gain more by engaging in both activities and this broadly contributes to the wider IB literature that has focused on a single activity such as outward internationalisation at a given time (cf. Adomako et al., 2017; Bagheri et al., 2019; Puthusserry et al., 2020). Thus, these findings provide important insights and respond to recent calls to examine how inward internationalisation activities affects domestic firms (cf. Westney, 2020, p. 1197). In addition, we provide important and fine-grained understanding to the innovation literature by connecting both activities and different types of innovation in the context of SMEs, as previous literature focuses on the cause-effect type of relationships -exploring either the impact of innovation on internationalisation or vice versa (cf. Chiva et al., 2014). Lastly, we provide a much fine-grained view of inward-outward activities across different types of firms and the impact of dual activities on different types of firms' innovation. Since firms varies in their resource base, therefore, examining inward-outward activities and their impact on different types of innovation across different types of firms provide a much needed understanding about the type of firms that may benefit from both vs. single activities. Developing capabilities and their role in internationalisation is at the centre of understanding the foreign expansion of firms as well as their survival in foreign markets, thus this study offers unique insights on this important topic.

The rest of paper is organised as follows. Section 2 reviews the existing literature and derives the set of the hypotheses to be examined in this paper. Section 3 presents the data and the measurements used in the model. Section 4 contains the statistical methods and the results of the paper. Section 5 discusses the results, and the last section concludes the paper and offers directions for future research.

2. Background and hypotheses development

2.1 Outward internationalisation and innovation

Although different modes of internationalisation are available to SMEs, exporting is still often considered a firm's initial stage of internationalisation (Jones, 2001; Golovko & Valentini, 2011). Following recent empirical studies in this area (e.g., Idris & Saridakis, 2018; Abubakar et al., 2019; Saridakis et al., 2019), we use exporting as a proxy for outward internationalisation, defined as 'outward international trade in goods and/or services, conducted either directly or through a third party' (Love & Roper, 2015, p. 29). Previous studies generally support the argument that exporting firms are more productive than non-

exporting firms. This assumption may be explained by either the 'self-selection hypothesis' or the 'learning-by-exporting hypothesis' (Fassio, 2018). The 'self-selection hypothesis' (Bernard & Jensen, 1999; Melitz, 2003) argues that, since the competition level in the export market is higher than that in the domestic market, only more productive firms will have the ability to export. Hence, a higher level of innovation enables firms to gain more access to export markets by increasing their productivity (Monreal-Pérez et al., 2012). Meanwhile, the 'learning-by-exporting hypothesis' suggests that exporting firms can become more productive because they are exposed to international markets. Although a great number of studies conclude that firms that introduce innovation are more likely to export (e.g., Roper & Love, 2002; Cassiman et al., 2010; Saridakis et al., 2019), the empirical evidence for learning-by-exporting is relatively inconclusive (Salomon & Shaver, 2005; Bratti & Felice, 2009, 2012; Kiriyama, 2012) and limited, especially in the context of SMEs. Nevertheless, this effect is found to hold (e.g., Salomon & Shaver, 2005; Wagner, 2007; Chang et al., 2013; Bratti & Felice, 2012); hence, we state that firms will be encouraged to introduce innovation due to their participation in international markets and due to the knowledge gained from foreign markets (e.g., Liu & Buck, 2007; Abubakar et al., 2019).

However, although some studies (e.g., Lileeva & Trefler, 2010; Bustos, 2011) found evidence that exporting increases innovation, there is no agreement about which specific type of innovation is mostly affected (Fassio, 2018). It has been implied that innovation activities by exporting firms will differ according to their innovation strategy (Golovko & Valentini, 2014). The review of the previous literature reveals inconsistent results regarding the effect of exporting on different types of innovation, with most studies focusing exclusively on one type. For instance, some studies find a positive association between exporting and product innovation (e.g., Salomon & Shaver, 2005; Iacovone & Javorcik, 2012; Olabisi, 2017), but fail to account for process innovation. Some other studies, in contrast, suggest a positive effect of exporting on process innovation (cf. Damijan et al., 2010) without considering the potential effect on product innovation. These findings, although contributing significantly to our knowledge about the internationalisation-innovation nexus, provide an incomplete picture; therefore, we can argue, for example, that firms may undertake these two types of innovation simultaneously or that some firms may be more prone to engage in either product or process innovation based on the industry in which they operate. Pursuing both innovations simultaneously can be a costly process, especially for SMEs, which tend to lack resources and key know-how such as finance, management and marketing, skilled labour and information (for a review, see Freel, 2000).

The study by Lee et al. (2014) considers both types of innovation and finds that internationalisation in Korean service firms is positively and significantly related to innovation but that the effect is greater on product innovation than on process innovation. A more recent study by Abubakar et al. (2019), using a sample of SMEs in developing countries, finds that there is no association between exporting and product innovation but that there is a negative association between exporting and process innovation. Monreal-Pérez et al. (2012) show that exporting firms are more likely to develop more product innovation than non-exporting firms, while Cooper and Kleinschmidt (1985) show that product innovation enables younger and smaller firms to adapt to foreign market demands. In other words, internationalisation forces firms to update their products to adapt to different market demands and requirements (Silva et al., 2010; Monreal-Pérez et al., 2012). Following this line of argumentation, firms that are engaged in international activities have to adjust their products and improve their quality after entering a foreign market (Alvarez et al., 2013), and the need for introducing product innovation in the international market is stronger for smaller firms than for larger firms (Golovko & Valentini, 2014), given that small firms face significant challenges and liabilities (e.g., smallness and newness) while expanding into foreign markets. It can also be argued, for example, that SMEs are more narrowly focused than larger firms and thus there is a need for them to invest in innovation to adapt their existing products or create new products so that they can compete successfully in the foreign market (Calantone et al., 2004). In addition, product innovation is more important for small firms that are engaged in exporting activities, since it can assist them in mitigating the prices in the export market and overcome the liability of smallness. Bratti and Felice (2012) show that the export status of a firm can positively affect its likelihood of introducing product innovation. They imply that the interaction and communication with foreign buyers can provide the firm with information regarding customers' needs and market demands, which may be translated into product innovation.

The results between process innovation and internationalisation, however, are also revealing. Damijan et al. (2010), for example, find a positive relationship between firm exporting and process innovation. Some researchers, though, argue that SMEs tend to focus their efforts on product innovation rather than process innovation to increase their productivity (e.g., Golovko & Valentini, 2014). Meanwhile, other scholars claim that process innovation, which is based on technological improvements and enhancement in developing production processes, can allow firms to introduce product innovation (Martínez-Ros & Labeaga, 2009). However, according to Bratti and Felice (2012), the probability of introducing process innovation increases for exporting firms only if they first introduce product innovation.

Baldwin and Gu (2004) find that firms that start to export increase their product specialisation and hence their production run, compared with firms that do not export. Importantly, Love and Ganotakis (2013) argue that the stronger competition in the international market puts pressure on exporting firms to improve both their product and their process innovation to operate internationally.

Previous research suggests that product and process development are interlinked. For instance, Hullova et al. (2016) argued that when firms introduce a new process innovation for reducing costs, firms have to adjust their product designs. Previous literature that examine the complementarity between product and process innovation focused on either investigating complementarities-in-use (e.g., Martínez-Ros & Labeaga, 2009) or complementarities-in-performance (e.g., Kotabe & Murray, 1990). The advantages of combining product and process innovation have been highlighted in the complementarities-in-performance stream of literature as it has been argued that combining these two types of innovation will lead to the introduction of new products, cost efficiency and higher returns (Hullova et al., 2016). The complementarity between product and process innovation can be demonstrated by the Industry Life Cycle Theory (Abernathy & Utterback, 1978) in its third phase where the motivation for innovation arise from reducing costs and improving products' quality. For instance, Martínez-Ros (2000) found that firms that introduced process innovation are more likely to introduce product innovation.

