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ABSTRACT

Using a multilevel analysis, we explore the gender—innovation activity relationship. We investigate founder education, inter-firm network ties, and firm regional location as mediators using a sample of 4,265 new Korean firms. Results show that male founders, compared to female, are more likely to complete engineering or natural science degrees, maintain heterogeneous inter-firm network ties, and locate firms in clustered regions. Further, engineering or natural science degrees, heterogeneous inter-firm network ties, and locating in clustered regions are positively associated with innovation activity. We find evidence that each of these multilevel constructs mediate the relationship between entrepreneur gender and innovation activity.

INTRODUCTION

Creating innovation is of immense interest as it is the primary instrument of competition for many firms (Baumol, 2010). A number of research studies examining academic and industrial scientists have shown that gender plays an important role in creating innovation, with men producing a higher degree of patents compared to women (Whittington & Smith-Doerr, 2005). Considering the bulk of innovations are created by new firms it is surprising that little research is available that examines gender differences in the innovation activity of entrepreneurs. Although most scholars agree that entrepreneurship is a gender-based process, little research has explored the gender—innovation relationship in new firms, representing a gap in the literature. We address this gap by developing and testing a multilevel model comprised of mediating factors between entrepreneur gender and innovation activity.

Most studies in entrepreneurship have tended to focus on a single level of analysis but as the field matures researchers are developing more complex understandings of phenomena by integrating multilevel lenses. A multilevel approach holds promise in increasing our understanding of entrepreneurial outcomes like innovation because it illuminates the multiple consequences of behavior. Low and MacMillan (1988) urged scholars to concurrently use both micro and macro approaches as they complement each other in explaining entrepreneurship phenomena but rather than deal with the complexities most scholars divide into camps of micro and macro experts who rarely engage each other in debate or collaboration. To advance as a field in which scholars explain the behaviors of individuals and organizations, we must expand our theories and empirical investigations to encompass these multilevel effects (Hitt, Beamish, Jackson, & Mathieu, 2007). Following Low and MacMillan (1988) and Hitt et al. (2007) we assert that a multilevel approach may provide a more holistic understanding of gender and innovation activity than previously available.

We draw from several research streams suggesting a plurality of constructs may be important to understanding the entrepreneur gender—innovation relationship in new firms. For example,
varying levels of analysis have been fruitful in explaining aspects of innovation activity including the individual level, inter-firm level, and firm regional location. At the individual level, formal education has been shown to bear on entrepreneurial outcomes with more advanced degrees being associated with higher degrees of innovativeness (Marvel & Lumpkin, 2007). On the other hand, Hagedoorn (2002) demonstrated that network ties expose individuals and organizations to a broader range of R&D partnership opportunities. These inter-firm ties allow for the ability to acquire and apply knowledge in useful ways as well as the acquisition of resources (Tsai & Ghoshal, 1998). In addition to educational background, and inter-firm network ties, there has been increasing interest in the notion that regional location relates to the competitive position of firms (Porter, 1998). Because of economies of agglomeration firms may be motivated to locate next to one another. This view asserts that the benefit to being in more clustered regional areas increases with the concentration of firms or skilled workers in that particular location (Arthur, 1990). Evidence from this research stream suggests that innovation activity improves as the cluster size increases (Baptista & Swann, 1998).

Differences between male and female entrepreneurs have been widely reported. Although educational level has been found to be comparable across gender (Birley, Moss, & Sanders, 1987), the fields of study are considerably different. Research has shown that women pursue degrees in liberal arts to a greater extent than men and men are more prevalent in technical fields of study (Scott, 1986; Neider, 1987; Brush, 1992). Men and women also have different preferences in their network ties. Women's networks are more likely to be comprised of family members and close friends compared to men (Renzulli, Aldrich, & Moody, 2000). Further, women’s networks tend to be comprised of individuals who know each other well, compared to men’s networks, which are generally more diffused and comprised of a greater variety of actors who are not connected to each other (Ridgeway & Smith-Lovin, 1999). While research shows that gender plays a role in education type and characteristics of their network ties, little research is available on gender differences and the regional location in which they start their business. However, men and women may have systematic preferences for where they locate their firms as male and female entrepreneurs have different motives for venture creation (DeMartino & Barbato, 2003).

We assert that entrepreneur gender directly influences the type of education, inter-firm network ties, and the regional location in which entrepreneurs start their venture. Further, we argue that type of education, inter-firm network ties, and regional location directly affects innovation activity—defined as patents applied for and R&D expenditure. Consequently, entrepreneur gender indirectly affects innovation activity through their effect on education type, inter-firm network ties, and new firm regional location. In other words, multilevel constructs mediate the relationship between entrepreneur gender and innovation activity. To test these relationships, presented in Figure 1, we draw on a sample of new ventures from the Republic of Korea (hereafter referred to as Korea).

