# Degree of Internationalization and Performance of High-tech Small and Medium-sized Enterprises: Evidence from Korea

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## Abstract

*Purpose* – In this study, we explore the relationship between the degree of internationalization (DOI) and firm performance (DOI–P) of small and medium-sized enterprises (SMEs) in the manufacturing sector. Specifically, we investigate whether the costs and benefits dynamics concerning the internationalization of SMEs differ between high-tech and non-high-tech industries.

*Design/methodology* – We extend the prior literature on this relationship by employing 5-year data on 589 Korean SMEs in the manufacturing sector and examining the moderating impact of the industry characteristics. Our findings reveal a U-shaped relationship between the DOI and SME performance. High-tech SMEs demonstrate an inverted U-shaped relationship, whereas non-high-tech SMEs exhibit a U-shaped relationship.

*Findings* – Our findings illustrate the importance of the industry factor in testing the performance impact of the internationalization of Korean SMEs. By incorporating industry dynamics, our results indicate that the DOI–P relationship depends on the context of the industry in which an SME operates. High-tech SMEs also display a higher DOI but are outperformed by non-high-tech SMEs for the entire internationalization path, which implies that high-tech SMEs face more challenges than non-high-tech SMEs while seeking internationalization.

*Originality/value* – The findings strongly validate that significant benefits exist for SMEs undertaking internationalization. We also employ the contextual framework contributing to increasing the understanding of the intrinsic value of internationalization and resolving the mixed results issue on the DOI–P relationship, by illustrating that the industry factor leads to different dynamics of costs and benefits of SME internationalization; it also determines the shape and direction of the relationship.

## 1. Introduction

In the past 50 years, studies have examined whether the international expansion of a firm improves its performance, thereby contributing significantly to the literature on international business and strategy. However, empirical findings continue to provide inconclusive and contradictory results on the degree of internationalization (DOI) and firm performance (DOI–P) relationship, ranging from linear to non-linear association (Nguyen and Kim, 2020). In recent years, several researchers have acknowledged the importance of the contextual factors as moderators that determine the success or failure of internationalizing firms and examined the DOI–P relationship in specific contexts, rather than finding a generic

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shape of the relationship (Fleming and de Oliveira Cabral, 2016; Kirca, Fernandez and Kundu, 2016; Kirca, Roth, Hult and Cavusgil, 2012; Shin, Mendoza and Choi, 2021). Kirca, Fernandez and Kundu (2016) contend that certain firm-specific assets and industry contexts lead to different dynamics of internationalization that shape DOI–P relationships differently. Similarly, Fleming and de Oliveira Cabral (2016) argue that contextual factors, such as firm, industry, and home-country, affect the DOI–P relationship by either enhancing or reducing the DOI effects on performance, and provide a broader insight into the DOI–P relationship. Therefore, applying a contextual framework to the DOI–P relationship and demonstrating the heterogeneous effects of contextual factors on this relationship can contribute to resolving the mixed results issue reported in the literature (Kirca, Roth, Hult and Cavusgil, 2012).

However, prior studies on contextual factors in the DOI–P relationship have mostly explored large firms, leaving small and medium-sized enterprises (SMEs) relatively unexplored. Particularly, with the growing importance of research on the performance implications of SMEs in dynamic and volatile business environments, several scholars have noted that research on the DOI–P relationship of SMEs from Korea remains unexplored and underlined the need to examine the factors affecting the dynamics of internationalization (Cho and Lee, 2018; Shin, Mendoza and Choi, 2021). Amid the accelerating process of globalization, internationalization is considered a crucial means of building the competitiveness of SMEs (Lu and Beamish, 2001). Despite deficiency in resources, SMEs have exhibited a high and growing propensity to internationalize to seize growth opportunities, using even high-commitment entry modes (Ruzzier, Hisrich and Antoncic, 2006; Schwens, Zapkau, Brouthers and Hollender, 2018). However, internationalization remains risky for SMEs (Evangelista, 2005; Mudambi and Zahra, 2007), given that managing foreign operations creates additional costs and risks (Dhanaraj and Beamish, 2003; Gomes and Ramaswamy, 1999; Lu and Beamish, 2001). Therefore, the DOI and related contextual factors should be investigated more extensively in the case of SMEs.

Research on the factors that influence the internationalization of SMEs, continues to attract scholarly interest (Musso and Francioni, 2014). While previous research on the contextual factors in the DOI–P relationship among Korean SMEs has provided important empirical insights, many unexplored avenues exist. For the home-country factor, using a sample of international new ventures from high-tech industries, Lee (2013) examines the effect of home region on the DOI–P relationship, illustrating that firms perform better in their home than in non-home regions, as the DOI increases. For firm factors, the moderating role of ownership structure (Cho and Lee, 2018; Shin and Gwon, 2019; Shin, Mendoza and Choi, 2021), firm size (Lee, Park and Namgung, 2019), and firm strategy (Cho and Lee, 2018a) have been examined, which demonstrate that the DOI–P relationship for SMEs depends on such contextual factors. In addition, Kim, Kim and Oh (2020) investigate the effect of research and development (R&D) intensity and reveal that the effect is statistically insignificant when using export as a DOI measure, but significant and positive when using foreign direct investment (FDI) as a DOI measure.

