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Software Entrepreneurship: Knowledge Networks and Performance Of Software Ventures In China and Russia

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Abstract: This study examines the impact of entrepreneurs' network structure and knowledge homogeneity/heterogeneity of their network members on product development, and revenue growth of software ventures in China and Russia. The empirical data are composed of structured interviews with 159 software entrepreneurs in Beijing and Moscow. The study found that structural holes and knowledge heterogeneity affect positively product diversity in interactive ways. The study also found that knowledge homogeneity accelerates product development. Product development speed enhances revenue growth in the long term. However, the combination of speed with dense and homogeneous networks harms revenue growth over time. The effects of structural holes and knowledge heterogeneity on product diversity and revenue growth over time are more salient in Russia due to the unique institutional, social, and cultural conditions present in the country.

Key words: networks, knowledge, entrepreneurs, software, China, Russia.

JEL Codes: M13; D85; L14; L25; P27

A popular domain in entrepreneurship research examines new venture creation from the perspective of social network theory. Previous research found that the alliance of young companies with external actors affects perceived legitimacy, IPO and revenue growth of new ventures (Baum, Calabrese & Silverman, 2001; Eisenhardt & Schoonhoven, 1996; Lee, Lee & Pennings, 2001; Stuart, Hoang & Hybels, 1999). At the individual level, personal networks of entrepreneurs enable them to access equity and debt capital, and facilitate industry-wide network formation (Shane & Cable, 2002; Walker, Kogut & Shan, 1997; Uzzi, 1999). On the other hand, there is evidence that tightly controlled relationships reinforce social obligations and expectations that may limit freedom of entrepreneurs to exploit new opportunities, and encourage agents to seek rents (Uzzi, 1997).

A fundamental assumption of the previous research on networks of entrepreneurs is that network structure operates autonomously of personal attributes of entrepreneurs as ego and his/her network members as alters. Ego is a focal actor who is connected to a set of people who are defined as alters. In the review of more than 70 papers on this topic, Hoang & Antoncic (2003) identified three structural and relational elements of networks that emerged as the key building blocks in models designed to explain entrepreneurial activity. They are relational content (e.g., access to information), network governance (e.g., trust), and network structure (e.g., centrality). Thus, there is a tendency to regard networks as separate and relatively autonomous entities that influence outcome variables independently of other factors. Networks themselves, however, do not “act” and do not “create” products and services. Players (individuals, organizations) act within the framework of existing networks that serve as the social and institutional contexts for actions of players (Burt, 1992). When individual players act, some social attributes, for example, gender and race, are likely to influence the existing patterns of network structure (Brass, 1985; Ibarra, 1992) and some attributes, for example, status and occupation, are likely to be influenced by the existing patterns of network structure (Burt, 1992). The connection between player and structure is a symmetric duality (Burt, 1992). This connection is a correlation rather than cause-effect because the link between actor attributes and network structure evolves and changes across populations and over time (Burt, 1992: 189). Outcomes of instrumental actions of players are likely to be influenced by network structure and actor attributes simultaneously due to the inherent player-structure duality.

Based on this conceptualization of the player-structure duality, I examine the interaction effects of entrepreneurs' network structure and knowledge attributes of network alters on product development and revenue growth of software startups in China and Russia. On the one hand, I propose that dense and homogeneous networks of entrepreneurs lead to faster product development because of cooperative behavior, high trust, easy coordination and knowledge relatedness and integration inherent in these networks (Coleman, 1988). I posit that the effect of dense and homophilous networks on revenue growth is contingent upon product development speed. On the other hand, I suggest that sparse and heterogeneous networks of entrepreneurs facilitate greater product diversity because of diverse information sources, greater opportunities and resources, and different knowledge content found in such networks (Burt, 1992). I propose that the impact of low-density and heterophilous networks on revenue growth is dependent upon product diversity. Finally, I compare the way in which networks of Chinese and Russian software entrepreneurs influence product development and revenue growth over time. I argue that the different institutional and social environments in China and Russia contribute to the expected differences in networks that influence outcome variables.

HYPOTHESES

Networks, Knowledge, and Firm Performance

I propose that dense networks of entrepreneurs accelerate product development when network ego and alters are homophilous in terms of knowledge. Cohesive networks accelerate product development because alters are motivated to collaborate, and interpersonal trust and cooperative norms facilitate frequent communication and coordination (Coleman, 1988). Social obligations, expectations, and commitment of members, enable entrepreneurs to complete multi-staged tasks of software development in tightly sequenced steps, and this may shorten waiting time (Coleman, 1988). For example, relational trust leads to early and rapid detection of faults, and hence to high efficiency programming. When network alters are strongly connected to each other, relationships are likely to be multiplex – information exchange, learning, and emotional caring do "co-exist" in each tie. Multiplex relationships facilitate flows of tacit knowledge that help to finish tasks in a timely fashion (Hansen, 1999). Another mechanism that speeds up design process is the explicit social pressure to accept views of network members, and the threat of sanctions for deviant ideas. This prevents the lengthy negotiations necessary for consensus-making (Coleman, 1988).

Efficiency benefits of high-density networks are enhanced when they are combined with homogeneous knowledge of ego and alters. Homophily is the principle that an interaction between similar people occurs at a higher rate than among dissimilar people (McPherson, Smith-Lovin & Cook, 2001). Knowledge homophily reflected in similar worldviews, mental models, education, shared symbols and language, knowledge relatedness and perceived knowledge similarity, may accelerate the design process when alters have strong relationships (Hansen, 2002; Ibarra, 1992; Stroebe & Diehl, 1994). Knowledge commonality breeds cognitive trust between parties when alters meet each other frequently. Trustworthy and homophilous alters would facilitate efficient knowledge integration that solves design problems quickly (Okhuysen & Eisenhardt, 2002). For example, at various stages of software design, developers encounter different types of cognitive tasks, and knowledge uniformity synchronizes efforts at various phases. This decreases waiting time (Schach, 2002). An important benefit of dense and homophilous networks is fast decision-making. Mental consensus enables entrepreneurs to generate agreements promptly when they consider conflicting versions of module cohesion and coupling (Schach, 2002). Knowledge relatedness also promotes faster project completion because tacit knowledge is more easily transferred between people who know similar things and who have higher absorptive capacity (Cohen & Levinthal, 1990; Hansen, 2002; Reagans & McEvily, 2003). Perceived similarity in knowledge promotes unconstrained exchanges between network alters because they experience less fear of revealing embarrassing gap and less intellectual pressure from alters (Stroebe & Diehl, 1994). High-density and homophilous networks enable entrepreneurs to be fast in product development because of communication, coordination, social obligation, cognitive trust, knowledge integration, and fast decision-making benefits found in these networks. Based on this logic, I propose that:

Hypothesis 1: Network density is associated negatively with product development duration, when network members are homogeneous.

While dense and homogeneous networks speed up products to market, sparse (rich in structural holes) and heterogeneous networks lead to greater product diversity. Sparse networks are the networks where alters are weakly connected or disconnected among themselves. A distant relationship or absence of relationship between two alters is called “structural hole”. A structural hole is a relationship of nonredundancy between two contacts (Burt, 1992). A structural hole is a universal phenomenon observable in all human networks including American, Chinese, and French managerial networks (Burt, Hogarth & Michaud, 2000; Tsui, Farh & Xin, 2002).

