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A Multi-Level Analysis of Innovative Korean SME Activity and Related Innovation Ecosystem*

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Faced with waning exports and returns from innovation, the Korean government has prioritized the facilitation of small and medium-sized enterprise (SME) innovative activity and marketization. But are policies working? This research deploys a multi-level perspective to more holistically examine individual, firm, network, and industry-level factors, to include the regulatory environment, impacting Korean SMEs. Quantitative analyses of data from the 2016 national Korean Innovation Survey delve into 1) firm motivations, costs, and purchases; 2) internal R&D and external cooperation and knowledge sourcing; 3) innovation impacts on domestic and international market positioning and entry; and 4) sources of support for, and impediments to, innovation in order to provide a nuanced understanding of Korea's innovation ecosystem. In a novel bifurcation, analyses compare firms engaged in new and incremental innovation and those engaged in only incremental innovation. Some key differences between the innovator groups emerge, such as training objectives, spending patterns on external knowledge, collaborate activity, and market positioning. Though there may be room for cautious optimism, perceived challenges to policy would appear to be equal for both groups of innovators, including those related to personnel, financing, and other government support and policy incentives. Implications for Korea's future are discussed.

Keywords Innovation, Innovation Policy, Korea, Korean Firms, Multi-level Perspective, SMEs

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I. Introduction

South Korea (referred to as Korea from here on) turned an innovation corner beginning in the early 1990s when the country began to emphasize future-oriented research and to increase the research and development (R&D) capabilities of its universities (Suh and Chen, 2007). Some scholars (Hobday et al., 2004; Hemmart, 2007; Kim, 2012) posit that Korea has therefore broken away from the fast follower strategies that helped the country initially gain a foothold in global markets and has now entered into a competitive market leader or, in some cases, a 'maker' position. Others (e.g., Choung et al., 2014) are less optimistic, concluding that Korea still has problems bringing early-stage technologies to market and, of equal importance, forging these technologies into market-dominant global standards. As such, given international competition and related shortened product life cycles in technologically competitive markets, firms choose to focus on shorter, rather than longer-term, incremental innovation and applied engineering (Lee, 2012). Indeed, as shall be discussed, the vast majority of firms in this study are pursuing incremental innovation compared to those pursuing new and radical innovation.

In general, statistics support the latter of the aforementioned views. In fact, despite its position as a first-tier leader in R&D expenditures, by both government and business, Korea has seen a steady deterioration of its technological trade balance and an associated decline in growth generated by technology since the 1980s (TWA Netwerk, 2011). The country's technological trade balance currently ranks last in the OECD (The Korea Times, 2021). As shall be outlined shortly, the Korean government has therefore prioritized SME innovation, marketization, and internationalization to rectify these shortcomings. Studies have found that whereas the quantity of R&D is not lacking, and that Korean SMEs have an above average rate of overall

technology development, the *quality* remains comparatively uncompetitive and their associated rate of *commercialization* is quite poor (Oh, 2015; Park et al., 2018).

Having said this, other recent work (e.g., Park et al., 2018) is cautiously optimistic, finding that improvements in Korea's overall innovation ecosystem, particularly in terms of cooperation, leads to increased SME innovation. Still, some research (e.g., Eom and Lee, 2010) concludes that while institutional linkages help to create new knowledge in innovative Korean firms, there is little perceivable impact on the bottom line. At least one study (Doo and Sohn, 2008) recommended that government research institutes (GRIs) more specifically target the transferable technology that can directly benefit SME innovative activities. Lee et al. (2015) found evidence of both public and private information sources correlating to technological development, with a more pronounced effect for private sources. Koo and Kim (2018) concluded that more innovative Korean SMEs had more employees dedicated to R&D and more patent experience. Firms with radical innovations in this study also had higher export rates and were more apt to have innovations that were first to market globally. More recent work by Yoon et al. (2018), however, concluded that financial subsidies, tax benefits, information support, and market support were more effective than labor support in terms of producing innovation.

The above findings, however insightful, represent multiple facets of one innovation diamond. The inferences drawn from the preceding are that there is a need to study innovative activity at Korean firms in a multi-actor, multi-spatial way, to include the local milieu; that SMEs, a crucible of Korea's efforts going forward, require specific attention, including attention to their sales, market positioning and penetration; and that it would be useful to understand facets of the innovation system that may impact policy and vice-versa. The cumulative question is what do these portend

for Korea's future? Korean SMEs, for example, have traditionally not been well represented in key export product sectors and have had difficulty establishing technological trends (Mahlich and Pascha, 2007). Have things changed, and, if so, how and why? Therefore, the purpose of the present innovation survey-based analyses is to examine Korean SME-innovative behavior and the local milieu holistically vis-à-vis: 1) firm motivations, costs, and purchases; 2) internal R&D and external cooperation and knowledge sourcing; 3) innovation impacts on domestic and international market positioning and entry; and 4) sources of support for, and impediments to, innovation in order to provide a nuanced understanding of Korea's innovation ecosystem. The underlying effort is to advance a multi-level approach to the study of innovation by Korean SMEs, a multi-actor, multi-spatial, holistic approach that includes analyses of individual, firm, network, and industry-level factors, to include the regulatory environment (Crossan and Apaydin, 2010).

It is important to note here that while most research focuses on comparing innovators and non-innovators, this contribution adds a small twist in an attempt to contribute to the literature by examining similarities and differences between two groups of innovators so as to provide a focused understanding relevant to Korea's innovation and market entry contexts. These contexts, as shall be discussed, are the focus of the government's policies. These two groups include firms that were engaged in new *and* incremental product innovation during the study period, and those that were engaged with *only* incremental product innovation. At least one study (Reichstein and Salter, 2006) found radical and incremental (product and process) innovation correlated, but analyses connected to market positioning were primarily conducted on incremental innovators versus non-innovators and radical innovators versus non-innovators. Another study, of high-tech firms in Korea's solar PV industry (Gress, 2015), found that even radical

innovator activity was located more along a spectrum that overlapped with incremental innovator activity. Other scholars, for example Chandy and Tellis (1998; 2000), Andersonet al. (2004), Chataway et al. (2004), and later Gupta et al. (2007), concluded that firms looking for new, radical innovations often rely on recombining their existing knowledge and technologies. Still, to the best of our knowledge, this particular bifurcation of innovator types has yet to be deployed in the innovation literature to date.