**The Korean Context**

Korea is a highly competitive society and among the most entrepreneurial in the world (Reynolds, Bygrave, Autio, & Hay, 2002). Entrepreneurship plays a vital role in job creation, increasing income, as well as contributing to economic growth of Korea through innovation. The Global Competitive Report (Schwab, 2009) published by the World Economic Forum, indicates that Korea is among the top 20 most competitive economies in the world. Both the Global Competitive Report and the Global Entrepreneurship Monitor divide countries into three vary-
ing economic stages: factor-driven, efficiency-driven, and innovation-driven, each involving an increasing degree of complexity in the operation of the economy. Korea ranks among the most advanced innovation-driven economies according to both the Global Competitive Report and the Global Entrepreneurship Monitor. While imitation may have dominated in the efficiency-driven stage, innovation-driven countries become innovators and generators of new knowledge. Research and development contribute to new innovative ideas, which form the basis for opportunity-based entrepreneurship. Firms in innovation-driven economies like Korea compete by producing new and differentiated products using advanced production processes (Schwab, 2009).

The Global Entrepreneurship Monitor assesses entrepreneurial activity defined as individuals between the age of 18 and 64 who are involved in setting up a business or have started a business that is less than 42 months old. Compared to other innovation-driven economies, Korea has the third highest entrepreneurial activity with only the United States and Iceland scoring higher (Bosma, Acs, Autio, Coduras, & Levie, 2009). The ratio of male-to-female participation in new firm creation in Korea is distinct when compared to other innovation-driven economies where entrepreneurs are generally twice as likely to be male than female. Korea is among the countries with proportionately fewer women entrepreneurs and the ratio of male-to-female entrepreneurs is about three-to-one despite high level of acceptance around women starting businesses. (Bahn, Seo, Lee, Kelley, & Lee, 2010).

**LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT**

**Gender and Formal Education**

Differences between male and female entrepreneurs in formal education have been well noted. Although the educational level of women business owners is comparable to men (Birley et al., 1987), the fields of study are considerably different. Several studies have shown that women pursue degrees in liberal arts more so than men and that men are more prevalent in engineering or technical fields of study (Scott, 1986; Neider, 1987; Brush, 1992). While both male and females have similar math and science achievement tests in high school, men outnumber women at the top levels of science, technology and engineering in the United States. Women receive about 30% of the doctoral degrees in physical science compared to 70% of men and only 17% of the doctorates in engineering granted in the United States are received by women (Viadero, 2009). The gender gap in the United States for women in science and engineering education are comparable to other countries. For example, fewer women pursue science and engineering degrees in Germany, Japan and Mexico compared to the United States. A study completed by the National Science Foundation (NSB, 2002) found that 4.9% of Korean women complete science and engineering degrees compared to 4.6% of women in the United States. According to the Korean Center for Education Statistics, of the 2009 undergraduate graduates in natural science or engineering fields, 70% were male compared to 30% female and for graduate programs 74% male compared to 26% female (http://cesi.kedi.re.kr/index.jsp). While the percent of females obtaining degrees in science and engineering is growing, there remains a significant gender gap.

*H1. Gender will be related to education type such that: (a) male entrepreneurs will be positively related to engineering and science degrees, and (b) female entrepreneurs will be negatively related to engineering and science degrees.*
Gender and Inter-Firm Network Ties

Inter-firm networks ties serve as a mechanism to vital resources in the external environment. Inter-firm network ties refer to external contacts for collaboration with other firm, universities, and/or public R&D institutions that may facilitate important information acquisition and technology development. Numerous research studies have found differences in network tie composition among male and female entrepreneurs. For example, the composition of women’s networks have been found to have significantly less wealthy, less powerful, and less prestigious actors (McGuire, 2000). Women’s networks are more likely to be comprised of family members and close friends compared to men (Renzulli et al., 2000). Such differences in network composition may direct attention away from the venture and towards alternative social activities that may have less value for their ventures (Lewis, 2006). In a study of Italian and U.S. business owners, the female owner’s network was composed of a greater proportion of other females (Aldrich, Reece, & Dubini, 1989). Women’s networks tend to be comprised of individuals who know each other well, compared to men’s networks, which are generally more diffused and comprised of a greater variety of actors who are not connected to each other (Ridgeway & Smith-Lovin, 1999). Consequently, male entrepreneurs are expected to have more heterogeneous inter-firm network ties compared to female entrepreneurs. Based on the reviewed literature, we assert:

H2. Gender will be related to inter-firm network ties such that: (a) male entrepreneurs will be positively related to heterogeneous inter-firm network ties for technology development, and (b) female entrepreneurs will be negatively related to heterogeneous inter-firm network ties for technology development.