Structural holes facilitate product diversity through several mechanisms: timely access to nonredundant information and referral sources, the discovery of new opportunities and resources in distant clusters, brokerage of knowledge and technology, and the transitivity mechanism when the ego connects directly two previously unconnected ties (Burt, 1992; Hargadon & Sutton, 1997; Granovetter, 1983).

Access to nonredundant information sources exposes entrepreneurs to diverse technological, product design and market information located in socially and geographically distant network clusters (Reagans & McEvily, 2003). Software entrepreneurs learn from bridging ties what applications are demanded and favored in different market niches, and what modules, functions, design features, algorithms and languages are combined and used in what ways to produce various applications in technically novel yet cost efficient ways. Third-party referrals help entrepreneurs to access greater pools of actor that generate greater amount of information (Fernandez, Castilla & Moore, 2000). Referees as information filters reduce search and deployment cost of information gathering in global networks (Burt, 1992). The matching principle in referral practices helps entrepreneurs to access the right codes and design elements at the right time to fill in the missing gaps in software production (Fernandez et al, 2000). Through low-density networks, entrepreneurs identify and exploit opportunities to form external alliances and embed their programs in hardware and middleware systems of other players (Lee et al, 2001). Entrepreneurs-knowledge brokers who spin boundaries of fragmented domains of ideas, artifacts and people, facilitate product diversification through bridging that exposes entrepreneurs to local resources, learning that obtains new knowledge, and linking that recognizes how knowledge, learned in one context, could be valuable in others (Hargadon & Sutton, 1997). Network transitivity may be beneficial to product design. Transitivity is a property that considers patterns of triples of actors in a network. A relation is transitive if every time AB relation and AC relation leads to BC relation (Granovetter, 1983). Transitive property enables actors to bring together two autonomous alters to create products. New products are the results of linking of previously disconnected players and filling in the structural hole between them. This is different from brokerage where the ego gains by playing two actors off against one another, draws value from intermediation and keeps sides apart (Burt, 1992).

The research literature suggests that there are three factors that indicate actor's knowledge diversity: experience, education, and perceived knowledge diversity (Beckman & Haunschild, 2002; Eisenhardt & Schoonhoven, 1990; Hargadon & Sutton, 1997; Stroebe & Diehl, 1994). The networks rich in structural holes are likely to be comprised of heterogeneous alters (Marsden, 1990). Knowledge heterophily, defined as the extent to which alters possess different knowledge in terms of content, is expected to influence the causal relationship between structural holes and product diversification.

Different industry knowledge of alters help entrepreneurs customize their products according to the industry specifics. Diverse functional experience affects outcome variables positively because it generates constructive conflict (Eisenhardt & Schoonhoven, 1990). Cross-industry experience also increases product variety, because designers "cross-pollinate" their ideas between products and industries (Hargadon & Sutton, 1997).

Laboratory experiments found that groups composed of heterogeneous members in terms of education generated both greater number of ideas and greater number of different categories of ideas than homogeneous groups (Stroebe & Diehl, 1994). Network members who studied different science and art disciplines have complementary knowledge that is used in the designing of various elements of software. While a mathematician writes algorithms, an artist designs architecture, and a consumer psychologist aims to enhance the user-friendliness of products. Effective developers often re-configure old modules and reuse codes to create "new" products. Marketing experts strive to make these products appear new and different. The perception that each contact has a different expertise to contribute may facilitate idea flows, because alters are more willing to listen to "expert" views (Stroebe & Diehl, 1994). These are reflected in the greater number of product ideas. Building on the reasoning, I posit that:

Hypothesis 2: Structural holes are associated positively with product diversity, when network members are heterogeneous.

At early stages of a venture life cycle, high-density and homophilous networks may generate greater revenues when product development time is shorter because easy coordination, communication, and unconstrained knowledge-sharing among alters helps the entrepreneur to be among the first who deliver unique products to the market. First movers may capitalize on the growing demand for certain types of software products. Because of the emergent nature of the industry markets for specific applications are likely to be fragmented (Eisenhardt & Schoonhoven, 1990). Therefore, customers have few alternatives, and are not able to judge product quality. This may provide a temporary advantage to those who are efficient in coordination, decision-making and product development. However, this advantage is likely to fade over time, causing revenue decline for three reasons: narrow product range, poor quality and limited functionality as the result of simple technology (Eisenhardt & Schoonhoven, 1990). As demand for certain applications matures, numerous firms will compete for a market share. Firms that supply varieties of software applications are likely to bundle different products together, and offer complex software solutions at lowered costs. This trend pressures those firms that have only a limited number of products to bundle together.

Software development is a prolonged series of activities, from design and refining to testing and insuring reliability. Therefore, efficiency sometimes may jeopardize application quality, reliability and functionality (Coleman & Verbruggen, 1998). As customers use first-to-market products, they may encounter design faults, and demand applications of greater functionality and better quality. This affects negatively the revenues of those firms that supply inferior products in terms of quality and functionality. In this way, sticking to the same contacts and preserving a high-efficiency culture that generated temporary advantages may turn into a liability, because tight and homogeneous networks restrict entrepreneurs' access to new information, opportunities and resources, and blind time-chasing may compromise product quality and functionality. Based on this logic, I suggest that:

Hypothesis 3: At early stages, dense and homogeneous networks are associated positively with revenue growth when product development is speedy. The positive interaction effects of density, homophily and product development speed on revenue growth are likely to decline over time.

Low-density and heterogeneous networks coupled with product diversity enable entrepreneurs to sell simultaneously a wide range of applications in several different market niches overlooked by other firms. Greater information, knowledge resources and flexibility embedded in such networks allow entrepreneurs to combine various elements of software in new ways to create complex products. Having many different modules and design samples helps developers to deliver varieties of products at low cost (Hargadon & Sutton, 1997). These factors facilitate gradual revenue growth.

The previous research on the main and moderating effects of product diversity on performance of large corporations in the Western context reported positive relationships between product diversity and performance (Hitt, Hoskisson & Kim, 1997; Tallman & Li, 1996) although overall evidence remains inconclusive (Hoskisson, Hitt, Johnson & Moesel, 1993). The firms that diversify their product offerings have greater capabilities, and learn from diversification efforts (Hitt et al, 1997). Broader product strategy achieves synergies (Tallman & Li, 1996).

As ventures develop, entrepreneurs learn to communicate with alters who do not know each other and who are different in their education and knowledge. The initial disadvantages of having incoherent networks and broader product scope may turn into assets. As firms grow, they must identify new revenue opportunities and satisfy customers whose needs are dynamic. The networks rich in structural holes and composed of heterogeneous members generate sustainable opportunities. Based on this reasoning, I propose that:

> *Hypothesis 4: At growth stages, sparse and heterogeneous networks are associated positively with revenue growth, when product diversity is greater. The positive interaction effects of structural holes, heterophily and product diversity on revenue growth are likely to grow over time.*

China versus Russia

It is assumed that the effects of network structure and knowledge composition on outcome variables vary across countries contingent upon context. Two environmental factors influence the way in which entrepreneurs network in the two countries: institutional evolution and social mobility. The Russian reforms resulted in the destruction of existing institutions and networks (Hitt et al, 2004). This forced actors, including entrepreneurs, to create new networks and clusters (Kharkhordin & Gerber, 1994; Sedaitis, 1998). In contrast, the institutional *status quo* in China enabled actors, including entrepreneurs, to preserve their *guanxi* networks intact over time (Yang, 1994). Arguably, Russian society is more mobile both horizontally and vertically because of the more liberalized labor market and elimination of the household registration system – *propiska*, and this facilitates entrepreneurial mobility. The Chinese labor market is becoming flexible, although rigidities remain because of the household registration system – *houkou* that constrains flows of people, ideas and resources (Bian, 1997).

