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National Systems of Innovation and firms? innovative performance: a comparison between American, Canadian and Chinese firms

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Abstract

This study examines the relationships between the performance of the firms and the perceived importance of the networked relationships with different types of partners, and compares the results for 3 countries, USA, Canada and China. The results show important differences of firms? perception about the importance of different partners for innovative activities, differences based on country of origin. It shows also that different levels of performance are correlated with the same different perceived importance of these partners.

The study adopts a less often used bottom-up approach in analyzing different NIS, and it finds important differences between the evaluations that firms allow to various categories of partners, for different sources of knowledge used in innovative activities.

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1. Introduction

The main purpose of this paper is to explore the importance of network partners as suppliers of knowledge from the perspective of firms and to understand how this perceived importance is related to the performance of firms, especially to the innovative performance. Our theoretical framework combines two complementary research streams: social networks (Granovetter 1973) and innovation systems (Freeman 1987, Lundvall 1992, Nelson 1993, Malerba 2002). The network literature reduces a social system to a network of ties, which enables it to underscore the role of network structure and actor position in the differential success of actors (Burt 1992, Ahuja 2000). For example, prior studies in biotechnology found that firms failing to be centrally positioned in the networks of collaborative research cannot keep up with the pace of innovation (Powell et al., 2005, Mina et al., 2007). The learning processes, as a key element of absorptive capability (Cohen and Levinthal, 1990), determinant of innovative performance of the firms, are favoured by the multiplicity of ties (Hagedoorn and Duyster, 2002). However, Floricel et al. (2008) point out that the nature and role of innovation networks varies function of the nature and direction of the dominant flows of knowledge and resources in the concrete innovation system in which firms participate. They suggest that a simple conceptualization of network structure and position, while having a higher generalization potential, may obscure the way some key characteristics of innovation systems impact the relation between networks and the innovative success of firms. In this paper, we advance on the same path, by exploring how the characteristics of different National Systems of

Innovation (NSI) , or heterogeneity in their structure (Balzat and Hanush, 2009) influence the role of networks in the innovative performance of firms.

In order to achieve this objective, we adopted a bottom-up approach, by capturing the impact of NSI at the level of firms and their proximate networks. While it proposes richer qualitative distinctions regarding the types of actors a system and the connections between them, the NSI literature is generally interested in the aggregate performance of the system in terms of innovation output 9a top-down approach), as opposed to the innovation performance of firms. Therefore, to be able to combine the insights from the NSI literature with those from the social network theory, we translated these distinctions into concrete types of network partners and contributions as perceived by a focal firm. By exploring the relation between this local picture of a network within a national system and the innovative performance of firms we hope to understand the key differences between the NSI in various countries in terms of moderating between firm networks and innovation. The paper proceeds as follows: in the next section we use NSI theories to develop our exploratory framework. In section 3 we present the methods used to compare the perceptions regarding the importance of the contributing actors in the innovation networks, while the section 4 presents the results. In the last section we discuss these findings and present their theoretical and practical implications, as well as the limitations of the study.

2. Theoretical background

Since the introduction of the term by Freeman (1987), NSI concept became popular for both scholars and policy makers. For Freeman NSI is “the network of institutions of private and public sectors, whose activities and interactions initiate, import, modify, and

diffuse new technologies." (Freeman, 1987, pp.1). Lundvall (1992) adds the emphasis on the relations between the elements that compose the system and consider that NSI consists of "elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge (…) either located within or rooted inside the borders of a nation state" (Lundvall, 1992, pp.2). Despite the growing internationalization of R&D networks and knowledge flows, enabled by the liberalization of trade and the increasing movement of people and information, as well as by the growth of supranational bodies such as European Union and NAFTA, NSI, having powerful historical roots, remain a key determinant of the difference in wealth between countries (Niosi, 2000). NSI stay important because firms still perform the key R&D in their home country, because the tacit knowledge produced in basic research and technological activities remains difficult to transfer and, due to similar norms and culture, knowledge still flows easier within the national borders (Carlsson, 2006; Lundvall, 1992).

Within the arena created by national border, the following elements are invariably considered the key components of a NSI (Nelson and Rosenberg, 1993; Archibugi and Michie, 1997; Niosi, 2000; Carlsson, 2006). The first component refers to knowledge producing entities, which include firms, with their R&D, design, manufacturing and marketing units, private and public laboratories, and universities. They actually perform most innovation activities. Knowledge flows between them through ICTs, movement of people, associations and collaborations. Second, NSIs rely on specialized financial entities, which include private organizations, such as banks and venture capital firms, as well as public funding agencies. They provide the resources that enable knowledge

production and innovation activities. Third, national and regional government agencies facilitate and regulate innovation through policies, laws and regulations. To various degrees, depending on national traditions and strategies, governments subsidize R&D activities, encourage specific industries or areas, welcome or block foreign investment etc.

Despite the recent convergence between different nations in terms of recognizing the sources of wealth and economic development, and also organizational forms and practices (Lemola, 2002), noticeable differences persist between NSIs because countries have different histories and cultures (Nelson and Rosenberg, 1993; Hofstede, 1991). "Competitiveness can only be built on heterogeneity and national institutions may explain how such heterogeneity is created" (Sornn-Friese, 2000, pp. 2).