Therefore, we argue that complementarity between product and process innovation potentially exists (e.g., Martínez-Ros, 2000; Reichstein & Salter, 2006; Roper et al., 2008; Martínez-Ros & Labeaga, 2009; Van Beers & Zand, 2014; Hullova et al., 2016; Lewandowska et al., 2016), and we propose that outward internationalisation can enable SMEs to gain valuable knowledge and skills related to production, marketing and R&D (Zahra et al., 2009) and to capitalise on opportunities to adapt their products or create new products for foreign markets, as well as adopting new and more efficient methods of production. The preceding discussion leads to the following hypothesis:

> ***H1****: Outward internationalisation increases the likelihood of SMEs introducing a single type of innovation or a combination of product and process innovation.*

2.2 Inward internationalisation and innovation

Firms can internationalise via two types of operations: outward and inward (Fletcher, 2001; Welch et al., 2007; Hernández & Nieto, 2016). Most of the previous studies, however, tend to

pay more attention to outward international operations, which allow firms to exploit opportunities and obtain knowledge that can be used for their expansion and growth (Pangakar, 2008). However, firms may also internationalise through inward operations, such as importing or contractual collaborations (Welch et al., 2007). Hence, recent studies identify strategic reasons for inward operations, such as their ultimate role in boosting innovation (Nieto & Rodríguez, 2011). Such activities can also aid outward internationalisation as firms could develop important capabilities by learning from foreign sources of knowledge. It is argued that, although imports are rarely viewed as an essential part of firms' internationalisation process, increasing competition forces firms to find ways to lower their costs and gain access to products and knowledge that are not available in their domestic market (Grosse & Fonseca, 2012). Therefore, previous empirical studies show that importing is positively associated with innovation (e.g., Bertschek, 1995; Liu & Buck, 2007; Anderson & Lööf, 2009; Damijan & Kostevc, 2010; Chen et al., 2017).

According to Damijan and Kostevc (2015), firms that have a large number of importing links are more likely to introduce new product or process innovation, which subsequently enhances their productivity and growth. A study by Paunov (2011) shows that firms in Ecuador that are engaged in importing activities are able to influence their product innovation. Meanwhile, Narayanan and Bhat (2009) suggest that a relationship exists between importing technology and firms' R&D. Additionally, Goldberg et al. (2010) find that firms that focus on their domestic markets have the ability to increase their product scope due to the fact that these firms gain access to valuable inputs, which result in the introduction of new products.

Reviewing the existing literature, we argue that SMEs that are engaged in importing are likely to introduce both product and process innovation. To put it differently, importing exposes firms to new processes, since new knowledge tends to be embedded in new machinery (Filippetti et al., 2012; Abubakar et al., 2019), and international suppliers and networks can provide valuable learning opportunities to SMEs (cf. Puthusserry et al., 2020). In addition, firms that are engaged in importing intermediate goods and inputs may have to adjust and advance their production processes. As with the literature on the complementarity between product and process innovation (e.g., Martínez-Ros, 2000; Reichstein & Salter, 2006; Roper et al., 2008; Hullova et al., 2016; Lewandowska et al., 2016; Saridakis et al., 2019), we suggest that inward internationalisation may enable firms to obtain more knowledge from their suppliers, for instance, and therefore have the ability to introduce a combination of product and process innovation. Hence, we hypothesise that:

***H2**: Inward internationalisation increases the likelihood of SMEs introducing a single type of innovation or a combination of product and process innovation.*

2.3 Outward-inward internationalisation and innovation

Although SMEs face significant challenges to internationalise, such as limited experience in internationalisation operations (Cadogan et al., 2012), it can be argued that exposure to foreign markets enables firms to develop capabilities that can enhance their future growth (Lu & Beamish, 2006; Hernández & Nieto, 2016; Puthusserry et al., 2020). Internationalisation via outward operations or inward operations exposes firms to new and diverse ideas, learning opportunities and specialised knowledge that enable them to enhance their ability to develop new skills and introduce innovation (Cheng & Bolon, 1993; Hitt et al., 1997; Chiva et al., 2014). Although the existing work finds that outward and inward internationalisation allow firms to exploit knowledge, gain more advantages and introduce innovation, a gap still exists in the literature regarding the potential impact that can be generated on innovation by implementing both forms of internationalisation operation (i.e., outward and inward) simultaneously (Hernández & Nieto, 2016).

The existing literature suggests that it is critical for firms to gain access to knowledge (Levitt & March, 1998) due to globalisation demands, especially for those firms that are involved in international activities. Outward and inward international operations allow firms to gain access to different and varied types of knowledge and information from a variety of sources. Firms can then develop competitive advantage by leveraging and exploiting diverse sources of knowledge (e.g., March, 1991; Argote, 2011). Studies that examine inward-outward internationalisation focus on investigating how knowledge obtained from inward internationalisation can be used to perform outward internationalisation or vice versa (Hernández & Nieto, 2016). When firms engage in both internationalisation operations at the same time, they may have the ability to develop connections that can create various advantages (Andersson & Lööf, 2012). For example, it is argued that firms can improve their absorptive capacity due to the greater exposure, and to the diversity and complementarity of the accumulated knowledge, hence allowing them to exploit opportunities and discover solutions to their problems and ultimately to achieve better organisational outputs (Zahra & George, 2002; Kostopoulos et al., 2011; Yao et al., 2013). Also, by engaging in both activities, firms can develop experiential learning, which can be vital for enhancing product and process innovation.

According to Hernández and Nieto (2016, p. 297), undertaking both internationalisation activities simultaneously allows firms to increase their 'diversity, relatedness and complementarity of their experiential knowledge', and thereby to increase their absorptive capacity (Yao et al., 2013). The OL literature is generally linked to innovation (Dodgson, 1993). Gomes and Wojahn (2017) argue that firms are able to obtain better competitive advantages and a larger market share when they direct their efforts to innovation. Especially for SMEs, innovation is the key factor that enables them to increase their market share and power (Gunday et al., 2011). Therefore, it can be argued that SMEs that have the ability to learn through internationalisation can be in a better position to detect trends and events in the marketplace and utilise the market opportunities that may emerge. Internationalisation therefore exposes SMEs to various types of knowledge, ideas and learning methods, and to a richer and wider flow of knowledge and information, thus enabling them to innovate. A study by Andersson and Lööf (2012, p. 749) found that Swedish SMEs that are engaged in trade (both exporting and importing) are more likely to 'apply for patents' than firms that are engaged in a single international trade activity (i.e., either exporting or importing). Therefore, we propose that undertaking both internationalisation operations will have a stronger effect on SMEs' innovation. Hence, we hypothesise that the probability of introducing innovation will be stronger when SMEs undertake both internationalisation operations simultaneously (i.e., outward-inward internationalisation).