The Chinese networks are denser and more homogeneous, and this is reflected in shorter waiting times to product shipment. The Chinese networks are composed of more family members, schoolmates and close friends due to the prevalent role of *guanxi* base – propensity to form relationships based on common background, e.g., ancestral origin and classmate (Farh, Tsui, Xin & Cheng, 1998; Tsui, Farh & Xin, 2000). Ethnographic and survey evidence on networks of urban residents and entrepreneurs are consistent with this claim (Bian, 1997; Yang, 1994). The Chinese are strongly inclined to categorize people as belonging to in and out groups, and members of in-groups are expected to fulfill their role obligations and demonstrate group solidarity (Farh et al, 1998). Interpersonal trust is higher in China because there are sophisticated social devices of detecting and sanctioning opportunistic behavior, e.g., saving and losing face. The institutional stability prevalent in China provides favorable conditions for relative trustworthy behavior of actors (Hitt et all, 2004). Social relationships are intensely personalized, and in this way, the *guanxi* ties are more multiplex. For example, boundaries between the personal and the professional networks in China are blurred. These features make the Chinese networks cohesive.

Knowledge homophily in *guanxi* networks is greater because many network members are classmates who studied the same subjects (Farh et al, 1998). Homophily as a selection mechanism favors those who are similar in their worldviews since the social and geographic distances restrict contact search and tie formation (McPherson et al, 2001). The strong in-group pressure and intense *guanxi* communication homogenizes ideas of members of a particular *guanxi* clique over time (Lin, 2001). Skillful consensus-making and willingness to accommodate each other's opinions promotes greater perceived intellectual similarity in the Chinese *guanxi*. Coordination, trust, knowledge integration and other efficiency benefits will be especially salient in China.

The interaction effects of density, homophily and product development speed on revenue growth of the Chinese firms will decline at a greater pace over time for a number of reasons. The revenue growth is greater at early stages, due to the relative efficiency. This rate, however, is unsustainable because of fewer resources and opportunities found in overlapping networks. Strong *guanxi* ties re-enforce normative expectations of alters to stick to the same old ties forever, and this places boundaries on identifying and exploiting potential opportunities and gaining access to resources necessary to exploit them (Tsui et al, 2002). Unlike in Russia, brokerage in China is perceived as exploitative, and therefore, entrepreneurs are constrained to generate rents from arbitrage. Since the Chinese triads are more transitive because of the relational strength and trust, *guanxi* networks become even more redundant and homogeneous over time (Granovetter, 1983). Such networks harm revenue growth in the long term. Therefore, I propose that:

Hypothesis 5: The interaction effects of density and homophily on product development duration are greater for the Chinese firms.

Hypothesis 6: The decline in the interaction effects of density, homophily and product development speed on revenue growth over time is greater for the Chinese firms.

In sharp contrast to the Chinese *guanxi*, the Russian *svyazi* networks contain greater numbers of structural holes and are composed of heterogeneous members with regard to their knowledge (Sedaitis, 1998). Relational base as a networking rule is not as prevalent as it is in China and therefore, contact recruitment is less path-dependent and more spontaneous. The internal hierarchy in the Russian networks is based on power and status, and this generates greater relational distance among alters (Kharkhordin & Gerber, 1994). Social sanctions used to punish deviant behavior are less severe and effective in Russia, and therefore, alters have greater autonomies in their networking behavior (Ledeneva, 1998). The Russian triads are less transitive because there is less trust embedded in triads (Petrovskii, 1991). Social reciprocity is less universal and often ignored in relationships. This is in a sharp contrast to the Chinese *guanxi*, which contains *renching* – a well-articulated set of expectations and exchange norms. Brokerage is more accepted, and therefore, the Russian brokers are likely to draw greater values from their intermediate positions (Burt, 1992). There are fewer constraining rituals and norms in the Russian networks, and this provides greater freedoms to act upon spotted opportunities in networks.

The Russians have greater opportunities for networking with people of diverse experience and education, because the education system and labor market are more liberalized. There is no dominant networking principle, e.g., *guanxi* base in China, that structures personal networks, and therefore, the *svyazi* networks are composed of alters who differ in their ascribed and achieved attributes (Ledeneva, 1994). Because of the less in-group cognitive pressure to internalize and accept views of other alters, the mindsets of Russian alters are less homogenized over time. In the contrast to the harmony-loving Chinese, the Russians are more expressive in relationships and do not mind conflicts, and therefore, there is a greater perception of opinion diversity in the Russian networks.

The growth rate of the Russian ventures is lower initially due to the difficulties of resource mobilization in incoherent and relatively isolated networks (Sedaitis, 1998). Therefore, there is greater room for revenue growth over time. Structural holes generate continuous opportunities because they enable entrepreneurs to reach actors in global networks in a timely manner at low cost (Sedaitis, 1998). Once the Russian entrepreneurs learn how to draw values from arbitrage opportunities, they are likely maximize the number of holes in their networks. Since the Russian triads are less transitive, the network redundancy rate is lower, and such networks preserve a balance between structural holes and strong ties among alters over time. Building effective networks that are resource-rich and nonredundant is likely to facilitate venture performance over time. All these features will be reflected in the performance of Russian ventures. I propose that:

Hypothesis 7: The interaction effects of structural holes and heterophily on product diversity are greater for the Russian firms.

Hypothesis 8: The growth in the interaction effects of structural holes, heterophily and product diversity on revenue growth over time is greater for the Russian firms.

METHODS

Contexts

The Chinese software industry. The roots of software firms in China are traced to four sources: research institutes of the Chinese Academy of Sciences, university research laboratories, R&D institutes of government ministries, and entrepreneurial startups (Tschang & Lan, 2003). The total sales of software and system integration products in 2003 were worth US$19.3 billion, a 45 percent growth year-on-year. Domestic software vendors command 30 percent share of the country’s software market. By the end of 2003, there were 8582 domestic software vendors (People’s Daily, 2004a). Roughly 70 percent of these firms are small firms that employ fewer than 50 full-time employees (Tschang & Lan, 2003). China’s software exports reached $3.6 billion in 2002 (Business Weekly, 2003). A recent study reports that the Chinese vendors focus on the domestic market and emphasize software products more than services (Tschang & Lan, 2003).

The Russian software industry. In contrast to China, the Russian software industry is older and smaller. The information technology industry was worth $3 billion in 2001, and one-third of this is software sector (ARIASYS, 2002). In terms of origin, Russian software ventures resemble the Chinese firms, with two important differences. Like the Chinese vendors, many originated in the Soviet/Russian Academy of Sciences, university laboratories, and government R&D institutions. Thanks to the Soviet government's heavy investment in the arms industry, Russia inherited advanced software technologies used in the space and weaponry industries. Many successful software firms are spin-offs from the Russian military-industrial complex, which still produces advanced weaponry systems, including software. A major difference between Russia and China is that most Russian vendors are private startup firms. At the end of 2002, there were more than 2000 domestic software companies (AMR Research, 2002). The average revenue growth of software makers was 50-60 percent in 2002 (Ekspert, 2003). Most Russian firms are small, employing fewer than 45 people and generating revenues about $2.5 million a year.