Each country has its own national setting, reflected by: technological capabilities, people's educational level, industrial structure, the amount and type of natural resources, or past strategies for innovation (Archibugi and Michie, 1997; Niosi, 2000; Carlsson, 2006). The size of the country or its wealth also shapes NSI (Nelson, 1993, Metcalfe, 1997). Large countries have a broader range of innovation activities and can support industries whose development is conditioned by the existence of large internal markets. On the other hand, smaller countries concentrate in a small number of industries, for which they have a comparative advantage.

Nowadays, networked innovation is becoming the new norm (Prahalad and Krishnan, 2008) and the institutional context and the technology, particularly ICT, play an important role in network formation and evolution (Swan and Scarbrough, 2005).

Assuming that to innovate successfully, firms in all countries require about the same kinds of knowledge, resources and support, the specific configuration of a NSI in a given country will favour specific pathways for acquiring the needed resources. For example, firms in countries that have a developed university system and a tradition of university-industry collaborations will more readily engage in such collaborations. Firms in countries without such a university system and traditions will acquire knowledge via foreign partners and international associations. Likewise, firms in countries with a policy centring on government subsidies, will more readily see funding from government agencies that firms in countries that emphasize private funding for innovation.

We examine the relationships between firm performance and the perceived importance of networked relationships with different types of partners in three countries, USA, Canada and China. We chose these countries because of a number of important differences between their NSIs. The US innovation system is generally considered as being the most developed and having a higher reliance on private institutions than others. Despite belonging to the same supranational entity, NAFTA, and having many cultural affinities, Canada has a higher degree of direct government involvement in innovation than the US (Niosi, 2000). Finally, China has an emerging innovation system, with many inconsistencies between a fading heritage from the period when the country was centrally planned economy, and the current period of accelerated reforms (Liu, 2001; Xiwei, 2007).

Our basic premise is that firms have to understand and follow these pathways in order to innovate successfully Accordingly, we expected to find a stronger relation between the reliance on private partners (firms, associations etc.) and success in the US (hypothesis

H1) and a higher relation between the reliance on government agencies and success in Canada (hypothesis H2). For China, we expected to find a higher overall number of relations between reliance on external partners and success (hypothesis H3), because in an emerging innovation system initial programs may be the first occasions for networked innovation available to firms, and firms who first learn about and use these opportunities may have an access advantage to these scarce resources over those who do not yet do so. By contrast, in countries with a developed innovation systems these resources are better known and more widely available, and the advantage may no longer reside in being the first to access them but the differential quality of resources (whose variability is not captured by our research design). Despite these anticipatory remarks, we consider that the relation between, on the one hand, the importance that firms assign to different network participants and their contributions, and, on the other hand, the success of the innovation activities of these firms, is not obvious. Therefore we adopt an exploratory approach in our research within the framework proposed in this section, in the hope of uncovering unexpected patterns that could enhance our understanding of how NSI moderate the relation between networks and the innovation success of firms.

3. Method

The hypotheses presented above were tested by taking advantage of dataset obtained by a survey conducted for a broader research program (see Miller and Floricel 2007 for details on the program and the overall instrument development and data collection approach).

Sample

A team of graduate students solicited firms involved in innovation by telephone and e-mail to participate in the survey. These firms belonged to 20 economic sectors (like IT,

engineering services, business and management consulting, biotechnology, pharmaceutics, electronic products, semiconductor manufacturing, machinery, metallurgy, chemicals and petro-chemicals, pulp and paper, etc.), selected mainly because of their theoretical interest for the broader research program. Some firms were contacted via relevant industrial associations. Solicited managers were usually Vice-presidents of R&D or Chief Technology Officers. Those who accepted to participate were given a password that enabled them to access the Web-based version of the questionnaire. Despite the considerable overall size of the survey (423 items divided into seven sections), about 80% of the firms that accepted to participate and received a password completed the questionnaire fully. Although it is difficult to establish a precise response rate because the lists of candidate firms had many unreachable personal or company names, and because of the variable ability of the students that were assigned to various sectors, we estimate the overall response at 25%, which is common in this kind of survey and could be considered as very good, given the complexity of the instrument. The resulting sample includes 943 firms from all the continents, but we retained only 642 usable (complete) answers. From a total of 642 valid responses, 374 (58%) come from these three countries, more exactly 104 from USA, 163 from Canada and 107 from China. Firm size varies from just start-ups to very large multinationals, with an average of 7000 employees. There is no significant difference in average size between Canadian and Chinese firms, but US firms are significant larger than the other. The distribution by economic sector (using NAICS codes) show that for Canada, the most represented sectors are in descending order: software, engineering services, transportation equipment manufacturing, computer and electronic manufacturing and fabricated metal product

manufacturing, for US they are software, chemical manufacturing, and machinery manufacturing, while for China they are: transportation equipment manufacturing, computer and electronic manufacturing, chemical manufacturing and software.

Measures

This study uses 89 variables out of a total of 432 variables included in the broader survey. The subsection of the questionnaire that captures the importance of network partners and their contributions was built by relying on a review of the literature on innovation systems, and covers all the key elements of NSIs described above. Its start with the following statement: "Firms rely on partners such as government, universities, and non-profit organizations for innovation-enabling contributions. Please indicate the importance for your firm of the innovation enabling-roles in the left column, and indicate the types of organizations that perform each role."

We used psychometric variables to measure the respondents' perceptions of the importance of a type of external innovation-enabling contribution, based on the assumption that respondents are able to recognize and rate network partners and their contributions accordingly to their real importance for the innovative activity.