Given the lack of previous studies that examine the effect of outward and inward internationalisation on different types of innovation, we argue, like the previous literature on the complementarity between product and process innovation, that undertaking both internationalisation operations may allow SMEs to receive a diverse set of knowledge and information, permitting them to introduce a combination of innovation forms. In addition, by applying the OL theory, we also argue that firms can acquire richer knowledge by undertaking both operations, and hence introduce both types of innovation. Based on the above literature, we hypothesise the following:

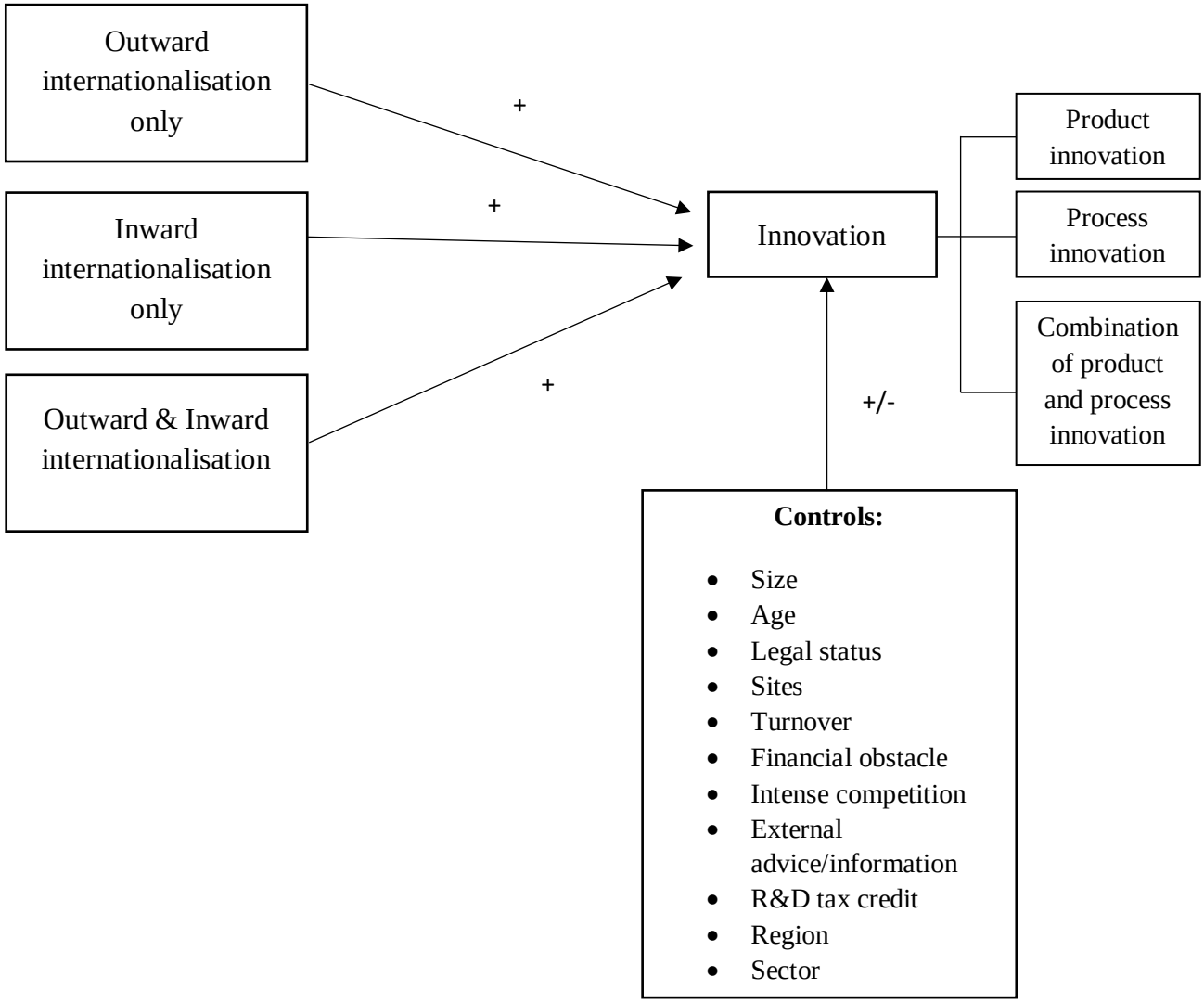
***H3**: Outward-inward internationalisation will have a stronger effect on the likelihood of SMEs innovating than a single internationalisation operation.*

***H4**: Outward-inward internationalisation will have a stronger effect on introducing a single type of innovation or a combination of product and process innovation than a single internationalisation operation.*

2.4 Theoretical framework

Based on the above literature, Fig (1) represents our conceptual model. The figure shows on the left the internationalisation operation of the firm; whether the firm is an exporter, importer or both an exporter and importer. We expect each type of the internationalisation operation (or a combination of them) to have a positive effect on innovation (H1-H2). Our model allows a disaggregation of the innovation variable, as it is presented on the right side of the figure, and thus allows us to examine whether a combination of outward and inward internationalisation would have a greater estimated effect on overall innovation (H3), and on each type of innovation separately (H4). The data used to measure our variables, the estimated approach adopted, and the empirical findings are presented in the following sections subsequently.

Figure 1: Theorised model.



3. Data and measurements

3.1 Data

This paper uses data from the UK Small Business Survey (BEIS, 2018a) conducted between August 2016 and January 2017 by BMG Research Ltd. The survey is a large-scale telephone survey of 9,248 small business owner-managers (those with up to 249 employees) in the UK, covering firms operating in England, Wales, Scotland and Northern Ireland. Therefore, it can be argued that the survey provides rich information from a large representative sample of UK SMEs (BEIS, 2018a). The Small Business Survey consists of two waves. Information about SMEs' importing activities are not provided in the first wave; therefore, in this paper we use data from the second wave only. Detailed information about the survey method, sampling and instruments can be found in the survey technical report (BEIS, 2018b). Regarding the key variables in this study - exporting, importing and innovation - the survey provides data on (i) whether a firm exports goods and/or services outside the UK, (ii) whether a firm imports goods or services from outside the UK and (iii) whether a firm has introduced a significantly new or improved product or process innovation. These measures are discussed analytically below. The survey also provides information related to firms' characteristics, such as the region, sector, age of the firm, number of employees and turnover. The latter variables are used as controls in our modelling approach.

3.2 Measurements

3.1.1 Dependent variables

We follow previous and most recent empirical studies and measure innovation as the introduction of new products (goods or services) and processes as a proxy for firms' innovative activities (Nguyen et al., 2008; Higón & Driffield, 2010; Higón, 2011; Golovko & Valentini, 2014; Van Beers & Zand, 2014; Fassio, 2018; Abubakar et al., 2019; Saridakis et al., 2019). The survey asks owner-managers the following two questions regarding product and process innovation (BEIS, 2018b, p. 64), respectively:

- 'Has your business introduced any new or significantly improved goods or services in the last three years?'
- 'Has your business introduced any new or significantly improved processes in the last three years?'

The survey does not provide information about the exact year and duration of innovation or whether or not the firm is a serial innovator.[1] Here, we simply create the following two dependent variables to capture the firm's innovative strategic activity:

Overall innovation

Overall innovation is measured through the above two dichotomous scale questions, taking the value of one if the firm introduced product or process innovation individually or jointly and zero otherwise. The survey shows that 41.52 per cent of SMEs introduced innovation, mostly product innovation followed by product and process innovation together (Table 1), while 58.4 per cent did not introduce innovation at all in the last three years.

Different types of innovation

An index is used to capture which types of innovation the firm has introduced. The variable takes the value of one if the firm introduced product innovation, two if the firm introduced process innovation, three if the firm introduced a combination of product and process innovation and zero if the firm did not introduce any innovation. Table 1 shows the distribution of innovation by firm size, suggesting that as the firm size increases, the scale of innovation increases, along with the tendency to carry out process innovation individually or in combination with product innovation. We test whether there are statistically significant differences in the proportions between non-innovative micro, small and medium-sized firms, and find that there are statistically significant differences between micro and small, between micro and medium-sized and between small and medium-sized firms at the 1 per cent level. For the product innovation, process innovation and product and process innovation categories, we also find statistically significant differences, with the sole exception being between small and medium-sized firms (for product innovation prob. = 0.397 and for the combination of product and process innovation prob. = 0.133).