Sample and Data Collection

The data are composed of structured telephone interviews with 159 software entrepreneurs in Beijing and Moscow. Some 82 Russian entrepreneurs were interviewed in June-August 2003, and 77 Chinese entrepreneurs were interviewed in September-October 2003. In total, 118 respondents were CEOs, and 41 respondents were chief technology officers (CTO). The technical directors were interviewed only in those occasions when the CEO was unavailable and the firm has more than 50 full-time employees. I used three criteria to sample new, dedicated and domestic software ventures. First, venture must be 6 years old or younger at the time of survey (Zahra, Ireland & Hitt, 2000). Second, firm should be registered as a software firm. Third, venture should be owned fully by domestic shareholders.

Using different information sources, my research assistants and I created a list of 111 new, dedicated and domestic ventures based in Moscow. The positive response rate for the Russian sample is 74 percent. In Beijing, we created a list of 172 ventures. The positive response rate for the Chinese sample is 45 percent. I conducted the ANOVA tests on firm age and Zhongguancun location (the high tech district in Western Beijing) between the two samples, and found that younger firms were more likely to decline. I carried out 14 in-depth interviews with four Russian and three Chinese entrepreneurs prior surveys.

The questionnaire was designed in English. Teams of Chinese and Russian management professors translated the questionnaire into Chinese and Russian. The back translation and checking was performed by different Chinese and Russian management professors who earned doctorates from North American universities. I pre-tested the questionnaire with three Russian and two Chinese entrepreneurs. Two research assistants and I conducted interviews in Moscow, and the team of six research assistants carried out interviews in Beijing. We sent questionnaires in advance by fax and email, so that respondents would have them during interviews. Each interview lasted approximately in 30 minutes.

Measures

Independent variables. Network data were collected by the standard method of name generators and name interpreters (Burt, 1992; Marsden, 1990). The questionnaire contained one name generator and three name interpreters. The name generator is: "The next questions are about those with whom you often discuss issues related to software programming and design. Please name those persons with whom you have discussed software programming issues over the last six months". This question generated maximum 8 names. The network content is the discussion network about software programming and design (Burt, 2004). Three name interpreters were relational duration between ego and alters measured in years (how long do you know the contact), alter education (BA degree in engineering, science and arts/humanities), and whether alter is a full-time employee of the firm (yes and no). The question that captured network structure is described below.[2] *Network density* is measured as the percentage of "especially close" relationships within the total number of possible relationships among alters (Marsden, 1990). *Structural holes* is measured as the number of "distant" relationships among alters (Burt, 1992, 2004). *Network size* is the number of contacts named. *Relationship duration* measures the tie strength between ego and alters and it is the sum of years ego knows all alters divided by the number of alters (Marsden, 1990). *Internal ties* captures the percentage of alters who are full-time employees of the firm. Knowledge homophily and heterophily were captured by education homophily and heterophily, and perceived knowledge homophily and heterophily.

[2] "The next question is to describe the strength of relations between listed people. You do this by circling codes in the matrix below. This is a complex question, but it is essential to measuring of social networks – and answering the question is a simple task when taken one column at a time. Begin with the first person listed. Relations with the first person are listed in the third column. Indicate his or her relationship with the person in each row in one of three ways: Circle E if there is an especially close relation between the row person and the first person. Circle D if the row person and first person are distant in the sense that they are rarely work together, are total strangers as far as you know, or do not enjoy one another's company. Leave E D blank to indicate that two people are neither distant nor especially close" (Burt 1992; 2000; 2003).

Education heterophily was measured by the Index of Qualitative Variation (IQV) (Agresti & Agresti, 1978).[3] Since I measure the extent to which alters differ in their education content, I used this measurement. This is consistent with the previous network research in the Western context (Marsden, 1987) and research on network diversity of Russian entrepreneurs (Sedaitis, 1998). The IQV indicates the dispersion of the alters over three nominal categories of education, i.e., engineering, science and arts/humanities (Sedaitis, 1998). *Education homophily* is measured as the inverse of the IQV. For example, if education heterophily is .45, education homophily is .55. This variable indicates the extent to which alters are similar in their education content. *Perceived homophily* is the scale comprised of two questions: "My way of thinking about software programming and design is similar to ways of thinking of those with whom I discuss ideas about software development"; "I always come up with similar ideas about software programming with those with whom I discuss ideas about software development". Distribution values of each question were five-point Likert scale items ranging from strongly agree (5) to strongly disagree (1). I computed the scale by adding up the values in each item and dividing them by two. *Perceived heterophily* is the inverse of perceived homophily. For example, if perceived homophily score is 3, then perceived heterophily score is 2.

Dependent variables. *Product diversity* is the number of market segments where the firm sold packaged software products and applications. The respondents were given a list of 14 market segments of packaged software, and were asked to indicate in which segments the firm sold packaged software and when. I measure packaged software products because they are standardized and clearly classified into groups whereas customized products and services are idiosyncratic depending on the need of the particular customer. Fourteen product market segments are finance/accounting software, general management, enterprise planning, customer relationship, supply chain, e-government, systems software, learning/education, middleware, embedded software, database, general office, home software, and others (e.g., medical, geographical, games, anti-virus, industrial, etc). I used software product classifications of the Chinese Software Industry Association, the China Software Union, the Russian National Software Development Association, the Russian Anti-software Piracy Association, and

[3] $I = [k/(k-1)]\left(1 - \sum_{i=1}^{k} \hat{p}_i^2\right)$ **The Index of qualitative variation:** *k* is the number of categories; $\hat{p}_i^2$ is the sample proportions of observations in these categories.

published reports (Business weekly, 2003; Ekspert, 2003). These sources generated 11 overlapping product segments in two countries, and 3 non-overlapping segments were added to the list. This classification is consistent with the previous research on the Chinese software industry (Tschang & Lan 2003). The information suggests that software product markets are comparable in two countries. I do not use the entropy measure of product diversification because during the pilot interviews I found out that it is virtually impossible to obtain reliable sales figures by segment (Hitt et al, 1997; Zahra et al, 2000). Furthermore, I follow the suggestion of Hoskisson et al (1993) that in process studies that examine the underlying managerial rationale and strategy, subjective measurements of product diversification might be more appropriate since objective and subjective measurements tend to be highly correlated. In addition, similar measurements (product market count) were used in the previous studies of entrepreneurial firms (Eisenhardt & Schoonhoven, 1990).

Product development duration is the average number of months from the month and year of founding (birth) until the month and year of first shipment of all products in different market segments for revenues. For example, firm B was founded in August 1999, and three different packaged software products were shipped for revenues first time in May 2000, December 2000, and July 2001 accordingly. The total waiting time for three products is 48 months (9+16+23). I divided this sum by three and the result is 16 months. This number is product development duration. Only 3 firms out of 159 ventures had more than one product in any of the fourteen market segments, and I excluded these exceptional cases from the analysis. Schoonhoven, Eisenhardt & Lyman (1990) used a similar measurement (month count from the founding date) for waiting time to first shipment. *Product development speed* is measured as the difference between the mean product development duration and the product development duration of each venture.