Respondents indicated also what type of partner provides an important role for each contribution, by selecting one or several types from a list of 7 options (other firms, government agencies, universities, non-profit research institutes, scientific associations and stakeholder group). These options were identified as a result of a literature review, 20 case studies and a brainstorming session and were revised during the validation of the survey. In order to reduce the difficulty to answer the questionnaire, which took more than one hour to be completed, checkpoints were used to indicate the type of

organizations that are important in providing a specific contribution. This way, we obtained a matrix of 10 X 8 variables for each respondent (including the importance associated to the contribution). But using checkpoints reduced considerable the variance we needed to examine this phenomenon. To highlight the different importance of a specific contribution for different respondents, we computed a relative importance of a type of organization by multiplying the importance of the respective role with the binary value of the presence of the type of organization between the important ones. As a result, the range of possible values for a type of organization and a contribution may be between 0 (meaning not mentioned) to 7 (mentioned for an extremely important role). While the accuracy of this method is not as high as using real psychometric variables, we can consider it as an acceptable proxy for the importance of a partner type. Our measures are an alternative to other modalities, such as using the number of contracts or collaborations, which are more formal, but cover only the visible part of an innovation network.

In order to measure innovation, we used a combination of psychometric and econometric indicators. The most common way of measuring innovation both in large system- and in firm-level research is the number of patents (Pavitt and Patel, 1988; Trajtenberg, 1990; Griliches, 1990). Patent information is available and objective (Griliches, 1990). However, as a measure of innovation output, patents have two weaknesses that make them inappropriate for our study. First, they are more related to invention than to innovation. Invention can be considered an input as well as an output of innovation. Second, the propensity to patent is different in different countries, because of cultural, institutional and economic factors. Therefore, we used self-reported assessments by respondents to measure innovation performance of firm. One set of questions referred to

the evolution over the last 3-years of economic performance indicators, such as growth rate, profit rate and return on equity. We provided an interval scale to help respondents answer the question and allay their confidentiality concerns. We also cross-validated the reported economic performance and data about employees' number and sales volume by using secondary sources of data, such as financial reports for the public companies. However, these measures were only indirectly measuring innovation, based on the assumption that innovative companies are also more profitable. Therefore, we also used a set of psychometric variables that measured the innovation output in terms of new products and business launched in the last three years.

Finally, we performed an exploratory factorial analysis with the 9 items measuring innovative and economic performance and we obtained 3 factors: Intensity of Innovation, Business Generation and Economic Performance. One item was dropped for the final analyses, the item loadings being high on two factors. The internal consistency of the constructs was assessed by a reliability test with Cronbach's alpha, using SPSS 13.0. An alpha over 0.70 is considered good, while one alpha over 0.60 is considered adequate (Cronbach, 1951; Nunnally, 1978). All factors show values over 0.60, the Intensity of Innovation factor having a Cronbach's alpha of 0.77 and the Business Generation factor an alpha of 0.69. The construct Economic Performance shows a value of 0.84 for Cronbach's alpha. We privileged for our purposes the first two factors, because we consider that the economic performance for a short term is influenced by too many factors beyond the framework of this study. Finally, a aggregate z-score for firms' performance was used to split firms in each country in high-performers and low-performers, with the aim to observe differences between the importance of specific

contributions between these two categories inside each country. We used Anova One-Way procedure to assess whether the differences between country averages or groups averages (each group corresponding to higher performers – HP or lower performers – LP inside each country) are statistically significant.

4. Results

A first series of analyses identified inter-country differences in the importance of contributions and frequency of partners. Significant differences between the 3 groups were found using Scheffe's test. These results are summarized in the Table 1. We observed that Chinese firms have a consistent tendency to give a higher importance to various contributions. For 8 contributions out of a total of 10, the importance of the contribution is higher than the averages for USA or Canada, and this is significant at 5%. American firms show the highest average only for one contribution, "Helps learn about new technologies", but the difference is not statistically significant. Canadian firms show a consistent pattern of having the lowest averages; in two cases the differences compared to American firms are even statistically significant.

		Partner							
Contribution	Country	Impor-tance	Other firms	Gover-nment agencies	Univer-sities	Research Institutu-tions	Indus-try associa-tions	Scien-tific Asso-ciations	Stake-holder Group
Helps learn about new technologies	USA	5.36	**.66**	.25	.56	.19	.55	**.52**	**.18**
	Canada	5.18	**.45**	.19	.48	.19	.50	.38	**.23**
	China	5.27	*.19*	.26	**.65**	.11	.42	.31	.10
Helps learn about new markets	USA	5.10	**.71**	*.16*	.07	.13	.58	.28	.33
	Canada	*4.78*	**.52**	.24	.07	.15	.51	.24	.29
	China	**5.36**	*.33*	**.32**	.13	.14	.58	.19	.20
Provides business advice	USA	4.39	**.63**	.12	.06	.09	.28	.27	**.36**
	Canada	4.21	.44	.15	.06	.07	.37	.16	**.40**
	China	**5.15**	*.30*	**.30**	**.29**	.15	**.54**	.25	.22
Identifies knowledge-able individuals	USA	4.77	**.61**	.14	.45	.14	.39	**.52**	**.27**
	Canada	4.58	**.39**	.16	.38	.11	.35	.35	**.31**
	China	4.78	*.16*	**.31**	.50	.12	.38	.33	.10
Identifies partner firms and orga-nizations	USA	**4.69**	**.63**	.16	.15	.17	.53	**.31**	**.37**
	Canada	4.30	**.42**	.25	.10	.15	.42	.23	**.40**
	China	**4.94**	*.25*	**.50**	.13	.14	.50	*.17*	.14
Facilitates innovation involving multiple or-ganizations	USA	4.42	**.43**	.31	.20	.18	.46	**.28**	.21
	Canada	3.95	**.30**	.34	.24	.16	.37	.14	.22
	China	**5.04**	.18	**.49**	.21	.09	.50	.18	.11
Promotes enabling standards	USA	4.63	**.28**	.39	.13	.12	**.66**	**.37**	**.15**
	Canada	*4.23*	.23	.41	.12	.15	.45	.23	**.12**
	China	**5.02**	*.14*	**.59**	.11	.07	.53	.18	.04
Undertakes innovative activities	USA	3.83	**.46**	.15	.45	.14	.21	.15	.09
	Canada	3.46	.28	.11	.37	.14	.17	.06	.12
	China	**4.66**	*.08*	.21	.40	.10	**.33**	.12	.09
Forces to innovate by changing regulations	USA	3.56	.16	.80	.01	.04	.17	.08	.05
	Canada	3.52	.09	.68	.02	.03	.15	.06	.06
	China	**4.49**	.07	.77	**.07**	.03	**.29**	.09	.02
Forces innovation through social pressure	USA	3.26	**.23**	.39	.06	.08	.22	.13	**.28**
	Canada	3.19	.16	.47	.07	.05	.22	.10	**.20**
	China	**4.52**	.10	**.69**	.08	.06	**.40**	.12	.08

