Networks of Enterprises and Innovations: Evidence from SMEs in Vietnam

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Abstract

By using the latest dataset from the survey of SMEs conducted in Vietnam in 2011, we show that a firm both participating in a wider network of input suppliers, buyers, and associations of enterprises and conducting innovative activities in production has higher labor productivity than others, implying that networks of enterprises and innovation are complementary to each other in affecting performance of SMEs in Vietnam. We also find that supports of the government including providing better infrastructure to the SMEs and helping the SMEs to be formalized when being established are conducive to the development of the SMEs in Vietnam.

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Keywords: Complementary, supermodularity, Network, Innovation, SMEs.

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1. Introduction

Networks are considered important social capital of enterprises. Innovation is also widely known to be a key determinant of enterprise performance. A firm tends to change their technology and promote innovation to be suitable for a network that it is a member of it. At the same time, participating in a network influences innovations that a firm carries out and, subsequently, its overall performance.

In Vietnam, enterprises in general and SMEs in particular are concentrated in big cities, where they can find it easier to have adequate supplies of inputs and larger customers. This phenomenon is often explained as the enterprises are taking advantages of agglomeration economy, about which there are numerous studies. By locating in big cities, enterprises are able to easily contact with their suppliers and customers, and, therefore, reduce transaction costs (Appold, 1995; Fujita & Thisse, 2002; Sabel, Hirst, & Zeidin, 1989; Scott, 1988). More specifically, Mazzola and Bruni (2000), by estimating the probability of success of post-entry performance of new firms in southern Italy, find that inter-firm linkages contribute to success in production for order and subcontracting of these firms. On the relationship between inter-firm linkages and innovations of firms, there are a great number of studies world-wide. Nooteboom (1999) and Segarra-Blasco and Arauzo-Carod (2008) among others argue that inter-firm linkages are important for innovations of enterprises. Machikita and Ueki (2010) also find that a variety of linkages are important determinants of innovations of firms in East Asia.

Rigorous studies on the relationship between inter-enterprise linkages and innovations of enterprises in Vietnam are, however, few. Anwar and Nguyen (2011) argue that horizontal and vertical linkages between FDI and domestic firms in Vietnam have positive effects on innovations on marketing including the decision of domestic firms to export and the export share of domestic firms. Besides, Nguyen et al. (2008) identified innovation is an important factor leading to export activities of SMEs in Vietnam. Furthermore, Nam *et al.* (2009) analyze the enterprises in a steel

and iron industrial cluster in northern Vietnam, which are concentrated in a small geographical village, and find that these enterprises carry out multifaceted innovations and linkages between family enterprises are important for such innovations. Nevertheless, there is no research that mentions about the compelementary between innovations and networks of SMEs, which play an essential role in recent economic development in Vietnam. This paper sheds a light on the issue by analyzing the networks and innovations of SMEs in Vietnam.

The remaining this paper is organized as follows. The theory on complementarity between innovation and networking is discussed in Part 2. Theoretical framework for the paper and data are presented in Part 3. Empirical results and discussions are shown in Part 4. Main findings are summarized and conclusions are presented in the last part.

2. Innovation, networking and their complementarity

Theoretical framework to evaluate the effects of corporate system or organization called complementarity is provided on the basis of theories on supermodular optimization and games. Milgrom and Roberts (1995) applied this model to analyze structural change of a producing firm in order to fit their strategy. In particular, Arora (1996) suggests testing for complementarities in regression model. Later studies can test complementarity (Athey & Stern, 1998; Cassiman & Veugelers, 2002; Galia & Legros, 2004; Guidetti, Mancinelli, & Mazzanti, 2008; Ichniowski & Shaw, 2003; Mohnen & Röller, 2005).

