Small Firms' Innovation in Two Technological Settings

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1. Introduction

Small firms have played an important role in technological innovation and economic growth in developed countries(DCs). Many studies conducted in the U.S. and other OECD countries have shown that small firms account for a disproportionately large number of new innovations(Advisory Committee on Industrial Innovation [1]; Rothwell [32]; Pavitt, [28]; Pavitt et al., [29]). The innovating role of small firms has recently received increasing attention in Newly Industrializing Countries(NICs), as they attempt to transform their industries from labor-intensive to technology-intensive. Some studies have demonstrated that small firms accounted for an disproportionate share of innovation in Korea (Kim [13]; Lee and Yoon, [21]).

Despite their important role in innovation, small firms appear to have a number of resource disadvantages. For example, they have limited financial and technical manpower resources, narrow external technical networks, small marketing resources, and lack of management skill (Rothwell, [31]). Given such resource constraints, small firms need to choose appropriate ways for acquiring technical knowledge in order to update existing products and move to new product markets. Their limited resources present challenges in acquiring technology. Many studies demonstrate that small firms' strategies for acquiring technical knowledge should include both in-house R & D investment and external technical sources (in DC: Rothwell and Dodgson, [34]; Dodgson, [8]; Oakey et al., [26]; in NICs: Bae and Lee, [4]; Kim et al., [16]). As small firms could employ a wide range of in-house R & D and external sources of technical information acquisition, a major strategic issue for them is to choose an appropriate level and form of technical information acquisition.

However, the existing studies mentioned above show contradictory results. Some research has demonstrated that external technical sources were extremely important to underlying technological advantage in innovative European small firms (Dodgson and Rothwell, [9]; Dodgson, [8]; Rothwell

and Dodgson, [34]). In contrast, others have argued that technical links with external information sources were not generally important for high-technology small firms' innovation in either the U.K. or the U.S. (Oakey [25]; Oakey et al. [26]).

This study, based on a sample of 116 small firms in the Korean Electronics industry, will examine the strategies of these firms for technology acquisition. The particular focus will be upon the emphasis upon in-house R & D versus utilization of external technical sources. It will also assess the impact of technology acquisition strategy on the rate of innovation. The rate of innovation is defined to include both the number and quality of innovations (terms to be defined later). Clearly, small firms need radical innovations as well as a large number of minor innovations in order to maintain technological leadership in competitive industrial markets.

Facing the recent erosion of competitive advantage in mature-technology products, NICs attempt to encourage the private sector to develop new-technology products. Public policies in NICs are increasingly motivating small firms accelerlate technological innovation in new or emergent technology setting. However, these policies in new technology setting may have to differ from those in traditional setting dealing with mature technology; the effectiveness of technolgy policies appears to differ according to the technological setting. This study attempts to suggest political implications for promoting small firms' innovation in new technology setting by examining the relationship between their technology acquisition strategies and the rate of innovation.

2. Public Technology Policies in Korea

Korean government policies to help firms accelerate technological innovation may be divided into three categories(MOST [23]; KIET [12]). The

first set of policies is designed to protect the local market for innovative new technologies produced by local firms, which includes tariff protection and import substitution policies. It is concerned with reducing their risks at the early stage of commercializing innovations. The second set of policies is for supporting firms' R & D activities through technological infrastructure, which includes supporting basic research at university and several public research institutes and encouraging technical training and technology transfer for firms. The third set of policies is for motivating firms' R & D activities through various incentives, which include tax incentives, preferential financing, and release from armed service duties for R & D persons.

However, such government policies toward innovation should be reevaluated in terms of their effectiveness and adjusted to the changing industrial environment. There are two reasons for this. First, the effectiveness of these policies appears to vary according to technology setting. Protecting the local market for innovations developed by local firms is more likely to be ineffective within new-technology settings than in mature-technology settings. This is because such policies might obstruct transferring advanced new-technology from abroad. It may also be difficult to achieve due to the pressure for local market openness from developed countries. Also, the effectiveness of supporting firms' R & D activities directly and indirectly varies according to technology setting, since the technological needs of the firms differ. For example, firms dealing with sophisticated technologies may need to invest extensively in R & D. Thus, they are more likely to be motivated by R & D support policies. Second, these policies are better suited to match the needs of large firms. Korean large firms have mostly enjoyed benefits from the monopolistic condition of the local market manipulated by the market protection policy. They are also expending the most amount on R & D investment.