Gender and Regional Location

A well known aspect of entrepreneurship is that men and women have systematic differences in their motivation for new venture creation. Differences in motivation are important to entrepreneurial action and where within a region (using degree of employment in that region) male and female entrepreneurs start new firms. Several studies highlight the motivation of male versus female business ownership and research has shown that men are more financially motivated compared to women who often start ventures to balance work and family (Buttner, 1993; DeMartino & Barbato, 2003; Fischer, Reuben, & Dyke, 1993). Women entrepreneurs use the autonomy of business ownership to integrate the goals of family and personal interests into the business. Indeed, many women attribute the motivation to start firms to the autonomy and flexibility to focus on family priorities (Fasci & Valdez, 1998; Still & Timms, 2000). On the other hand, men have goals that are focused outside the home, and they direct their efforts toward challenges in the marketplace and wealth creation (Bailyn, 1993). These differences among male and female motivation for business ownership impact the actions of the entrepreneur such as where to locate a new firm within a region. For example, if men are more motivated by financial advancement, rather than family goals or work-life balance, they may start new ventures in locations associated with wealth creation. Women are more motivated by integrating family goals with work, autonomy and flexibility, and will locate new firms more so based on family priorities rather than financial advancement. Consistent with this logic, we assert that men will locate new ventures in more employee clustered regions and women will locate in less clustered regions.

H3. Gender will be related to regional location such that: (a) male entrepreneurs will be positively related to more employee clustered regions, and (b) female entrepreneurs will be negatively related to employee clustered regions.
Formal Education and Innovation Activity

Education is a key aspect of a person’s knowledge resources that may be valuable to creating innovation. Education increases a person’s stock of information and skills, including those needed to create innovation. Numerous studies examining formal education have accepted the notion that “more is better” and explored formal education or years of schooling (e.g., Bruderl, Preisendorfer, & Ziegler, 1992; Cooper, Gimeno-Gascon, & Woo, 1994; Wiklund & Shepherd, 2008). However, the findings for a positive association between aspects of education and positive entrepreneurial outcomes have been mixed (Bates, 1990; Evans & Leighton, 1989; Daviddson & Honig, 2003). A possible reason for the lack of consistent findings may be that the functional type of degree is more important than years invested in formal education. Scientists and engineers are the main carriers of advanced technology and produce the bulk of all patents (Jacobsson & Oskarsson, 1995; Morgan, Kruytbosch, & Kannankutty, 2001). The growing complexity of present day technology requires advanced knowledge in order to use technology and innovate across industries. In a study of Sweden over 15 years, Lekander (1990) showed there had been a clear increase in engineers and scientists at key technological functions including research and development as well as design roles. The advanced nature of technology makes it rather difficult for social scientists or those with liberal art degrees to substitute for scientists and engineers in highly technical aspects of innovation.

H4. Education type will be related to innovation activity such that engineering and science degrees will be positively related to innovation activity.

Network Ties and Innovation Activity

At any given period an entrepreneur’s knowledge set is inadequate due to inherent knowledge shortcomings (Shook, Priem, & McGee, 2003; Simon, 1957; Thompson, 1967), thereby hindering the innovation creation process. Therefore, new firms must seek avenues to lessen the effects of knowledge inadequacies and network ties may be one way of accomplishing this. Network ties provide for external collaboration and may facilitate important information acquisition and technology development. Commonly studied network tie characteristics include the number of network ties with whom the entrepreneur is connected and the relative heterogeneity of the network ties (Borgatti & Foster, 2003). Research examining benefits associated with these network ties suggests that they may provide entrepreneurs and new firms with an information advantage. Building from this research, we propose that the heterogeneity of inter-firm network ties may impact the innovation activity of the entrepreneur. Network ties provide numerous benefits including gaining informational resources, technological benefits (Shan, Walker, & Kogut, 1994), as well as identifying entrepreneurial opportunities (Singh, Hills, Lumpkin, & Hybels, 1999). Shan et al. (1994), for example, found that new biotechnology start-ups benefited from more network ties in terms of producing innovative offerings.

We propose that a greater variety of inter-firm network ties for collaboration should better position entrepreneurs to accurately and efficiently use their knowledge resources as they innovate. This is because individuals are thought to be specialists based on the knowledge that they possess (Grant, 1996). Thus, heterogeneous network ties provide for more idiosyncratic knowledge one has access to for technology development (Dew, Velamuri, & Venkataraman, 2004). That is, more heterogeneous network ties encompass more individual specialists and less redundant information. Through acting on more accurate, timely and relevant knowledge, the innovation process should be enhanced. Simply put:
H5. Network ties will be related to innovation activity such that heterogeneous inter-firm network ties for technology development will be positively related to innovation activity.