Regarding the influence of management on firm performance, Athey and Stern (1998) employed alternative strategies to estimate the effect of organization design practices on performance in a cross-section of firms. Furthermore, Laursen and Foss (2003) identify nine new factors in Human Resource Management (HRM) including interdisciplinary workgroups; quality circles; systems for collection of employee proposals; planned job rotation; delegation of responsibility; integration of functions; performance related pay; firm-internal training; and firm-external training. They

conclude that all nine above aspects of HRM affect innovating abilities. Moreover, two factors related to individuals have high significance to innovation performance. On the other hand, innovation activities are complementary to each others. To illustrate, Cassiman & Veugelers (2002) used data from Community Innovation Survey of firm production in Belgium and find that there is complementarity between their own R&D and external technology sourcing activities.

In another paper on obstacles of macro policies' influence on firm's innovation, Mohnen and Röller (2005) tested discrete complementarities in innovation policy using European data on obstacles to innovation and find that the evidence regarding the existence of complementarity in innovation policies depends on the phase of innovation that is targeted as well as on the particular pair of policies that is being considered.

Another factor that affects networks of enterprises is physical infrastructure. Bharadwaj (2000) find that information technology infrastructure including system as a whole, resources, and intangible assets of IT, influences firm performance. In another study, Dollar, Hallward-Driemeier, and Mengistae (2005) compared how firm performance among Bangladesh, China, India, and Pakistan is affected by investment in climate that consists of public infrastructure. They conclude that better infrastructure reduces corporate costs and positively influences firm performance.

In this study, we advance the following hypotheses:

H1. *Innovation and network of enterprises positively affects performance, measured by labor productivity, of SMEs in Vietnam.*

H2. *Supports of the government by providing better physical infrastructure to and helping the formalization of SMEs are important for the performance, measured by labor productivity, of SMEs in Vietnam.*

3. Methodology and data

Conceptual framework

Conceptually, this paper is to analyze effects of the complementarity between innovations and networks of enterprises on the performance of enterprises. In other words, we are going to identify whether innovations and networks complement each other to induce higher performance of enterprises. According to Milgrom and Roberts (1990, 1995); Milgrom and Shannon (1994); and Mancinelli and Mazzanti (2009); Topkis (1998), the F(x) function is affected by $x_j = (x_{j1}, x_{j2}, \ldots, x_{jk})$ variables, where k is the number of variables such as policy, consumer behavior, monopoly pass-through, Bertrand and Cournot competition, strategic R&D, search, or matching; and j is the number of value a variable takes on. For instance, if j=2, that variable is a dummy variable. We have to determine variables x_j such that the function F(x) reaches max or supermodular in its parameters. Following Athey and Stern (1998); Mancinelli and Mazzanti (2009); Mohnen and Röller (2005), a productivity function of an enterprise in this study (PRODi) contains two main variables: innovations and networks.

$$PROD_i = PROD_i(IN, NET, Ø_i)\ \forall_i \quad (1)$$

where, IN and NET are innovations and networks, respectively. In our dataset, they are dummy variables. IN equals to 1 if an enterprise has any innovation activities and equals to 0 otherwise, i.e., IN(0,1). NET equals to 1 if an enterprise is in any formal networks such as an association of enterprises or has a wider network of input suppliers and/or buyers, i.e., NET(0,1). $Ø_i$ represents other exogenous variables representing history of enterprises, characteristics of the owners/managers, and infrastructure.

Because IN and NET variables take on either value: 1 or 0. There are, hence, four possibilities that an enterprise state is, namely 00 (no innovations, no network); 10 (no innovations, with network); 01 (with innovations; no network) and 11 (with both innovations and network). Variables IN and NET are complementary to each other through function PRODi that is supermodular if and only if:

$PROD_i(11, Ø_i)$ - $PRODi(00, Ø_i)$ ≥ $[PROD_i(10, Ø_i) - PROD_i(00, Ø_i)] + [PROD_i(01, Ø_i) - PROD_i(00, Ø_i)]$ (2)

If Inequation (2) holds, there is complementarity between innovations and network and, thus, the productivity function ($PROD_i$) of an enterprise is a supermodular.