Note : The group with the highest value (significant difference at 5%) is highlighted in bold, lowest in italic

Table 1 Averages for the importance of a contribution and frequency of a partner type

Looking at the frequencies of the partners mentioned for each contribution, we can observe first that universities, industry associations and scientific associations are, as expected, well represented in every country. But there are remarkable differences to be mentioned, too. We observe that Canadian and American firms tend to have more similar positions and the contrast with Chinese firms is stronger. American firms give a significant higher importance to inflows from other firms for all the ten contributions, differences being statistically significant in the most of the cases.

Chinese firms stress frequently and as expected the importance of government agencies, universities and industry associations. The government agencies are the most frequent in 9 of the 10 types of contribution, in 7 cases the differences being statistically significant. Universities are more frequent in 6 cases and in 3 the differences are statistically significant, while for Industry associations we found 4 contributions were the average for Chinese firms is significantly higher.

American firms show a different consistent pattern. They give a significant high importance to inflows from other firms. For all the ten contribution, the averages for other firms are higher for American firms, sometimes the average for Canadian firms being close enough. It is worth to emphasize that American firms privilege the category "other firms" to the other partner types in almost all the contribution types. The American firms show another consistent pattern, that of the high frequency of scientific associations as an important partner. The averages are significantly higher than those for the other 2 countries for 5 contributions.

Canadian firms tend to have the same pattern as the American firms when evaluating the importance of the stakeholder, firms for both countries contrasting with Chinese firms for

this type, too. The Canadian firms tend to show closer values to American firms for many contributions and partner types, rather than to Chinese firms. This holds true when mentioning the other firms as important partner type, where Canadian firms show intermediate values in all 10 contributions, often not significantly different from American firms, but different from Chinese firms. The figures 1, 2, 3, 4 and 5 use radar diagrams to better emphasize the structural differences between the partners' importance given by firms in these 3 countries.

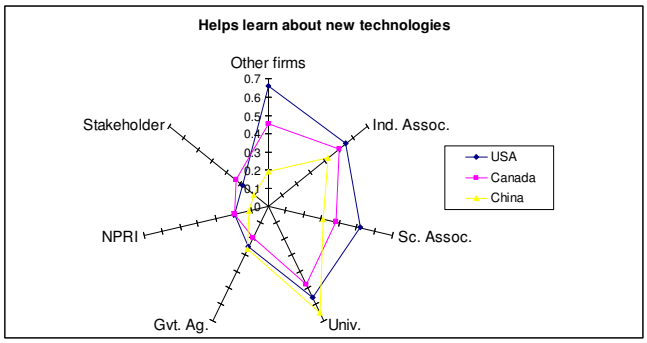

Fig.1 Partner's type frequency for the contribution "Helps learn about new technologies"

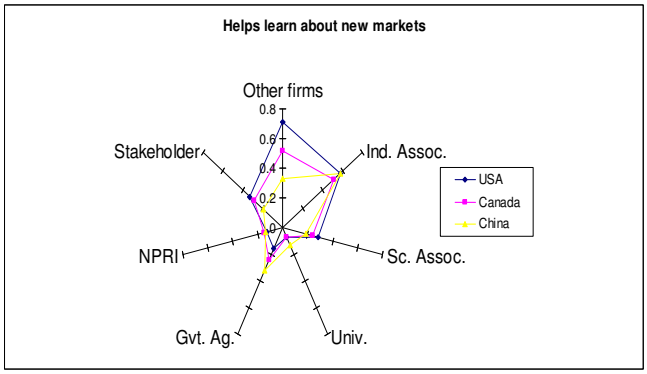

Fig. 2 Partner's type frequency for the contribution "Helps learn about new markets"