Revenue growth was measured as the difference between sales in two consecutive years divided by sales one year earlier, with the quotient multiplied by 100 (Zahra et al, 2000). The respondents were given a table where the year 1999, the year 2000, the year 2001, and the year 2002 were listed. The interviewees were asked to calculate revenue growth in percentage for each year from the previous year. *Revenue year two* is the percentage growth in sales in the second year of revenue generation. It can be 1999, 2000, 2001, or 2002 depending on when the firm generated first revenues. *Revenue year three* is the percentage growth in sales in the third year of revenue generation. *Revenue year four* is the percentage growth in sales in the fourth year of revenue generation. *Revenue year five* is the percentage growth in sales in the fifth year of revenue generation. Eisenhardt & Schoonhoven (1990) used a similar yearly differentiation of revenue growth of new semiconductor firms.

Control variables. *Firm age* is the number of years a venture had been in existence (Zahra et al, 2000). *Firm size* is measured by the number of full-time employees at the time of survey. *Venture capital* is a binary variable of one if private equity was raised and zero otherwise (Eisenhardt & Schoonhoven, 1990). *Ownership* is a binary variable of one if the major shareholder is the respondent and zero otherwise (Zahra et al, 2000). *China* dummy was included in the regressions of the total sample, while *Russia* dummy is the reference group.

Data and construct validity. Measurements for network size, density, structural holes, relationship duration, and internal ties are externally valid because the name generator method has been proved as valid and reliable (Burt, 1992; 2004; Marsden, 1990).

The reliability coefficient (Cronbach alpha) for the perceived homophily is 0.82. I conducted a confirmatory factor analysis of the measurement model associated with Likert scale items to assess how well the interview questions load onto the constructs. I found that the comparative fit index is 0.79, the incremental fit index is 0.84, and the root mean squared error of approximation is 0.071. The findings suggest that the measurement is valid and reliable.

In order to check common methods bias and social desirability bias, we carried out data cross-validation phone calls. During the interviews, we asked for phone numbers of one of the contacts listed. In all, 41 Chinese respondents and 28 Russian respondents provided phone numbers. By selecting every second on the list of 41 Chinese contacts, and every second and third on the list of 28 Russian contacts, we contacted 20 Chinese and 20 Russian alters and asked several questions. We asked whether the contact's BA education was in engineering, science, and arts/humanities. The answers of 19 (95%) Chinese alters and the answers of 18 (90%) Russian contacts were consistent with our data collected from the respondents. Therefore, education homophily and heterophily measurements are valid. We asked each contact to describe her/his relationship with the person next on the list in terms of "especially close", "distant" and "neither especially close nor distant". All 20 (100%) Chinese answers and 17 (85%) Russian answers matched up our findings. This indicates that the measurements for network density and structural holes are valid. To my knowledge, this study is the only study that validated perceptions of the ego of relationships among alters by asking one alter to characterize her relationship with another alter. To cross-validate the perceptual homophily items, we asked two questions: "My way of thinking about software programming and design is similar to the way of thinking of (Ego)"; "We (Ego and I) always come up with similar ideas about software programming". The answers of 17 (85%) Chinese contacts and the answers of 15 (75%) Russian alters were consistent with our findings. The homophily items are valid.

In order to validate revenue growth data, we approached the Chinese and Russian government departments for information. We created lists of 15 firms in two countries with their 2002 revenue growth data, and we submitted this information to the Department of Taxation of the Haidian district government in Beijing, and the Department of Taxation of the Moscow City Government in Russia. The Chinese and Russian experts directed me to these departments as the organizations that possess accounting information of firms. The formal requests were made on the behalf of Peking University and the Academy of National Economy in Moscow. We asked the authorities to confirm whether our information were consistent with their data. After many phone calls and faxes, we received confirmatory results. The revenue information of 12 (80%) Chinese ventures and 11 (73%) Russian firms have been confirmed to be accurate. Although I do not have hard accounting information, this confirmation indicates the validity and reliability of the revenue data. Two trained research assistants who were not members of the interview teams conducted validation interviews in Beijing and Moscow. This study is a cross-level study in terms of unit of analysis. Predictor variables are measured at individual level but dependent variables are measured at organizational level. Such research strategies are acceptable as long as measurements and constructs are valid internally and externally.

RESULTS

Descriptive Statistics

Table 1 reports the means, standard deviations, and Pearson's correlations for all variables of the total sample (N=159). Since network size and internal ties were significantly correlated with network density and structural holes, I did not include these variables in the regression analysis. Table 1 reveals that the mean firm age is 3.33 years (S.D.=1.44) and the mean relationship duration is 4.92 years (S.D.=3.53). This indicates that the entrepreneurs knew most alters before they started their ventures. I excluded the relationship duration variable in the regression analysis because it did not have any meaningful relationships with predictor and outcome variables. Table

2 reports the means, standard deviations, and the ANOVA results of the Chinese and the Russian samples. It shows that two samples significantly differ from each other in all variables except perceived homophily, perceived heterophily and revenue year five. The Chinese networks are smaller, denser, contain fewer structural holes, and composed of more internal ties and homogeneous alters. The Chinese ventures are younger, larger, more likely to raise private equity, and faster in product development yet have narrow product range. In general, the Chinese ventures have higher accumulated revenue growth. In contrast to Russia, fewer software ventures in China are owned by the entrepreneur.

Insert Tables 1 and 2 about here

Networks, Knowledge and Firm Performance

In Table 3, I present the results of the linear regression analysis predicting product development. Model 1 examines the main effects of network density, education homophily, and perceived homophily on product development duration. The model is significant (F=11.38). The model reveals that education homophily and perceived homophily have significant negative effects on product development duration. Model 2 examines the interaction effects of network density, education homophily and perceived homophily on product development duration. The model is significant (F=10.22). The model finds that the interaction effects of density and homophily variables are not significant while education homophily and perceived homophily have the main negative effects on product development duration. *Hypothesis 1* that predicted negative interaction effects of network density and knowledge homophily on product development duration has not been confirmed.

Insert Tables 3 and 4 about here

Model 3 examines the main effects of structural holes, education heterophily, and perceived heterophily on product diversity. The model is significant (F=14.03). The model shows that structural holes, education heterophily and perceived heterophily have positive main effects on product diversity. Model 4 shows the positive and significant interaction effects of structural holes, education and perceived heterophily on product diversity. The model is significant (F=17.19). *Hypothesis 2* that expected positive interaction effects of structural holes and knowledge heterogeneity on product diversification is supported.

Table 4 reports the results of the linear regression analysis predicting revenue growth. Models 1-3 report insignificant interaction effects of density, education homophily, perceived homophily and product development speed on revenue growth in the year two, three and four. Model 1 (F=3.09) and Model 2 (F=3.10) are significant. Model 4 indicates that the interaction effects on revenue growth in the year five are significant and negative. The model is significant (F=2.23). *Hypothesis 3* that proposed positive effects of dense and homophilous networks on revenue growth when product development is speedy at early stages, and that predicted decline of positive effects over time is partially supported. Models 5-8 show insignificant interaction effects of structural holes, education heterophily, perceived heterophily and product diversity on revenue growth in the year two, three, four and five. *Hypothesis 4* that predicted positive and sustainable effects of holes, heterophily and product diversity on sales is not supported.