Empirical model

To test the hypotheses advanced earlier, we use a simple estimation as follows:

$PROD_i = \beta_0 + \beta_1$ (characteristics of enterprises) + β_2 (link innovations and networks) + β_3 (infrastructure as electricity, water, road, rail) + ε_i (3)

where $PROD_i$ is the labor productivity of the enterprises in 2010 measured by the logarithm of value added divided by the number of full-time workers. Value added is calculated by subtracting material costs and other costs except labor cost from revenue; ε_i is error term; β_0 is intercept. Variables related to coefficients β_1 and β_3 are presented in Table 1. β_2 is used to estimate the complementarity between innovations and networks of enterprises. It is noted that in this paper we measure the networks of an enterprise by whether the enterprise is a member of any formal associations and whether the enterprise has a wider networks of suppliers and buyers than others. We believe that an enterprise that has networks of suppliers and buyers, which are more distant, and more diversified than others tend have wider networks.

If innovations and networks are complementary, PRODi function must be supermodular, i.e., $(b_1 + b_2 – b_3 - b_4) \geq 0$, where b_1 is the coefficient of the 00 state (no innovations, no network); b_2 is the coefficient of the 11 state (with both innovations and network); b_3 is the coefficient of the 01 state (no innovations, only network); and b_4 is the coefficient of the 10 state (only innovation, no network). We are going to one-sided t test with hypothesis H_0: $[b_1 + b_2 – b_3 - b_4] \geq 0$. H_0 is expected not to be rejected so that we can conclude that there is complementarity among the innovations and networks (Mancinelli & Mazzanti, 2009; Mohnen & Röller, 2005).

Data

We use the data from the Small and Medium Enterprises Vietnam Survey conducted in 2011 by Institute of Labour Studies and Social Affairs (ILSSA) in the Ministry of Labour, Invalids and Social Affairs (MOLISA), Central Institute for Economic and Management (CIEM) and Department of Economics, University of Copenhagen with funding from SIDA and DANIDA. The surveyed enterprises are in 10 cities/provinces in Vietnam including registered and informal ones. Due to some missing values, we finally use 2,494 observations in the dataset.

Table 1 presents data description. The focus is on two groups of variables: innovations and networks. Firstly, the innovation variable equals to 1 if in 2010 an enterprise has at least one innovative activity out of three activities including introduction of new products; improvement of existing products; and introduction of new production processes/new technology. The innovation variable equals to 0 if otherwise. The variable for networks of suppliers takes on value of 1 if an enterprise is either importing machines/equipment from abroad, importing materials from overseas, or outsourcing its production. It takes on value of 0 if otherwise. The variable for networks of buyers equals to 1 if an enterprise is either exporting its products or subcontracting part(s) of its production.

4. Regression results

We apply the simple OLS estimation in this paper. In Table 2, from column (1) to column (3), firm size is a categorial‡ variable, which does not affect productivity. However, when firm size is a continuous variable in column from (4) to (6), it positively affects labor productivity of the enterprises, which is similar to previous findings in other countries (Mancinelli & Mazzanti, 2009; Wincent, 2005).

‡ According to World Bank Group, a microenterprise is defined as an enterprise which employs fewer than 10 persons (size1), a small enterprise is defined as an enterprise which employs from 10 to 50 persons (size2), a medium enterprise is defined as an enterprise which employs from 50 to 300 persons(size3)

Complementarity between innovations and networks

As mentioned in Part 3, innovations and networks are binary variables, forming four dummy variables. We will find the condition so that $PROD_i$ function is supermodular or, in other words, there is complementarity between innovation and networking. We chose enterprises that had at least one type of innovations and have wider and more diversified networks as a base group. The coefficients of variables from inno_sup1 to inno_asso3 are negative and significant, suggesting that the productivity of enterprises that carried out innovations and had wider networks is higher than others. However, if an enterprise only carries out innovation and does not have a wider network (inno_sup2, inno_buyer2, inno_asso2 variables), the coefficients are insignificant or at 10% level of significance compared to base group, indicating that its productivity is not higher than enterprises that do not carry out innovation. It can be seen that enterprises with innovation activities perform better than those who only have wider networks. However, having both of them is the best for raising labor productivity.