Regional Location and Innovation Activity

A surging area of theoretical and empirical interest is the regional economic development in terms of performance of particular regions (Scott, 2000). The central argument of this line of research is that the advantage to the firm of locating in a particular region varies with the resources and number of other firms in that region (Stuart & Sorenson, 2003). Regions with higher degrees of clustering have been shown to benefit firm survival (Folta, Cooper, & Baik, 2006), revenue growth (Canina, Enz, & Harrison, 2005) as well as performance in terms of innovation (Deeds, Decarolis, & Coombs, 1997). Regions with greater clustering represent large markets that create opportunities for testing and introducing new ideas more easily (Venkataraman, 2004). Porter (2003) called for studies to integrate regional analysis in order to increase our understanding of competitive dynamics, economic development and growth. He described a process where firm concentration increases local competition and requires firms to innovate in order to remain competitive thereby impacting the economic performance of regions (Porter, 1998). Supporting this view, Baum and Haveman (1997) showed small firms can benefit by locating close within a region to other well established large firms that are similar on one product dimension such as price to benefit from agglomeration economies, but different on another product dimensions, to avoid localized competition and create complementary differences.

While regional clustering and firm performance has received some attention, very little research examines new firms. Chung and Kanins (2001) examined the Texas lodging industry and found that new firms benefit the most from cluster locations and more so than established firms. Although new firms face liabilities of newness, lack of established procedures, and are typically smaller in size they perform better in markets populated by larger competitors. Chung and Kanins (2001) findings indicate that independent and small hotels benefit the most in terms of performance compared to large established chain hotels when clustered together. In a related study using a sample of manufacturing firms over eight years, Baptista and Swann (1998) showed that employment in a region was positively related to innovation activity. In a study of high-technology firms Gilbert, McDougall, and Audretsch (2008) found support that performance benefits accrue to new firms when founded within more clustered regions. Their findings suggest that locating in clustered regions facilitates gaining access to resources, potential customers and other benefits of agglomeration. Because new firms may particularly be affected by clustered regions, we expect that the effect of employee clustered regions on the innovation activity to be positive. Therefore:

H6. Regional location will be related to innovation activity such that new firms in more employee clustered regions are positively related to innovation activity.

Education Type, Network Ties, and Regional Location as Mediators

As illustrated in Figure 1, the previous hypotheses posit that gender directly influences founders’ formal educational type, inter-firm network ties, and new firm regional location, which, in turn, directly influence innovation activity. Therefore gender indirectly affects the innovation activity through the three channels hypothesized. In other words, founders’ formal educational type, network ties, and regional location mediate the relationship between gender and innovation activity. Based on the model depicted in Figure 1, and extending the logic of H1 – 6:

H7. The relationship between gender and new venture innovation activity is mediated by (a) founder formal educational type, (b) inter-firm network ties, and (c) firm regional location.
METHODS

Sample

We draw on secondary data collected by the Korean Small and Medium Business Administration (KSMBA) in 2002. The survey questionnaire was sent to the CEO of Korean small- and medium-sized enterprises (SMEs) that had registered with the KSMBA. 6,023 firms out of 11,392 SMEs responded to the survey, representing a relatively high response rate of over 50%. Of the 6,023 firms that responded, 4,265 met the sample criteria of (a) firm founder information included (b) the firm being no more than six years old (Shrader, 2001) and (c) having fewer than 200 employees (Coviello & Jones, 2004).

Dependent Variables

We measure the innovation activity of new Korean ventures using two proxies that are vertically related through an input-output relationship of innovation: patent activity and R&D intensity of each firm. We use the number of patents applied for to measure the downstream innovation activity (Baptista & Swann, 1998; Morgan et al., 2001; Ruef, 2002). On the other hand, the latter stands for an upstream input activity of innovation, because, in order to increase the level of innovation activity, a company should increase its R&D input to be exploited in an innovation process. We measure the R&D intensity of each company with a ratio of R&D personnel compared to total employees to catch the upstream input side of innovation activity (Jacobsson & Oskarsson, 1995; Fritsch & Lukas, 2001).