II. Guiding Framework: The Multi-level Perspective

The multi-level perspective is not a theory. Rather, it represents an attempt to examine innovative behavior more holistically in a multi-spatial (and/or multi-scalar), multi-actor way. Ardito et al. (2015: 115) inclined, "… an explicit consideration of multiple levels of analysis is critical to fully understand the determinants and dynamics of firms' innovative performance." As briefly alluded to in the introduction, the multi-level perspective includes analyses of individual, firm, network, and industry-level factors, to include the regulatory environment (Crossan and Apaydin, 2010). Individual-level factors include managerial outlooks and training; firm-level (or organizational-level) factors include firm orientation (e.g., customer), knowledge sourcing, and use of internal R&D. Network-level factors examine collaboration and the possible integration of process and product innovation. Industry-level factors include turbulence (market uncertainty) and competition as well as the regulatory market (see Ardito et al., 2015 for all factors). Support for the use of this perspective grew out of general dissatisfaction with the trend toward a 'routinization' of innovation studies that includes a concentration on smaller scales of observation (e.g., individual or firm as opposed to network or industry) and a concentration on N. American firms (Anderson,

et al., 2004). Later work by Crossan and Apaydin (2010) verified this, finding that over 50 percent of the studies in their review concentrated on the organizational level, whereas only eight percent adopted a multi-level perspective.

The present research examines the above factors, interlacing them by dissecting multiple aspects of Korean SME innovative behavior. For example, analyzing firm motivations, costs, and purchases aids in establishing the firm-level orientation of the firms in the study and their positioning vis-à-vis the local milieu. Looking at internal R&D and external cooperation and knowledge sourcing provides insight into not only firm level, but also network-level interactions. This has been acknowledged as a multi-level strategic approach (see Gupta et al., 2007). Industry-level factors, for example competition and turbulence, may be revealed via an examination of innovation impacts on domestic and international market positioning and entry. This is also a crucial part of a multi-level examination given the fact that actually selling products is part and parcel of the very definition of innovation (see Ardito et al., 2004; Crossman and Apaydin, 2010). Industry-level factors are examined via firm perceptions of sources of support for, and impediments to, innovation. These industry-level considerations are severely under-represented in the innovation research (Crossman and Apaydin, 2010).

A multi-level approach has the potential to improve prescriptions in at least two key ways. First, as Mumford et al. (2008) detailed, single-level analyses make it difficult to produce models for innovation vis-à-vis corporate planning. To the contrary, they related that observing individual, group, and organizational-level behaviors, including technological scanning and longer-term evaluation processes, is key when it comes to producing innovation-oriented planning that allows companies to break out of long-held molds and to target newness. This, as will be discussed, seems to be a

problem for Korean SMEs. At the more meso and macro levels, Weber and Rohracher (2012) examined the need to support innovation policy geared toward larger systems changes. Their contribution, including an integration of innovation systems and multi-level perspectives, suggested that policy needs to address failures that impede innovation and systems change. They discussed institutional failures (poor hard infrastructure and regulations), network failures (too weak or too strong ties with network partners), capability failures (knowledge absorption problems), as well as policy coordination and reflexivity failures (progressive learning). These aspects could have implications for Korean firms and Korea's innovation system. The country, as shall be discussed, has singled out major technological areas to pursue on the one hand, while its SMEs remain challenged in a number of ways when it comes to innovating newness, garnering market share, and establishing longer-term trends.

III. Background: Korean Innovation Policy, SMEs, and (External) Linkages

As mentioned previously, Korea has seen a steady decline in its technology-generated growth for the past several decades (TWA Netwerk, 2011). Even though the gross quantity of R&D has risen to even exceed that of Japan's, there has been little impact on profits (Mahlich and Pascha, 2007). To reverse these trends, SMEs figure predominantly in the Korean government's drive to compete in future-oriented technological markets, though this presents a bit of a paradox. While Korea's large conglomerates (*chaebol*) dominate in terms of economic contribution to the country's GDP and brand recognition in global markets, SMEs in Korea in fact supply the greatest number of jobs compared to any other country in the OECD (OECD,

2018). However, of the four actors participating in R&D and technological commercialization in Korea, SMEs, along with universities, are the weakest compared to the dominance of the country's *chaebol* and government research institutes (GRIs) (Eom and Lee, 2010). In gross terms, the *chaebol* dominate corporate R&D expenditures, but even this is lopsided when all firms are examined. Samsung, for example, spends as much on R&D as the next top four *chaebol* combined. Further, R&D by SMEs, along with their connection to global production networks, ranks lowest in the OECD (OECD, 2018). Korean SMEs invest roughly 20 percent of profit back into R&D compared to a 30 percent OECD average (Mahlich and Pascha, 2007).

External R&D linkages are important for SMEs in the innovation context. In the Korean innovation system, this means cooperation between SMEs and large corporations, universities, and GRIs. In general, prior studies have found that Korean SMEs tend to rely more on inter-firm relationships for innovation purposes (Park, 2000), and that firm-firm cooperation promotes higher levels of innovative activity (Doo and Sohn, 2008), activity that includes both domestic *and* international linkage impacts on technological development (Ernst, 2000). Large *chaebol*, however, hold unparalleled sway in their relationships with SMEs. In 2010, the government therefore formed the Korea Commission for Corporate Partnership specifically to promote the interests of SMEs in relation to the *chaebol*, and in 2016, along with the Korea Fair Trade Commission, began tallying a Shared Growth Index. Twelve thousand SMEs assess large firm contributions to their R&D, skilled labor, and access to overseas markets, and while some overall improvement in cooperation has been noted, there has been little change specifically in manufacturing sector relationships (OECD, 2018). The present research may be able to shed light on any progress being made vis-à-vis SME innovative activity in this regard.

Korea had the lowest amount of university R&D in the OECD until

roughly the mid-2000s, by which time significant government investment over the course of some ten years had tripled institutional R&D activity (Hemmart, 2007). Still, even in the early 2000s, GRI R&D exceeded university R&D, striking as Korea was the only such country in the OECD with this imbalance (Eom and Lee, 2010). And even if technological innovation does take place, studies suggest that very little of the knowledge is transferred to firms (Lee, 2012), rendering technology transfer processes in Korea 'mediocre' (Suh and Chen, 2007). For this reason, the present research takes an in-depth look at cooperative partners and sources of knowledge used during technological development by Korean SMEs.

Indeed, technology transfer emerges as a key theme characterizing impediments to SME innovative activity in Korea, and the government has been keen to help overcome any barriers. Public–private cooperation is seen as vital to success (Lim, 2000; Hwang, 2002). This may be because previous policies rewarded universities and GRIs based on the number of their international scientific publications, largely ignoring the issue of knowledge transfer to the private sector (Park and Leydesdorff, 2010). As early as 2001, the government had passed the Technology Transfer Promotion Law dictating that public universities create Technology Licensing Offices, followed by the 2004 passage of the Law on Industrial Education and Industry-University Cooperation (Eom and Lee, 2010).