In Table 5, I present the results of the regression analysis predicting product development of the Chinese and Russian software ventures. Model 1 reports that the interaction effects of network density, education homophily and perceived homophily on product development duration of the Chinese ventures are not significant. The model is significant (F=2.2). Model 2 reveals the non-significant interaction effects of network density, education homophily, and perceived homophily on product development duration of the Russian ventures. The model is significant (F=6.37). *Hypothesis 5* that predicted greater interaction effects of density and homophily for the Chinese firms is not supported. Model 3 finds that the interaction effects of structural holes, education heterophily, and perceived heterophily on product diversity of the Chinese ventures are not significant. The model is not significant. Model 4 reports the significant positive interaction effects of structural holes, education heterophily and perceived heterophily on product diversity of the Russian ventures. The model is significant (F=5.66). *Hypothesis 7* that proposed greater interaction effects of structural holes and heterophily for the Russian firms is supported.

Insert Tables 5 and 6 about here

Table 6 demonstrates the results of the linear regression analysis predicting revenue growth of the Chinese and Russian firms. I did not perform regression analysis in the year 4 and 5 for the Chinese ventures because the sample size drops below 20 (Eisenhardt & Schoonhoven 1990). Models 1-5 suggest that the interaction effects of network density, education homophily, perceived homophily and product development speed on revenue growth of the Chinese and Russian ventures over three years are not significant. Model 1 (F=2.02) and Model 2 (F=2.66) are significant. Models 3-5 are not significant. Model 6 reveals the significant negative interaction effects of the network density, education homophily, perceived homophily, and product development speed on revenue growth in the year five of the Russian ventures. The model is significant (F=2.7). *Hypothesis 6* that predicted greater declines in the interaction effects of density, homophily, and product development is greater for the Chinese firms is not supported. Models 7 and 9 show that the interaction effects of structural holes, education heterophily, perceived heterophily and product diversity on revenue growth of the Chinese ventures over three years are not significant. The models are not significant. Model 8 finds that the interaction effects of structural holes, education heterophily, perceived heterophily and product diversity on revenue growth of the Russian firms in the year two are negative and significant. The model is significant (F=3.4). Model 12 reveals the significant positive interaction effects of structural holes, education heterophily, perceived heterophily and product diversity on revenue growth of the Russian ventures in the year five. The model is significant (F=3). *Hypothesis 8* that proposed growth in the interaction effects of structural holes, heterophily, and product diversity for the Russian firms over time is supported.

DISCUSSION

Education homophily and perceived homophily accelerate product shipment independent of network density, and their effects become greater once the interactions are controlled. Knowledge homophily shortens product development cycles through efficient knowledge utilization, cognitive trust, and faster design decisions. Education overlap enables entrepreneurs to know who knows what, and this knowing reduces search time to find appropriate software components. Cognitive trust reflected in shared meanings creates a sense of certainty and confidence. Confident entrepreneurs are likely to move faster because they are optimistic about outcomes. Having discussion networks characterized by the absence of conflicting disagreements helps entrepreneurs to make speedy decisions when they integrate numerous ingredients to create applications. When entrepreneurs create simpler products rapidly, unconstrained exchanges without psychological blocking seem more effective (Stroebe & Diehl, 1994). The ideational commonality promotes efficiency.

The simultaneous exploitation of structural holes and diverse knowledge enables entrepreneurs to create new products from novel ingredients that did not exist before (e.g., new module), produce different applications from existing technologies through recombination and reuse, and sell similar products in different market segments by re-packaging and re-branding.

Network members who have complementary knowledge help entrepreneurs to define a relative value of new information for product development. Different specialized knowledge of alters enhances entrepreneurs' alertness to recognize and exploit new opportunities in global networks. Socializing with people who are disconnected and know different things is likely to generate greater benefits from third-party referrals because it helps the entrepreneur to identify what resources she should seek from whom, when and how (Shane & Cable, 2002). When the entrepreneur penetrates distant network clusters, alters with heterogeneous experience would help the entrepreneur to internalize behavioral norms in a particular network clique, and this maximizes obtaining of new technology and ideas. Knowledge diversity of alters eases up access to tangible resources such as private equity (Batjargal & Liu, 2004). For example, approaching a particular group of venture capitalists requires awareness of the investment preference and social habits of members. Being situated in networks composed of people who are different in their mentalities enables the entrepreneur to tailor her networking strategy and tactics towards a particular investor (Beckman & Haunschild, 2002). Greater tangible resources including cash lead to successful product diversification (Hitt et al, 1997). Entrepreneurial brokerage between separated players generates effective acquisition, storage and retrieval of technological solutions when the entrepreneur relies on advice of alters who process information differently (Hargadon & Sutton, 1997).

When the ego connects two contacts who did not know each other before and who are distant in their knowledge to design new products the outcome might be two extremes contingent upon how they were connected: success or failure. It may not work because social distance blocks communication and coordination, and knowledge distance hinders knowledge transfer. The key factor for successful use of diverse knowledge in triads is strong relationships between the ego and each alter (Granovetter, 1983). Common particularistic ties to the third person reduce social uncertainties that make triads transitive. Once players with diverse knowledge are linked by an influential third-party to create new applications, the results may enhance product diversification. The perception that network members are "experts" in different fields may create comfortable psychological atmosphere where alters exchange their views and learn from each other. This may increase the number of new product ideas available.

Speedy product development enhances long-term performance. However, when speed is combined with persistent dense and homophilous networks, it turns into a liability, gradually harming revenue growth. The isolated cliques, where entrepreneurs are situated, cut them off from the external world by blocking information flows on the latest competition, market demand and technological progress. A strong sense of social obligations and mutual commitment found in such networks encourages entrepreneurs to stick to the redundant ties over time. This perpetuates the vicious circle of over-embeddedness (Uzzi, 1997). Coupling the over-embeddedness in the clique where everybody knows the same thing with product development speed accelerates the venture's revenue loss, because entrepreneurs learn to be fast in producing the wrong systems and applications that are not demanded, technologically backward, and of poor quality.

Perceptual similarities directly influence product shipment in China as the result of the core cultural value for social and opinion harmony. In Russia, both educational and perceptual homogeneity reduces the average waiting time of product shipment. Thus, the real and imagined agreements push product development forward in the Russian context of extreme institutional and social upheavals (Hitt et al, 2004).

The interaction effects of density, homophily, and product speed became negative and significant over time for the Russian firms. Combined deployment of the redundant networks and efficiency is harmful especially to those firms that operate in unstable environments where market changes occur at faster rates. Transacting with well-known actors and introducing products rapidly in unpredictable technical and market environments lead to revenue loss because entrepreneurs waste their resources fast.

The mechanisms through which structural holes and knowledge heterophily enhance product diversity are more salient in Russia. The institutional turbulence reflected in more "chaotic" networking strategies of players enabled the Russian executives to recruit unconnected alters with heterogeneous background (Kharkhordin & Gerber, 1994). The Russian entrepreneurs create new applications and re-design "old" products for new customers by spanning various industry boundaries and geographic localities, as well as overcoming social and knowledge distances of players. The Russian entrepreneurs bridge different localities to harvest new product ideas and identify un-served market niches.