In order to better motivate small firms to innovate, current technology policies should be tailored to characteristics of technology setting and adjusted to reflect realites of small firms' innovation. Thus, it is

important to understand technological behavior of small firms in varing technology settings.

3. External Technical Sources for Small Firms in NICs/LDCs

In-house R & D may be a necessary though not sufficient condition for innovation. Firms have to access external technological resources and modify them in order to develop technological capabilities needed to respond effectively technological change (Nicholls-Nixon [24]). Recent research in developed countries has indicated that innovative small firms utilize various linkages with external technology sources to complement and supplement their in-house R & D (Beesley and Rothwell [5]; Parolini [27]). Such a strategic direction for small firms' technology development appears to be the case in NICs/LDCs.

There are many ways whereby small firms in NICs/LDCs can acquire technological information and expertise from outside. Formal technology transfer from abroad has been a major technology development strategy available to local firms in NICs/LDCs (Lee, Bae and Choi [19]; Westphal et al. [39]; Marcy [22]). This method involves adopting technology from foreign firms through formal channels such as technological licensing agreements. It has been more widely used by large firms than small firms, since, in general, costs associated with searching for suitable foreign technology sources and making use of this proprietary know-how burden small firms. However, despite of the high cost of formal technology tranfer, technology-based small firms in NICs presently utilize it aggressively to acquire technology (Bae and Lee [4]).

Informal channels of technology acquisition are also very important for small firms (Lee and Kim [20]; Bae and Lee 1986). Small firms in NICs/LDCs have informally acquired technological information and expertise from various external sources.

First, suppliers of equipment or materials often provide informal

technological assistance. Kim, Kim and Lee [16] showed that innovative small firms perceived the role of foreign suppliers as important sources of their technological input in the Korean pharmaceutical industry.

Second, buyers' roles in innovation are important as they communicate their needs to supplier firms. These might include sophisticated firms within NICs, as well as in DCs. Kim and Kim [14] argued that the buyers in NICs are important initial sources of stimulus either through order placing or through serious inquiries. Especially in case of original equipment manufacturer exports, foreign buyers often provide valuable technological assistance (Bae and Lee [4]; Westphal et al. [39]).

Third, technological support and guidance from domestic R & D institutes and universities have been useful tools for technology acquisition. Bae and Lee demonstrated that small firms in the Korean machinery industry utilized informal technology transfer from local institutions to solve their engineering problems. Recently, entrepreneurial small firms have tended to maintain close relationships with local research institutes and universities to complement and supplement their indigeneous development efforts (Kim, Lee and Lee [15]; Kim, Kim and Lee [16]).

Fourth, academic and technical literature provide technical knowledge and information useful to small firms. Many small firms in the Korean machinery industry acquire technical knowledge from technical literature; this is particularly valuable in the early stage of industrial development(Bae and Lee [4]). Kim, Kim and Lee [16] demonstrated that small firms in the Korean pharmaceutical industry perceived the role of foreign publications as very important for their innovation efforts.

Fifth, government agencies, which include government-sponsored information centers, technical assistance institutes, and industry associations, have been strengthened in their functions to encourage and support small firms' technological innovation. Although they do not appear to have been utilized much by small firms (Kim, Kim and Lee, [16]), the acquisition of technical knowledge and information from these agencies is often costless and useful.

Among the five external sources mentioned above, there are conceptual relationships. These external sources could be classified into two categories. One is related to vertical linkages including suppliers and buyers. Rothwell and Dodgson [34]) demonstrated that the vertical linkages were utilized to a major degree by innovative small and medium-sized firms in the U.K.. The other is related to technological infrastucture, including domestic R & D institutes or universities, government agencies, and technical literature. Figure 1 summarized the external technical sources which small firms could utilize in NICs and LDCs.

