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HOW TO PROMOTE OPEN INNOVATION IN EGYPT? ANSWERS FROM THE EGYPTIAN NATIONAL INNOVATION SURVEY.

RASHA Y. TANTAWY*
Assistant Lecturer, Nile University, Cairo, Egypt.
Technology Innovation Entrepreneurship Center (TIEC), Cairo, Egypt
rashatantawy@nileu.edu

NIZAR BECHEIKH
Assistant Professor,
The American University in Cairo (AUC), New Cairo, Egypt.
nbecheikh@aucegypt.edu

Abstract

Increased knowledge on the adoption of open innovation (OI) in less developed countries (LDCs) is required as emerging markets in these countries evolve. In this paper, OI in Egyptian firms is studied. A group of variables are investigated that directly affect innovative small and medium enterprises (SMEs) in Egypt to fathom how open are these firms to an OI strategy and what makes them more open than others.

The objective of this research is twofold: 1) investigate if Egyptian manufacturing SMEs use the OI model to innovate, and 2) identify the determinants that push these firms to adopt an OI strategy. The independent variables investigated are both firm specific (size, location, absorptive capacity and ownership structure), and industry related (the technological intensity of the industry in which the firm operates and the availability of public financial support).

Using a dataset derived from the first Egyptian National Innovation Survey, two linear regression models are estimated to test the effect of the different determinants included in our hypotheses on the tendency of firms to connect with knowledge institutions on one side and business partners on the other side for innovation purposes. Results show that some determinants of OI play a different role depending on whether it's about openness to knowledge institutions or to business partners. The discussion of our research results contributes to the literature, and opens the door to several research avenues on OI in LDCs. Moreover, it allows the generation of several recommendations for both managers and policy makers interested in fostering innovation and promoting an OI culture in Egypt.

Keywords: Innovation in SMEs; Open Innovation; Emerging markets; Networking; OLS regression.

* Corresponding author. Please address all correspondence to: Rasha Y. Tantawy, Technology Innovation and Entrepreneurship Center (TIEC), B5, Smart Village, Cairo Alex Desert Road, Cairo, Egypt.

Introduction

A review of the literature on innovation in small and medium enterprises (SMEs) shows that studies on knowledge exchange and collaboration for innovation purposes are limited to developed countries and are quite scarce for under developing countries and less developed countries(LDCs). The term "Open Innovation" (OI) was coined by Chesbrough in 2006, opening up the way for a new wave of research on open innovation models. From 2006 to 2011, several empirical papers and case studies have been published to investigate the OI phenomenon in different contexts and industries. However, very few of this research were dedicated to developing and less developed countries.

On the other side, it's argued that in the context of globalization, emerging economies are playing a far greater role in the world's economy today, and they are expected to play an even greater role in the coming decades (Siqueira & Bruton, 2010). Many "latecomer" firms from LDCs have increasingly built an innovation-based competitive advantage in international markets (Hobday, 2005). Often, these firms are competing from behind the world technology frontier. The catching-up reality of LDCs urged many authors to argue that the innovation models underlying the innovation activity in developed countries are, at the best, partially valid when applied to developing countries. Additional research is therefore needed to further investigate the specific reality of innovation in LDCs and understand the innovation patterns followed by firms.

Following this line of research, this paper contributes to increase knowledge on the adoption of OI in LDCs by examining its determinants in Egyptian SMEs. The OI determinants explored are both firm specific (firm size, location, absorptive capacity and ownership structure), and industry related (the technological intensity of the industry in which the firm operates and the availability of public financial support).

The remainder of this paper is organized as follow. In the next section we will review the published literature on OI and its determinants included in this research. The objective is to: 1) define what is meant specifically by the term open innovation, and 2) generate our research hypotheses. Research methodology is then thoroughly described and summary statistics are provided. Results are presented in a third section concluded with a discussion of the research findings and recommendations for future research, managers, and policy-makers.

Literature Review

Open innovation has become an important research theme for both academia and industry. Yet, most OI studies focused primarily on large firms in high technology sectors (Verbano et al., 2011). There have been few attempts to understand how SMEs implement OI and what factors affect it especially in LDCs.

What is Open Innovation?

Basically, open innovation corresponds to the situation where a company opens up its "solid" boundaries to exchange and share knowledge for innovation purposes. Part of OI is when a firm lets valuable knowledge flow in from the outside in order to create opportunities for cooperative innovation processes with customers, suppliers, and/or

other partners. OI also includes the exploitation of ideas and intellectual property (IP) in order to bring them to market faster than competitors can (Gassmann & Enkel, 2004). The system is referred to as open because the boundaries of the product development funnel, otherwise "hermetic", become "porous" and "permeable". Some ideas from innovation projects may be initiated by other parties before entering the firm's internal development funnel, while some other projects may leave the funnel before getting to the last gate, and are therefore further developed by other parties (Dittrich and Duysters2007). This means that innovation can be regarded as resulting from distributed inter-organizational networks, rather than from single firms (Perkmann and Welsh2008).

