THE EFFECTS OF KNOWLEDGE FROM COLLABORATIONS ON EXPLORATORY INNOVATION OF GREEK SMES

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Abstract. *There is very limited research linking the collaborations of Greek SMEs and their innovation output. This paper argues that exploration innovation output is linked to the knowledge flows towards SMEs coming through their collaborations. It explores three types of knowledge, namely managerial, technological and market-related. It finds that the exchange of management knowledge has a positive and significant effect on exploratory innovation, the exchange of technical/technological knowledge has a negative and significant effect, and the exchange of market knowledge does not have an effect on innovation output. Also, partnering with same nationality firms has a negative effect on exploratory innovation.*

Keywords: *SMEs; exploratory innovation; collaborations; knowledge flows.*

Theory

According to Huizingh (2011) the concept of open innovation is gradually being integrated in the innovation management practices, transforming itself into the new status quo. The open innovation perspective allows for penetrating novel technology, product, and market landscapes that extend beyond the actual core business of firms and that would be difficult to discover by isolated individual firm (Chesbrough, 2007). Collaborations are important means for open innovation (Sammarra & Biggiero, 2008) because they allow partnering firms to share knowledge and resources (e.g. Bierly, Damanpour & Santoro, 2009; Gulati, Dialdin & Wang, 2002). Knowledge from external relationships expands the firm's knowledge base (Bierly et al., 2009) that can be applied to commercial ends (e.g. Spithoven, Clarysse & Knockaert, 2010), thus enhancing the development of the innovative capability of a firm (Li & Tang, 2010). So, according to the open innovation perspective, innovation can emerge by combining and recombining knowledge elements from collaborations (Bauer & Leker, 2013; Wang, Rodan, Fruin & Xu, 2014). However, in the case of the Greek business environment there is clear deficit of research evidence on the effect of collaborations (as an open innovation practice) on the innovation output of firms (Livieratos, 2009). Moreover, SMEs are major actors for innovation (e.g. Van de Vrande, De Jong, Vanhaverbeke & De Rochemont, 2009) and the question arises as to the current state of Greek SMEs' benefits from open innovation through collaborations.

In line with Sammarra and Biggiero (2008), the purpose of this study is to explore the types of knowledge that Greek SMEs exchange and share with their partners in the context of three basic types: (1) technical/technological knowledge, (2) managerial knowledge, and (3) market knowledge, and their effects on a firm's innovation output. The first research question is whether SMEs exchange more than one type of knowledge through their collaborations. The second research question addresses the relationship between different types of knowledge acquired through collaborations and the innovation output of Greek SMEs. Furthermore, empirical contributions have confirmed that the effects of collaborations on innovation output are contingent on the type of innovation task at hand – exploratory and/or exploitative – and that a contingency research approach might be more effective (Bauer & Leker, 2013; Hernández-Espallardo, Sánchez-Pérez & Segovia-López, 2011; Yamakawa, Yang & Lin, 2011). This paper focuses on exploratory innovation only. Exploratory innovation refers to the creation of knowledge that differs from that used by a focal firm in prior innovations even though this knowledge may have been in existence earlier elsewhere (March, 1991). Empirical investigation of the effects of collaborations on exploratory innovation is very recent and this paper

attempts to fill this literature gap for the case of Greek SMEs (Bierly et al., 2009; Hernández-Espallardo et al., 2011).