Independent and Mediating Variables

To measure founder gender of each new venture, we created a dummy variable that indicates whether the firm founder is male or female. Therefore, it is denoted as 1 if a new firm is founded by a male entrepreneur and 0 by a female entrepreneur. To assess founders’ formal educational background, we use the academic major of their highest degree. Engineering or natural science degrees were coded as a 1 and all other majors such as humanity, social science, or business/economics were coded as 0. To measure the level of network ties that a company maintains in its inter-firm partnerships, we use whether new firms cooperate with universities, public R&D institutes, and/or other private companies. Therefore, the higher this measure is, the more heterogeneous a company is evaluated in terms of its network ties. To assess regional location we use the total number of employees in each county of Korea where the firm is located (Carlton, 1983; Holmes, 1998; Campi, Blasco, & Marsal, 2004; Gilbert et al., 2008; Baptista & Swann, 1998). This includes all 234 counties of Korea. The 234 counties of Korea were categorized into five ordinal groups (i.e., 1-5) based on the degree of employees clustered in the representative county. For example, counties with the least 20% of total employees are coded as a 1, and the most clustered counties with the upper 20% of total employees are coded as a 5.

Control Variables

We use six control variables that may influence innovation activity. These controls include firm age (Sørensen & Stuart, 2000), firm size (Arvanitis & Hollenstein, 1996; Becker & Dietz, 2004), marketing intensity (Robertson & Gatignon, 1986; Weerawardena, 2003), capital structure (Li & Simerly, 2002; O’Brien, 2003), degree of internationalization (Wakelin, 1998; Becker & Dietz, 2004), and different types of industries (Audretsch, 1997; Baptista & Swann, 1998; Ruef, 2002; Becker & Dietz, 2004).
Empirical Models

In order to test $H1-3$, we utilize ordered probit regression (OPR) models. This is because founder formal education, inter-firm network ties, and firm regional location are all represented as categorical dependent variables. On the other hand, we use negative binomial regression (NBR) models to examine $H4-6$ as we use the number of patents applied (i.e., a count variable) as a dependent variable in the regressions. When we use the continuous variable of R&D intensity as the dependent variable for testing $H4-6$, feasible generalized least square (FGLS) regression was utilized to alleviate heteroskedasticity issues that exist when using cross-sectional data as in this current study (Greene, 2000b). For all the FGLS regression models, we transform the continuous variables by taking logarithms (i.e., log-log models). Prior to transforming variables with zeros, we up-scaled our data to bring our smallest value to 0.1 (Crozet, Mayer, & Mucchielli, 2004; Maitland, Rose, & Nicholas, 2005). Therefore, the estimated coefficients from each regression represent elasticities between two relevant variables. We executed stepwise analyses following Baron and Kenny (1986) to test the mediating effects proposed in $H7$.

RESULTS

In Table 1, we report the mean innovation activity of Korean new ventures by founder gender from our sample. As can be seen clearly, male entrepreneurs seem to consistently achieve higher levels of innovation activity on average than female entrepreneurs do across multiple innovation-related measures. For example, male entrepreneurs are submitting a higher number of intellectual property rights (IPRs) that include patents, utility models, designs, and trademarks than female entrepreneurs (i.e., 3.2 IPRs applied by males vs. 2.8 by females). This trend becomes stronger when we compare the number of patents applied by gender. Table 1 shows that male entrepreneurs are submitting 20% more patents to the patent office as a result of their innovation activities than female entrepreneurs (i.e., 2.0 patents applied by males vs. 1.6 by females). This picture does not change even if we consider an upstream activity of innovation: both R&D expenditures (385.8 million KRW by males vs. 338.9 million KRW by females) and R&D personnel (6.5 persons by males vs. 4.3 persons by females) for male-founded new firms are greater than those for female-founded new firms.

Regression results for $H1-7$ are presented in Table 2, Table 3, and Table 4. These include ordered probit regression (OPR) models, negative binomial regression (NBR) models, and feasible generalized least square (FGLS) regression models respectively. Baron and Kenny (1986) state four conditions to be satisfied for mediation relationships to exist between a dependent variable and an independent variable. First, the independent variable should exert statistically significant effects on the mediators. Second, the independent variable should have statistically significant influences on the dependent variable. Third, the mediators should show statistically significant impacts on the dependent variable. Fourth, after including both the independent variable and the mediators in the same regression, the independent variable should remain statistically significant, but its size should be reduced compared to that estimated in the regression without the mediators.

The ordered probit regression (OPR) results in Table 2 show that the first condition of Baron and Kenny (1986) is satisfied with our sample, supporting $H1-3$. Founders’ gender exhibits statistically significant effects on the formal educational variable, the network ties variable and regional location variable. Therefore, we interpret these results as indicating that, male founders are inclined to have engineering or natural sciences degrees (i.e., $\beta = 0.58$ at $p < 0.01$), to maintain
more heterogeneous technology cooperation with universities, public R&D institutes, or other private companies (i.e., $\beta = 0.21$ at $p < 0.1$), and to locate in clustered regions (i.e., $\beta = 0.31$ at $p < 0.01$) whereas a female founder shows opposite tendencies.