However, Athey and Stern (1998); Mohnen and Röller (2005) indentify some weak point of using regression model. Particularly, we cannot know whether there is complementarity between innovations and networks or whether there is satisying supermodular condition of $PROD_i$ functions. We run the regression in Table 2 again with no constant term to estimate all coefficients of variables related to innovations and networks. We, then, do one-sided t-test[§] to test H_0 mentioned in Part 3. We expect that we cannot reject H_0, so there is complementarity between innovation and networking.

Table 3 provides results of one-sided t-test with innovations, networks of suppliers; innovations, networks of buyers; and innovations, association variables. We conclude not to reject H_0. In other words, there is complementarity between

[§] In Stata, after regression command, we use lincom command for coefficients of innovation and networking variables

innovations and networks of SMEs in Vietnam. The first hypothesis is, thus, supported.

Characteristics of enterprises and enterprise owners/managers

Variable firmage has negative and highly significant effects on labor productivity of the enterprises, indicating that younger enterprises tend to be more dynamic. It is interesting to observe that the variable iformal has positive and highly significant effects, suggesting that an SME that was formally registered when being established tends to have higher labor productivity in 2010 than others. It is often costly and time consuming for very small and small enterprises to be registered without any supports from the governement. This finding confirms Hypothesis H2 and implies that there is room for the government to promote SME development in Vietnam.

The regressions also show that enterprises of the owners/managers who graduated universities tend to have higher labor productivity than others, suggesting that education of owners/managers is an important determinant of the enterprise performance.

Physical infrastructure

In Table 2, Columns from (1) to (6) show that there are two kinds of infrastructure positively affecting enterprises' productivity. They are roads and electricity. If an enterprise finds it easy to access public electricity grids and roads, they will have higher productivity by around 33% and 9%, respectively, than those have more difficult access given that other factors are constant. This finding shows that the road and electricity systems in Vietnam do not meet requirements of the SMEs and SMEs in Vietnam need better access to such important services, which are the responsibility of the public sector.

5. Conclusion

With data on SMEs 2011 in Vietnam, we find evidence that local infrastructure where enterprise are situated and operate have significant influence on labor productivity of the SMEs. Main roads and public electricity grids affect the performance of SMEs positively and significantly. Moreover, initial support of the government in helping newly established enterprises to be formally registered also has positive effects on the labor productivity of the SMEs. These findings suggest important roles of the public sector in promoting the development of SMEs in Vietnam.

More importantly, we find the positive influence of innovations and networks on the performance of SMEs and show evidence of the complementarity between innovations and networks in Vietnam. If an enterprise carry out innovations and have wider and more diversified networks of suppliers, buyers, and business associations, they will perform better than others.

Table 1: Descriptive statistics of variables (N=2494)

Variable	Descriptions	Mean	Std. Dev.	Min	Max
lnProductivity	Log of productivity (Value added/employees)	10.86	0.77	7.50	15.41
Innovation					
newProduct	New product groups	0.04	0.20	0	1
impProduct	Improvements of existing products	0.38	0.49	0	1
newProcess	New production processes	0.13	0.34	0	1
Network of Suppliers					
Immachine	Imports (foreign equipment/machine)	0.52	0.50	0	1
Outsource	Outsource production	0.04	0.20	0	1
importD	Imports (foreign raw materials)	0.03	0.18	0	1
Network of Buyers					
exportD	Exporter	0.03	0.18	0	1
sub	Subcontractor	0.11	0.31	0	1
Joining formal association					
associationD	Member of one or more business associations	0.08	0.27	0	1
Controls					
fullworker	Number of Employees (fulltime)	14.04	27.84	1	321
firmage	Firm age	13.39	9.42	2	61
iformal	Formally registered business (formal = 1; informal=0)	0.42	0.49	0	1
road	Main road	0.78	0.42	0	1
rail	Easy access to rail	0.51	0.50	0	1
port	Easy access to port	0.39	0.49	0	1
elec	Access to public electricity grid	0.97	0.16	0	1
water	Access to public provided water system	0.67	0.47	0	1
Characteristics of respondent					
gender	Gender of respondent (1 = male; 0 = female)	0.63	0.48	0	1
age	Age of respondent	44.70	10.61	16	91
kinh	Ethnicity of respondent (Kinh=1; other=0)	0.93	0.25	0	1