In terms of GRI, Korea established a number of consortium (two or more GRIs), in part to help level the playing field between GRIs and the R&D dominant *chaebol* by increasing the availability of qualified scientists on the one hand, and by facilitating technology transfer processes on the other (Park et al., 2010). These consortia were dissolved in 2011 with mixed results, but others would emerge to take their place. There are currently, for example, 220 consortiums focusing on bringing new technological innovations to market for some 2,700 SMEs in Korea, and Korea's Small and Medium

Business Association (SMBA) helps SMEs meet the costs associated with bringing newly developed products to market (Keenan, 2012). Further, Korea began a Technology Incubator Program for Startups in 2014, and by 2016 there were 67 university and GRI R&D centers in the country specifically geared toward assisting SMEs (OECD, 2018). Again, the present research may help to shed light on the efficacy of these programs now and going forward.

This has led to recommendations that funding for SMEs be based on technological development and economic success rather than on whether or not they are merely surviving (Doo and Sohn, 2008). Korean SMEs have been characterized, however, by a deficiency in external linkage usage compared to their counterparts in the west. Whereas cooperative R&D activity and contracting aid larger firms, Korean SMEs benefit from strong, family owned and controlled management structures and the longer-term employment of personnel (Lee et al., 2009). This may be because Korean SMEs that do survive and that do become innovators build up knowledge over time prior to beginning their own R&D programs (Chung and Lee, 2015). Since 2017, the Ministry of SMEs and Startups (MSS) has been focusing on labor related problems inhibiting SME productivity, innovation and financial performance; 80 percent of Korean SMEs report shortages of qualified labor (OECD, 2018). Complicating labor shortages is a mismatch in skills capabilities (Keenan, 2012), a problem voiced by Korean firms in burgeoning technological industries as well (see Gress, 2015). Again, Doo and Sohn (2008) concluded that technological training contributes to higher levels of innovation in Korean SMEs. The present research examines a host of these factors potentially inhibiting innovation.

There may be a virtuous cycle should this advice be heeded. A later study by Baumann and Kritikos (2016), for example, found that product innovation contributed to labor productivity at small Korean firms. Cha (2015)

found a positive correlation between product innovation and organizational innovation at Korean SMEs. Koo and Kim (2018) concluded that firms in their study with radical innovations also had higher export rates and were more apt to have innovations that were first to market globally. In a different study of Korean SMEs (Lee et al. 2012), however, R&D staff was found to have no impact, nor did the age of the firm. Industry life cycle and government subsidy effects were present in another study of Korean SMEs. Jun et al. (2006) concluded that SMEs in the electronics industry financially benefited from cooperation with large firms and via exporting. This last link is of growing importance, particularly since exports make up roughly one half of Korea's GDP, but have been steadily declining since 2012 (OECD, 2018). Eom and Lee (2010) found evidence of a link between exports and propensity to innovate. This underscores the emphasis on foreign market penetration by Korean SMEs in the present research.

Finally, there is the issue of government redundancy. Oh and Gress (2017), for example, found evidence of such redundant government services related to firm innovative activity in their study of Korea's solar PV industry and regional innovation systems. By 2016, 16 government-run SME programs run by four separate ministries had been disposed of. This was long overdue, as the government had been championing GRI-firm innovation linkages at least since the early 2000s (see Hwang, 2002) with a suggested focus on increased specialization (Lim, 2000) and cooperation (Doo and Sohn, 2008).

IV. Data

According to Korea's Science and Technology Policy Institute (STEPI), the 2016 Korean Firm Innovation Survey, for manufacturing in this case, is

based on the OECD Oslo Manual, currently accepted as an international standard for innovation survey instruments. Survey distribution was conducted from 24 July until 17 October of 2016 by STEPI. The data were primarily obtained by visiting firms in person. However, online and fax distributions complemented the effort. The total database of 4,075 firms represents a response rate of 29.1 percent. Only SMEs are included for the purposes of the forthcoming analyses. Within the Korean context, this definition encompasses firms with fewer than 300 employees or revenue of less than 8.0 billion Korean won (KEIA, 2015). Overseas affiliates were not included in any analyses. Once these delineations were made, of all 4,075 firms in the database, 3,792 firms remained, 1,369 medium-sized firms and 2,423 small firms. 7.2 percent (272 firms) had both new product innovations and incremental product innovations over the three-year, 2013-2015, period (156 medium and 116 small firms). 19.8 percent (752 firms) had only incremental product innovations (396 medium and 356 small firms), and 2.3 percent (89 firms) had only new product innovations (37 medium and 52 small firms). Firms were asked to reply yes or no to the following two statements based on the prompt, "Over the past three years (2013-2015) did you bring to market the following product innovations?": "New product completely different from existing product," and, "Significantly improved product compared to existing products." 2,679 firms indicated the presence of no product innovation of any type during the three-year survey window.

For the ensuing analyses, it should be noted that chi-square tests confirmed no difference between firm size and innovator types, the presence of new innovation, the presence of incremental innovation, being first to market ahead of competitors, having a product first for the company (but not first for the market), or for releases of products first domestically or globally. By 20th percentiles, 20 percent of all firms range between the ages of three and six; the next 20th percentile

Table 1 Descriptive statistics by innovator type

	New and Incremental		Only Incremental	
Sales				
1170-7000	31.2*		33.1	
7001-30000	39.2		37.6	
30000-100,000+	29.6		29.3	
	Mean	SD	Mean	SD
Sales Growth	22.3	94.9	19.8	98.8
Export Growth	23.8	113	24.2	138
Export Intensity	37.1	28.6	33.5	38.6
R&D Intensity	4.80	7.50	3.80	6.00
Patent Applications	5.99	13.22	4.13	7.95

*By percentage of responding firms

of seven to 11, the next of 12 to 16, the next of 17 to 23, and the last 20th percentile of firms between 24 and 70. In short, roughly 50 percent of the SMEs in the database are fourteen years of age or younger, while 10 percent of firms are twenty-eight or older. Table 1 provides other descriptive metrics for the two innovator groups.

A t-test unearthed a difference in sales growth between innovators and non-innovators (2.49, 0.01). Innovators had an average growth rate of 20 percent (SD=0.95), while non-innovators had an average sales growth rate of 12 percent (SD=0.69). An additional t-test revealed no difference for export growth (-0.28, 0.82), with both averaging roughly 23 to 25 percent. Still, sales growth and export growth are positively correlated (0.74, 0.00). Chi-square tests, however, revealed that 37 percent of innovators, compared to only 6.5 percent of non-innovators had new *process* innovation (556, 1, 0.00). For the presence of new logistics process technology, the percentages were 19.1 and 6.6 respectively (134.91, 1, 0.00), and for the presence of new support

activity, 14.1 and 5.1 (88.90, 1, 0.00). This is a firm-network level consideration that should be mentioned here, though for brevity's sake it will not be part of the ensuing analysis. This could have implications for Korean firms going forward. As previously discussed, Korean SMEs are not well represented in key export product sectors and have difficulty establishing technological trends. Firms characterized by radical and incremental simultaneous innovation coupled with organizational and managerial innovation are better situated to usher in a major change to technological systems (see Freeman and Perez, 1988). There is room for improvement in terms of introducing process innovation in Korean SMEs, though a potential beneficial impact in the future is clear.