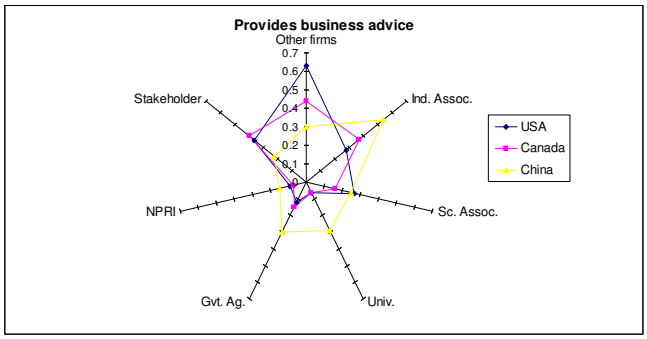

Fig. 3 Partner's type frequency for the contribution "Provides business advice"

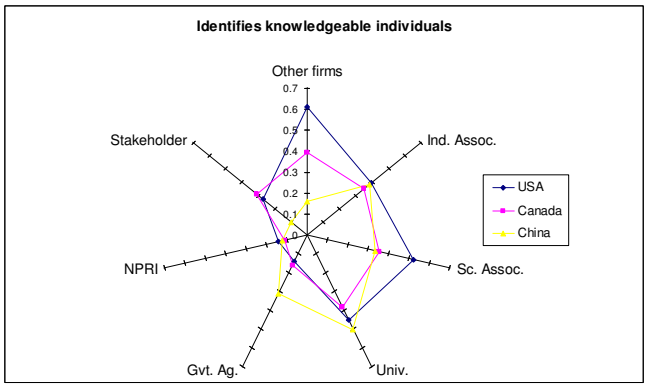

Fig. 4 Partner's type frequency for the contribution "Identifies knowledgeable individuals"

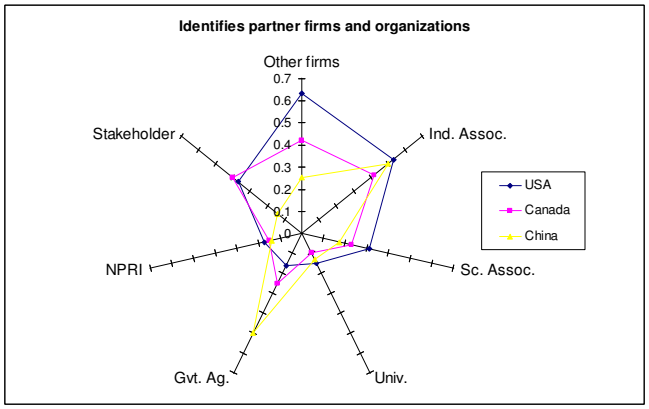

Fig. 5 Partner's type frequency for the contribution "Identifies partner firms and organizations"

The next step of our study was to verify if firms belonging to different NSI show a significant correlation between the importance they allow to different types of partners and the innovative performance.

The tables 2 and 3 show the results of the bivariate correlation tests between the firms' innovative performance, measured with the z-scores of the 2 constructs presented above, intensity of innovation and business generation, and the importance given to different partner's types for each specific contribution. Table 4 summarizes the significant correlations, using a p-value of 5%, for each country. We mention that there are 70 coefficients for each country and each construct.

	Intensity of innovation	Business generation	Total
USA	2	4	6
Canada	7	8	15
China	12	11	23

Table 4 Number of significant correlations

As expected, the number of significant correlations is lower for the American firms, but it is remarkably higher for the Chinese firms. The Canadian firms show an intermediate value, close to the values of Chinese firms.

		Partner							
Contribution	Country	Importance	Other firms	Government agencies	Universities	Non Profit Research Institutions	Industry associations	Scientific Associations	Stakeholder Group
Helps learn about new technologies	USA *Canada* **China**	**.387****		**.190***			**.199***	**.311****	*.168**
Helps learn about new markets	USA *Canada* **China**	*.161** **.284****		-.217*			*.180**	**.255****	
Provides business advice	USA *Canada* **China**	**.322****			**.214***			**.271****	
Identifies knowledgeable individuals	USA *Canada* **China**	**.210***					**.213***	**.239***	
Identifies partner firms and organizations	USA *Canada* **China**						*.190**	**.207***	**-.205***
Facilitates innovation involving multiple organizations	USA *Canada* **China**						*.175**	**.233***	
Promotes enabling standards	USA *Canada* **China**		*.198**						
Undertakes innovative activities	USA *Canada* **China**	**.198***	*.280***						
Forces to innovate by changing regulations	USA *Canada* **China**	**.256****				-.219*	**.236***		
Forces innovation trough social pressure	USA *Canada* **China**	**.293****			*-.175**				

Note: ** : p < 1%
* : p < 5%

Table 2 Significant Pearson correlations between the importance of a network partner and the Intensity of Innovation

		Partner							
Contribution	Country	Importance	Other firms	Govern-ment agencies	Univer-sities	Research Institutu-tions	Industry associa-tions	Scien-tific Asso-ciation s	Stake-holder Group
Helps learn about new technologies	USA *Canada* **China**	**.253****	-.224*	*.173**	**.270****	**.217***			
Helps learn about new markets	USA *Canada* **China**	**.385****		*.169**			**.204***		**.258****
Provides business advice	USA *Canada* **China**	**.370****		*.198**	-.197*	**.258****			**.234***
Identifies knowledge-able individuals	USA *Canada* **China**	*.161* **.297***							
Identifies partner firms and orga-nizations	USA *Canada* **China**	*.215*** **.297****			*.193**	*.188**	*.176** **.193**		
Facilitates innovation involving multiple or-ganizations	USA *Canada* **China**	**.282****			-.280**			*.177**	**.205***
Promotes enabling standards	USA *Canada* **China**	**.203***			**.252****				
Undertakes innovative activities	USA *Canada* **China**	*.171**			*.175**				.235*
Forces to innovate by changing regulations	USA *Canada* **China**	.247* **.237***							
Forces innovation trough social pressure	USA *Canada* **China**	.251* **.285****			**.215***			**.223***	

Note: ** : p < 1%
* : p < 5%

Table 3 Significant Pearson correlations between the importance of a network partner and the Business Generation

We obtained a more fine-grained view by splitting firms inside each country into a group of high-performers (z-scores of the three criteria of performance above the average of

national sample) and low-performers. The results need to add another dimension to the Table 1, complicating the reading. We are presenting here only some excerpts.