[1] We use information from the panel and find that there is a great deal of persistence in non-innovation activity. Nearly 83% and 87% of the firms reported no good/service innovation or process innovation activity, respectively, in either wave. There is less persistence, however, among innovative firms, with nearly half of the firms that reported innovation activity in wave 1 reporting innovation in wave 2. This is because innovation is costly, and SMEs especially have restricted access to financial resources to allocate for innovation. Hence, if a firm admitted innovation activity in wave 1 but not in wave 2, it suggests that those SMEs have been free of innovation for three years or more since the last innovation.

Table 1: Innovation types by firm size, %.

	All SMEs	Micro firms (<10 employees)	Small firms (10-49 employees)	Medium firms (50-249 employees)
No innovation	58.48	64.17	52.21	46.89
Product innovation only	19.91	18.54	21.43	22.69
Process innovation only	6.40	5.45	7.10	8.99
Product and process innovation	15.21	11.85	19.26	21.43
Observations	8,171	4,811	2,170	1,190

Note: Percentages may not add up to 100 due to rounding.

3.1.2 Independent variables

Outward internationalisation (i.e., exports)

Similarly, following the previous literature, we use exports as a proxy for internationalisation (e.g., Salomon & Shaver, 2005; Higón & Driffield, 2010; Ganotakis & Love 2011; Liang et al., 2012; Serra et al., 2012; Boehe, 2013; Golovko & Valentini, 2014; Idris & Saridakis, 2018; Abubakar et al., 2019; Saridakis et al., 2019). The survey asks owner-managers the following question:

- 'In the past 12 months did your business export any goods and/or services outside the UK?' (BEIS, 2018b, p. 36).

This construct takes the value of one if the firm exports goods and/or services outside the UK and zero otherwise.[2] The survey shows that 21.67 per cent of SMEs in the UK exported goods and/or services outside the UK. Also, 59.29 per cent of the exporting SMEs had introduced innovation in the last three years. In addition, 20.76 per cent of micro firms that export introduced a combination of product and process innovation, whereas 29.70 per cent of small firms and 28.77 per cent of medium-sized firms did so.

Inward internationalisation (i.e., imports)

Based on the previous literature (e.g., Hernández & Nieto, 2016; Abubakar et al., 2019), we use imports as a proxy for inward internationalisation. The survey asks the participants to respond to the following question:

- 'In the past 12 months, have you directly imported any goods or services from outside the UK?'[3] (BEIS, 2018b, p. 38).

[2] Again, we use information from the panel and find that there is much persistence in both exporting firms (79%) and non-exporting firms (96%) between waves 1 and 2.

[3] The survey asks owner-managers whether the imports were from the EU or outside the EU. However, this differentiation is beyond the scope of this paper, so we group them into one category.

We constructed a variable taking the value of one if the firm imported goods or services from outside the UK and zero otherwise. The survey shows that 22.82 per cent of SMEs imported goods or services from outside the UK. Moreover, 58.97 per cent of the importing firms had introduced innovation in the last three years and 22.63 per cent of the importing micro firms had introduced a combination of product and process innovation (followed by 28.11 per cent of the importing medium-sized firms and 25.81 per cent of the importing small firms).

Outward and inward internationalisation (i.e., exports and imports)

To capture the different internationalisation operations of firms, we follow recent work (e.g., Seker, 2009; Hernández & Nieto, 2016) and distinguish between firms according to their internationalisation operations. In particular, we create an index to distinguish between firms that are (i) only involved in outward internationalisation (i.e., exporting), (ii) only involved in inward internationalisation (i.e., importing), (iii) involved in both international operations (i.e., exporting and importing) simultaneously and (iv) not involved in any international operations (reference category). Table 2 shows that about 20 per cent of medium-sized firms are engaged in exporting and importing activities, followed by 18.32 per cent of small firms and 7.85 per cent of micro firms. We also test whether there are statistically significant differences in the proportions between different-sized bands with different internationalisation operations. The results show that, for exporting firms, there is no statistically significant difference between micro and small firms that export only (prob. = 0.420), between micro and medium-sized firms that export only (prob. = 0.565) or between small and medium-sized firms that export only (prob. = 0.949). Moreover, we find that the difference between micro and small firms that import only is statistically insignificant (prob. = 0.310). As for importing and exporting firms, the results show that all coefficients are statistically different, with the sole exception of between small and medium-sized firms (prob. = 0.227).

Table 2: Firms' internationalisation operations by firm size, %.

	All SMEs	Micro firms (<10 employees)	Small firms (10-49 employees)	Medium firms (50-249 employees)
No international operations (i.e., no trade)	67.97	73.59	61.73	56.65
Outward operations (i.e., exports) only	9.21	8.98	9.58	9.51
Inward operations (i.e., imports) only	10.41	9.58	10.37	13.80
Outward-inward operations (i.e., both exports and imports)	12.41	7.85	18.32	20.03
Observations	8139	4790	2161	1188

Note: Percentages may not add up to 100 due to rounding.

3.1.3 Control variables

In our specification, we control for several variables, such as the firm's age (e.g., Hansen, 1992; Abubakar et al., 2019), measured as the number of years since the firm started operating, the firm's turnover, its size (Higón, 2011), the number of sites it has (e.g., Roper & Love, 2002) and its legal status (Higón & Driffield, 2010). Following previous work (e.g., Andersson & Lööf, 2009; Abubakar et al., 2019), we also control for the firm's external environmental factors, specifically its ability to obtain financial resources, the market competition and the networking linkages (for the latter, see Kingsley & Malecki, 2004; Rogers, 2004; Saridakis et al., 2019). It is argued, for example, that access to finance is often a major obstacle for small firms to carry out innovative activities. Moreover, we control if the firm has received R&D tax credits in the past three years. Finally, a general argument in the neo-Schumpeterian literature is that the characteristics of a particular sector or industry may influence its innovative activities (Andersson & Lööf, 2012); hence, we control for the sector effects along with the regions. Table A1 in the Appendix presents the definitions of the variables used in this paper. In addition, also in the Appendix, we present the summary statistics of the key variables (Table A2) and the correlation matrices (Tables A3-A4).

4. Empirical model and results

4.1 Empirical model

To test the association between internationalisation and innovation, we use two statistical approaches. First, since overall innovation takes only two possible values (1 if the firm introduced innovation and 0 otherwise), we use a probit regression (for a discussion, see Gujarati 1995: 552-570) to examine the association between internationalisation operations

(i.e., exporting, importing and both exporting and importing) and innovation.[4] Our model can be written as follows:

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

$$I_j^* = X_j b_j + EX_j \vartheta + IM_j \delta + EXIM_j \gamma + e_j \tag{2}$$

where I_j^* denotes the latent variable and *EX*, *IM* and *EXIM* are the indicator variables for whether the firm has exported, imported or both (i.e. exported and imported), respectively. *X* is the vector of firm characteristics for firm *j*. b, ϑ, δ and γ are the parameters to be estimated. In addition, following the previous literature (e.g., Wagner, 2002; Yasar & Rejesus, 2005; Saridakis et al., 2019), we apply propensity score matching techniques (Rosenbaum & Rubin, 1983) to reduce the potential biases and allow for stronger causal inferences between the internationalisation operations and innovation.

Second, when the innovation variable is disaggregated to capture a single (i.e., either product innovation or process innovation) or combined type of innovation (i.e., both product and process innovation), the above model is re-estimated using a multinomial logit model (the base category is no innovation), which is a generalisation of the binary logit model (Brooks, 2008). We test for the independence of irrelevant alternatives (IIA) using both the Hausman and the Small–Hsiao test. Both tests suggest that the IIA has not been violated. Our dependent variable in this case is a categorical and unordered variable, $j = 4$, and can be written as follows:

$$I_j = \begin{cases} 0 & \text{if} \quad I \neq j \\ 1 & \text{if} \quad I = j \end{cases} \tag{3}$$

For both models, we present the marginal effects to assist with the interpretation of the results and estimate the particular effects for each category (in the case of the multinomial logit model).