Because Korean SME policy favors both SME growth and innovation, and sales growth positively correlates to export growth, it stands to reason that we should concentrate on innovators and on their ability to garner position locally and globally. Further, among innovators, a Kruskal-Wallace test (10.21, 2, 0.002) confirmed a difference in patenting success between groups, with those firms with only new innovations generating 3.94 patents on average (SD=5.33), those innovating only incrementally with 4.13 (7.95), and those innovating both ways 5.99 (13.22). Patents, in turn, positively correlate to both sales growth (0.109, 0.002) and export growth (0.117, 0.016).

V. Analyses and Discussions

1. SME Innovators: Motivations, Costs, and Purchases Outside of R&D

The motivations for innovation for the two cohorts are apparent in Table 2. The two groups are similar in their ratings of the following four objectives: product diversification, product or process substitution,

Table 2 Objectives of product and process innovation: Innovator types compared

Main Objective of Innovation	All Firms		Incremental and New Product Innovation		Only Incremental Innovation		T-Statistic
	Mean	SD	Mean	SD	Mean	SD	
Product diversification	2.51	0.75	2.60	0.69	2.52	0.75	1.92
Substitute existing products or processes	2.64	0.68	2.62	0.76	2.66	0.68	-0.96
Expand markets or market share	2.61	0.71	2.71	0.65	2.62	0.72	2.00*
Improve product quality	2.78	0.55	2.89	0.38	2.80	0.54	2.36*
Improve production flexibility	2.46	0.74	2.53	0.76	2.46	0.74	1.29
Increase production capacity	2.27	0.78	2.26	0.89	2.27	0.78	-1.14
Reduce labor costs	1.99	0.79	2.21	0.82	1.98	0.78	3.95**
Reduce raw materials and energy costs	2.07	0.81	2.31	0.82	2.07	0.81	4.30**
Improve adverse environmental effects	1.95	0.82	2.22	0.87	1.95	0.81	4.56**
Improve work environment or safety of workers	2.00	0.81	2.27	0.89	1.98	0.82	5.06**

*Significant at the .05 level; **Significant at the .01 level; Answers based on Likert scales (0=Totally Unimportant; 3=Extremely Important)

improvement in production flexibility, and increase in production capacity. At the firm level, in other words, both groups want to improve the scope

and scale of their operations, and at the same time improve flexibility. The latter could indicate the introduction of advanced technology (e.g., 3D printing). Taken together, this would equate both types of innovator categories as having primarily a customer, or market, orientation, a position that better assists firms to meet customer needs while increasingly finding possible new outlets for their innovations (Bagchi-Sen, 2007).

In six additional categories, the ratings are significantly higher for the group "new and incremental" product innovators: quality improvement, market expansion, cost reduction (both labor and material, including energy), improvement in the internal environment for the workforce (which could help SMEs draw talent away from the *chaebol*), and the reduction of adverse external environmental effects. Quality improvement and market expansion for these dual-type innovators comes as no surprise given the aforementioned result pertaining to their patenting and export growth. Still, this should be a welcome sign for Korean policy makers keen to see the county's SMEs not only innovate, but also capture more global market share. A nod to the industry level, the final category may be connected to Korea's ongoing effort to better coordinate its manufacturing sector with environmental considerations to include a support for green industrial parks. The combination of size, in this case all firms are SMEs, and an emphasis on flexibility for firms innovating both ways, backs up suppositions in previous research that SMEs are well-placed to bring about radical innovations (see Therrien, Doloreux, and Chamberlin, 2011).

Table 3 provides a breakdown of innovation-related costs. The expenditures are similar for internal (firm level) and external (network level) R&D and the acquisition of machinery and equipment. However, the innovators conducting both new and incremental product innovation expend significantly more in acquiring external knowledge whereas the incremental innovators spend more on design, training, and so on. Prior

Table 3 Innovation cost and cost breakdown: Innovator types compared

Total innovation costs and activity by percentage	All Firms		Incremental and New Product Innovation		Only Incremental Innovation		T-Statistic
	Mean	SD	Mean	SD	Mean	SD	
Total Innovation Costs	549.61	763.21	598.35	796.58	531.01	749.90	1.16
Internal R&D	69.62	29.03	70.72	29.47	69.20	28.87	0.72
External R&D	24.41	25.91	23.39	23.42	25.50	28.73	-0.30
Machinery, equipment, etc.	35.65	27.82	36.41	26.71	35.33	28.32	0.35
External knowledge	15.06	18.93	21.58	26.67	11.06	10.73	1.96*
Other (design, training)	29.68	27.44	22.28	24.07	31.87	28.01	-3.89**

*Significant at the .10 level; **Significant at the .01 level

research has demonstrated that innovators, particularly those seeking to release new, radical innovations, benefit from new-knowledge searches in two ways, namely by finding possible ways by which to more successfully use their existing applications on the one hand (see also Chandy and Tellis, 1998), while also discovering potential new ideas on the other (Li et al., 2013). This finding lends further support for splitting innovators into these two groups. It is interesting that training rates (included in the 'other' category) are statistically higher for firms innovating only incrementally, but it should be noted that training is nonetheless not overlooked by firms innovating both ways. At the individual level, this transects with human capital considerations. We have known for some time that human capital impacts a firm's innovative capabilities (Barney, 1995), and that training can buttress specific skills necessary to remain technologically competitive (Freel, 2005).

Table 4 further confirms that a significantly higher percentage of firms innovating incrementally allocate funds for job training. In fact, note that for the last four categories, more of these innovators signified expenditures.

Table 4 Supplementary activities and purchases outside of R&D: Percent of responding firms by innovator type

Category	Incremental and New Product Innovation	Only Incremental Innovation
Machinery, Equipment, Software, Buildings	43.0	36.4
Purchase of external knowledge	7.0	4.1
Job training	40.8*	57.2
Market launch activities	34.2	41.0
Design (modify form or appearance of product)	30.1	36.7
Other (feasibility study, testing, verification)	40.4	47.3

Note: The last four categories all registered significant chi-square statistics.