The OI process redefines the boundary between the firm and its surrounding environment, making the firm more porous and embedded in loosely coupled networks of different actors, collectively and individually working towards commercializing new knowledge (Dodgson, Gann, Salter, 2006).

Open Innovation and Absorptive Capacity

Absorptive capacity (ACAP) has been recognized as an important factor catalyzing open innovation adoption. ACAP is defined as the "ability to recognize the value of new, external information, assimilate it, and apply it" (Zahra and George 2002: 185) Yet according to Newy (2010: 730) "different absorptive capacity may be required for inbound versus outbound open innovation". Brunswicker & Hutschek (2010) add that cognitive distance may affect "a firm's ability to absorb external knowledge". This suggests that although absorptive capacity is critical for innovation, when it comes to open innovation it is affected by the direction of flow of knowledge and the "distance" between partners. Actually, the seeker and the provider of innovation information and knowledge must be "sufficiently close, in cognition and language, to enable meaningful communication" and collaboration (Nooteboom 1999).

These arguments suggest that it's essential for firms located in LDCs to enhance their ACAP in order to get closer to those firms innovating at the technology frontier and collaborate with them for innovation purposes. Similarity between partner firms' knowledge and knowledge processing systems is actually critical for them to learn from each other and take advantage of the collaboration (Lane & Lubatkin 1998). Therefore, we propose that:

> **H1**. SMEs with high absorptive capacity are more likely to engage in open innovation.

Open Innovation and Financial Support

The objective of OI is to allow firms go beyond their, usually limited, internal capabilities and get access to complementing resources in order to introduce more radical innovations. This innovation model is gradually becoming inevitable for those firms who want to make innovation their main competitive edge. However, as technologies become more complex and sophisticated, firms need more resources including financial resources and human resources to develop and improve them (Gnyawali & Park 2009). Prochnik & Dias (2005) argue that economic cost and the lack of finance are among the most serious obstacles to innovation in developing countries. The availability of financial support will permit the availability of required

resources needed for partners to share upon collaboration. The resource limitation problem which seems to be prevalent especially among SMEs may hinder them from undertaking large-scale innovation projects (Liu and Schwörer, 2011). Moreover, as noted by Chesbrough (2006), direct incentives in the form of public financial support often under-serve small and medium sized enterprises. Therefore we propose:

> **H2.** The availability of financial support positively affects SMEs' tendency to collaborate with partners to innovate.

Open Innovation and Ownership Structure

Several studies have shown a significant positive relationship between multi-nationality and performance (Frenz and Ietto-Gillies, 2007; Goerzen and Beamish, 2003). Herstad et al. (2008) found that superior innovation performance is associated with predominant international linkages within the value chain. International interaction has become paramount for enterprises that want to stay at the cutting edge of innovation (Hacievliyagil and Auger, 2010). Ebersberger et al (2011) explain that employees of multinational companies are exposed to richer knowledge flows and broader social networks than are the employees of uni-national firms. They consequently conclude that operating in more than one country and/or inflow of employees with multinational background has a positive impact on innovation performance and success. Moreover, Dachs et al. (2007) found that foreign ownership yields a higher innovation output and higher labor productivity. They conclude that affiliates of foreign multinationals show similar to higher propensity to partner than domestically owned enterprises. Therefore we hypothesize that:

> **H3**. Being part of a larger foreign company affects positively the ability of a firm to partner for innovation purposes.

Open Innovation and Technological Intensity

While the relationship between the OI behavior of firms and the technological intensity of the industry in which they operate has not been extensively investigated in the literature, the few existing research show a significant relationship between the two variables. Verbano et al. (2011), for example, found that while SMEs in industries of low or medium low-tech intensity indicate high capacity and aptitude to innovate, they make little use of OI practices. On the other hand, Miotti and Sachwald (2003) notice that even the largest companies in high technology industries lack all the necessary capabilities to cope with emerging technologies, hence the necessity to partner with external parties to be able to innovate. Moreover, Daurte and Sarkar (2011) acknowledge that cooperation is linked to more formal collaboration, generally firm-firm collaboration, where a large focus on market features, especially technological intensity, was found. Therefore we hypothesize that:

> **H4.** The technological intensity of the industry in which the firm operates positively affects its ability to engage in open innovation projects.