Figure 1, Here

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4. Hypotheses

A firm's technology acquisition strategy is affected by evironmental factors including market structure, government policies, technological characteristics of the product (Kamien and Schwartz [11]: Porter [30]: Chakravati and Souder [6]). These environmental factors can differ among sectors within an industry. For instance, electronics includes many heterogeneous sectors from the labor-intensive and low-technology based (TV, Transistor, Cassette Tape recorder, etc.) to the high-technology based (VCR, Computer, Memory Chips, etc.), which differ in their market structure, government policies, and technological environment.

Categorizing Korean electronics firms into the new and traditional technology sectors appears to provide a useful research scheme to identify their technology strategies and their impacts on innovation. New technology sector includes products dealing with technologies which are in the emergent or growing stage and remain strategic values still in developed

countries. In contrast, traditional technology sector includes products whose technologies are in the mature stage in developed countries and being transferred to developing countries. A study in five major industries of Korea shows that firms' strategic behavior differs significantly between the new and traditional technology settings (Lee and Miller [18]).

We might expect that relative emphasis upon both internal R & D and external technical sourcing would vary according to the technology maturity of the industry setting. There are two reasons for this. First, rates of technological change would vary, such that firms competing in the new technology setting must devote more effort to acquiring new technology, simply to keep up. Second, the availability of technology from DCs would vary by setting. For new technology, firms in DCs are reluctant to transfer to those that may be potential competitors. Thus, to cope with new environmental pressures, small firms in the new technology setting are likely to invest more heavily in in-house R & D and use external technology sources more than in the traditional technology setting.

Hypothesis 1. Small firms in NICs invest more heavily in in-house R & D and utilize more external technical sources in the new technology setting than they do in the traditional technology setting.

The relative effectiveness of both internal R & D and external technical sourcing appears to vary according to technology setting. There are two reasons for this. First, the cost and availability of technology strategies would vary by setting. In-house R & D commitments contribute more strongly to successful innovation in the new technology setting, since purchasing technologies from abroad is very expensive and often impossible in this setting. Second, the technical sophistication firms must deal with would vary. New technologies are advanced and complex, such that firms face technological difficulties in merging various technologies and skills. Since small firms possess internally a narrow range of skills, external technical sourcing is essential for successful innovation. Also, in order

to implement and subsequently improve externally acquired technological information, a significant level of internal technological capability should be accumulated through internal R & D.

Hypothesis 2. Investment in in-house R & D and utilization of external technical sources are more strongly correlated to rate of innovation in the new technology setting than in the traditional technology setting.

5. Research Methods

Sample

This study collected data from members of the Korean Electronics Industry Association(KEIA), which includes most small firms in the Korean electronics industry. The KEIA contacted all of member companies to acquire their cooperations for data collection. Of these, 131 firms or 33 percent made a positive responses. But 15 companies were excessively large. These companies were excluded from the sample. The final sample consisted of 116 firms. A research questionnaire was mailed to senior managers of these firms. Average sales amount(1988 to 1990) of the sample firms was about 5.6 million U.S. dollars. Average number of employees and firm ages were 85 persons and 12 years, respectively. Specialists of KEIA agreed that such characteristics of sample firms were similar to those of its common members.

Firms were classified into two groups according to the maturity of their technology using a five-category scale. The new technology group consisted of firms whose executives agreed that: 1) three years had not yet passed since their dominant technology was first developed and commercialized; or 2) their technology is used in developed countries but has not yet been diffused into developing countries. The traditional technology group consisted of firms whose executives stated that: 3) the technology has already begun to diffuse into developing countries; 4) the technology is

being widely used in developing countries; and 5) the technology has diffused into even the least developed countries. This five-category scale reflects the degree of diffusion and adoption of a technology at the world level rather than from a one-sided view of developed countries or developing countries. Choi [7] and Bae [3] showed that this scale reflected well the technology development stages of machinery, pharmaceutical, and synthetic fiber industries in Korea.