In many ways this helps to shed light on the findings described above as these firms are training at the individual level, yes, but also spending at the firm level on market launches, design modifications, and other activities related to product introduction and/or upgrading. This may be explained by the fact that for firms innovating both ways, there is perhaps a necessary emphasis on new innovation development paired with an imperative to keep up with incremental innovation, while for the incremental innovators, training may be more commercialization-oriented, something increasingly common in diverse technological environments (see Van Oorschot et al., 2010).

2. Internal R&D and External Cooperation and Knowledge Sourcing

On the questionnaire, firms were asked who developed their product innovation over the specified thee-year time period. As previously, this examines both firm and network level effects. Multiple responses were allowed, with firms denoting their prioritization based on whether a response was the first, second, third or fourth choice. For purposes of

Table 5 Location of product innovation: Percentages of responding firms

	Who developed your product innovation over the pasts three years?	Incremental and New Product Innovation	Only Incremental Innovation
First answer choice	Developed in-house	90.3	95.7
	Collaboration with other companies or organizations	8.6	2.1
	Modified something developed by another firm or organization	1.1	1.9
	Developed by other companies or organizations	0.0	0.3
Second answer choice	Collaboration with other companies or organizations	85.7	53.8
	Modified something developed by another firm or organization	7.1	43.3
	Developed by other companies or organizations	7.1	2.9

comparison, only the top two choices will be used in the ensuing analyses. Table 5 notes that over 90 percent of both types of innovators depend on company resources only for R&D. Only 8.6 percent of firms citing both new and incremental innovation collaborates with other organizations compared to 2.2 percent of incremental innovators. In other words, collaboration is not a major *primary* source of innovation, though a Fisher's exact test indicated differentiation between the groups of innovators. Interestingly, however, collaboration *does* emerge as a second-tier mode of innovation, and this is much more pronounced for firms innovating both ways. Further a significantly higher percentage of firms innovating only incrementally also attributed their innovation as having come from the modification of something developed externally. As above, a Fisher's exact test indicated differentiation between the innovator types. As we shall soon see, GRIs figure predominantly into this mix, thereby lending credence to Doo and Sohn's (2008) aforementioned recommendations for these institutes to

Table 6 Cooperating partners useful for innovation activities: Percentages of responding firms by innovative activity

Cooperating Partner	Incremental and New Product Innovation	Only Incremental Innovation
Own affiliates	11.3	17.2
Suppliers (raw materials, parts, software)	11.3	8.6
Private sector demand: Companies and customers	33.0	37.1
Public sector demand*	4.1	9.3
Competitors and other companies in the same industry	5.2	2.0
Private service providers (Consulting, commercial labs)	0.0	1.3
Universities and other higher learning institutions	9.3	11.9
Government, public, and private R&D institutes	25.8	12.6

*Includes government offices, public enterprises, schools, and hospitals that provide services such as safety, transportation, housing, and energy as well as that perform governmental or local governmental functions.

concentrate specifically on *transferable* innovation that can benefit SMEs. Here, results suggest that this is even more warranted when it comes to assisting firms targeting both new and incremental innovations.

Table 6 helps to shed light on the above findings. Firms were asked to choose one most useful cooperating partner for their innovating activities among eight actors, actors that span firm, network, and industry levels. A Fisher's exact test indicated no differentiation between innovator groups, though there are some discernable trends. Firms innovating both new and incrementally opted for private sector demand and external R&D institutes as first and second, while affiliates and suppliers tied for third, and universities for fourth. Firms innovating incrementally, however, recognized

private sector demand and their own affiliates as first and second followed by external R&D institutes and then universities. Suppliers also ranked behind public sector demand. In part this may be explained because of all innovating firms with domestic procurement contracts (industry level), 69 percent report innovating only incrementally versus 31 percent innovating both ways. Also, as was briefly discussed previously, firms innovating both ways have greater patenting success, which correlates to both sales and export growth.

A subsequent question on the survey inquired after primary customers, and the percentage of firms innovating both ways (13.2) nearly tripled the percentage of those innovating only incrementally (5.1) in terms of the importance of export markets was concerned. Recall that market expansion was a primary motivator for innovating for these firms. Private enterprise customers dominated with 76.1 percent and 89.2 percent respectively. Intuitively, it would seem that at the firm and network levels, there is interactive learning taking place between innovative firms and customers, and, again, this type of customer orientation helps firms to more ably secure new markets for their products (Bagchi-Sen, 2007). This is further borne out by additional analysis, but suffice it to say here that this may be a positive shift for Korean SMEs given the aforementioned goals of the government going forward.

Figure 1 shows that both sets of innovators share common sources for information. Firms rated the usefulness of these sources from zero (no contribution) to three (significant contribution). These are features of the firm and network levels. Some statistical differences emerge, but these are more specifically for inside the company (2.74 vs 2.62), private sector demand (2.56 vs 2.45), and use of professional journals (1.33 vs 1.48), and are largely a matter of a small degree of differentiation. Of the eleven sources of information, inside the company, private sector demand, suppliers, and competitors,

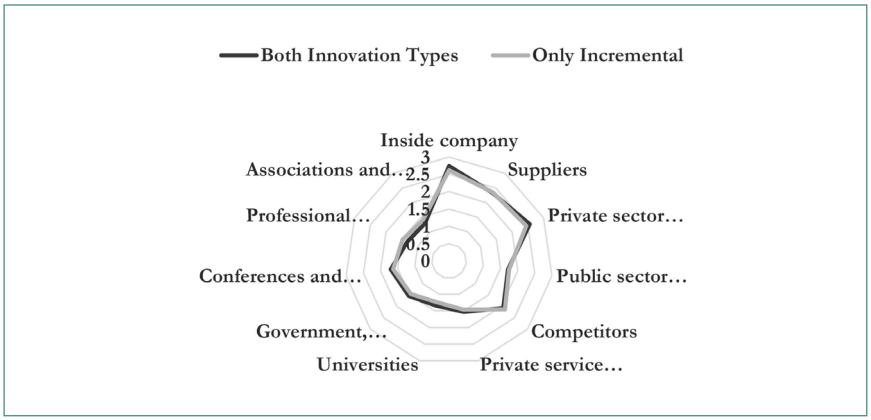

Figure 1 Importance of information sources to SME innovators

in that order, are the only to rank above 2 (of average importance on the questionnaire). None of the remainder, however ranked below 1, indicating that they are of comparatively less or low importance to innovative efforts, but are nonetheless not considered totally unimportant (0 on the questionnaire). These results largely mirror the above analyses except for the role of government/private R&D and competitors; above, the role of the former was acknowledged to be quite strong, while the latter quite weak. This suggests that external R&D partners are considered good for innovative activity, but perhaps less so as sources of information. The importance placed on competitors for sources of information suggests a heavy use of benchmarking, something that could perhaps be considered in conjunction with the importance placed on conferences and trade fairs. In totality, these results, in conjunction with the in-house R&D activity discussed previously, bode well for Korean SMEs in terms of innovation potential. This type of customer, or market-oriented type of search for information, for example, has been shown to accentuate in-house R&D, and external knowledge sourcing is crucial in high-paced, technologically challenging markets (Sofka and Grimpe, 2010).