primary	Primary school	0.08	0.28	0	1
lower	Lower secondary	0.28	0.45	0	1
upper	Upper secondary	0.62	0.49	0	1
uni	University	0.24	0.43	0	1
skill	Skills of repondent (skills=1; unskills =0)	0.94	0.24	0	1
cadre	Village, commune, district, province cadre	0.03	0.17	0	1
veteran	War veteran	0.08	0.27	0	1
dv	Member of the Communist Party	0.10	0.29	0	1
worksoe	State enterprise (previous work)	0.20	0.40	0	1
worknonsoe	Non-state enterprise	0.26	0.44	0	1
selfindus	Self-employed in manufacturing-construction	0.09	0.28	0	1
selfser	Self-employed in trade/services	0.19	0.39	0	1
Province					
prov1	Ha Noi	0.12	0.32	0	1
prov2	Phu Tho	0.10	0.30	0	1
prov3	Ha Tay	0.14	0.34	0	1
prov4	Hai Phong	0.09	0.28	0	1
prov5	Nghe An	0.14	0.34	0	1
prov6	Quang Nam	0.06	0.24	0	1
prov7	Khanh Hoa	0.04	0.19	0	1
prov8	Lom Dong	0.03	0.18	0	1
prov9	TP HCM	0.23	0.42	0	1
prov10	Long An	0.05	0.22	0	1

Source: Authors' calculation from SMEs 2011 data

Table 2: Determinants of labor productivity

	(1)	(2)	(3)	(4)	(5)	(6)
size2	0.0381	0.0540	0.0509			
	(1.07)	(1.50)	(1.41)			
size3	0.0419	0.0507	0.0484			
	(0.61)	(0.73)	(0.68)			
lnEmp				0.0553***	0.0643***	0.0653***
				(3.36)	(3.92)	(3.91)
inno_sup1	-0.255***			-0.226***		
	(-6.87)			(-5.99)		
inno_sup2	-0.108*			-0.0887*		
	(-2.55)			(-2.09)		
inno_sup3	-0.0747*			-0.0584		
	(-2.16)			(-1.68)		
inno_buyer1		-0.214***			-0.178**	
		(-3.60)			(-3.03)	
inno_buyer2		-0.108			-0.0876	
		(-1.85)			(-1.51)	
inno_buyer3		-0.229**			-0.200*	
		(-2.68)			(-2.35)	
inno_asso1			-0.227**			-0.170*
			(-2.83)			(-2.10)
inno_asso2			-0.114			-0.0738
			(-1.43)			(-0.92)
inno_asso3			-0.236*			-0.214*
			(-2.32)			(-2.09)
gender	0.00597	0.0179	0.0184	0.00763	0.0183	0.0187
	(0.20)	(0.60)	(0.62)	(0.26)	(0.62)	(0.63)
age	-0.00268	-0.00281	-0.00303*	-0.00259	-0.00267	-0.00284
	(-1.77)	(-1.85)	(-2.00)	(-1.72)	(-1.77)	(-1.89)
firmage	-0.00634***	-0.00665***	-0.00666***	-0.00671***	-0.00704***	-0.00699***
	(-3.73)	(-3.90)	(-3.90)	(-3.99)	(-4.17)	(-4.14)
iformal	0.155***	0.159***	0.159***	0.121**	0.122**	0.123**