The first columns in Table 3 and Table 4 confirm satisfaction of the third condition suggested by Baron and Kenny (1986), supporting $H4-6$. The negative binomial regression (NBR) results in Table 3 show that formal educational type, inter-firm network ties and firm regional location are statistically significant and positively related to the number of patents applied for. We find this is consistent with the feasible generalized least square (FGLS) regression results in Table 4 where R&D intensity was used as a dependent variable. We interpret these results as indicating that founders can enhance both downstream (i.e. the number of patents applied) and upstream (i.e. the ratio between R&D personnel compared to total employees) activities of innovation by having engineering or natural science degrees (i.e., $\beta = 0.19$ at $p < 0.01$ in Table 3 and $\beta = 0.61$ at $p < 0.01$ in Table 4), maintaining more heterogeneous network ties with outside partners (i.e., $\beta = 0.33$ at $p < 0.01$ in Table 4 and $\beta = 0.46$ at $p < 0.01$ in Table 4), and locating new firms in more clustered regions (i.e., $\beta = 0.05$ at $p < 0.05$ in Table 3 and $\beta = 0.09$ at $p < 0.01$ in Table 4).

The last two columns in Table 3 and Table 4 provide evidence that the second and fourth conditions of Baron and Kenny (1986) are satisfied supporting $H7$. Both tables show that founder gender exerts statistically significant influences on both the number of patents applied for and the level of R&D intensity confirming the satisfaction of the second condition. Male entrepreneurs have a larger number of patents applied for (i.e., $\beta = 0.25$ at $p < 0.05$ in Table 3), and higher levels of R&D intensity (i.e., $\beta = 0.37$ at $p < 0.01$ in Table 4) compared to female founders. Both tables show that, after including the individual formal educational type variable, inter-firm network ties variable, and firm regional location variable in the same regressions, the gender variable maintains statistically significant effects on innovation activity represented by the number of patents applied for and the level of R&D intensity. It should be noted that the size of the gender coefficient in the last columns of both tables decreases after including the three mediating variables in the regressions (i.e., $\beta = 0.22$ at $p < 0.05$ in Table 3 and $\beta = 0.20$ at $p < 0.1$ in Table 4) compared to the columns where the mediators are not included (i.e., $\beta = 0.25$ at $p < 0.05$ in Table 3 and $\beta = 0.37$ at $p < 0.01$ in Table 4). These results confirm satisfaction of the fourth condition by Baron and Kenny (1986). Therefore, we find that mediation effects of founders’ educational background, inter-firm network ties, and firm regional location exist on the relationship between founder gender and new venture innovation activity.

**Discussion**

The purpose of this study was to explore the gender—innovation relationship using a multilevel perspective. In seeking to achieve these aims, this research builds upon and contributes to the burgeoning and impressive research on gender and entrepreneurship. Our study extends this research in several key ways. First, the vast majority of gender studies rely on a purely micro or macro perspective which can yield an incomplete understanding of behaviors occurring at either level (Porter, 1996). Hitt et al. (2007) called for theories and empirical investigations to encompass multilevel effects so that we can advance as a field and explain the behaviors of individuals and organizations. The current study heeds this call using a model of individual, inter-firm and regional level constructs to explore the gender—innovation relationship in new firms. Recent research on gender and entrepreneurship has developed and tested multilevel theory. For example, Elam (2008) used cross-national data to examine both micro and macro factors in explaining
aspects of gender and entrepreneurship. However, her study was limited to the decision to start a business and did not examine the factors associated with the role of gender and innovation outcomes. We advance the body of knowledge by demonstrating how combinations of individual education, inter-firm network ties, and new firm location affect the relationship among gender and innovation activity.

Findings support each of our hypotheses that male founders, compared to females, are positively associated with engineering or natural science degrees, heterogeneous inter-firm network ties, and locating ventures in clustered regions. The finding that male entrepreneurs, compared to female, are more likely to complete engineering or natural science degrees is not surprising. Although education level has been found to be comparable across gender (Birley et al., 1987), the fields of study are considerably different. In line with other research, our findings show that women pursue degrees outside the hard sciences to a greater extent than men, and men are more prevalent in technical fields of study. We also find that ventures that are founded by men tend to have heterogeneous inter-firm network ties for technology development compared to ventures founded by women. A few studies have examined gender and network composition differences. Our finding are overall consistent with these results as women’s networks tend to be more homogeneous compared to men’s networks, which are generally more diffused and comprised of a greater variety of actors who are not connected to each other (Ridgeway & Smith-Lovin, 1999; Renzulli et al., 2000). An area of study that has received very little consideration is the location strategies or regional location of firms founded by men versus women. We find support for our assertion that firms founded by men, compared to women, tend to locate in clustered regions and attribute this finding to motivational differences. Men are more likely to have goals that are focused outside the home, and they direct their efforts toward challenges in the market and financial advancement (Bailyn, 1993). Women, on the other hand, use the autonomy of business ownership to integrate family goals and personal interests into the business. Indeed many women start businesses compared to men because of the autonomy and flexibility which allows for a greater emphasis on family needs (Fasci & Valdez, 1998; Still & Timms, 2000). Men are motivated more so by wealth creation and they tend to start new firms in locations associated with higher financial performance—clustered regions. Very little research is available on founder gender and the location of new ventures, and our findings suggest that, indeed gender plays an important role as to the regional location firms are started in.