3. Innovation Impacts on Domestic and International Market Positioning and Entry

Next, domestic and international market positioning are examined, an important consideration given the aforementioned aims of Korean government policy. This portion of the analyses is connected in many ways to the firm level (e.g., orientation), while also being connected to the industry level (e.g., turbulence and competition). Firms with products produced from both new and incremental innovation were compared to those with only incrementally innovated products with some differences arising (see Table 7).[1] Firms innovating both ways reported a higher percentage of products first to market, 63.9 percent compared to only eight percent for firms with only incrementally innovated products, a statistically significant difference. In fact, of all companies reporting the development of products first to market, 73.6 percent innovated both ways compared to only 26.4 percent incrementally. Also, additional chi-square tests indicated differences between these groups for releasing a product first in Korea and globally. Roughly 50 percent of firms innovating both ways were first to release their products in Korea versus only 10 percent for firms innovating incrementally. Globally, the associated percentages were 10 percent and 0.6 percent respectively, a much more pronounced effect than when comparisons were run based on whether firms innovated *only* incrementally compared to those with *only* new product innovations. This adds to the insight by Reichstein and Salter (2006) that these two types of innovation are correlated. Here, however, we see an impact on market positioning.

[1] For purposes of comparison across categories, firms who answered 'Do not know' to questions on Korean and global market positioning were excluded from all analyses.

Table 7 First mover and domestic and international market position by innovator type

Innovator Type	1st to market ahead of competitors			1st for Korea			1st globally		
	Yes	No	Total	Yes	No	Total	Yes	No	Total
New and Incremental	(145)	(82)	(227)	(113)	(114)	(227)	(23)	(204)	(227)
	63.9	36.1	100	49.8	50.2	100	10.1	89.9	100
	73.6	12.1	26.0	63.5	16.4	26.0	85.2	24.1	26.0
	16.6	9.4	26.0	12.9	13.1	26.0	2.6	23.4	26.0
Only Incremental	(52)	(594)	(646)	(65)	(581)	(646)	(4)	(642)	(646)
	8.0	92.0	100	10.1	89.9	100	0.6	99.4	100
	26.4	87.9	74.0	36.5	83.6	74.0	14.8	75.9	74.0
	6.0	68.0	74.0	7.4	66.6	74.0	0.5	73,5	74.0
Total	(197)	(676)	(873)	(178)	(695)	(873)	(27)	(846)	(873)
	22.6	77.4	100	20.4	79.6	100	3.1	96.4	100
	100	100	100	100	100	100	100	100	100
	22.6	77.4	100	20.4	79.6	100	3.1	96.4	100
Chi-square			299.60			163.24			50.72
(Probability)			(0.00)			(0.00)			(0.00)

An additional chi-square test (70.47, 1, 0.00) revealed that firms with innovations first to market ahead of competitors had a distinct edge when releasing products first globally, 12.3 percent versus a scant 0.4 percent of firms not making it first to market. Domestically, this imbalance is much more pronounced, with associated percentages of 70.6 and 5.8 respectively (394.48, 1, 0.00). Perhaps unsurprisingly, t-tests revealed that firms with products released first globally had higher R&D intensity (2015, the only year for which the statistic could be generated), 7.1 percent compared to 4.2 percent for those without new global releases (2.06, 0.04), as well as higher cumulative export growth (weaker, at the .10 level of confidence) over the three-year survey

Table 8 Contribution to sales by product innovation category: Innovator types compared

Contribution to sales	All Firms		Incremental and New Innovation		Only Incremental Innovation		Mann-Whitney U
	Mean	SD	Mean	SD	Mean	SD	Significance
Launched in the last 3 years (first to market ahead of competitors)	30.47[a]	22.51	28.90	19.50	34.95	29.16	0.64
Launched in the last three years (first for our company, but not first to market)	29.63	23.54	32.06	22.10	28.75	24.01	0.00
Other products (including existing products)	70.04	28.15	56.90	29.13	74.80	26.23	0.00

[a]Percent of contribution from sales out of total sales

period (1.74, 0.08), 78 percent compared to 22 percent. Again, among innovators, a difference in patenting success exists between groups, with those firms innovating only incrementally generating 4.13 (7.95) patents, and those innovating both ways with 5.99 (13.22). Patents, in turn, positively correlate to both sales growth and export growth.

A more nuanced perspective is provided by an analysis of sales from product launches. Table 8 shows that 28.9 percent of new and incremental product innovators and 34.9 percent of incremental innovators note first-mover advantages from innovative product launches. The role of incremental innovators as first-movers should be noted here. Statistical differentiation is present for the next two categories. 32 percent of the new and incremental group versus 28.75 percent of the incremental group note sales from an innovative product launched in the past three years,

but that the product was not first to market. Existing products continue to play a significant role in contributing to sales, especially for incremental innovators. This may help to buttress the rationale for combining innovators active with both new and incremental innovating activity. If a firm were to put all its eggs into one radical innovation basket, there would perhaps be too much risk involved to justify the length of time necessary to bring a new product innovation to market. By also having a marketable stock of existing products, radical innovators may have increased flexibility.

4. Sources of Support and Impediments to Innovation

At the industry level, government support systems are also explored (different than policy support to be discussed shortly), namely 1) tax support (credits and exemptions), 2) funding (e.g., participation in national R&D projects), 3) financial support, 4) human resources support, 5) technical support (including technology transfer), 6) certification support, and 7) purchase support. Firms rated the efficacy of these facets of support from zero (totally unimportant), to 1 for 'of low importance', to 2 for 'of average importance,' and to three for 'extremely important'. Firms were asked to gauge their usefulness had they used the services. For brevity's sake, no table is provided. For numbers one through four, a majority of firms (exceeding 60 percent) relayed that these systems were 'totally unimportant'; for numbers five and six, over 70 percent of firms viewed these items as 'totally unimportant', and over 80 percent of firms for the last category. Still, this leaves sufficiently large numbers of firms stating that these types of support are at least of low importance, with many (in the high teen and twentieth percentiles) rating them of average importance or extremely important.