Measurement

Technology strategy:

The internal R & D was measured by the proportion of R & D personnel among the total employees. The utilization of external technology sources was assessed by the manager's perception of the contribution of formal technology transfer from abroad and other informal sources which included suppliers of equipment or materials, buyers, domestic R & D institutes and universities, academic and technical literature, and government agencies, to the product and process development of the focal firm. The measure of external technical sources used a single item with a five point scale. In order to acquire reliable responses, KEIA noticed the sample firms to pay a special attention to filling out the questionnaire.

Rate of innovation:

Rate of innovation was assessed by two different measures reflecting different aspects of innovation. One was a quantitative measure of innovation - the average number of new products developed per year (requiring substantial technological input and commercial success) for the past five years. The other was a qualitative measure of innovation - the proportion of radically innovative products among the new products developed. The above new products were categorized into six classes according to technological radicality. The radically innovative products belonged to the first or second radicality class: (1) world-wide new ones, (2) those developed with distinct design concepts and improved technology comparing with the counter products in developed countries.

Analytical technique

In order to test how small firms' technology strategies vary according to technological settings (Hypothesis 1), t-tests were utilized for analyzing the mean strategy differences among the new and traditional settings.

Hypothesis 2 argues that the impact of technology strategies on the rate of innovation varies according to the technological setting. This hypothesis is of the following form: the positive impact of Xi (technology strategy variables) on Y (rate of innovation) is stronger when Z (technology setting) is high (or low) as compared to when Z is low (or high). The most appropriate analytical method to test such a hypothesis is the regression analysis using the following formula (Govindarajan [10]; Southwood [36]; Schoonhoven [35]):

$$Y = f (Xi, Z, Xi*Z)$$

6. Results

Table 1 presents the means and standard deviations of all the variables for the total sample. It also gives the correlation coefficients between variables.

Table 1, Here

Table 2 presents measures of the technology strategies of the sample firms in the new and traditional settings. The data in the table show how the technology strategies used to acquire technical information differ according to the two settings. Firms in the new technology setting had a higher proportion of R & D employees among the total employees than those in the traditional setting did (10.2% vs. 6.1%). The former showed higher

scores in the external sources utilized, including domestic R & D institutes and government agencies (significant at ten percent level only), than the latter. The former firms perceived that acquisition of technical information from academic or technical literature was more important than from any other external sources except buyers. They showed a significantly higher score on this variable than firms in the traditional setting did (3.9 vs. 3.4). These results are consistent with the argument of hypothesis 1. However, in regard to formal technology transfer from abroad, there was no significant difference between the two settings. This variable was perceived as less important than external sources in both settings. It might be because technical licenses require high costs and these are beyond the financial capability of most small firms. Although suppliers and buyers were perceived as the most important among the external sources, they did not show significant differences between the two settings.

The data mentioned above indicate that small firms in the new technology setting invest in in-house R & D and utilize external technical infrastructure, such as domestic R & D institutes, government agencies, and technical literature, more than those in the traditional setting. However, they did not show significant differences in utilization of formal technology transfer mechanisms and such external sources as suppliers and buyers. Thus, it could be said that hypothesis 1 was partly supported.

Table 2 also shows that there were some differences in the rate of innovation between the two settings. Unexpectedly, the absolute number of new products was higher in the traditional setting than in the new technology setting (below the ten percent significance level). This might be because this innovation measure included minor or imitative improvements of foreign products. However, a substantial amount of technical input was required to classify them as local innovations. These technological improvements could be easily achieved in the traditional setting in which product technology was not very sophisticated. In contrast, the technological radicality of new products was higher in the new technology setting than in the traditional setting; the proportions of radically

innovative products were 72.9% and 39.1% respectively in the new and traditional settings. This might be because radical innovation is more necessary to acquire competitive advantage in the new technology setting. In the early stages of industry development, when product designs are fluid and a dominant design has not yet emerged, competition among firms is based on design and "first movers" are likely to acquire greater profits (Teece [37]; Utterback and Abernathy [38]).