	(4.11)	(4.19)	(4.17)	(3.22)	(3.22)	(3.24)
road	0.0974**	0.116**	0.116**	0.0896*	0.105**	0.104**
	(2.64)	(3.14)	(3.13)	(2.44)	(2.87)	(2.83)
rail	0.0547	0.0489	0.0525	0.0549	0.0498	0.0539
	(1.29)	(1.15)	(1.23)	(1.30)	(1.17)	(1.26)
port	-0.00343	0.00250	-0.00234	-0.00520	-0.000586	-0.00448
	(-0.08)	(0.06)	(-0.05)	(-0.12)	(-0.01)	(-0.10)
elec	0.334***	0.337***	0.341***	0.329***	0.332***	0.335***
	(3.39)	(3.42)	(3.46)	(3.38)	(3.40)	(3.43)
water	-0.0150	-0.0115	-0.0131	-0.00958	-0.00591	-0.00748
	(-0.41)	(-0.31)	(-0.35)	(-0.26)	(-0.16)	(-0.20)
kinh	0.0136	0.0102	0.0139	0.0129	0.00991	0.0122
	(0.25)	(0.19)	(0.26)	(0.24)	(0.18)	(0.22)
primary	0.0134	-0.00495	-0.00417	0.00749	-0.00926	-0.00806
	(0.14)	(-0.05)	(-0.04)	(0.08)	(-0.10)	(-0.08)
lower	0.0626	0.0549	0.0547	0.0575	0.0507	0.0515
	(0.67)	(0.59)	(0.59)	(0.63)	(0.56)	(0.57)
upper	0.149	0.149	0.148	0.137	0.137	0.137
	(1.59)	(1.59)	(1.58)	(1.50)	(1.50)	(1.51)
uni	0.114**	0.130**	0.128**	0.0889*	0.101*	0.0994*
	(2.83)	(3.24)	(3.19)	(2.20)	(2.51)	(2.47)
skill	0.102	0.105	0.108	0.106	0.110	0.112
	(1.75)	(1.80)	(1.85)	(1.82)	(1.89)	(1.93)
cadre	0.0969	0.0823	0.0803	0.0951	0.0818	0.0811
	(1.27)	(1.08)	(1.06)	(1.25)	(1.07)	(1.07)
veteran	-0.0267	-0.0189	-0.0169	-0.0257	-0.0185	-0.0180
	(-0.48)	(-0.34)	(-0.30)	(-0.46)	(-0.33)	(-0.32)
dv	0.0689	0.0723	0.0717	0.0636	0.0649	0.0663
	(1.34)	(1.41)	(1.40)	(1.24)	(1.27)	(1.30)
worksoe	0.0692	0.0707	0.0743	0.0649	0.0662	0.0691
	(1.58)	(1.61)	(1.69)	(1.49)	(1.51)	(1.58)
worknonsoe	0.103**	0.111**	0.112**	0.0925*	0.0988**	0.0995**
	(2.72)	(2.93)	(2.97)	(2.46)	(2.62)	(2.64)

selfindus	0.0978	0.0953	0.0960	0.0934	0.0916	0.0914
	(1.94)	(1.90)	(1.91)	(1.87)	(1.85)	(1.84)
selfser	0.166***	0.173***	0.174***	0.160***	0.166***	0.166***
	(3.74)	(3.88)	(3.90)	(3.60)	(3.71)	(3.74)
_cons	10.43***	10.48***	10.50***	10.37***	10.39***	10.38***
	(61.28)	(60.17)	(54.21)	(61.28)	(60.35)	(53.74)
N	2494	2494	2494	2494	2494	2494
R^2	0.293	0.287	0.286	0.297	0.291	0.291

Note: OLS estimation with robust check; province variables are dropped down the table above; and t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Testing complementarity between innovations and networks

Dependent variable	Variables on which complementarity is tested	One-sided t-test[a]
Productivity	Innovations, Suppliers	-.037
	Innovations, Buyers	.310
	Innovations, Associations	.671

[a]One-sided t test is higher than 1.645 at 5% probability level.

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