Perceptions of all but number four (human resource support) differed between firm exercising both types of innovation compared to those

innovating only incrementally, but these were largely differences in degree rather than in rating categories; in all cases, firms innovating both ways nonetheless rated everything as more important than their incrementally innovating peers. Taken in conjunction with previous results, it should perhaps be no surprise, therefore, that each of these categories of government support positively correlate with R&D intensity (2015), and all but two categories, tax support and financial support, correlate positively with patents.

Next in the analyses is the impact of policy support. Policy support at the industry level is part and parcel of any multi-level assessment of firm innovative activity (Baba and Walsh, 2010). Firms were asked to gauge the impact of policy support on the success of their innovative activities, from zero (no contribution) to three (significant contribution). Figure 2 provides a snapshot of innovative firm perceptions. The only differentiation between firms innovating both ways and those innovating only incrementally appeared for the R&D-related subsidies and loans, and for intellectual property rights (IPR) protection, both of which were rated as contributing somewhat more for firms innovating both ways. This stands to reason given the potential of developing and then releasing new inventions. Given the specificities of Korea's regulatory and policy infrastructure discussed previously, responses for the top four categories should be cause for some concern, with over 60 percent of firms signifying that support for global market development, large firm-SME cooperation, overall regulatory reform, and firm/university/government did not contribute to their innovative performance. Having said this, the fact that some 20 to 30 percent of firms voiced that these contributed to some degree may be indicative of the fact that policies have yet to gain traction or, as Gress (2015) found, that Korean firms were simply unaware of opportunities and/or how to avail themselves of them.

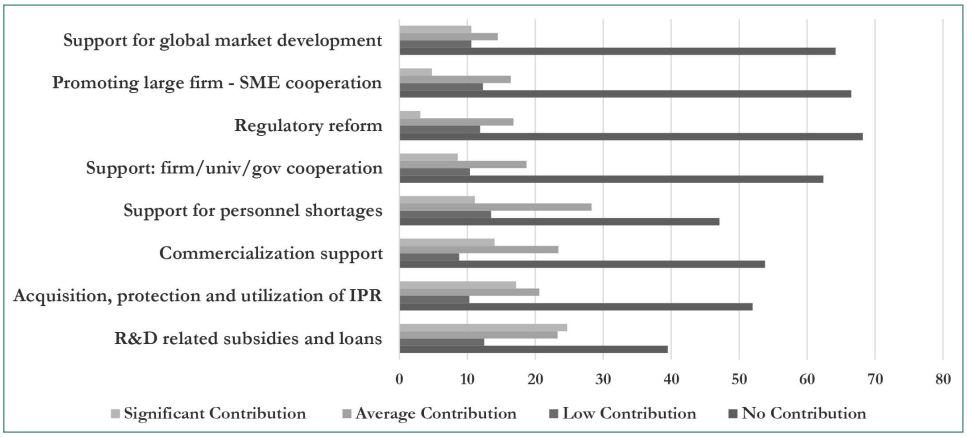

Figure 2 Perceptions of policy support contribution to innovative activities by percentage of responding innovating firms

Going further down the categories, increasingly larger percentages of firms indicated that policy support was indeed making a contribution to their innovative performance. The acknowledgement of support for personnel shortages, commercialization, and R&D-related subsidies and loans in particular should be welcomed news for the Korean government even though there is obvious room for improvement. IPR protection support, acknowledged as beneficial to some degree by roughly 50 percent of responding firms, has long been seen as a key motivator for innovative firms as this affords them the opportunity to capture value from their efforts (Teece, 1986). This category, along with support for firm/university/government cooperation, personnel, and commercialization do in fact correlate with patenting which, again, correlates to both sales and export growth.

The flip-side of the support coin is impediments to innovation within a given system. The categories in Table 9 run the gamut from the individual, to the firm, to the network, to the industry level of analysis. The highest modes were three for lack of internal funds (firm level) and for difficulty

in obtaining government (financial) support (network level), both of which ranked at or near the very top for both innovator type groups. Financing, in particular government financing, is often recognized as crucial in terms of firm performance and technology commercialization (Maine, 2008; Czarnitzki et al., 2011). Three categories in particular-lack of external private financing, lack of tech-related information, and lack of market information emerged as statistically different between innovator groups, with incremental innovators ranking these categories as significantly more important. Inhibition from the latter two categories may help to explain the results presented previously, namely in conjunction with incremental innovator increased spending on training, market launch, and design activities on the one hand, and their prioritization of cooperation with private sector demand, external R&D, and universities on the other (see Table 6). The acknowledgement of problems revolving around personnel should be of concern to Korean policy makers. As discussed in the background section, this has been the target of specific innovation-related policies in the country, but results here indicate that there is more work to be done.

One interesting result here is the fact that market, or industry level factors, namely competition and uncertainty (turbulence) are ranked *lowest* by both groups of innovators. This should be treated with caution, however, as mode scores were still two. In other words, many companies perceive competition and turbulence to be impacting their innovative trajectories to at least some degree, and this may help to explain why such a comparatively large number of firms are innovating only incrementally. Highly competitive markets with shortened technological life cycles entice firms to rely on incremental innovation *even if* they are simultaneously developing radical products (see Molina-Castillo et al., 2011). Uncertain customer demand may create conditions wherein firms can capitalize by moving first to market, particularly with new innovations (Bao et al., 2012). And, indeed,

Table 9 Factors inhibiting innovative activity: Modes, means, and percentages of responding firms by category

		All Firms			Incremental and New Product Innovation		Only Incremental Innovation		T-Statistic
		Mode	Mean	SD	Mean	SD	Mean	SD	
Funding Issues	Lack of internal funds	3	2.22	0.83	2.22	0.91	2.22	0.83	-0.12
	Lack of external financing or private funds	2	1.83	0.10	1.70	1.08	1.89	0.10	-2.45*
	Difficulty in obtaining government support (grants/ subsidies)	3	1.97	1.01	1.95	1.08	1.99	1.02	-0.44
	Excessive innovation costs	2	1.91	0.96	1.89	1.03	1.93	0.96	-0.45
Corporate Confidence Factors	Lack of talented personnel	2	2.00	0.91	1.95	1.02	2.03	0.91	-1.08
	Lack of tech-related information	2	2.06	0.93	1.93	1.05	2.12	0.91	-2.57*
	Lack of market information	2	2.04	0.95	1.89	1.04	2.10	0.94	-2.41**
	Lack of cooperative partners	2	1.84	0.99	1.78	1.06	1.88	0.10	-1.26
	Lack of innovative ideas	2	1.98	0.95	1.91	1.00	2.01	0.96	-1.37
Market Factors	Severe market competition	2	1.39	0.99	1.32	1.09	1.42	0.99	-1.27
	Uncertain market demand	2	1.71	1.02	1.67	1.08	1.73	1.02	-0.72