In the contextual variables, the education level of founders was somewhat higher in the new technology setting than the traditional setting (below the ten percent significance level). In regard to mode of founding, 44.4 percent among firms in the new technology setting (the majority of this type of firm), were founded by technical entreprenuers spun off from technical institutes and other businesses. In contrast, 43.1 percent among firms in the traditional setting were founded by individual investors without technical background. This fact indicates that most firms in the new technology setting are founded by highly-educated technical entrepreneurs.

Table 2, Here

This study attempts to examine the impact of technology strategies on two measures of innovation. Independent variables include technological setting as a moderating variable, the proportion of R & D employees, formal technology transfer methods utilized, and two kinds of external sources of technical information. Since there are conceptual relationships among the external sources in Table 2, this study classified these variables into two categories. One is related to vertical linkages including suppliers and buyers. The other is related to technological infrastructure, including domestic R & D institutes or universities, government agencies, and technical literature. Those variables within each category were

significantly correlated as shown in the correlation matrix of Table 1. The new variables reflecting these two categories of external sources were measured by averaging standardized values of the focal external-source variables.

Table 3 contains the results of the multiple regression analyses undertaken to test hypothesis 2. In order to test the contingency effect of technological setting, the four interaction terms for strategy variables and technological settings were included in the regression model, as shown in Table 3. Since the technological setting is qualitative, it was coded "0" in case of the new technology and "1" in case of traditional technology. Therefore, if the beta coefficient of the interaction term is negative and significant, one could conclude that the positive effect of the strategy variable on the rate of innovation is stronger for the new technology compared to the traditional technology . Alternatively, if the coefficient of the interaction term is positive and significant, then the effect could be said to be stronger for the traditional rather than the new technology. If the coefficent is not significantly different from zero, it could be said that technology setting does not have any contingency effect on the relationship between strategy and innovation.

Table 3, Here

The multiple regression analyses in table 3 are based on two equations which had different dependent variables: equation A using number of new products as the dependent variable and equation B using technological radicality of new products.

As the results of equation A in Table 3 indicate, the beta coefficient of the interaction term for the technological infrastructure and technological setting is negative and significant (beta coefficient = -.467, $p < .05$). This means that the external technological-infrastructure has a stronger positive effect on the number of new products within the new technology setting than in the traditional one. This finding is consistent with

hypothesis 2. However, the coefficients of other interaction terms are not significantly different from zero. This means that the effects of in-house R & D, formal technology transfers, and vertical linkages on the number of new products are not significantly different between two technology settings.

Equation B in Table 2 shows that the beta coefficients of the proportion of R & D employees and vertical linkages are positive and significant (.593 and .534, $p < .01$). Since these beta coefficients are affected by the correlations of the independent variables, this study observed R square changes by droping each variable and its interaction term in the equation. Both R square changes by the proportion of R & D employees and vertical linkages were significantly large (respectively, .124, $P < .01$ and .083, $P < .05$) These findings mean that in-house R & D and technical contacts with suppliers and buyers generally have positive impacts on the dependent variable.

However, the strength of their impacts seems to differ according to the technological setting, because the interaction terms for these variables and technological setting have significant coefficient values. As shown in equation B, the beta coefficients of these interaction terms are negative and significant(-.569, $p < .01$ and -.466, $p < .05$). This indicates that in-house R & D and technical contacts through vertical linkages have stronger effects on the innovation performance within the new technology setting rather than the traditional one. This result supports hypothesis 2.

7. Summary and Discussion

The primary emphasis of this study was to determine how small firms' strategies for acquiring technical information and their effects on the rate of innovation differ according to the new and traditional technology

settings in the Korean electronics industry. The findings suggest that two groups of small firms categorized by technology setting were significantly different with respect to investment in in-house R & D and degree of utilization of such technological infrastructure variables as external R & D institutes, government agencies, and technical literature. In-house R & D and external technical sources did not have significant effects on the number of new products, a quantitative innovation measure. However, in-house R & D and acquisition of technical information from buyers and suppliers had significant and positive effects on the technological radicality of new products, a qualitative innovation measure. Also, their positive effects on the innovation measure were stronger within the new technology setting rather than in the traditional technology setting.