In the context of Korean SMEs, although the industry factor can be a significant determinant of the DOI–P relationship, it has not yet been investigated. The underlying logic for the industry factor impacting the DOI–P relationship is that industry characteristics, such as R&D intensity, influence the costs and benefits of internationalization, and in turn, the viability of the firm's internationalization strategies.

Therefore, in this study, we aim to fill this gap by analyzing the dynamics of the internationalization path of SMEs from high-tech manufacturing industries, where R&D intensity is relatively higher than non-high-tech industries. Thus, we seek to ascertain whether the DOI–P relationship for SMEs differs between high-tech and non-high-tech industries. More

specifically, using export as a DOI measure, we investigate whether the costs and benefits dynamics concerning the internationalization of SMEs differ between high-tech and non-high-tech industries. To this end, we build a dataset composed of 5-year data from 589 SMEs operating in Korea and examine the moderating impacts of the industry factor.

We contribute to the literature on the DOI–P relationship among Korean SMEs in the following ways. First, we use a contextual framework that contributes to increasing the understanding of the intrinsic value of internationalization and addressing the mixed results issue in the DOI–P relationship in the extant literature" be a better suited phrase in this context. By incorporating industry dynamics, our results demonstrate that the DOI–P relationship depends on the context of the industry in which an SME operates. Second, we explore the performance implications of the international expansion of Korean SMEs in relation to R&D intensity. Contrary to our expectations, our findings imply that SMEs from high-tech industries are likely to face more challenges than those from non-high-tech industries, and these challenges increase as the DOI increases, given SMEs' resource deficiencies. Third, our study offers valuable guidelines for managers of high- tech SMEs that the coordination and transaction costs should be considered carefully to compete successfully across foreign markets.

The remainder of this paper proceeds as follows. Section 2 reviews the literature on the DOI–P relationship and develops the hypotheses. Section 3 presents the methodology used in this study. Section 4 describes the results of the statistical analysis, while Section 5 discusses the key findings. Section 6 outlines the major implications for research and management, while Section 7 presents the limitations of this study and future research directions.

## 2. Literature Review and Hypotheses Development

### 2.1. DOI–P relationship

The DOI–P relationship has attracted considerable scholarly attention for several years, providing numerous but inconclusive results on the shape of this relationship (Kirca, Roth, Hult and Cavusgil, 2012). The results have demonstrated the following types of relationships: linear (Yeoh, 2014; Zhang, Ma, Wang and Wang, 2014); squared, U-shaped, or inverted U-shaped (Capar and Kotabe, 2003; Lu and Beamish, 2001; Michael Geringer, Beamish and DaCosta, 1989), cubic, S-shaped, or inverted S-shaped (Bowen, 2007; Contractor, Kundu and Hsu, 2003), and, more recently, quadratic, M-shaped, or inverted M-shaped (Almodóvar and Rugman, 2014; Benito-Osorio, Colino, Guerras-Martín and Zúñiga-Vicente, 2015).

The increasing participation of firms in the international market creates costs and benefits dynamics of managing foreign operations. Accordingly, the rationale for a non-linear DOI–P relationship is that such dynamics would change the slope of the relationship as DOI increases. For the inverted U-shaped relationship, the costs of internationalization exceed the benefits beyond the point at which further expansion starts to drain resources, resulting in decreased performance (Gomes and Ramaswamy, 1999; Hitt, Hoskisson and Kim, 1997). Meanwhile, the U-shaped relationship signifies that performance decreases at low internationalization levels because of the liabilities of internationalization. As the DOI increases, performance begins to increase because of the accumulated knowledge, capabilities, and experience of firms in foreign markets (Lu and Beamish, 2004; Ruigrok and Wagner, 2003). More complex models, such as cubic and quadratic models, signify that after the point where performance increases or decreases as the DOI increases, firms again reach a point where further increases change the slope of the relationship, positively or negatively. Increasing

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international operations often adds to the complexity of conducting business, which escalates coordination costs (Guisinger, 2001). The costs of excessive internationalization then outweigh the benefits if firms are not competitive enough (Contractor, Kumar and Kundu, 2003)

To address these inconclusive findings, various contextual factors have been included as moderators to explain the different findings and shed light on the DOI–P relationship in specific contexts (Fleming and de Oliveira Cabral, 2016; Kirca, Fernandez and Kundu, 2016; Kirca, Roth, Hult and Cavusgil, 2012; Shin, Mendoza and Choi, 2021). Thus, in this study, we focus on the specific context of industry differences. Specifically, we investigate whether the costs and benefits dynamics concerning the internationalization of SMEs differ between high-tech and non-high-tech industries.