Control variables

Firm size and location are introduced in our analysis as control variables. The general innovation literature shows a mixed relationship between firm size and innovation performance (Becheikh et al., 2006). On one side, compared to larger ones, small firms usually face constraints associated with the shortage of financial, management, marketing, and knowledge resources, as well as technically qualified employees. However, on the other side, too many SMEs tend to be more flexible and specialized rather than diversified in their technological competencies and therefore better prepared to innovate.

The literature on OI suggests however a positive correlation between the size of the firm and its ability to collaborate with partners to innovate. As asserted by De Backer et al. (2008), larger firms tend to innovate more openly than smaller firms. Munier (2006) argues that findings show that large firms are definitely more qualified to weave innovative relations in fields which are traditionally reserved to them such as competencies of positioning on the market, developing co-operations but also financing and sale of the innovation. Therefore, we propose that:

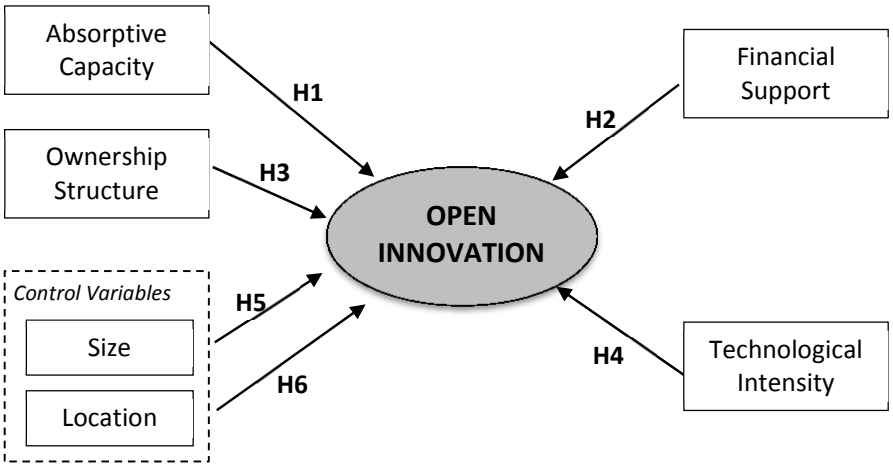
> **H5**. The size of the firm is positively associated with its ability to collaborate with partners to innovate.

In addition, research, although scarce, has shown a relationship between the location of a firm and its ability to partner for innovation. Firms located in technological parks, with access to resources, networks and innovation platforms are more likely to cooperate with other peer partners. De Backer et al. (2008) investigated the relationship between geographic proximity and the decision of companies to innovate openly in Europe. They found that European companies seem to be more willing to cooperate with external innovators located also in Europe than with those outside Europe. However, evidence on the impact of firm's location on its open innovation practices is rather lacking for companies located in the rest of the world. Therefore we propose that:

> **H6**: The location of a firm has a significant effect on its tendency to cooperate for innovation purposes.

Figure 1 shows the conceptual framework of this research, and depicts the dynamics between open innovation and the determinants investigated in this study.

Figure 1. Conceptual Framework and Research Hypotheses



Methodology and Summary Statistics

Data

The data used in this research is extracted from a survey conducted in 2009 by the Egyptian Ministry of Scientific Research on 3000 enterprises covering various Egyptian governorates and cities. The survey used a questionnaire adapted from the third edition of the Oslo Manual (OECD, 2005). The sample was stratified to represent the different sectors of activity as per the Federation of Egyptian Industries classification. Prior to launching the survey, a pretest of the survey questionnaire was conducted with 150 firms, and the questionnaire has been reviewed accordingly. The data were collected by university graduates with a prior experience in data collection. The data collecting team received training and orientation on using the questionnaire. All data were collected via personal interviews with the representatives of responding firms. In the end, 2943 firms answered the survey for an exceptional response rate of 98%. For the purposes of this study, only a subset of 447 firms representing the innovative manufacturing SMEs were included in the analysis.

Econometric Model and Variable Measurement

The following linear regression model was estimated to identify the factors that explain the firm's OI activity:

$$OI = \beta_0 + \beta_1 FORNOWN + \beta_2\ PEREMPTEC + \beta_3\ KMGMTSYS + \beta_4\ FINSUPP + \beta_5\ LOC + \beta_6\ LNSIZE + \beta_8\ TECHINTEN + \varepsilon$$

Where:

- β_i ($i = 0 \ldots 8$) are the regression parameters to be estimated.
- OI is the dependent variable "open innovation" measured using a multi-item index (see appendix 1). Two types of OI activities have been measured leading to two regression models estimated. The first type is knowledge OI (KGEOI) which corresponds to links with knowledge institutions, and the second one is

business OI (BUSOI) which represents the collaboration with business partners for innovation purposes. The measurement scales of these two types of OI are presented in Appendix 1.