*Significant at the .05 level; **Significant at the .01 level; Answers based on Likert scales (0=Totally Unimportant; 3=Extremely Important)

Table 10 Summary of multi-level factors impacting Korean SMEs and their innovation ecosystem

	Common to Both Groups of Innovators	New & Incremental Innovators	Only Incremental Innovators
Individual Level	Personnel problems are perceived impediment	Training is innovation oriented	Training is commercialization oriented
Firm Level	Motivations include improving scope and scale; improving flexibility (customer orientation)	Motivations are quality improvement; market expansion; workforce environment	
	Internal R&D focused		
	Lack of internal funds perceived problem		
Network Level	Spending on external R&D and on machinery and equipment; Use of benchmarking	More spending on external knowledge acquisition	More spending on design, training, market launch, and testing
	Private sector demand-provided partners; universities rank lowest as innovating partners	More collaboration; Export markets much more important	May modify something produced elsewhere
	Obtaining government financial support is a perceived impediment		Impediments include lack of external private financing, tech-related information, and market information
Industry Level	Turbulence and competition contributing to pronounced use of incremental innovation	More products first to market in Korea and globally; More patents correlated to increased sales and export growth	Existing products contribute more to sales
	Seek to reduce negative impact on environment		
	Government support systems considered totally unimportant by 60%-80% of SMEs	A more optimistic outlook on government support; Support correlated to R&D intensity and patenting	

Table 10 (continued)

	Common to Both Groups of Innovators	New & Incremental Innovators	Only Incremental Innovators
Industry Level	60% indicate policy support such as global market development, chaebol-SME and firm/ univ/government cooperation not contributing	More optimistic about policy support for R&D subsidies and IPR protection	
	Cautiously optimistic about personnel, commercialization, and R&D subsidies		

results presented previously suggested that firms innovating both ways had a much higher percentage of products first to market both domestically and globally. This fact, and a generalized synopsis of results presented thus far, is presented in Table 10.

VI. Concluding Remarks

This paper endeavored to provide an analysis of the innovative ecosystem for Korean SMEs, examining motivators, innovative activities and partners, support systems and impediments to innovation, and market positioning from a multi-level perspective inclusive of individual, firm, network, and industry-level factors. It was argued that such analyses may prove useful given Korea's deteriorating exports and returns from technology, and the government's emphasis on SME success going forward. A number of noteworthy differences emerged between the two groups of firms analyzed in this multi-actor, multi-spatial fashion: 1) those that

engaged in incremental *and* new product innovation and 2) those that engaged in only incremental innovation, a somewhat novel bifurcation and addition to innovation-oriented research. An overview of these results was provided in Table 10.

Overall, firms that embarked upon new *and* incremental product innovation were more motivated by internal factors (e.g., reducing labor and material costs) as well as external factors (e.g., environment) as part of their innovation-related deliberations. They also tended to engage more with outside business partners and appeared to be the first to develop products for wider markets. As for the firms that embarked on *only* incremental innovation, a different set of characteristics emerged. The most noteworthy of these pertained to competitive issues. They cited a lack of access to external financing and information as significantly more critical issues than those firms also innovating with newer products. Tangentially tied to this, they also tended to spend more on job training, a reaction to personnel shortages, a major competitive obstacle unearthed in the research. Also worrisome was the diminished perception of university usefulness, and of large firm-government R&D-SME cooperative activity in the innovative ecosystem. For the future of Korea's technological competitiveness, these findings are important. Seo and Choi (2012) inclined, for example, that Korean SMEs may be at a competitive disadvantage globally because of difficulties associated with foreign market and partner information acquisition, partially because of a lack of management expertise, *even if* they have technologically competitive products. In short, going forward, Korea and Korean firms need to concentrate on human capital tied to marketization and market penetration as much as on product innovation. The present study briefly discussed process innovation as well, and the fact that it could have positive knock-on effects for Korean firms going forward.

Some policy bright spots were highlighted as well, and these speak to

the future of Korea's innovation ecosystem. A wide array of government support factors, for example, correlated to R&D intensity and to patenting activity (further correlated to sales). Firms engaged in new and incremental product innovation, though in the minority, also appeared to be more export oriented, and derived larger percentages of sales from products that were the first to the Korean and global markets, the latter of which aligned well with government goals. The long-term ramifications of these trends remain to be seen. Results suggested, for example, that industry-level turbulence and competition may be narrowing the scope of firm-level innovative activity to the safer incremental type. This may not be good enough. In the future, Korean SMEs will be increasingly squeezed between competition from MDC firms, when they will have to compete increasingly based on novelty and quality, and simultaneously from firms from quickly developing LDCs, for example China, India, Vietnam, and Malaysia, when they will have to compete based on price (see Gress and Kalafsky, 2020). Perhaps for this reason, Korea is championing its new International Science and Business Belt (ISBB) project, a multi-spatial, multi-actor endeavor that seeks to engage brand new markets via basic science research spearheaded by SME activity with government support. This, it is hoped, will resituate Korea strategically in innovation-oriented competition in the global space economy in the future, while providing more spatially balanced regional participation opportunities in Korea's innovation ecosystem.[2]

All of that said, there a few avenues for future research that may help to further address this topic. Given the external focus of the new-incremental innovators, perhaps additional analyses could address how these innovative activities and challenges more specifically relate to firm-level export

[2] A description of Korea's ISBB project necessarily falls outside the purview of the present research. For an overview and analysis of the project since its inception, see Gress (2020).

behaviors—especially in light of the importance of exports to Korea's economy, and increasingly, to its SMEs. An additional and valuable research angle might come from more in-depth studies of these firms via interviews and case studies. The present analyses provided a broad overview, which was in line with the data available. This newer approach would enable further insights into individual and firm-level behaviors related to SME innovation as well as the role that experience (e.g., of culture, staff, management, ownership) might play in approaching innovation in the Korean context.

Finally, there are a number of shortcomings that should be mentioned. First, this was an attempt to approach Korea's innovation ecosystem for SMEs via the multi-level perspective, yet different factors (individual, firm, network, and industry) were not all modeled simultaneously. It is hoped that the broad-based analyses provided, and the inferences drawn concerning factor interactions, helped to make up for this shortcoming. Second, analyses examined innovative SMEs, yet did not take into consideration possible variations across industries. This was related to the nature of the data set as it was received, but future studies may wish to consider industry-specific considerations if afforded the opportunity. Third, more individual-level factors (e.g., gender, education levels) were included in the database, yet for brevity's sake were not included in the present research. As mentioned earlier, attention to more individual-level factors impacting innovation at Korean SMEs may be a fruitful line of future inquiry.

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