The negative interaction effects of structural holes, heterophily, and product diversity turned into positive effects over three years for the Russian ventures. At early stages, sparse and heterogeneous networks combined with broad product strategy prevent the Russian managers to communicate effectively with alters, coordinate their efforts, build trust, mobilize resources, integrate knowledge, and deliver software programs in a timely manner (Sedaitis 1998). The broad product scope spreads limited resources thinly across several segments. These factors affect revenues negatively at early stages. Once the Russian software ventures reach the threshold of revenue year 5, the liability of low-density, heterogeneous networks and product diversification turns into an asset that boosts revenues in the long term. Three mechanisms are at work here. Brokerage is a tested strategy (Sedaitis, 1998). When the Soviet distribution system collapsed, brokerage firms mushroomed in the country legitimizing brokerage as a strategy and encouraging the Russians to profit from playing off parties against one another. Transitivity functions in different ways than in China. To link two alters is time-consuming in Russia because of the traditional Russian distrust of unfamiliar persons, even if that person was recommended by a "trusted" third-party (Petrovskii, 1991). The initial cost of linking two parties therefore is high, and this is reflected in firm under-performance. However, once two sides endure the relationship for a certain time, parties are likely to cooperate. This affects positively outcome variables. Paradoxically, the mutual distrust and secrecy observed in the Russian triads keeps the Russian networks sparse and less homogenized over time. Product diversification spreads venture risks across various market segments. Thus, the Russian entrepreneurs who combine sparse and heterogeneous networks with product diversity are likely to outperform those executives whose networks are dense and homogeneous and product portfolio is narrow.

To conclude, this study found that network structure and player attributes affect dependent variables in interactive ways. This is a confirmation of the player-structure duality of network theory (Burt, 1992). Networks do not "act", but players with their attributes act and create values within the existing patterns of relationships among actors. The study also found direct effects of alter attributes on outcome variables. Although product development speed enhances revenue growth in the longer term, the interactive deployment of high-density, homogeneous networks and efficient product development harms revenue growth over time. The way in which network structure and composition influences outcome variables is contingent upon a country's institutional and social peculiarities, i.e., China versus Russia.

I claim three contributions. First, this article makes a contribution to social network theory, by confirming the interactive effects of network structure and actor attributes on outcome variables. Second, the finding that revenue growth of new ventures is a function of the combination of entrepreneurs' social and knowledge resources, and product development, is a contribution to the entrepreneurship literature. Third, the evidence that the way in which entrepreneurs' network structure and composition influences venture performance is different in China and Russia, contributes to the growing management literature on emerging markets.

Several limitations should be discussed. This is a retrospective study, where the effects of current discussion networks were examined on the past performance of ventures. Therefore, there is an issue of causality between network variables and venture performance. The severity of this problem, however, is reduced by the fact that the respondents had relationships with most alters before they set up ventures. The software industries in China and Russia are young, and therefore, institutional, regulatory and market immaturity may have affected these results, although I assume that all the entrepreneurs are exposed to the same country conditions in each country to the same extent. The sample size is relatively small. The assumption that 14 market segments have similar product development cycles constitutes a shortcoming. The product diversification measurement is subjective, although this measurement suits the country and industry contexts.

A research implication is that combined effects of network structure and knowledge characteristics of actors may be studied further at the inter-organizational level. For example, one could examine how structural closeness and distance interact with knowledge relatedness and distance at the inter-organizational level, and how they affect outcome variables in interactive ways. Complex models are required to explain revenue growth of young firms in developing countries. For instance, marketing strategy in parallel with entrepreneurs' networks and product development may be incorporated in models that designed to explain revenue growth of new ventures over time. A practical implication is that entrepreneurs are advised to rely on cohesive networks at early stages, but restructure their networks as their ventures age and grow to generate sustainable opportunities.

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Table 1. Descriptive Statistics and Pearson's Correlations

	Variables	N	M	S.D	1	2	3	4	5	6
1	Network size	158	4.29	1.34						
2	Relationship duration	157	4.92	3.53	.05					
3	Network density	157	.42	.38	-.18*	.14				
4	Structural holes	157	2.63	3.21	.56**	.14	-.42**			
5	Internal ties	158	.73	.29	-.18*	-.02	.40**	-.48**		
6	Education homophily	158	.67	.28	-.14	.07	.13	-.17*	.13	
7	Education heterophily	158	.32	.28	.14	-.07	-.13	.17*	-.13	-1**
8	Perceived homophily	158	3.18	.89	-.09	.09	.31**	-.25**	.32**	.14
9	Perceived heterophily	158	1.82	.90	.08	-.09	-.31**	.25**	-.33**	-.16*
10	Product development duration	156	13.17	10.13	.13	.12	-.21**	.26**	-.21**	-.18*
11	Product diversity	158	2.27	1.68	.30**	.03	-.30**	.46**	-.24**	-.25**
12	Revenue year two	142	12.81	23.23	-.12	-.12	.23**	-.18*	.14	.09
13	Revenue year three	83	8.60	11.09	-.11	-.16	.12	-.20	.07	.10
14	Revenue year four	58	10.25	9.17	.01	-.29*	.06	-.06	-.02	-.02
15	Revenue year five	41	15.64	12.56	.02	-.29	-.07	.01	-.07	-.28
16	Firm age	159	3.33	1.44	.12	.25**	-.13	.29**	-.10	.15
17	Firm size	159	47.67	52.37	.15*	-.06	-.15*	.07	.04	.17*
18	Ownership	159	.59	.49	-.08	.22**	.15	.06	-.17*	-.15
19	Venture capital	159	.13	.33	-.02	-.05	-.14	-.03	.01	-.06
20	China	159	.48	.50	-.26**	-.26**	.20*	-.40**	.26**	.24**

$*p < 0.05$
$**p < 0.01$

Table 1. Descriptive Statistics and Pearson's Correlations (Continued)

	Variables	7	8	9	10	11	12	13	14	15
8	Perceived homophily	-.14								
9	Perceived heterophily	.16*	-.99**							
10	Product development duration	.18*	-.30**	.29**						
11	Product diversity	.25**	-.27**	.28**	.43**					
12	Revenue year two	-.09	.18*	-.19*	-.19*	-.27**				
13	Revenue year three	-.10	.18	-.18	-.29**	-.34**	.62**			
14	Revenue year four	.02	.03	-.01	-.25	-.16	.33*	.69**		
15	Revenue year five	.28	-.13	.18	-.14	.21	-.08	.32*	.67**	
16	Firm age	-.15	.01	-.01	.43**	.25**	-.06	-.02	-.28*	-.45**
17	Firm size	-.17*	.03	-.04	.12	.05	.10	.16	.09	-.01
18	Ownership	.15	.09	-.07	.05	-.01	.04	.06	-.05	-.08
19	Venture capital	.06	-.14	.13	.02	.03	.11	.03	-.06	.11
20	China	-.24**	.10	-.11	-.43**	-.55**	.30**	.40**	.26*	-.07

*p < 0.05
**p < 0.01

Table 1. Descriptive Statistics and Pearson's Correlations (Continued)

		16	17	18	19
17	Firm size	.31**			
18	Ownership	-.09	-.28**		
19	Venture capital	.00	.17*	-.09	
20	China	-.29**	.14	-.18*	.18*