## 2.2. DOI–P relationship among high-tech SMEs

Although internationalization provides benefits, entering foreign markets is risky for SMEs, given their resource constraints (Mudambi and Zahra, 2007). Internationalizing SMEs are assumed to encounter three liabilities (Lu and Beamish, 2006), of which, the liabilities of foreignness (Hymer, 1976) and newness (Stinchcombe and March, 1965) are commonly encountered by all internationalizing firms. The liability of foreignness arises from a lack of local knowledge and business connections (Johanson and Vahlne, 2009), which generates significant costs for inexperienced firms in foreign markets. The liability of newness indicates a lack of legitimacy in the new market. Building legitimacy in entering markets can be expensive and time-consuming because it requires establishing new relationships with customers and business partners (Sørensen and Stuart, 2000). These two liabilities involve a considerable amount of cost in terms of adjusting to a new environment (Goerzen and Beamish, 2003). The third challenge commonly faced by SMEs is their liability of smallness. Once SMEs initiate internationalization, they must compete with local firms that have experience and knowledge of local markets and multinational enterprises (MNEs) that are equipped with resources and other advantages (Oviatt and McDougall, 1995). Unlike MNEs, internationalizing SMEs need to address all three liabilities (Wright, Westhead and Ucbasaran, 2007) that directly impact the costs and benefits dynamics (Lu and Beamish, 2006) and may constrain growth.

The importance of R&D for SMEs is a well-researched topic in the management literature (Davcik, Cardinali, Sharma and Cedrola, 2021). Studies have found that R&D intensity has a positive effect on SME growth because R&D is useful for preserving and augmenting firm competencies (Karlsson and Olsson, 1998; Kim, Kim and Oh, 2020; Love and Roper, 2015). However, R&D investment creates both opportunities and threats for SMEs(Booltink and Saka-Helmhout, 2018). In other words, R&D investment is widely acknowledged as a predictor of better performance (H. Zhu, Zhao and Abbas, 2020; J. Zhu, Wang and Wang, 2019), although it may constrain the growth of SMEs, with high expenditures (Davcik, Cardinali, Sharma and Cedrola, 2021). R&D investment demands financial commitment; thus, internationalization for market expansion is essential for SMEs to realize R&D costs. However, the initial costs may not be easily covered because of the liabilities of internationalization. Given the liabilities of smallness and the distinctive nature of high-tech firms, the initial stage of international expansion requires incurring more costs in terms of learning and adjusting to overcome the liabilities of foreignness and newness. Collectively, these costs would result in a negative slope in the DOI–P relationship. Non-high-tech SMEs may face a lower burden of investment than high-tech SMEs, thereby resulting in the former suffering less from the liabilities of smallness during the initial stage of internationalization. Therefore, we formulate the following hypotheses:

*H1: The DOI–P relationship for SMEs is likely to be negative at low levels of internationalization.*

*H1-1: The negative slope of the DOI–P relationship for high-tech SMEs is greater than that for non-high-tech SMEs at low levels of internationalization.*

R&D creates an organizational climate that favors market changes (Freel, 2000; Hsu, Lien and Chen, 2015) and helps SMEs quickly seize opportunities in foreign markets by generating more earnings, by facilitating internationalization (Lee, Kelley, Lee and Lee, 2012; McDougall, Oviatt and Shrader, 2003; Suh and Kim, 2014) and reducing the risk level associated with SME activities (Beise-Zee and Rammer, 2006). Unlike SMEs from non-high-tech industries, those from high-tech industries view R&D as one of the crucial drivers of performance (Ren, Eisingerich and Tsai, 2015; Stam and Wennberg, 2009). In other words, for their abilities to launch innovations and technology resources to serve as key contributors to the value of their products, high-tech SMEs are perceived as more capable than non-high-tech SMEs in terms of surviving under highly competitive environments (Paulo Maçãs Nunes, Serrasqueiro and Leitão, 2012; Paulo Maças Nunes, Serrasqueiro, Mendes and Sequeira, 2010; Stam and Wennberg, 2009). For internationalizing firms, technical resources can be employed to overcome liabilities arising from a lack of experience in foreign markets (Evangelista, 2005).

Given that a firm's technological intensity represents a strategic resource for achieving sustainable competitive advantage (Barney, 2000; Oviatt and McDougall, 1995), firms that are more technologically intensive can pursue new market opportunities and overcome the challenges of limited experience in a foreign location by improving effectiveness (McDougall, Oviatt and Shrader, 2003; Meyer and Lopez, 1995). Accordingly, at low levels of internationalization, entering a new market may exacerbate the liabilities of internationalization, although this may be a temporary challenge that can soon be surmounted with accumulated experience and knowledge, as the DOI increases (Evangelista, 2005). Therefore, we hypothesize the following:

*H2: High-tech SMEs are more likely to exhibit increased performance compared with non-high-tech SMEs as the DOI increases.*