Contri-bution	Canada-LP		Canada-HP		USA-LP		USA-HP		China-LP		China-HP	
(nb. Of groups)	Rank.	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value
Helps learn about new technologies (1)	5	5.05	4	5.28	2	5.35	3	5.34	6	4.96	1	5.57
Helps learn about new markets (2)	6	4.64	5	4.85	2	5.15	4	4.96	3	5.11	1	5.63
Provides business advice (2)	6	4.16	5	4.26	4	4.31	3	4.5	2	4.88	1	5.43
Identifies knowledge-able individuals (1)	6	4.40	4	4.69	3	4.72	2	4.76	5	4.65	1	4.86
Identifies partner firms and orga-nizations (2)	6	4.13	5	4.46	4	4.50	2	4.84	3	4.80	1	5.08
Facilitates innovation involving multiple organizations (2)	6	3.69	5	4.22	4	4.39	3	4.46	2	4.93	1	5.16
Promotes enabling standards (2)	6	4.00	5	4.42	3	4.69	4	4.48	2	4.91	1	5.10
Undertakes innovative activities (3)	6	3.12	4	3.81	5	3.70	3	3.90	2	4.52	1	4.80
Forces to innovate by changing regulations (3)	6	3.07	3	3.86	5	3.37	4	3.62	2	4.32	1	4.65
Forces innovation trough social pressure (3)	6	2.98	4	3.27	3	3.43	5	3.08	2	4.30	1	4.73

Note: Nb. Of Groups represents the number of statistical significant groups at 5% (Scheffe's test)
LP = lower performers (under national average)
HP = higher performers (above the national average)

Table 4. Average value for contribution's importance and order of average values by country and performance level

The data in the table 4 stresses the lesser importance that lower-performing Canadian firms have about the partner network, comparing to all other 5 groups. Interestingly, even the better-performing Canadian firms seem to rely lesser on partners than low-performing

American firms, in most of cases, which may be interpreted as a structural difference between Canadian and American firms on the effectiveness of their networks.

	Canada-LP		Canada-HP		USA-LP		USA-HP		China-LP		China-HP	
	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value
Other firm	4	0.39	3	0.46	2	0.61	1	0.70	6	0.18	5	0.20
Gvt. Agencies	6	0.19	5	0.19	3	0.22	2	0.22	4	0.21	1	0.31
Univer-sities	5	0.53	6	0.45	3	0.56	4	0.55	2	0.57	1	0.75
Non-profit research institutes	2	0.20	1	0.21	3	0.19	4	0.18	6	0.09	5	0.14
Industry associ-ations	3	0.49	4	0.47	2	0.54	1	0.54	6	0.39	5	0.45
Scientific Asso-ciations	3	0.45	5	0.39	2	0.46	1	0.56	6	0.23	4	0.38
Stake-holder	1	0.24	2	0.22	3	0.17	4	0.16	5	0.14	6	0.06
Total Frequency		2.49		2.39		2.75		2.91		1.91		2.29

Table 5. Share of important partners as source for knowledge about new technologies, and rank between groups of countries and firm's performance

While the main trends shown by the date in the Table 1 remain, some interesting values may be found in the tables 5 and 6. First of all, the low-performing firms (LP) rely less on the other firms than the higher-performing firms (HP) in the same country, both for new technologies and information about new markets. This confirms again the correlation between the network ties and the firm's performance

	Canada-LP		Canada-HP		USA-LP		USA-HP		China-LP		China-HP	
	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value
Other firm	4	0.49	3	0.54	2	0.63	1	0.76	6	0.32	5	0.35
Gvt. Agencies	3	0.26	4	0.23	5	0.19	6	0.12	1	0.34	2	0.31
Univer-sities	3	0.08	5	0.04	6	0.04	4	0.08	2	0.13	1	0.14
Non-profit research institutes	2	0.16	3	0.14	4	0.13	5	0.12	6	0.11	1	0.18
Industry associ-ations	5	0.54	6	0.50	2	0.57	3	0.56	4	0.55	1	0.63
Scientific Asso-ciations	1	0.29	5	0.19	3	0.26	2	0.28	6	0.14	4	0.25
Stake-holder	1	0.36	5	0.22	2	0.33	3	0.32	4	0.23	6	0.18
Total Frequency		2.18		1.86		2.15		2.24		1.82		2.04

Table 6. Share of important partners as source for knowledge about new markets, and rank between groups of countries and firm's performance

Next, except for the Canada, LP firms have fewer connections with the partners than HP firms (Total frequency lines). Canadian exception is quite hard to be explained. A possibility will be that LP Canadian firms try to look everywhere in order to bring valuable knowledge to improve their performance. Another interesting finding in the same line is the order of important partners as source for knowledge about new technologies (table 5). For Canadian LP firms, the partner "other firms" comes in the 4-th place, while for Canadian HP firms it is in the 2-nd place. It is worth to mention that all American firms consider this "partner" on first place, while it is only in the 5-th place for all Chinese firms. As a conclusion, one characteristic of Canadian NIS is the contrast between HP and LP firms.