[4] We also use a logit model; however, the results are similar and thus are not reported here.

4.2 Empirical results

4.2.1 The relationship between internationalisation operations and innovation

In Table 3, we present the marginal effect of the probit analysis of the relationship between internationalisation operations and innovation for all SMEs.[5] The results presented in Model 1 of Table 3 show that compared with no trading, exporting only increases the probability of introducing innovation by 12.3 percentage points, while importing only increases the probability of introducing innovation by 17.3 percentage points. In addition, the results show that carrying out both exporting and importing activities increases the likelihood of introducing innovation by 23.2 percentage points. To examine the robustness of this finding, we also use propensity score matching techniques (see Cameron & Trivedi, 2005, for a technical discussion) that account for potential endogeneity. Using a model that allows multiple nominal-level treatments, the results are found to be consistent with those reported in Table 3 and thus are not discussed here (see Model 3, Table 5A in the Appendix). Using the Wald test (see Judge, Griffiths, Hill, Lutkepohl & Lee, 1985), we determine whether these coefficients are statistically different from each other. The results show that the coefficient of exporting is statistically significantly different from the coefficient of importing ($x^2(1) = 4.49$ and prob. = 0.034) and the one reported for the combination of exporting and importing ($x^2(1) = 17.72$ and prob. = 0.001). Moreover, the results show that the coefficient of importing is statistically significantly different from the coefficient of the combination of exporting and importing ($x^2(1) = 4.67$ and prob. = 0.030). Hereafter, we restrict the sample to those SMEs that import. The results in Model 2 of Table 3 show that compared with importing, exporting increases the likelihood of innovation by 11.7 percentage points. In addition, we find that the combination of exporting and importing increases SMEs' innovation by 22.2 percentage points compared with importing. Finally, the results show that the coefficients of exporting and exporting and importing together are statistically significantly different from each other ($x^2(1) = 16.37$ and prob. = 0.001). Overall, the results in Table 3 confirm our *H1-H3* which state that each internationalisation operation will be positively associated with innovation, and that outward-

[5] We test if exporting is associated with innovation, and the results confirm previous literature and so are not discussed here (exporting increases the likelihood of introducing innovation by 13.9 percentage points compared to non-exporting firms). Similar results are obtained for importing firms compared to non-importing firms (18 percentage points). We also use the propensity score matching techniques that account for potential endogeneity between exporting and innovation and between importing and innovation. We apply the nearest neighbour estimator, and the results show that for firms that are engaged in exporting (importing), exporting (importing) has caused the probability of introducing innovation to be 16 percentage (12.9 percentage) points higher than it would have been otherwise (see Table A5 in the Appendix).

inward internationalisation will have a stronger effect on the likelihood of SMEs' innovation than a single internationalisation operation.

Table 3: The association between internationalisation operations and overall innovation (all SMEs), *probit estimates (ME and standard errors)*.

	Overall innovation	
	Model (1)	Model (2)
Internationalisation operations (Base category: No trade)		
Exports Only	0.123***	
	0.021	
Imports Only	0.179***	
	0.019	
Exports & imports	0.232***	
	0.020	
Internationalisation operations (Base category: Imports)		
Exports only		0.117***
		0.021
Exports & imports		0.222***
		0.020
Key independent variables		
Firm size	0.036***	0.036***
	0.007	*0.007*
Financial obstacle	0.106***	0.109***
	0.015	*0.016*
Intense competition	0.054***	0.051***
	0.011	*0.012*
External advice/information	0.164***	0.165***
	0.013	*0.013*
R&D Tax credit	0.209***	0.219***
	0.027	*0.029*
Other controls	**Yes**	**Yes**
log Likelihood	-4937.8824	-4373.7321
x^2 (degrees of freedom)	1170.45(45)	1074.35(44)
Observations	8139	7292
Wald test (x^2)		
Exports only = Imports only = Exports & imports	17.76***	
	0.001	
Exports only = Imports only	4.49**	
	0.034	
Exports only = Exports & imports	17.72***	16.37***
	0.001	*0.001*
Imports only = Exports & imports	4.67**	
	0.030	

Notes: All the models include control variables (full results are available upon request). The standard errors of the coefficients are in *italics*.
As a robustness check, we also estimate a logit model, and the results are found to be similar to those reported here.
Values in *italics* are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2.2 The relationship between internationalisation operations and different types of innovation

Table 4 presents the marginal effect of the multinomial logit analysis of the relationship between internationalisation operations and different types of innovation for all SMEs (we exclude the marginal effect of the base category, which is no innovation). The results show that firms that are engaged in exporting increase the probability of introducing product innovation only (Model 1a, Table 4) by 6.6 percentage points and the combination of product and process innovation (Model 1c, Table 4) by 5.3 percentage points. However, the results show that exporting is not associated with process innovation. Therefore, although the results continue to support our *H1*, they indicate that outward internationalisation increases the likelihood of SMEs introducing a product innovation only, and a combination of product and process innovation. Moreover, we find that importing increases the probability of introducing product innovation and a combination of product and process innovation by 7.5 percentage points and 7.3 percentage points, respectively (Model 2a, 2c, Table 4). Again, we find that importing is not associated with process innovation. Hence, the results support our *H2* indicating that inward internationalisation increases the likelihood of SMEs introducing a product innovation and a combination of product and process innovation, but not a process innovation.

When differentiating between firms according to their internationalisation operations, the results suggest that the probabilities of introducing product innovation only and a combination of product and process innovation are both associated with engaging in different international operations. More specifically, the results (Models 3a, 3c, Table 4) show that, compared with no trading at all, the combination of exporting and importing increases the probability of introducing product innovation only and a combination of product and process innovation by 10.4 percentage points and 9.2 percentage points, respectively. Importing only, on the other hand, only increases the probability by 6.2 percentage points for product innovation and 8.1 percentage points for a combination of product and process innovation. Meanwhile, exporting only is found to increase the probability of introducing product innovation by 4.8 percentage points and the probability of a combination of product and process innovation by 5.4 percentage points. Overall, the results show that outward-inward internationalisation has a stronger effect on introducing a combination of product and process innovation than a single internationalisation operation.

We test whether the above coefficients are statistically significantly different from each other. The results show that, for the coefficients associated with product innovation (Model 3a, Table 4), both exporting only and importing only are statistically significantly different from

the combination of exporting and importing ($x^2(1) = 14.65$ and prob. = 0.001; and $x^2(1) = 6.26$ and prob. = 0.012, respectively); while, for the coefficients associated with product and process innovation (Model 3c, Table 4), the results show that importing only is not statistically significantly different from the combination of exporting and importing ($x^2(1) = 1.94$ and prob. = 0.164). Hence, our *H4* seems to be partially supported.

When restricting the sample to those SMEs that import only, the results support the previous findings. The results (Model 4a, 4c, Table 4) show that exporting only increases the probability of introducing product innovation by 4.5 percentage points, and by 5 percentage points for introducing a combination of product and process innovation. In addition, the results show that the combination of exporting and importing increases the probability of introducing product innovation by 9.8 percentage points and the probability of introducing product and process innovation by 8.4 percentage points. We test whether these coefficients are statistically significantly different from each other, and the results suggest that they are indeed ($x^2(1) = 13.39$ and prob. = 0.001 for Model 4a, $x^2(1) = 11.53$ and prob. = 0.001 for Model 4c).

Table 4: The association between internationalisation operations and different types of innovation (all SMEs), *mlogit estimates (ME and standard errors)*.