R&D investment may improve the capabilities and competitive advantages of SMEs and increase their export performance. However, the lack of managerial and financial resources of SMEs, complicates R&D endeavors, particularly for high-tech firms (Lee, Kelley, Lee and Lee, 2012). As the DOI increases, further expansion often poses challenges to the R&D endeavors of SMEs, given the diversity of product requirements and customers' needs from various institutional environments in different countries (Fabrizio and Thomas, 2012). High-tech SMEs are more likely to face even tougher challenges than non-high-tech SMEs, because R&D investment can increase the risk level (Müller and Zimmermann, 2009; Zou and Ghauri, 2010). Indeed, R&D investment can serve as an indicator of innovation to some extent, although the nature of R&D investment decisions may place SMEs at a disadvantage because of resource constraints (Booltink and Saka-Helmhout, 2018). Moreover, these challenges may increase as the DOI increases as internationalization adds to difficulties in obtaining finances and managing R&D investment efficiently (Müller and Zimmermann, 2009; Voss and Voss, 2013).

As the DOI increases, performance increases up to a threshold, and thereafter starts decreasing because of the complexity of international operations (Sullivan, 1994). Beyond a certain level, the increasing costs of coordination and governance of foreign operations dispersed across countries exceed the benefits of internationalization (Contractor, Kumar

and Kundu, 2003; Li, 2005; Siddharthan and Lall, 1982). Increasing foreign participation requires high-tech SMEs to implement new routines to gather resources and the capability to adapt to local contingencies (Calantone, Kim, Schmidt and Cavusgil, 2006; Siddharthan and Lall, 1982). High-tech firms typically encounter tougher challenges than non-high-tech firms because the added complexity of operations renders R&D endeavors more complicated (Lee, Kelley, Lee and Lee, 2012). Therefore, we hypothesize the following:

> H3: At high DOI levels, the threshold of internationalization is likely to occur earlier for high-tech than non-high-tech SMEs.

## 3. Methodology

### 3.1. Sample and Data

Korea provides a unique and interesting empirical setting to analyze the DOI–P relationship for SMEs, given that Korean SMEs, which constitute over 95% of all Korean enterprises in terms of assets and revenue, have successfully internationalized over the past three decades.

We collected information on Korean manufacturing SMEs listed on the Korea Composite Stock Market Index, Korea Securities Dealers Automated Quotations, and Korea New Exchange, with asset values less than or equal to KRW 500 billion (approximately USD 427 million) and with less than 500 employees for the 2015–2019 period. Secondary data were obtained from the TS2000 (Total Solution 2000), which contains company profiles, ownership information, business characteristics, and financial data for all publicly listed Korean firms. Other financial indicators requiring further processing were retrieved from the KISVALUE database, the online database of Korea Listed Companies Association (KLCA), of the NICE information service.

### 3.2. Econometric Model

The estimated empirical equation for the DOI–P relationship can be expressed as:

$$ROA_i = m\beta_0 + \beta_1 * DOI_i + \beta_2 * DOI_i^2 + \sum(\beta_c * Control\ Variables_{ci}) + \varepsilon_i,$$

where, for each independent variable i, $ROA_i$ is the return on asset, $DOI_i$ is the DOI, and $Control\ Variables_{ci}$ comprise four heterogeneous characteristics.

In addition, the square fit between DOI and ROA moderated by the type of high-tech SMEs ($HighTech_i$) is estimated as follows:

$$ROA_i = \beta_0 + \sum(\beta_c * Control\ Variables_{ci}) + \beta_1 * (DOI_i * HighTech_i) + \beta_2 * (DOI_i^2 * HighTech_i) + \varepsilon_i,$$

where $HighTech_i$ is a dummy variable that takes a value of one for high-tech SMEs and zero for non-high-tech SMEs

To minimize potential heteroscedasticity in the panel data (Greene, 2003), we use the feasible generalized least square regression method.

### 3.3. Measures

#### 3.3.1. Performance

Performance is measured by ROA, an appropriate indicator of the benefits of internationalization (Capar and Kotabe, 2003; Contractor, Kumar and Kundu, 2007; Kotabe, Srinivasan and Aulakh, 2002). The ROA for manufacturing firms reflects how the benefits of international operations have been achieved from the assets employed, thereby offering an accurate measurement of operating efficiency (B Elango, 2011; Kim, Hwang and Burgers, 1989; Lin, 2014). Previous studies have widely used ROA for evaluating the DOI–P relationship (Cho and Lee, 2018; Gomes and Ramaswamy, 1999; Lu and Beamish, 2004; Shin and Gwon, 2019; Shin, Mendoza and Choi, 2021), which renders our findings comparable to those in prior studies.