The findings support each of our hypotheses that engineering or natural science degrees, heterogeneous inter-firm network ties, and locating new firms in clustered regions are each significant and positively related to innovation activity. A number of studies have highlighted that degrees in engineering or natural sciences are associated with the bulk of all patent activity (Jacobsson & Oskarsson, 1995; Morgan et al., 2001). The growing complexity of present day technology requires deep technical knowledge in order to innovate across industries. We also find that heterogeneous inter-firm ties are positively associated with innovation activity. Heterogeneous network ties provide for more idiosyncratic knowledge one has access to thereby enhancing their ability to innovate (Dew et al., 2004). Our findings support this notion as heterogeneous network ties expose entrepreneurs to novel ideas and increase the stocks of knowledge to which the entrepreneur has access to (Shan et al. 1994; Yates, 2000). We also find support that new firms located in clustered regions are positively associated with innovation activity. There is substantial literature on regional economic development and numerous studies have explored economic development in terms of performance in particular regions (Scott, 2000). Our findings concur
with other research that emphasizes how greater clustering impacts firm performance in terms of innovation (Deeds et al., 1997). Although the relationship among cluster regions and innovation has received some attention, little research examines new firms. The current study contributes to this growing literature, as new firms appear to benefit from economies of agglomeration at least in terms of innovation activity. Our finding that cluster locations do indeed provide innovation advantages raises the question: Do cluster locations provide equal innovation advantages to new and established firms? Chung and Kanins (2001) found that new firms are more likely to benefit from cluster locations in terms of financial performance compared to larger firms. While our focus here was new male and female owned firms and the innovation relationship, this may be a fruitful direction for future research.

In sum, our findings show that men and women entrepreneurs have systematic differences in individual education type, inter-firm network ties, as well as new firm location preferences. In turn, these bear on the innovation activity in terms of patents applied for as well as R&D intensity. Our findings provide robust evidence that the gender—innovation activity relationship is mediated by founder education, inter-firm network ties, and the regional location new firms are started in. Despite the increasing attention on gender and female entrepreneurship in particular, the notion of how these entrepreneurs can increase the rate of innovation activity has not been adequately explored. Traditionally, gender differences in firm performance have been attributed to human or social capital (Greene, 2000a), risk tolerance (Cliff, 1998), and that women tend to be more sensitive than men to a variety of non-monetary factors. By integrating multilevel constructs, this paper sought to provide a deeper understanding of gender and innovation activity than previously available.

Conclusion

Previous studies have demonstrated that gender plays a role in innovation creation and other aspects of firm performance, although this has been assumed to be a straight-forward direct relationship. Our study sheds light on how men and women can increase their innovation activity through their individual formal education, inter-firm network ties and the location in which they start their venture. This study offers a deeper understanding of founder gender and innovation activity than previously available and illustrates the value of a multilevel perspective in management research.

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SELECTED REFERENCES

References Available From Corresponding Author


**Figure 1. Founder Gender, Three Mediators, and Innovation Activity**

The numbers shown on the paths of the model reflect some of the study hypotheses. Hypothesis 7 is not shown because it represents indirect effects (i.e. mediation) rather than a specific hypothesized relationship.

**Table 1. Mean Innovation Activity of New Korean Firms by Founder Gender**

<table>
<thead>
<tr>
<th>Mean Innovation Activity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPRs Applied</td>
<td>3.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Patents Applied</td>
<td>2.0</td>
<td>1.6</td>
</tr>
<tr>
<td>R&amp;D Expenditure</td>
<td>385.8 million</td>
<td>338.9 million</td>
</tr>
<tr>
<td>R&amp;D Personnel</td>
<td>6.5</td>
<td>4.3</td>
</tr>
</tbody>
</table>

*IPR (Intellectual Property Right) includes patent, utility model, design, and trademark.