Methodology

The present study acquired data from managers of Greek SMEs in order to obtain factual information on basic company demographics and the collaborations of these organizations for knowledge creation and innovation (e.g. Van de Vrande et al., 2009). The list of candidate firms was acquired from the website of the Athens Chamber of Commerce and Industry. The sample chosen was cross-sectional and contains high-tech as well as low-tech SMEs. The interviewees completed telephone and web-based questionnaires and the response rate of 11% is considered normal for this methodology (Saunders, Thornhill & Lewis, 2007). The dependent variable is *Number of exploration products* and, in line of Sammarra and Biggiero (2008), the independent variables are the *Number of collaborations; Collaboration experience; Exchange of management knowledge; Exchange of technological knowledge; Exchange of market knowledge.* The control variables are *Strength of ties; Trust in ties; Social capital; Age of the firm*; *Number of employees; Number of employees in R&D; Number of patents; Collaboration manager; Same nationality; Formal collaboration; High tech firm. Strength of ties* measures the frequency of interaction in a collaboration to assess the strength of the relationship. *Trust in ties* asked whether on average respondents have developed trust in their collaboration and *Social capital* whether they believe they have developed social capital though their collaboration. Firm performance declines with firm age; that is, profit falls, margins get thinner, costs rise and firms tend to innovate less on their own when they age, since they are faced with significant rigidities that may hinder change (Loderer & Waelchli, 2009). So the age of a focal firm was controlled for using the variable *Age of the firm*. Firm size is also a critical variable identified in the literature, as larger firms have more financial means and resources to invest in R&D (Rothaermel & Deeds, 2004), so the control variable *Number of employees* was introduced. Another important variable that was controlled for was *Number of employees in R&D*, as it has been shown in the literature that R&D effort is a significant determinant of a firm's innovation output (Faems, Van Looy & Debackere, 2005). The control variable *Number of patents* was calculated as the sum of patents obtained by a firm because Stuart (2000) has argued that such a variable is a particularly good control for unobserved heterogeneity (due to factors such as inter-firm differences in internal processes and incentive structures, as well as differences in underlying innovation strategies) that produce variance in firms' capabilities, opportunities, or dispositions to patent. Finally we controlled for the existence of a dedicated collaboration manager using the dummy variable *Collaboration manager,* for a collaboration between firms of the same nationality using the dummy variable *Same nationality,* and whether the collaboration is formal using the dummy variable *Formal collaboration*. Finally, *High tech firm* is a dummy variable to control for high technology firms.

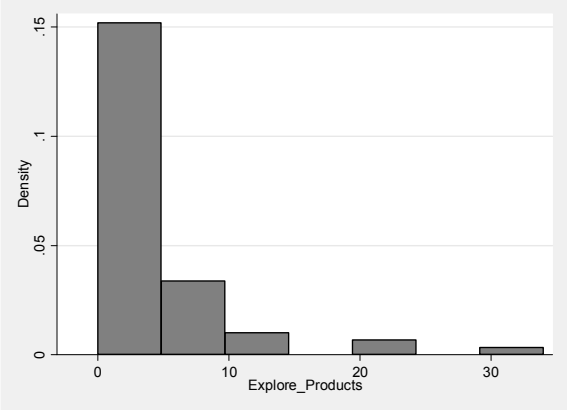

Figure 1. The distribution of the dependent variable: Number of exploration products

Since the dependent variable, *Number of exploration products,* is a count variable with non-normal distribution (see Figure 1) and because of fear of overdispersion in the data, Negative Binomial regression models were run using the robust option to obtain robust standard errors for the parameter estimates (Cameron & Trivedi, 2009) to control for mild violation of underlying assumptions and because we need to be consistent (i.e. asymptotically unbiased) but we do not want to have to assume homoskedasticity and normality of the random error terms. Also, the distribution of some of the variables was clearly non-normal and in those cases the variables were transformed by taking the natural logarithm.

Results

The descriptive statistics are shown in Table 1 and it is worth noting that Greek SMEs exchange management, technological and market knowledge with their partners almost at equal levels and with similar standard deviation levels for all three types of knowledge exchanged.