#### 3.3.2. Degree of internationalization

The ratio of foreign sales to total sales (FSTS) is the most widely used proxy for the DOI in the DOI–P literature (Contractor, Kumar and Kundu, 2007; B. Elango and Pattnaik, 2011; Ruigrok and Wagner, 2003; Shin, Mendoza and Choi, 2021; Siddharthan and Lall, 1982). The focus on exports to operationalize the DOI of SMEs is due to the resource constraints of SMEs, which lead to the use of exports rather than FDI as the most common route to enter foreign markets (Love and Roper, 2015). Although, based on reliability and validity concerns, a multidimensional measure for the DOI has been recommended (Thomas and Eden, 2004), we could not consider this option given data availability constraints. However, studies have found that FSTS correlates highly with other DOI alternatives, such as foreign assets-to-total assets and foreign subsidiaries-to-total subsidiaries (Gomes and Ramaswamy, 1999; Tallman and Li, 1996) reflecting the importance of international operations to a firm (Grant, 1987).

#### 3.3.3. High-tech SMEs

To classify high-tech SMEs from our sample, we use the International Standard Industrial Classification, 4th revision, of the United Nations. The Organisation for Economic Co-operation and Development (OECD) defines high-tech industry (manufacturing) as including basic pharmaceutical products and pharmaceutical preparations, the manufacture of computers, electronics, and optical products, and the manufacture of aircraft, spacecraft, and related machinery (OECD, 2001). The distinction between high-, medium-high-, medium-low-, and low-technology manufacturers is based on their R&D intensity (R&D expenditure relative to output). In our study, high-tech SMEs include 145 firms from the "electronic components and boards" sector, 50 from the "measuring, testing, navigating, and control equipment" sector, and 28 from the "pharmaceuticals, medicinal chemicals, and botanical products" sector, which together comprise 37.86% of our sample.

#### 3.3.4. Control Variables

We include control variables that are known to affect firm performance, during internationalization. We control for firm age, firm size, debt-to-equity ratio, R&D spending, and the total share of controlling shareholders. Firm age is the number of years since a firm's establishment, whereas firm size is represented by the number of employees. Firm age and size are important indicators of a firm's resources, helping reduce its costs related to internationalization (Agarwal and Ramaswami, 1992; Bausch and Krist, 2007; Dhanaraj and Beamish, 2003). While firm size represents the availability of resources, firm age is related to the accumulation of resources over time (Dhanaraj and Beamish, 2003; Karadeniz and Göçer,

2007). We include indebtedness (debt-equity ratio) as a measure of financial leverage (Hitt, Hoskisson and Kim, 1997; Lu and Beamish, 2004) as a control variable. The total share of controlling shareholders is measured by the percentage of shares held by the ultimate owner and the related parties. SME ownership is frequently concentrated in the hands of a small and closed group of shareholders. The controlling shareholder variable is positively correlated with firm performance by mitigating the traditional agency problem between shareholders and managers (Anderson and Reeb, 2003; Demsetz and Lehn, 1985; Jensen and Meckling, 1976).

## 4. Results

Table 1 presents the descriptive statistics for the FSTS, ROA, and control variables. The firms in our sample are well-established, with an average age of approximately 23 years and an average size of 160 employees.

**Table 1.** Statistics for FSTS, ROA, and control variables

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| ROA | 1,731 | −1.116555 | 14.35706 | −158.79 | 45.05 |
| Age | 1,731 | 23.15185 | 13.2585 | 0.5 | 90.33334 |
| Employees | 1,731 | 160.5708 | 120.2387 | 4 | 505 |
| DebtRatio | 1,731 | 35.26961 | 20.85138 | 0.6872423 | 158.5276 |
| R&D | 1,731 | 1896.069 | 3287.56 | −48 | 31193 |
| HighTech (1) | 1,731 | 0.4602992 | 0.4985648 | 0 | 1 |
| Ownershare | 1,731 | 36.50259 | 16.77571 | 2.28 | 100 |
| FSTS | 1,731 | 0.3910229 | 0.29829 | 0.0000302 | 1.001991 |

Table 2 presents the pairwise correlations of the sample. Correlations between the variables exhibited significant values. To further test for the effects of multicollinearity, we calculate the variance inflation factors (VIF), illustrated in Table 3.

**Table 2.** Sample's pairwise correlations

| | ROA | Age | Employees | DebtRatio | R&D | Affiliation | Ownershare | FSTS |
|---|---|---|---|---|---|---|---|---|
| ROA | 1 | | | | | | | |
| Age | 0.0309 | 1 | | | | | | |
| Employees | 0.3134*** | 0.0491** | 1 | | | | | |
| Debt Ratio | −0.3006*** | −0.0487** | −0.031 | 1 | | | | |
| R&D | 0.0257 | −0.1644*** | 0.2821*** | −0.0848*** | 1 | | | |
| HighTech (1) | −0.1191*** | −0.0713*** | −0.0078 | −0.1473*** | 0.184*** | 1 | | |
| Ownershare | 0.1453*** | −0.1226*** | −0.0891*** | −0.0612** | −0.1245*** | −0.1494*** | 1 | |
| FSTS | 0.0399* | −0.1968*** | 0.0112 | −0.0269 | 0.1286*** | 0.1663*** | −0.0517** | 1 |