These findings have several implicatons. First, the importance of external technical linkages to innovation has recently become an important issue. However, there are some contradictions among recent reported research. Some research demonstrated that external linkages were extremely important to small firms' innovation (Dodgson and Rothwell [9]; Dodgson [8]; Rothwell and Dodgson [34]), while others argued that they were not (Oakey [25]; Oakey et al., [26]). The findings of this study appear to provide insight for interpreting these inconsistent results, according to the innovation measures used and technological setting. The result from the qualitative innovation measure (technological radicality of new products) indicated the importance of external linkages to innovation, while that from the quantitative innovation measure (number of new products) did not. The importance of external linkages to innovation was more strongly supported for the new technology setting rather than the traditional one.

Second, the Korean government has attempted to encourage small firms to innovate with three categories of technology policies: (1) the local market protection, (2) supports for in-house R & D activities through technological infrastructure, (3) various incentives for motivating in-house R & D activities. This study implies that supporting the technical sourcing from technological infrastucture (the second category of policies)

may partly contribute to developing incrementally innovative products in the new technology setting; as seen in the equation A of Table 3, technological infrastructure sourcing had a negative and significant coefficient for its interaction term with technological setting. However it does not work for increasing the number of radical innovations; no significant effect on the technological radicality of new product was observed in the equation B of Table 3. The study implies that R & D incentives (the third category of policies) might encourage small firms to develop radically innovative products. As seen in the equation B of table 3, R & D inputs of small firms had a significant effect on the technological radicality of new products. Moreover, vertical linkages, which are ignored by current policies, had a significant effect on this measure also. This means that government policies toward small firms' innovation should be adjusted to recognise the importance of vertical linkages and encourage interactions among suppliers, manufacturers, and customers. This implication is consistent with the argument of Rothwell and Dodgson's research emphasizing "near-to-market" policies in the U.K.. This study also indicates that the effectiveness of government policies might vary according to the technology setting. Government policies to promote small firms' in-house R & D commitment and contacts with external technical sources would be more effective within the new-technology rather than in the mature-technology setting.

Third, small firms need innovative products to maintain technological advantages against large firms. This study implies that, while formal technology transfers from abroad are not effective for successful innovation, in-house R & D commitment and external vertical linkages are important to enhance innovativeness of small firms' products. However, qualified technical specialists are essential to pursue in-house R & D and identify and use external technical sources(Rothwell & Dodgson [34]). Lack of qualified scientists and engineers often inhibits the small firms' ability to access and assimilate external technical-information (Angell et al. [2]; Rothwell & Beesley [33]). Such technical persons are particularly

scarce in NICs. Therefore, how to employ these technical persons must be an important issue for small firms seeking to acquire distinctive competences.

Fourth, this study implies that in-house R & D and vertical linkages more strongly contribute to technological radicality of new products within the new technology setting rather than in the traditional one. However, Korean small firms within the new technology setting are not fully utilizing vertical linkages compared to those in the traditional setting, as seen in the data of Table 1. Technical information acquisition from buyers and suppliers must be a potential strategy with which they can be more helped to achieve radical innovation. One of the most favorate technology strategies in Japanese firms is the technical sourcing from local buyers and suppliers: Korea Productivity Center reports that over 70% of Japanese firms are utilizing the vertical technical linkages. However, less than 25% of Korean firms are doing this external linkages for technology development (Korea Productivity Center [17]).

Finally, the pattern observed in the Korean electronics industry may not necessarily prevail in other newly industrializing countries. Therefore, it is necessary to replicate this study in different industries and different countries.