Type of innovation:	Product innovation				Process innovation				Product and process innovation			
	Model (1a)	Model (2a)	Model (3a)	Model (4a)	Model (1b)	Model (2b)	Model (3b)	Model (4b)	Model (1c)	Model (2c)	Model (3c)	Model (4c)
Exports	0.066***				0.001				0.053***			
	0.011				*0.007*				*0.009*			
Imports		0.075***				0.008				0.073***		
		0.010				*0.006*				*0.009*		
Internationalisation operations (base category: no trade)												
Exports only			0.048***				0.002				0.054***	
			0.015				*0.009*				*0.012*	
Imports only			0.062***				0.012				0.081***	
			0.014				*0.008*				*0.011*	
Exports and imports			0.104***				0.004				0.092***	
			0.014				*0.009*				*0.011*	
Internationalisation operations (base category: imports)												
Exports only				0.045***				0.003				0.050***
				0.015				*0.009*				*0.012*
Exports and imports				0.098***				0.006				0.084***
				0.014				*0.009*				*0.011*
Controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
log Likelihood	-8288.429	-8219.1534	-819.8806	-7200.619	-8288.429	-8219.1534	-819.8806	-7200.619	-8288.429	-8219.1534	-819.8806	-7200.619
x^2(degrees of freedom)	1358.58(129)	1420.54(129)	1465.09(135)	1320.48(132)	1358.58(129)	1420.54(129)	1465.09(135)	1320.48(132)	1358.58(129)	1420.54(129)	1465.09(135)	1320.48(132)
Observations	8171	8139	8139	7292	8171	8139	8139	7292	8171	8139	8139	7292
Wald test (x^2)												
Exports only = Imports only = Exports & Imports			15.40***								6.57**	
			0.001								*0.037*	
Exports only = Imports only			1.94								4.83**	
			0.163								*0.027*	
Exports only = Exports & Imports			14.65***	13.39***							13.07***	11.53***
			0.001	*0.001*							*0.001*	*0.001*
Imports only = Exports & Imports			6.26**								1.94	
			0.012								*0.164*	

Notes: All the models include control variables (full results are available on request). The standard errors of the coefficients are in *italics*.
Values in *italics* are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2.3 Robustness check

4.2.3.1 Results by firm size

Although the results are not presented here due to brevity, we perform a robustness check and differentiate between firms according to their size-bands (i.e., micro, small and medium). We first test the association between different internationalisation operations and innovation. Some of these findings are interesting and thus discussed here. We find that all internationalisation operations increase the probability of introducing innovation in micro and small firms; however, for medium-sized firms, exporting only is not associated with innovation. For example, we find that, compared with no trading, exporting only in micro firms increases the probability of introducing innovation by 10.5 percentage points, while importing only increases the probability of innovation by 19.6 percentage points. However, the results show that a combination of exporting and importing has a stronger effect on the probability of introducing innovation in micro firms (increasing the probability by 26.8 percentage points). We find that the estimated coefficients are statistically significantly different from each other.[6] Similar results are obtained for small firms, that is, 18.8 percentage points for exporting only, 18 percentage points for importing only and 23.1 percentage points for exporting and importing.[7] However, for medium-sized firms, the results show that, isolating the exporting activity, exporting only is not associated with innovation. In contrast, operating an importing activity only is shown to increase the probability of introducing innovation by 8.8 percentage points. However, when both exporting and importing activities are performed together, they are found to increase the probability of innovation by 9.5 percentage points.[8]

Also, we perform similar tests to examine the association between different internationalisation operations and different types of innovation. The results show that, in micro firms for example, different types of internationalisation operations increase the likelihood of introducing product innovation and a combination of product and process innovation. For instance, the results suggest that exporting only in micro firms increases the probability of introducing product innovation by 4.1 percentage points and product and process innovation by 4.2 percentage points. Importing only, however, increases the probability of

[6] The results show that exporting only is statistically significantly different from importing ($x^2(1) = 6.85$ and prob. = 0.008) and from exporting and importing ($x^2(1) = 19.19$ and prob. = 0.001). In addition, importing is statistically significantly different from exporting and importing ($x^2(1) = 3.95$ and prob. = 0.046).

[7] We also test whether these coefficients are statistically significantly different from each other, and the results suggest that they are not.

[8] We test whether these two coefficients are statistically significantly different from each other, and the results show that they are not ($x^2(1) = 0.01$ and prob. = 0.903).

introducing product innovation by 7 percentage points and product and process innovation by 8.8 percentage points.

In addition, the results show that the combined internationalisation operation (exporting and importing) has a stronger effect on introducing product innovation (increasing the probability by 11.5 percentage points) and a combination of product and process innovation (increasing the probability by 9 percentage points). Using the Wald test, we determine whether these coefficients are statistically significantly different from each other. We found that, in the product innovation equation, exporting is statistically significantly different from both exporting and importing activities ($x^2(1) = 13.66$ and prob. = 0.001) and from importing ($x^2(1) = 3.25$ and prob. = 0.071), as well as that importing is also different from both exporting and importing activities ($x^2(1) = 4.11$ and prob. = 0.042). Similar results are obtained for small firms, where a combination of exporting and importing has the strongest effect on introducing product innovation and a combination of product and process innovation (i.e., 11.3 percentage points and 9.8 percentage points, respectively). On the other hand, the results for medium-sized firms show that only a combination of exporting and importing increases the likelihood of introducing a combination of product and process innovation (by 7 percentage points), compared to no trading at all.

4.2.3.2 Results for restricted sample

As mentioned earlier, our data provides no information about the year of the firm's introduced innovation and how often the firm innovates. However, we combine information from the survey on when the firm started exporting for the first time. We find that less than 10 per cent of firms reported exporting activity in the last year have up to 3 years exporting experience. When we run the innovation model excluding the firms with 3 years or less experience in exporting, we still find that exporting activity increases the probability of innovation. There is no information about when the firms started importing goods to repeat this robustness check for the relationship between importing and innovation. To examine these relationships further, we use information from the earlier wave, and generate a sample of 2,967 firms that a) have reported innovation activity at the time of the second wave only, (i.e., responded positively to the innovation question in wave 2 but not in wave 1) as well as b) firms that have reported no innovation activity in both waves. The former group (a) consists of innovators firms and the second group (b) consists of non-innovators firms. The results from this model suggest that firms with importing activity and a combination of exporting and importing activities are more

likely to innovate than firms with no trade at all, but this was not the case for exporting that is found not to be statistically different for no trade (see Figure B1 in Appendix; full results available upon request). In particular, we find that these variables are strongly related to product innovation.[9]

5. Discussion

This paper examines the relationship between different internationalisation operations (i.e., outward internationalisation, inward internationalisation and outward-inward internationalisation) and different types of innovation in SMEs. Such studies are rare in the IB field that have examined both activities and their impact on innovation (cf. Bagheri et al., 2019; Puthusserry et al., 2020). Our results show that there is a direct and positive relationship between outward internationalisation (i.e., exporting) and innovation, and between inward internationalisation (i.e., importing) and innovation in all SMEs.

Our results therefore provide support for the limited but growing number of studies that highlight the importance of learning by exporting (e.g., Liu & Buck, 2007; Lileeva & Trefler, 2010; Filippetti et al., 2012; Amodóvar et al., 2014; Love & Roper, 2015; Hernández & Nieto, 2016; Chen et al. 2017; Damijan et al., 2017). Moreover, our results are consistent with some previous studies that examine the effect of importing on innovation (e.g., Liu & Buck, 2007; Fritsch & Görg, 2015; Hernández & Nieto, 2016; Chen et al., 2017; Abubakar et al., 2019).