**Note:** $p^{***}<0.01$; $p^{**}<0.05$; $p^{*}<0.1$.

**Table 3.** Result for the variance inflation factors (VIF)

| Variable | VIF | 1/VIF |
|---|---|---|
| Age | 1.11 | 0.904265 |
| Employees | 1.10 | 0.907334 |
| DebtRatio | 1.04 | 0.959127 |
| R&D | 1.18 | 0.845274 |
| HighTech (1) | 1.11 | 0.904249 |
| Ownershare | 1.07 | 0.930923 |
| FSTS | 1.07 | 0.930413 |
| Mean VIF | 1.10 | |

Multicollinearity causes problems in interpretation, because it can increase the variance of regression coefficients, undermining the statistical significance of independent variables (Hair, 2010). The thumb rule is that multicollinearity exists if the VIF for any independent variable is greater than 10 (some authors use a cutoff of 5). A tolerance coefficient can also be calculated in conjunction with VIF as 1 divided by VIF from the abbreviated model. If the coefficient is close to zero, multicollinearity is considered to be a problem (Moore, McCabe and Craig, 2012). The highest VIF is well below the benchmark of 10, suggesting that multicollinearity is not a problem in our data.

Table 4 presents a general model for testing the hypotheses, which incorporates linear, quadratic, and cubic terms. The analysis reveals a non-linear U-shaped DOI–P relationship for the entire sample of manufacturing SMEs. Therefore, the results support H1. As we expected, the data implies that the initial costs of internationalization resulting from the liabilities of internationalization, do not outweigh the benefits. Fig. 1 visually depicts this finding, with the horizontal axis representing the DOI and the vertical axis denoting the mean ROA values.

**Table 4.** General model for testing the hypotheses

| IV | ROA Model 1 Coefficient | ROA Model 2 Coefficient | ROA Model 3 Coefficient |
|---|---|---|---|
| Intercept | −3.190241*** | −1.940567*** | −1.835965*** |
| Age | 0.0084988 | −0.002014 | −0.002337 |
| Firmsize | 0.0349637*** | 0.0345353*** | 0.0345892*** |
| DebtRatio | −0.1850034*** | −0.1812115*** | −0.181815*** |
| HighTech (1) | −4.398943*** | −3.906146*** | −4.075324*** |
| Ownershare | 0.1228926*** | 0.1143038*** | 0.1105149*** |
| FSTS | 2.336011*** | −5.00944*** | −1.821274 |
| FSTS2 | | 8.161645*** | 0.4164264 |
| FSTS3 | | | 4.674836 |
| N of Obs. (N of firms) | 1,731(589) | 1,731(589) | 1,731(589) |
| F test | 4,353.25*** | 6,731.35*** | 5,705.95*** |

**Note:** $p^{***} < 0.01$; $p^{**} < 0.05$; $p^{*} < 0.1$.
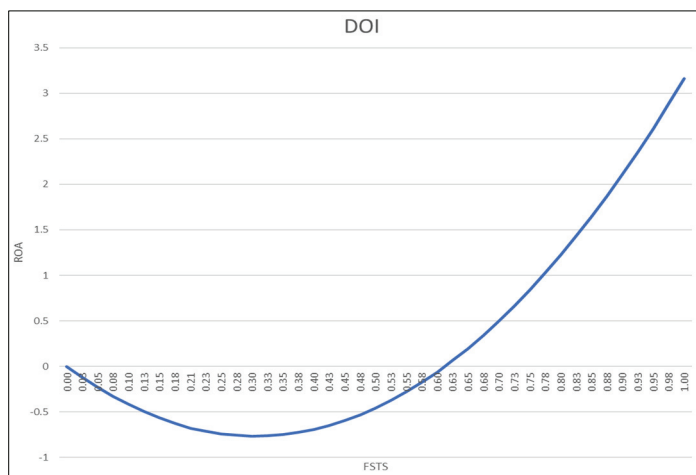
**Fig. 1.** U-shaped the DOI–P relationship graph



**Table 5.** DOI–P relationship: High-Tech vs. Non-High-Tech

| IV | ROA Model 4 Coefficient | ROA Model 5 Coefficient | ROA Model 6 Coefficient |
|---|---|---|---|
| Intercept | −2.904434*** | −1.624494*** | −1.674533*** |
| Age | 0.0061203 | 0.0027226 | 0.0032843 |
| Firmsize | 0.0344076*** | 0.0336106*** | 0.0338532*** |
| DebtRatio | −0.1840787*** | −0.1746776*** | −0.1751544*** |
| HighTech (1) | −4.290269*** | −4.91945*** | −4.911192*** |
| Ownershare | 0.1196523*** | 0.1077658*** | 0.1088749*** |
| FSTS | 2.410919*** | −7.511493*** | −7.553224** |
| FSTS2 | | 11.34504*** | 10.58769 |
| FSTS3 | | | 1.018259 |
| HighTech (1) x FSTS | 0.0131664*** | 10.84534*** | 9.995137** |
| HighTech (1) x FSTS2 | | −12.25542*** | −9.89493 |
| HighTech (1) x FSTS3 | | | −1.721168 |
| N of Obs. (N of firms) | 1,731(589) | 1,731(589) | 1,731(589) |
| F test | 4,064.84*** | 2,955.13*** | 3,249.07*** |

**Note:** $p^{***}<0.01$; $p^{**}<0.05$; $p^{*}<0.1$.

Model 2 demonstrates a negative and significant coefficient for HighTech, suggesting a performance difference between high-tech and non-high-tech SMEs. Age is not significant, whereas Firmsize yields a positive sign, as reported in the extant literature. The DebtRatio is

negatively related to performance. In addition, the proportion of controlling shareholders exhibits the efficiency of concentrated ownership in SMEs.