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Figure 1

External Technical Sources for Small Firms

	Formal Technology Transfer	
Informal / Informal	Suppliers Buyers	Vertical Linkages
	Domestic R & D Institutes or Universities Government Agencies Academic or Technical Literature	Technological Infrastructure

Table 1
Descriptive Statistics

Variables	Means	s.d.	1	2	3	4	5	6	7	8
1. Proportion of R & D employees	7.48	8.64								
2. Formal Technology Transfers	2.53	1.20	-.11	1)						
3. Suppliers	3.79	.91	-.08	.07						
4. Buyers	4.04	.84	.03	.01	.26					
5. Domestic R & D Institutes	3.19	1.10	.26	.04	.02	-.06				
6. Government Agencies	3.22	1.05	.15	.02	-.08	.05	.55			
7. Technical Literature	3.60	.93	.19	-.19	.07	.13	.30	.37		
8. Number of New Product	3.58	10.14	-.00	-.14	.04	.03	-.17	-.21	-.29	
9. Technological Radicality of New Product	51.25	90.66	.18	-.01	.03	.12	.11	.07	.08	.00

1) Correlations greater than .19 are significant at $p < .05$.

Table 2
Technology Strategies in the New and Traditional Settings

Variables	New 1) (n=39)	Traditional (n=76)	t-value
Proportion of R & D employees	10.2(9.3)2)	6.1(8.1)	2.5 ***3)
Formal Technology Transfer From Abroad	2.6(1.1)	2.5(1.2)	0.4
Suppliers	3.7(0.9)	3.9(0.9)	-0.9
Buyers	4.0(0.7)	4.1(0.9)	-0.4
Domestic R & D Institutes or Universities	3.4(1.0)	3.1(1.1)	1.5 *
Government Agencies	3.5(1.0)	3.1(1.1)	1.7 *
Academic or Technical Literature	3.9(0.9)	3.4(0.9)	2.6 ***
Number of New Product	1.9(1.7)	4.2(12.4)	-1.4 *
Technological Radicality of New Product	72.9(106.6)	39.1(78.4)	1.7 *
(Context)			
Firm Age	11.4(6.2)	13.1(7.4)	-1.2 4)
Number of Employees	70.5(70.0)	90.4(78.2)	-1.3
Founder's Age	38.9(7.8)	39.8(7.3)	-0.6
Founder's Education	3.9(0.7)	3.6(0.9)	1.9 *
Foundation Mode (Results of Cross Tabulations--Percentage)			
* Founded by Technical Entreproneurs	44.4	33.3	
* Co-founded by Technical Entrepreneur and Individual Investors	16.7	16.7	
* Founded by Individual Investors	33.3	43.1	
* Founded by Investment of Existing Firm	5.6	6.9	

1) There were missing values among the t-tests:maximum missings were 19 cases.
2) Mean Values:Standard Deviation in Parentheses.
3) t-values by one-taled t-test:*p<0.1, **p<0.05, ***p<0.01.
4) t-values by two-taled t-test:*p<0.1, **p<0.05, ***p<0.01.

Table 3
Results of Multiple Regression Analysis for Rate of Innovation(N=92)

(Dependent Variables)	(A) Number of New Product	(B) Technological Radicality of New Product
(Independent Variables)		
Technological Setting (TS)	.380 1)	.103
Proportion of R & D employees (R&D)	-.017	.593***
Formal Technology Transfer From Abroad(T/T)	.071	-.037
External Sources Related to Vertical Interactions (ES1)	-.137	.534***
External Sources Related to Technolcgical Infrastucture (ES2)	.108	-.117
R&D * TS	.068	-.569***
T/T * TS	-.412	.056
ES1 * TS	.220	-.466**
ES2 * TS	-.467**	.118
R2	.199	.216
F	2.27**	2.46**

1) Standardized Beta Coefficients, *** $p < .01$; ** $p < .05$.

ABSTRCT

This paper explores the relationships between technological acquisition strategies of small firms and innovation in the Korean Electronics industry. Its thesis is that small firms' technology strategies and their effects on the rate of innovation differ according to the new and traditional technology settings. A primary finding of this study is that in-house R & D and technical linkages with buyers and suppliers have stronger effects on the radical innovation in the new technology setting rather than in the traditional technology setting. The findings of the study provides insight for interpreting inconsistent results of recent research for the importance of external linkages to innovation. They also suggest some implications of small firms' strategies and public policies for accelerating technological innovation.