Most importantly, when we examine the relationship between outward-inward internationalisation, in the form of exporting and importing, and innovation in all SMEs and in different sizes of SMEs, we find interesting results. Our results suggest that engaging in a single individual international operation (either exporting or importing) or in both international operations simultaneously increases innovation in SMEs - however the effect is found to be larger in the magnitude for firms that perform both operations at the same time. These results are confirmed in the full-sample analysis and in the sub-sample analysis for micro and small firms. As for medium-sized firms, the results show that, compared with not trading at all, exporting only is not associated with innovation. The findings suggest that only engaging in

[9] We also split this sample into young firms (5 years or less) and older ones (6 years and above); for the former group, the firms reporting innovation are likely to be firms with no prior history of innovation (i.e., these firms have reported no innovation for the last three years in the previous survey). For young firms, importing activity is found to be associated with innovation, whereas for older ones both importing and a combination of exporting and importing are found to increase the probability of innovation compared to firms with no trade activity.

importing activities, or engaging in both internationalisation operations simultaneously, have a significant association with innovation in medium-sized firms.

Moreover, when we differentiate between different types of innovation (i.e., product innovation, process innovation, product and process innovation), the results provide evidence on the association between exporting and the introduction of product innovation and a combination of product and process innovation. Hence, our results are consistent with previous studies that examine the effect of exporting on product innovation (e.g., Higón & Driffield, 2010; Bratti & Felice, 2012; Iacovone & Javorcik, 2012; Monreal-Pérez et al., 2012; Lee et al., 2014; Olabisi 2017). However, we do not find evidence of the association between exporting and process innovation (e.g., Damijan et al., 2010; Higón & Driffield, 2010; Abubakar et al., 2019); we argue that this may be due to the fact that we introduce a combination of product and process innovation, which isolates the pure individual effects.

The sub-sample analysis reveals some interesting results as well. The results show that micro and small firms engaged in outward internationalisation (i.e., exporting) have a higher probability of introducing product innovation and a combination of product and process innovation. However, we find that, for medium-sized firms, exporting is not associated with any type of innovation. We argue, alongside the previous literature, that the need for product innovation is stronger for smaller firms than for larger firms (Golovko & Valentini, 2014). Since small firms face more resource constraints compared with larger firms, they tend to invest to adapt their existing products or introduce new products to the market so that they can continue operating and competing successfully in the export market. In conclusion, our findings suggest that learning and acquiring knowledge through exporting is potentially important for innovation in SMEs (Kafouros et al., 2008; Higón & Driffield, 2010; Altomonte et al., 2014; Amodóvar et al., 2014).

In addition, we find evidence on the association between importing and product innovation and between importing and product and process innovation in all SMEs, as well as in the split analysis between different-sized firms. Our results are consistent with the previous literature that finds a positive effect between importing and product innovation (e.g., Blind & Jungmittag, 2004; Liu & Buck, 2007; Goldberg et al., 2010; Paunov, 2011; Abubakar et al., 2019). We also find evidence on the association between importing and a combination of product and process innovation. Although previous studies (e.g., Bertschek, 1995; Damijan & Kostevc, 2010) find evidence for their individual effects, we argue that the acquisition of knowledge obtained from importing is an important channel for international knowledge

spillovers (e.g., Coe & Helpman, 1995; Keller, 1998), and therefore it can enable firms to engage in introducing both types of innovation at the same time.

When differentiating between firms according to their size bands, we obtain similar results. The findings show that micro, small and medium-sized firms that are engaged in importing activities have a higher probability of introducing product innovation and a combination of product and process innovation. We argue alongside previous studies (e.g., Paunov, 2011) that the gains from importing intermediate goods or inputs allow firms to obtain new and previously unavailable different inputs that allow for better production methods or different final outputs.

Lastly, we find that outward-inward internationalisation operation has a stronger effect on introducing product innovation and a combination of product and process innovation in the sample of all SMEs and in the different-sized sub-sample estimates. We argue that our results are consistent with the literature on organisational learning in its emphasis on the role of knowledge acquisitions for the development of absorptive capacity (e.g., Cohen & Levinthal, 1990; Zahra & George, 2002; Eriksson & Chetty, 2003). It is suggested that firms that look beyond their national borders have the ability to acquire internationalisation and market knowledge (Eriksson et al., 1997). In this context, our results are consistent with the existing research that considers the effect of both outward and inward international operations simultaneously (e.g., Hernández & Nieto, 2016). Carrying out both internationalisation operations at the same time helps firms to combine the diverse knowledge in a more comprehensive way, therefore generating complementary knowledge that can increase the opportunity for learning and result in better forms of innovation.

6. Conclusion, implications and limitations

Internationalisation studies traditionally focus on analysing outward operations, with most scholars, until recently, ignoring the critical role of inward operations (Quintens et al., 2006; Westney, 2020). Moreover, although research on outward and inward operations have started to receive more attention from scholars, it remains an area of study in which many research and policy questions await answers (Hernández & Nieto, 2016; Westney, 2020). In this paper, we contribute to the previous literature on the association between outward and inward internationalisation operations in firms' innovation in the context of SMEs. We follow previous recent studies (e.g., Hernández & Nieto, 2016; Gerschewski et al., 2018) and apply the organisational learning theory, which stresses the role of knowledge in developing absorptive capacity (Zahra & George, 2002; Eriksson & Chetty, 2003). It is suggested that firms that

operate beyond their national borders gain different types of knowledge, such as internationalisation knowledge, market knowledge and technological knowledge (Eriksson et al., 1997; Fletcher & Harris, 2012), and such knowledge can be vital important for developing innovation. Therefore, this research shows that undertaking outward-inward internationalisation operations simultaneously allows firms to gain diverse knowledge that increases their opportunities for experiential learning and aiding their absorptive capacity, which can ultimately enhance their innovation activities. By gaining diverse knowledge can have an important influence on SMEs' innovation (Hartman et al., 1994). In particular, this paper adds to the development and enhancement of our understanding of the role and the impact of conducting outward and inward internationalisation simultaneously on firms' innovation, which is relatively limited discussed so far in both the IB and the small business literature.

From an academic point of view, this research contributes to the ongoing debate regarding inter-connected internationalisation strategies and their potential effect on firms (Hernández & Nieto, 2016). This paper advances our understanding of the importance of different types of internationalisation operations and their effect on SMEs' innovation. Our argument points towards the idea that sharing related and diverse knowledge and information through different internationalisation operations can potentially increase firms' absorptive capacity in the form of innovation. The results show that each internationalisation operation itself has a different effect on innovation; however, the effect of combined internationalisation operations has a greater effect on innovation in SMEs. These findings have important implications for the wider literature on internationalisation as it provides important insights on the fundamental role of diverse and variety of sources of knowledge for resource constrained SMEs to develop innovation. The extant process view of internationalisation has either focused on the outward internationalisation aspect as a form of gaining market knowledge or only on inward internationalisation (cf. Johanson & Vahlne, 1977, 1990). This study provides a unique and much needed multidimensional - holistic view of both activities and explicate their role in innovation. By engaging in both activities, SMEs can simultaneously explore and exploit external sources of knowledge for developing competitive advantage (cf. March, 1991; Argote, 2011; Puthusserry et al., 2020). The engagement in both activities give access to diverse networks of knowledge and provides double loop learning opportunities to firms, and through such learning SMEs can develop innovative capabilities, which further enables their internationalisation process (e.g., Johanson & Vahlne, 2009; Puthusserry et al., 2020). Overall, we contribute to the extant literature and particularly focus on both outward and inward activities and their effect on SMEs' innovation, which to date has been underexplored in the

extant literature (Welch & Luostarinen, 1993; Hernandez & Nieto, 2016; Li et al., 2017; Bagheri et al., 2019; Westney, 2020).