Table 1. Descriptive statistics of all the variables

Variable (Obs=67)	*Mean*	*Std. Dev.*	*Min*	*Max*
Number of exploration products	3.21	2.24	0	11
log(Number of collaborations)	1.25	0.86	0	3.91
log(Collaboration experience)	1.48	0.88	-0.69	3.21
Exchange of management knowledge (Likert scale)	4.31	1.45	1	7
Exchange of technological knowledge (Likert scale)	4.97	1.33	1	7
Exchange of market knowledge (Likert scale)	4.40	1.44	2.5	7
Strength of ties (Likert scale)	5.49	1.25	2	7
Trust in ties (Likert scale)	5.63	0.75	3.67	7
Social capital (Likert scale)	5.42	0.85	1.75	7
log(Age of the firm)	2.19	1.03	-0.69	3.95
log(Number of employees)	2.34	1.10	0	5.52
log(Number of employees in R&D)	1.03	0.85	0	2.56
Number of patents	0.61	1.29	0	5
Collaboration manager (dummy variable)	0.40	0.49	0	1
Same nationality (dummy variable)	0.65	0.37	0	1
Formal collaboration (dummy variable)	0.78	0.37	0	1
High tech firm (dummy variable)	0.52	0.50	0	1

The VIF collinearity diagnostics and correlations are shown in Table 2 and the VIF coefficients are low indicating no significant problem with multicollinearity.

Table 2. Correlations and collinearity diagnostics (obs=57)

		VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Number of exploration products	**(1)**	1.60	1.00																
log(Number of collaborations)	**(2)**	1.62	0.15	1.00															
			0.25																
log(Collaboration experience)	**(3)**	2.91	-0.07	0.18	1.00														
			0.60	0.17															
Exchange of management knowledge	**(4)**	3.13	0.01	0.00	0.08	1.00													
			0.91	0.95	0.50														
Exchange of technological knowledge	**(5)**	5.74	-0.05	-0.02	0.35*	0.47*	1.00												
			0.68	0.87	0.00	0.00													
Exchange of market knowledge	**(6)**	1.86	0.10	0.12	0.11	0.22	0.23	1.00											
			0.42	0.37	0.40	0.08	0.08												
Strength of ties	**(7)**	4.08	-0.04	0.09	0.26*	0.54*	0.51*	0.45*	1.00										
			0.72	0.46	0.04	0.00	0.00	0.03											
Trust in ties	**(8)**	4.34	0.08	0.17	0.12	0.12	0.44*	0.47*	0.39*	1.00									
			0.51	0.19	0.35	0.35	0.00	0.04	0.00										
Social capital	**(9)**	3.47	0.01	0.19	0.11	0.37*	0.15	0.26*	0.28*	0.41*	1.00								
			0.88	0.15	0.41	0.00	0.23	0.02	0.03	0.00									
log(Age of the firm)	**(10)**	2.53	-0.05	0.01	0.67*	-0.04	0.19	-0.09	0.01	0.08	-0.09	1.00							
			0.67	0.91	0.00	0.73	0.14	0.49	0.90	0.54	0.46								
log(Number of employees)	**(11)**	2.71	-0.13	0.18	0.34*	-0.09	0.04	-0.05	0.08	0.25	0.13	0.38*	1.00						
			0.30	0.17	0.01	0.49	0.73	0.70	0.53	0.06	0.33	0.00							
log(Number of employees in R&D)	**(12)**	1.97	-0.06	-0.02	0.05	0.12	0.08	0.01	0.02	0.22	0.24	-0.06	0.50*	1.00					
			0.65	0.86	0.71	0.41	0.56	0.94	0.84	0.13	0.11	0.67	0.00						
Number of patents	**(13)**	1.50	-0.01	-0.11	0.20	0.06	0.19	-0.16	-0.05	0.13	0.15	0.18	0.09	0.26	1.00				
			0.91	0.40	0.11	0.62	0.13	0.22	0.69	0.31	0.24	0.16	0.46	0.07					
Collaboration manager	**(14)**	1.92	0.27*	0.25	0.18	-0.081	0.08	0.23	0.07	0.23	0.17	0.05	0.10	0.14	0.13	1.00			
			0.03	0.05	0.17	0.54	0.54	0.07	0.59	0.07	0.18	0.70	0.41	0.35	0.31				
Same nationality	**(15)**	2.48	-0.01	0.10	-0.06	0.10	-0.11	0.31*	0.14	0.20	0.10	-0.16	-0.32*	-0.11	-0.02	-0.06	1.00		
			0.90	0.44	0.60	0.44	0.37	0.01	0.26	0.12	0.42	0.21	0.01	0.44	0.87	0.61			
Formal collaboration	**(16)**	2.35	-0.03	0.29*	0.18	0.21	0.24	0.06	0.40*	0.22	0.11	0.03	0.19	-0.01	-0.13	-0.19	-0.05	1.00	
			0.77	0.02	0.15	0.10	0.06	0.63	0.01	0.08	0.38	0.78	0.15	0.92	0.32	0.14	0.69		
High tech firm	**(17)**	1.69	-0.24	0.11	0.12	-0.04	-0.00	-0.23	0.06	-0.14	0.01	0.15	0.35*	0.26	0.01	-0.07	-0.33*	0.08	1.00
			0.07	0.39	0.34	0.72	0.97	0.07	0.64	0.26	0.91	0.26	0.01	0.08	0.90	0.55	0.01	0.53	