Table 2. Descriptive Statistics and ANOVA of Chinese and Russian Samples

		China			Russia			ANOVA model
		N	Means	S.D.	N	Means	S.D.	F
1	Network size	76	3.92	1.45	82	4.63	1.13	11.82***
2	Relationship duration	75	3.95	2.57	82	5.80	4.04	11.42***
3	Network density	75	.50	.45	82	.34	.29	6.76*
4	Structural holes	75	1.26	2.61	82	3.87	3.21	30.77***
5	Internal ties	76	.81	.30	82	.66	.26	11.34***
6	Education homophily	76	.74	.33	82	.60	.21	9.70**
7	Education heterophily	76	.25	.33	82	.39	.21	9.70**
8	Perceived homophily	76	3.28	1.02	82	3.09	.75	1.80
9	Perceived heterophily	76	1.71	1.02	82	1.93	.76	2.25
10	Product development duration	76	8.72	8.71	80	17.41	9.59	34.89***
11	Product diversity	76	1.31	.73	82	3.16	1.82	67.75***
12	Revenue year two	64	20.59	27.21	78	6.42	17.06	14.31***
13	Revenue year three	37	13.51	13.44	46	4.65	6.61	15.38***
14	Revenue year four	13	14.69	12.76	45	8.97	7.54	4.13*
15	Revenue year five	6	13.33	15.05	35	16.02	12.30	.23
16	Firm age	77	2.89	1.32	82	3.74	1.43	15.29***
17	Firm size	77	55.48	54.67	82	40.34	49.33	3.36¶
18	Ownership	77	.50	.50	82	.68	.46	5.24*
19	Venture capital	77	.19	.39	82	.07	.26	5.22*

¶p< 0.1
*p < 0.05
**p < 0.01
***p< 0.001

Table 3. Linear Regression Analysis Predicting Product Development (N=159)

	Product development duration		Product diversity	
	Model 1	Model 2	Model 3	Model 4
Controls				
Firm age	.34***	.34***	.03	.06
Firm size	.11	.11	.07	.11
Ownership	.07	.08	-.07	-.03
Venture capital	.01	.01	.08	.07
China	-.24*	-.24*	-.44***	-.37***
Predictors				
Network density	-.01	-.11		
Education homophily	-.13¶	-.18*		
Perceived homophily	-.28***	-.31***		
Structural holes			.22**	.01¶
Education heterophily			.11¶	.02
Perceived heterophily			.13*	.06
Interactions				
Network density X Education homophily X Perceived homophily		.16		
Structural holes X Education heterophily X Perceived heterophily				.45***
Model F	11.38***	10.22***	14.03***	17.19***
Adjusted *R* square	.35	.35	.4	.48

Values represent standardized B coefficients.

¶p< 0.1
*p < 0.05
**p < 0.01
***p< 0.001

Table 4. Linear Regression Analysis Predicting Revenue Growth

	Revenue year 2	Revenue year 3	Revenue year 4	Revenue year 5	Revenue year 2	Revenue year 3	Revenue year 4	Revenue year 5
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Controls								
Firm age	.05	.21¶	-.28	-.47	.02	.16	-.23¶	-.37*
Firm size	.07	.13	.18	.05	.07	.13	.18	.02
Ownership	.12	.17¶	.01	-.04	.11	.15	-.02	-.04
Venture capital	.08	-.05	-.13	.01	.07	-.03	-.1	.25
China	.24*	.42**	.16	-.05	.25*	.39*	.2	.01
Predictors								
Density X Education homophily X Perceived homophily	.11	.01	-.18	-.19				
Product development speed	.02	.18	.27	.38¶				
Structural holes X Education heterophily X Perceived heterophily					-.11	-.06	.33	.08
Product diversity					-.03	-.22	.19	.13
Interactions								
Density X Education homophily X Perceived homophily X Product development speed	.15	.03	-.07	-.32*				
Structural holes X Education heterophily X Perceived heterophily X Product diversity					-.25	.11	.11	.34
N	142	83	58	41	142	83	58	41
Model F	3.09*	3.10**	1.63	2.23*	2.9*	3.1*	1.4	1.89¶
Adjusted *R* Square	.10	.17	.08	.2	.1	.16	.06	.15

Values represent standardized B coefficients.

¶p< 0.1
*p < 0.05
**p < 0.01
***p< 0.001

Table 5. Linear Regression Analysis Predicting Product Development of Chinese and Russian Firms

	Product development duration		Product diversity	
	China	Russia	China	Russia
	Model 1	Model 2	Model 3	Model 4
Controls				
Firm age	.17	.53***	-.19	.14
Firm size	.1	.25*	.26¶	.13
Ownership	.16	-.05	-.03	-.08
Venture capital	.11	-.17¶	.25*	.01
Predictors and Interactions				
Network density	-.12	-.06		
Education homophily	-.16	-.25¶		
Perceived homophily	-.41**	-.23*		
Network density X Education homophily X Perceived homophily	.15	.11		
Structural holes			.04	.03
Education heterophily			-.01	.08
Perceived heterophily			-.01	.11
Structural holes X Education heterophily X Perceived homophily			-.07	.42*
N	76	80	76	82
Model F	2.2*	6.37***	1.3	5.66***
Adjusted R square	.12	.35	.03	.31

Values represent standardized B coefficients.

¶p< 0.1
*p < 0.05
**p < 0.01
***p< 0.001

Table 6. Linear Regression Analysis Predicting Revenue Growth of Chinese and Russian Firms

	Rev. year 2		Rev. year 3		Rev. y. 4	Rev. y. 5	Rev. year 2		Rev. year 3		Rev. y. 4	Rev. y. 5
	Ch M 1	Rus M 2	Ch M 3	Rus M 4	Rus M 5	Rus M 6	Ch M 7	Rus M 8	Ch M9	Rus M 10	Rus M 11	Rus M 12
Firm age	.33*	-.31*	.48*	-.29	-.52	-.59**	.39*	-.41**	.5*	-.26	-.48	-.47
Firm size	.08	-.01	.09	.07	-.1	-.21	.06	-.05	.07	.09	-.05	-.2
Ownership	.06	.27*	.23	.33	.1	-.11	.15	.21*	.25	.28¶	.05	-.1
Venture capital	.15	.07	-.04	.06	.07	.14	.11	.15	-.05	.06	.07	.11
Predictors												
Density	.34*	-.11	.17	-.05	-.05	-.11						
Education homophily	.02	.13	-.03	.25	.04	-.03						
Perceived homophily	.21	.13	.15	.06	-.04	.01						
Product dev. speed	-.11	.07	.22	.01	-.01	.15						
Structural holes							-.09	.25	-.05	-.01	.09	.10
Education heterophily							-.03	-.06	.05	-.13	.03	-.00
Perceived heterophily							-.15	-.07	-.12	.01	.05	-.06
Product diversity							.01	.02	.02	-.11	-.25	-.13
Interactions												
Density x Education homophily x Perceived homophily x Product dev. speed	-.13	.11	-.26	.04	-.01	-.26¶						
Structural holes x Ed. heterophily x Per. heterophily x Product diversity							.1	-.39*	.1	-.14	.08	.51¶
N	64	78	37	46	45	35	64	78	37	46	45	35
Model F	2.02*	2.66*	1.19	1.04	1.48	2.7*	1.16	3.4*	.97	1.26	1.72	3*
Adjusted *R* square	.12	.16	.04	.01	.09	.31	.02	.21	-.01	.05	.12	.34

Values represent standardized B coefficients. ¶p< 0.1; *p < 0.05; **p < 0.01; ***p< 0.001

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