To shed light on the effect of the DOI–P relationship in different manufacturing sectors, we add the interaction terms of HighTech in the single, squared, and cubic terms of FSTS. As demonstrated in the empirical results of Model 5 (Table 5) and Fig. 2, high-tech SMEs exhibit an inverted U-shaped relationship, whereas non-high-tech SMEs display a U-shaped relationship. Therefore, H-1 is not supported. For the inverted U-shaped high-tech SMEs, the slope of the DOI–P curve increases moderately initially and then begins decreasing moderately at high levels of internationalization, whereas the slope of the DOI–P curve of non-high-tech SMEs exhibits a negative slope at low levels of internationalization and a steep increase in performance as the DOI increases. Therefore, H2 is not supported, whereas H3 is supported.

For high-tech SMEs, the moderately declining slope at high internationalization levels reveals that further expansion beyond the threshold would be detrimental. The DOI–P graph (Fig. 2) indicates that non-high-tech SMEs outperform high-tech SMEs for the entire internationalization path.

**Fig. 2.** DOI–P relationship graph: High-Tech vs. Non-High-Tech
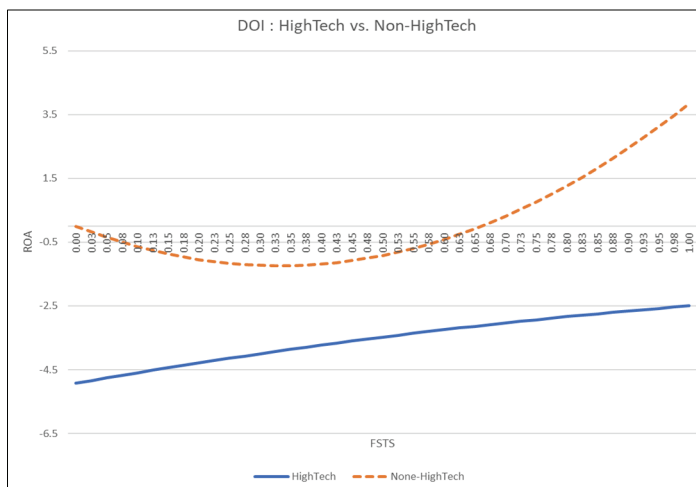


## 5. Discussion

We seek to ascertain whether the DOI–P relationship differs between Korean SMEs from high-tech and non-high-tech industries. Contrary to expectations, the high-tech SMEs in our sample demonstrate an inverted U-shaped relationship, whereas non-high-tech SMEs reveal a U-shaped relationship. The results suggest that high-tech SMEs generally experience the increased performance at low internationalization levels. Meanwhile, non-high-tech SMEs tend to suffer from internationalization costs because of the liabilities of internationalization. The performance of non-high-tech SMEs begins to decline with international expansion before reaching a point of inflection. Beyond this point, performance picks up and continues to improve as firms learn to minimize the costs associated with foreign expansion over time. Non-high-tech SMEs expanding internationally are found to experience performance

deterioration before experiential knowledge leads to high performance levels. However, non-high-tech SMEs outperform high-tech SMEs for the entire internationalization path.

The slope of the DOI–P relationship of high-tech SMEs is moderately positive, from low to high levels of internationalization, and gradually decreases at high levels. Meanwhile, the slope of the relationship for non-high-tech SMEs increases dramatically from the middle level of internationalization. The results signify that non-high-tech SMEs can better achieve economies of scale through international expansion and tend to be more capable and flexible in responding to external changes. The outperformance of high-tech SMEs by non-high-tech SMEs has two possible explanations.

First, a strong commitment to R&D increases SMEs' chances of survival and growth. Thus, compared with non-high-tech SMEs, high-tech SMEs are perceived as more capable of succeeding in highly competitive environments because of the high technology intensity connected to products (Baptista and Karaöz, 2011; Del Monte and Papagni, 2003). The high-tech SMEs in our study also demonstrate a higher DOI, which can be considered as an indicator of their success (Greenaway and Kneller, 2007). Among its various activities, R&D investment is fundamental to the success of high-tech SMEs. However, undertaking such an investment may restrict the growth of high-tech SMEs compared with non-high-tech SMEs because of the resulting lower productivity. Although high-tech SMEs realize the benefits of internationalization earlier than non-high-tech SMEs, based on the positive slope of the DOI–P relationship at low levels of internationalization, the relatively high development cost and low productivity may increase the performance gap with non-high-tech SMEs as the DOI increases. Moreover, high-tech SMEs may be more affected by the uncertainty and risk related to increasing internationalization because of difficulties in obtaining external finance and a lack of resources to manage R&D investment efficiently (Müller and Zimmermann, 2009). At high levels of internationalization, further expansion increases expansion costs because the complexity associated with internationalization complicates R&D endeavors to exceed firms' capacities and capabilities in coordinating international activities (Gomes and Rama-swamy, 1999; Guisinger, 2001; Lee, Kelley, Lee and Lee, 2012; Ruigrok and Wagner, 2003).