From a managerial and policy makers' point of view, this research suggests that owner-managers of small firms should not limit their consideration to only the positive effect of undertaking a single type of international operation; rather, firms' innovation is strongly affected by undertaking both outward and inward international operations simultaneously. The specific and diverse knowledge flows from these two operations may lead to a higher probability of introducing innovation, more specifically product innovation and a combination of product and process innovation. Hence, it can be suggested that our research is of importance for owner-managers of SMEs, because, despite their limited resources, these firms can benefit from different international operations, especially where intangible resources, such as knowledge flows, are fundamental to their operations. As for policy makers, this study argues, alongside previous studies (e.g., Korhonen et al., 1996; Hernández & Nieto, 2016), that governments should promote programmes that encourage not only entry into foreign markets but also international sourcing through importing.

Our research has some limitations that may provide interesting lines for future research. First, due to the data limitation and constraints of the measures used, our conclusions should be interpreted with caution; we can only provide theoretical justification for the claim that organisational learning increases firms' absorptive capacity when outward and inward internationalisation operations are performed simultaneously. The association should be better explored in a time-series or a panel data framework that allows for studying dynamics and exploring causality between the variables. Further research may include empirical measures of the organisational learning generated from international operations and investigate whether this generates an effect on the association between outward-inward internationalisation and innovation via moderation and/or mediation. Second, our measure of international operations is limited to the propensity to export to and import from international markets. Further research may consider including other measures of internationalisation, such as the intensity of exporting and importing, to test the association for highly internationalised SMEs. To this end, we call for more theoretical and empirical studies in the small business innovation and international activity and their connections with international performance. Finally, further research should differentiate between novel innovation and incremental innovation to

determine the association between different internationalisation operations and these types of innovation.[10]

To conclude, this paper examines the association between different internationalisation operations and innovation in SMEs. Given the gaps in the previous literature, this paper does not limit its analysis to examining a single type of internationalisation operation. Contrary to previous empirical studies, this paper examines the effect of outward, inward and outward-inward internationalisation operations. Moreover, we reach beyond this distinction to examine the above association for different types of innovation introduced by SMEs (i.e., product, process, and product and process innovation). Most importantly, this paper examines this association for the first time in different-sized SMEs. It highlights the role of organisational learning and the knowledge flow generated by engaging in both internationalisation operations for product innovation and a combination of product and process innovation. Accordingly, this paper contributes to the previous literature by providing empirical evidence indicating that SMEs that are engaged in outward and inward internationalisation operations simultaneously are able to take greater advantage of the acquired knowledge flow and information and have a higher probability of introducing innovation.

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[10] We would like to thank reviewer 2 for pointing this out.

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Appendix A (Tables)

Table A1: Variable definitions used in this study.

Variable	Definition
Overall innovation	Dummy variable = 1 if the firm has introduced product or process innovation.
Innovation types index	Index ranges from 0 to 3: 0 if the firm did not introduce any innovation; 1 if the firm introduced product innovation only; 2 if the firm introduced process innovation only; 3 if the firm introduced both product and process innovation.
Outward internationalisation (i.e., exports)	Whether the firm sells goods and/or services outside the UK (coded 1) or not (coded 0).
Inward internationalisation (i.e., imports)	Whether the firm imports goods and/or services from outside the UK (coded 1) or not (coded 0).
Internationalisation operations	Dummy variable = 1 if the firm is not involved in international operations (i.e. no trade). Dummy variable = 1 if the firm exports outside the UK only. Dummy variable = 1 if the firm imports from outside the UK only. Dummy variable = 1 if the firm both exports and imports from outside the UK.
Firm size	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; >20 years = 4). Dummy variables are created for each category.
Legal status	Legal status of the business (sole proprietorship = 1, company = 2, 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; 11+ sites = 5). Dummy variables are created for each category.
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; 12 = £25 m or more). Dummy variables are created for each category.
Business environment: financial obstacle	Dummy variable = 1 if the major obstacle for the business is obtaining finance.
Business environment : intense 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.

R&D tax credit	Dummy variable = 1 if the firm received R&D tax credit in the past three years.
Regions	Location of the business (England = 1, Scotland = 2, Wales = 3, Northern Ireland = 4). Dummy variables are created for each category.
Sectors	SIC 2007 (1-digit) classification. Dummy variables are created for each category.

Table A2: Descriptive statistics.

Variable	All SMEs	Micro firms (<10 employees)	Small firms (10-49 employees)	Medium firms (50-249 employees)
Overall innovation*	41.52	50.81	30.56	18.63
Innovation combination*				
No innovation (base category)	58.48	64.17	52.21	46.89
Product innovation	19.91	18.54	21.43	22.69
Process innovation	6.40	5.45	7.10	8.99
Product and process innovation	15.21	11.85	19.26	21.43
Outward internationalisation*	21.67	45.96	34.22	19.82
Inward internationalisation**	22.82	44.96	33.39	21.65
Internationalisation operations**				
No international operation (base category)	67.97	73.59	61.73	56.65
Outward internationalisation only	9.21	8.98	9.58	9.51
Inward internationalisation only	10.41	9.58	10.37	13.80
Outward–inward internationalisation	12.41	7.85	18.32	20.03

Notes:
* n_{SMEs} = 8171; n_{micro} = 4811; n_{small} = 2170; n_{medium} = 1190.
** n_{SMEs} = 8139; n_{micro} = 4790; n_{small} = 2161; n_{medium} = 1188.

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

Variable	All SMEs	Micro firms (<10 employees)	Small firms (10-49 employees)	Medium firms (50-249 employees)
Outward internationalisation†	0.189*	0.166*	0.216*	0.120*
Inward internationalisation‡	0.192*	0.193*	0.171*	0.124*
Internationalisation operations‡				
No international operation	-0.221*	-0.213*	-0.233*	-0.122*
Outward internationalisation only	0.077*	0.073*	0.122*	0.006
Inward internationalisation only	0.082*	0.109*	0.051*	0.014
Outward–inward internationalisation	0.169*	0.153*	0.159*	0.133*

Notes:
†n_{SMEs} = 8171; n_{micro} = 4811; n_{small} = 2170; n_{medium} = 1190.
‡ n_{SMEs} = 8139; n_{micro} = 4790; n_{small} = 2161; n_{medium} = 1188.
* $p < 0.05$.

Table A4: Correlation between the key explanatory variables and the dependent variable (overall innovation) by firm size.

Variable	All SMEs	Micro firms (<10 employees)	Small firms (10-49 employees)	Medium firms (50-249 employees)
Outward internationalisation†	0.187*	0.163*	0.200*	0.137*
Inward internationalisation‡	0.189*	0.195*	0.152*	0.129*
Internationalisation operations‡				
No international operation	-0.219*	-0.216*	-0.211*	-0.141*
Outward internationalisation only	0.079*	0.074*	0.114*	0.030
Inward internationalisation only	0.082*	0.117*	0.039	0.020
Outward–inward internationalisation	0.164*	0.147*	0.147*	0.135*

Notes:
†n_{SMEs} = 8171; n_{micro} = 4811; n_{small} = 2170; n_{medium} = 1190.
‡n_{SMEs} = 8139; n_{micro} = 4790; n_{small} = 2161; n_{medium} = 1188.
* $p < 0.05$.

Table A5: Propensity score matching results.

Approach	Nearest-neighbour matching				MMWS approach	
Model					Model 1 (Table 3)	
	Coef.	Std Err.	Coef.	Std Err.	Coef.	Std Err.
Exports	0.160***	0.024			0.119***	0.030
Imports			0.129***	0.026	0.174***	0.022
Exports and imports					0.196***	0.035

Notes: *** $p < 0.01$.

Appendix B (Figure)

Figure B1: Predictive margins of trade with 95% Cis, n=2,967.