*p<0.0

Table 3 shows the results for *Number of exploration products*. The results indicate that the exchange of management knowledge has a positive and significant effect on exploratory innovation only, the exchange of technical/technological knowledge has a negative and significant effect on exploratory innovation output, and the exchange of market knowledge does not have an effect on innovation output. The results indicate that trust is the lubricant for collaboration effectiveness and that the sampled firms exchange mildly useful technological knowledge with partners (although they make the effort to exchange such knowledge), and probably rely more on their internal technological expertise to produce innovation. This can be an indication of a closed innovation strategy of Greek SMEs when it comes to sourcing technological knowledge through their collaborations. The results also indicate that when firms share high social capital with their partners (i.e. when they share the same vision, goals and commit strongly) the effect is negative (probably due to heavy alignment with partners that leads to learning inertia), and management knowledge exchange with partners has a positive effect (probably because it saves time and resources thus reducing the risk associated with exploratory innovation). Also, partnering with same nationality firms has a negative effect on exploratory innovation probably because it reduces the requisite variety in resources required for exploration and risk taking.

Table 3. Negative binomial regression for dependent variable Number of exploration products

	Robust					
Number of exploration products	***Coef.***	***Std. Err.***	***z***	***P>|z|***	***[95% Conf.***	***Interval]***
log(Number of collaborations)	.0836248	.0986341	0.85	0.397	-.1096945	.2769441
log(Collaboration experience)	.1441136	.1626389	0.89	0.376	-.1746527	.46288
Exchange of management knowledge	.1889913	.0790855	2.39	0.017	.0339865	.3439961
Exchange of technological knowledge	-.3944923	.119195	-3.31	0.001	-.6281102	-.1608744
Exchange of market knowledge	.0434124	.0799443	0.54	0.587	-.1132756	.2001004
Strength of ties	.1063777	.0903419	1.18	0.239	-.0706891	.2834445
Trust in ties	.4687203	.2294665	2.04	0.041	.0189743	.9184663
Social capital	-.4291554	.1341193	-3.20	0.001	-.6920244	-.1662864
log(Age of the firm)	-.0307444	.1280857	-0.24	0.810	-.2817879	.220299
log(Number of employees)	-.1821304	.1172683	-1.55	0.120	-.411972	.0477113
log(Number of employees in R&D)	.1045432	.1363202	0.77	0.443	-.1626396	.3717259
Number of patents	-.1097697	.0622506	-1.76	0.078	-.2317785	.0122392

Collaboration manager	.2255168	.2120045	1.06	0.287	-.1900043	.6410379
Same nationality	-.5644885	.2916624	-1.96	0.050	-1.136136	.0071593
Formal collaboration	-.3227069	.3300685	-0.98	0.328	-.9696294	.3242155
High tech firm	-.2708204	.179626	-1.51	0.132	-.6228809	.0812401
_cons	2.064986	.5907208	3.50	0.000	.9071949	3.222778
/lnalpha	-16.16376	3.071424			-22.18364	-10.14388
alpha	9.55e-08	2.93e-07			2.32e-10	.0000393

Negative binomial regression
Number of obs = 57
Dispersion = mean
Wald chi2(16) = 78.29
Log pseudolikelihood = -81.518936
Prob > chi2 = 0.0000

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