Table 5 and table 6 concern only two of the ten contributions, for space reasons. The table 7 summarizes for all ten contributions the cases when both low-performing and

high-performing firms from the same country have close ranks when all six combinations (3 countries X 2 performance levels) are sorted in decreasing order, for each contribution and each partner.

	Number of close ranks								
Contribution	Other firms	Gvt. Agencies	Universities	NPRI	Industry associations	Scientific Associations	Stakeholder Group	Total	%
Helps learn about new technologies	3	2	3	3	3	1	3	18	85.7
Helps learn about new markets	3	3	1	2	2	1	1	13	61.9
Provides business advice	1	1	2	1	3	2	1	11	52.4
Identifies knowledge-able individuals	3	3	0	1	0	1	1	9	42.9
Identifies partner firms and organizations	3	3	1	1	1	1	3	13	61.9
Facilitates innovation involving multiple organizations	3	3	1	1	1	1	3	13	61.9
Promotes enabling standards	1	2	1	3	3	3	3	16	76.2
Undertakes innovative activities	3	3	0	0	2	2	0	10	47.6
Forces to innovate by changing regulations	1	1	3	1	1	1	3	11	52.4
Forces innovation trough social pressure	1	3	0	1	2	1	3	11	52.4
Total	22	24	12	14	18	14	21	125	59.5

Table 7: Frequencies of close ranks for high- and low-performing firms from the same country for the different types of partners, for each contribution.

Each cell in the table 7 may have values between 0 and 3. For example, the value 3 in the cell in the high-left of this table corresponds to the first line of the table 5, which shows that the percentages of the firms' nominations as an important partner type are ranked in the next order: USA-HP, USA-LP, Canada-HP, Canada-LP, China-HP, China-LP. This

means that the membership to a NSI seems to be the first criteria, while the level of performance accounts for less in this case. Overall, in more than 50% of the possibilities, both low-performing and high performing firms from the same country show close ranks when all the 6 categories are sorted. In our interpretation, this means that the importance given by the firms to their different categories of partners is highly influenced by the membership in a specific NSI. This is exceptionally high (86%) for the contribution "Helps learn about new technologies".

5. Discussion

The graphs in figures 1 to 5 and the table 1 show that firms in these 3 countries have some significant differences in the importance they appreciate for different partners when searching for specific external contributions. The main explanation may reside in the different stages and directions of the NSI evolution they belong. American firms rely heavily on networks of firms, to find the knowledge they need. While the importance of Industry associations is relatively similar between countries, as well as that of universities, American firms emphasize more than others the importance of scientific associations, highlighting the role of the network where each firm looking for a "central" role in the network. External resources of knowledge are powerful and generally known.

Chinese firms show a more hierarchical structure in their networks, with a high importance considered for governmental agencies and industry associations. Unfortunately, we do not have more detailed data to analyze the specificities of those industry associations considered by Chinese firms. It is noticeable the weaker importance given to the stakeholders by the Chinese firms, consistently lower than the importance of

government agencies. These values uncover again that hierarchical network structure and, perhaps, the remaining of a decision system proper to a command economy. In our sample the Chinese firms are smaller in size than American ones, but a test of mean differences show that they are in the same homogenous group as the Canadian firms.

Canadian firms show a behaviour not far from American firms, with three main exceptions: the importance of the other firms as partner for different contributions is generally lower than for the American firms, the role of the scientific associations is also considered less often important, and LP firms tend to value many different partners than HP firms. The importance of the stakeholder for most of the contribution is greater than for American firms, but not statistically significant and this reveals a good level of knowledge accumulated inside the companies, making a good argument for the networked structure of the knowledge flows. Quite interesting while not expected, the importance given to government agencies as a partner in networks is not statistically different from the averages for American firms for neither contribution.

We computed 420 correlation coefficients between the innovative performance and the importance for the 3 countries. Only 44 (10.5%) of them are statistically significant at 5%. Some of them are worth enough to be discussed. American firms have the lowest number of significant correlations, only 6 (4.3% of their total) and, more interesting, 5 of them are negative. The American firms show a significant and negative correlation between the intensity of innovation and the importance of government agencies for helping them to learn about new markets and this when USA have the lowest frequency of firms indicating the partner as being important for this contribution. There may be several explanations, one of them being that some firms stressing the importance of this

type of partner are more oriented to extend geographically their current markets and not to introduce really new products. Another interesting negative correlation coefficient concerns the factor Business Generation and the generic partner "other firms" for the contribution "Helps learn about new technologies". It is an interesting result explained mainly by the lower value of the z-score for this factor for American firms, -.248, contrasting with the highest frequency and importance given to this type of partner. In our sample, the American firms consider themselves less innovative, in terms of business generation, than the sample average. The tendency to acquisitions and mergers may be higher.