**Table 2. Ordered Probit Regression (OPR) Results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) Education Type</th>
<th>(2) Network Collaboration</th>
<th>(3) Regional Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.58*** (20.48)</td>
<td>0.21* (3.05)</td>
<td>0.31*** (7.07)</td>
</tr>
<tr>
<td>[Female]</td>
<td>[-0.58*** (20.48)]</td>
<td>[-0.21* (3.05)]</td>
<td>[-0.31*** (7.07)]</td>
</tr>
<tr>
<td>N</td>
<td>4,265</td>
<td>4,265</td>
<td>4,265</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-2,795.46</td>
<td>-4,979.29</td>
<td>-5,818.16</td>
</tr>
</tbody>
</table>

*Significance levels: *P < 0.1, **P < 0.05, ***P < 0.01.

* Coefficients are followed by χ²-statistics in parentheses.

* Intercept terms are not reported.
Table 3. Negative Binomial Regression (NBR) Results\textsuperscript{abc}

<table>
<thead>
<tr>
<th>Variable</th>
<th>Innovation Activity: Patents Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Firms</td>
<td>-0.05*** (-2.74)</td>
</tr>
<tr>
<td># of Employees</td>
<td>6.7E-3*** (6.47)</td>
</tr>
<tr>
<td>Marketing Intensity</td>
<td>-1.0E-3 (-1.51)</td>
</tr>
<tr>
<td>Financial Leverage</td>
<td>0.9E-3** (2.20)</td>
</tr>
<tr>
<td>Internationalization</td>
<td>0.20 (0.36)</td>
</tr>
<tr>
<td>Industry Dummy 1</td>
<td>0.30** (1.98)</td>
</tr>
<tr>
<td>Industry Dummy 2</td>
<td>-0.08 (-0.53)</td>
</tr>
<tr>
<td>Industry Dummy 3</td>
<td>0.02 (0.13)</td>
</tr>
<tr>
<td>Industry Dummy 4</td>
<td>-0.07 (-0.43)</td>
</tr>
<tr>
<td>Education Type</td>
<td>0.19*** (3.66)</td>
</tr>
<tr>
<td>N/W Collaboration</td>
<td>0.33*** (11.15)</td>
</tr>
<tr>
<td>Regional Location</td>
<td>0.05** (2.21)</td>
</tr>
<tr>
<td>Male</td>
<td>0.25** (2.29)</td>
</tr>
<tr>
<td>[Female]</td>
<td>[-0.25** (-2.29)]</td>
</tr>
<tr>
<td>Alpha</td>
<td>1.59*** (27.25)</td>
</tr>
<tr>
<td>N</td>
<td>3,791</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-6,900</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Significance levels: *P < 0.1, **P < 0.05, ***P < 0.01.
\textsuperscript{b} Coefficients are followed by \(t\)-statistics in parentheses.
\textsuperscript{c} Intercept terms are not reported.

Table 4. Feasible Generalized Least Square (FGLS) Regression Results\textsuperscript{abc}

<table>
<thead>
<tr>
<th>Variable</th>
<th>Innovation Activity: R&amp;D Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Firms</td>
<td>0.09** (2.32)</td>
</tr>
<tr>
<td># of Employees</td>
<td>-0.23*** (-6.25)</td>
</tr>
<tr>
<td>Marketing Intensity</td>
<td>7.6E-3 (0.66)</td>
</tr>
<tr>
<td>Financial Leverage</td>
<td>0.01*** (2.86)</td>
</tr>
<tr>
<td>Internationalization</td>
<td>0.88*** (5.02)</td>
</tr>
<tr>
<td>Industry Dummy 1</td>
<td>0.20 (1.08)</td>
</tr>
<tr>
<td>Industry Dummy 2</td>
<td>0.92*** (5.24)</td>
</tr>
<tr>
<td>Industry Dummy 3</td>
<td>0.23 (1.18)</td>
</tr>
<tr>
<td>Education Type</td>
<td>0.61*** (10.38)</td>
</tr>
<tr>
<td>N/W Collaboration</td>
<td>0.46*** (13.31)</td>
</tr>
<tr>
<td>Regional Location</td>
<td>0.09*** (3.64)</td>
</tr>
<tr>
<td>Male</td>
<td>0.37*** (2.94)</td>
</tr>
<tr>
<td>[Female]</td>
<td>[-0.37*** (-2.94)]</td>
</tr>
<tr>
<td>N</td>
<td>3,754</td>
</tr>
<tr>
<td>(F)-Statistic</td>
<td>47.62***</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.1325</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Significance levels: *P < 0.1, **P < 0.05, ***P < 0.01.
\textsuperscript{b} Coefficients are followed by \(t\)-statistics in parentheses.
\textsuperscript{c} Intercept terms are not reported.