Second, the notions "high-tech" and "low-tech" derived from the OECD definition assume that a high level of R&D expenditure is causally related to firm innovation (Hirsch-Kreinsen, 2008). Most studies on R&D and performance have focused on product innovation, especially technological product innovation linked to R&D spending (Hirsch-Kreinsen, 2008). Innovation can be of four types: product, process, marketing, and organizational innovation (Mortensen and Bloch, 2005). Each of these can be a source of competitive advantage (Kirner, Kinkel and Jaeger, 2009). Thus, non-high-tech SMEs can develop innovation capacity by cultivating resources that are not associated with R&D but involve organizational and market innovations (Eisingerich, Rubera and Seifert, 2009).

Considering our findings, we conclude that non-high-tech SMEs can develop competence through other activities. Indeed, the lower presence of R&D in non-high-tech SMEs does not limit their competitiveness. Therefore, focusing on the innovation of non-high-tech SMEs is significant because it is less explored in the extant literature.

## 6. Conclusion

In this study, we analyzed the dynamics of internationalization of SMEs using a contextual approach to explain the contradictory and inconclusive results on the DOI–P relationship and aimed to understand the intrinsic value of SMEs' international operations. The main objective of this study was to empirically investigate the DOI–P relationship for Korean

manufacturing SMEs, focusing on the moderating effects of the industry factor. We demonstrated how the effects of technology intensity change the direction and strength of the DOI–P relationship for manufacturing SMEs. The results indicated that both high-tech and non-high-tech SMEs were affected differently in terms of the DOI–P relationship, contingent on the industry factor. In other words, the DOI–P relationship varied even within the same industry, and technological intensity determined the direction and shape of the DOI–P curve. In summary, the effects of DOI on performance depend on contextual factors, and the shape of the DOI–P relationship curve tends to become more significant when these factors are considered (Contractor, 2007; Verbeke and Li, 2009).

In the era of globalization, international expansion is vital for SMEs to develop and sustain the competitiveness. For decades, international business (IB) scholars have studied whether and how internationalization directly improves firm performance. In response to this concern, more recent research has assessed the role of different resource-based drivers in shaping the process of how internationalization affects performance (Kirca, Fernandez and Kundu, 2016). However, many studies have explored how firm assets help firms expand abroad and then subsequently improve profitability, but have focused mostly on intangible asset such as R&D and advertising intensity (Buckley and Tian, 2017; Kirca, Roth, Hult and Cavusgil, 2012). A large number of studies has documented a positive relation between technological innovation linked to R&D spending and firm performance in international settings, which can be implicitly assumed that the non-high tech firms seem less competitive during the internationalization (Booltink and Saka-Helmhout, 2018). By showing that non-high-tech SMEs that operate internationally can gain substantial performance benefits compared to high-tech SMEs in Korea, traditional notion on non-high-tech firms has been challenged and in turn, competitiveness of non-high-tech firms should be analyzed carefully in order to intrinsically understand dynamics of internationalization of SMEs.

Our study also offers valuable insights and guidance for managers of manufacturing SMEs. High-tech SMEs have competitive advantages to succeed in international markets, although firms should be aware that expanding into foreign countries reduces performance. Meanwhile, the opposite is true for non-high-tech SMEs, where the positive performance effects of firm internationalization are stronger for the entire internationalization path. Thus, managers from high-tech SMEs should consider coordination and transaction costs to compete successfully across foreign markets.

## 7. Limitation and Future Research

Overall, this study provided unique insights into the internationalization of high-tech SMEs. Nonetheless, our study has several limitations that provide opportunities for further research. First, the study sample was restricted to Korean SMEs, which may limit the generalizability of the findings. Future research should examine SMEs in other countries. This replication enhances the validity of the findings in our study. Second, given the scarcity of sources, the Korean SMEs covered in this study were all public companies. Privately held, non-listed enterprises were not included in the analysis, and the findings may not necessarily hold for unlisted firms. Listed and unlisted firms may exhibit different patterns of internationalization because the latter may have fewer acute agency problems or less conflict between minority and majority owners in making strategic decisions, such as foreign expansion. Moreover, unlisted firms have limited financial resources, whereas listed firms are likely to have better access to capital and better corporate governance (Loderer and Waelchli, 2010), which may enhance the likelihood of their survival in foreign markets.

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