Chinese firms show, as expected, the many significant correlations, 23 (16.4%). They show high positive correlations between the importance given to external partners, for almost all types of contribution, and their innovative performance, which corresponds to the theory. The specificities of Chinese NSI are revealed by the positive significant correlation between the factor Intensity of innovation and the importance of governmental agencies for the contribution "Helps learn about new technologies", meaning that firms that appreciate the importance of this partner (and implicitly use it) have a better innovative performance. This affirmation may hold true for most developing NSI. The significant correlations between the importance of Industry associations and many types of contribution may be seen as another argument in favour of the effectiveness of this NSI. The different nature and behaviour of Chinese NSI is contrasted by the correlations between the importance given to Scientific Association and Intensity of innovation for no less than 6 contributions and this despite the lower frequencies in mentioning this type of partner (as seen in Table 1). This may suggest an

emerging re-arrangement knowledge power in this NSI, as well as the coexistence of an older, low-tech sector with new, high-tech industries with viable links with the scientific development. It also worth to mention the only negative and significant correlation coefficient between the factor Intensity of innovation and a partner, namely stakeholder, and this is found for the contribution "Identifies partner firms and organizations". For the same contribution and factor, the Scientific Associations partner type shows a positive significant correlation and they together, constitute an argument for the importance of distributed knowledge as presented by Hayek (1945). More explicitly, reliance on stakeholder's knowledge about possible partners for creating new products or services is a high risk option. Overall, only our first hypothesis, that American firms must show a higher correlation between their innovativeness and reliance on other firms was not confirmed. We think that the main reason, related to the higher averages of the importance given to other firms as contributors of knowledge, is that when a competitive advantage is used by most of the actors implied in the respective competition, this "advantage" ceases to differentiate between these actors. Some more subtle, qualitative characteristics may prevail.

Canadian firms have an intermediate number of significant correlation, 15, meaning 10.7% of the possible total. The average frequencies in mentioning different types of partners for specific contributions were quite close, generally, to values shown by American firms. Still, some differences exist in correlations between the 2 factors and the importance of partners for specific contributions. Mainly, the Intensity of innovation is positively correlated with the importance of Industry associations for 3 contributions, especially for helping to create networks of collaboration with other firms. This must be a

specificity of Canadian firms, many of them smaller or relatively new, trying to enter established networks.

Analyzing the construct Business generation we can observe significant correlations with governmental agencies for contributions like “Helps learn about new technologies” or “Helps learn about new markets”, which emphasizes the effectiveness of these agencies. The importance of universities have, they too, many positive correlations with the construct Business generation. The respective contributions are “Provide business advice”, “Identify partner firms and organizations” and “Undertakes innovative activities” and, keeping in mind that the Canadian firms’ averages for the same partners and contributions are the lowest, they all suggest a very efficient role of Canadian universities compared to other systems.

The data in the table 7 suggests that the partners’ perceived importance, especially for some of the criteria used here, is influenced, beyond the “general economic behaviour”, by factors linked to a specific NSI.

The data presented above support the idea that the 3 different NSI find themselves in different stages of evolution and most probably on different trajectories. The American NSI, with the fewer significant correlations between the constructs and the importance given by the respondents to different types of partners for specific contributions suggest that this system reached a high degree of self-organisation, with the most evaluated network of collaboration and an emphasis on the role of firms. With some few exceptions, the firms belonging to it master the meta-knowledge, the knowledge about where the needed knowledge is located and they have the mean to access it.

Canadian NSI shows the traits of a system in evolution, with a significant (and effective) role of governmental agencies, universities and industry associations, helping firms to innovate and compete in a global market. Some firms must still work to find their most appropriate partners. The data presented here can not explain why LP Canadian firms seem to rely on a larger number of partners' categories than HP firms. But two explanations could be considered: either these firms struggle to find a better support to improve their performance, or the imperfection of the "Other firms" variable, which counts as only one even if the number of this kind of partner could be higher. The contrasting values for the importance of different partner (HP vs LP firms) represent a specificity of Canadian NIS, which needs to be verified in other studies.

Chinese NSI combines reminiscences of the centrally planned economy, which may include some scarcity of knowledge resources or preferential access to these resources, underdevelopment of institutional system (Eun et al., 2006) with more evaluated aspects, like the effectiveness of scientific associations. The results confirm the relative weakness of linkages between Chinese firms, the need of more cooperation with universities coming from the fact that these have a relatively higher level of technology (Motohashi and Xiao, 2005).

The contributions of this study are twofold: first, it tries to give the support for the theory that NSI differs in form and effectiveness of implied actors. Using psychometric data we analyzed these differences from the firm's perspective. We consider this "impressionistic" view not less valid than other "objective" measures, like patent numbers or GDP per capita. On the other side, some important differences we observed between high and low performers inside the same NSI, with the respect to the frequency

they cite different partners, suggest that the reasons to look for help at a specific partner depends also on internal factors, regardless the characteristics of the specific NSI. Secondly, as a practical implication, we consider that national policies must be built to offer the tools the firms really need. And this includes maintaining or expanding programs that proved their efficiency. Differences in national cultures, even between regional cultures (Didero et al., 2008) may impede in the translation of external successful policies. We are considering that the positive correlation coefficients reveal insufficient exploited resources by firms. These positive coefficients show that firms using that type of partners improved their innovative performance. Another practical implication of this study is the guidance it provides to firms that intend to establish themselves in the countries that we compared with respect to the nature and object of the partnership that need to be developed in each country.

This study has also some limitations, the most important being that only 3 countries were considered. The firms included in the original sample show a constant bias favouring large firms, especially for United States. Financial and timing restriction impeded us to collect more data on firms and have enough respondents from many countries (all other countries have less than 100 responding firms). Another limitation is represented by the coarse-grained representation of the partner's types, especially "other firms" type. It was the price to pay in the trade-off between the need to obtain as much as possible information and let the questionnaire usable.

As a future direction, the methodology used here opens the way for both a refinement and an extension to other NSI.

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