- FORNOWN is a binary variable coded 1 if at the time the survey was conducted the firm was partially owned by a foreign counterpart and 0 otherwise.
- PEREMPTEC is a proxy to the competence and qualifications of employees measured by the percentage of employees that had a university or technician degree or diploma in 2007.
- KMGMTSYS represents the use of advanced knowledge management systems measured by a binary variable coded 1 if during the three years 2005 to 2007 the enterprise introduced new or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within the company, and 0 otherwise.
- FINSUPP corresponds to the public financial support available to enterprises for innovation measured by a five-item index (see Appendix 1).
- LOC corresponds to the location of the firm measured with a categorical variable coded 1, 2, and 3 if the firm is located in Cairo, Alexandria, and other governorates respectively.
- LNSIZE represents the size of the firm measured by the logarithm of the number of employees.
- TECHINTEN corresponds to the technological intensity of the industry where the firm operates measured with an ordinal variable coded 1, 2, 3, and 4 if at the time the survey was conducted the enterprise was operating in a low tech, medium-low tech, medium-high tech, and high tech industry, respectively.

FORNOWN is used as proxy to firm's ownership structure. PEREMPTEC and KMGMTSYS are used to measure firms' absorptive capacity. They measure respectively the employees' qualifications, and the quality of knowledge management systems used internally by the firm. FINSUPP measures the availability of public financial support whether governmental or foreign. Finally, LNSIZE and LOC are introduced into the regression models to control for size and location of firms, respectively.

Preliminary analyses were performed to ensure no violation of the assumptions of normality of continuous variables introduced into the models. Correlations between the independent variables were also computed and are reported in Appendix 2. The results show that the highest correlation coefficient between covariates equals .28 (SIZE to KMGMTSYS). This shows that no serious multicollinearity disturbance is associated with the regression models, which increases the reliability of the model results.

To assess the uni-dimensionality of the multi-index constructs, we conducted a principal components factor analysis with VARIMAX rotation on the items included in the scales (Ahire and Devaray, 2001). The factor analysis results show that:

- One factor explains 52.7% of the original variance of the phenomenon for the KGEOI index with an initial Eigenvalue of 2.64;
- One factor explains 63.5% of the original variance of the phenomenon for the BUSOI index with an initial Eigenvalue of 2.54;
- One factor explains 83.0% of the original variance of the phenomenon for the FINSUPP index with an initial Eigenvalue of 4.15.

The results for the Kaiser-Meyer-Olkin (KMO) and Bartlett tests are all acceptable and significant showing a good adequacy of the factor solutions. In light of these results, we can consider that the observed items used to measure knowledge OI (KGEOI), business OI (BUSOI), and public financial support (FINSUPP) are, respectively, associated with each other and represent a single concept. In addition, Cronbach's alphas were computed to assess the statistical reliability of the three scales. As shown in Table 1, the Chronbach's alphas are .76 for KGEOI, .78 for BUSOI, and .95 for FINSUPP. These levels are very acceptable considering that Ahire and Devaray (2001) and Nunally (1967, 1978) recommend the threshold of .50 for emerging construct scales and .70 for maturing constructs.

Descriptive Statistics

Table 1. summarizes the descriptive statistics for the variables introduced into the regression models. It shows that the averages for KGEOI and BUSOI are 3.51 and 6.21, respectively. The average innovative manufacturing firm is therefore much more open to business partners than knowledge institutions to innovate. The low average for KGEOI suggests that manufacturing SMEs have not yet developed a culture of collaborating with universities, research centers, and other knowledge institutions to develop their innovations. On the contrary, when it comes to business partners (clients, suppliers, competitors, etc.) it seems that these firms are more open to collaborate for innovation purposes.

The descriptive results show also that innovative manufacturing SMEs composing the research sample are relatively small with 36% of firms employing less than 10 employees. The average firm operates with 44 employees, whereas 38.6% of firms employ between 10 and 50 employees, and only 25.4% of firms employ more than 50 employees. Only 27.1% of innovative manufacturing SMEs are part of a larger group, and 46.3% of them have introduced new or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within the firm during the three years covered by the survey.

Moreover, the average percentage of employees holding a university or technical degree or diploma is 56.17 %. As for the location of firms, around 22% of SMEs included in our sample are located in Cairo, while 8.5% are located in Alexandria, and around 70% of the firms are located in other Egyptian governorates. The statistics related to the technological intensity show that the majority of the firms included in our sample operate in low tech industries, while 23.2% and 19.6% are in low-medium and medium- high industries respectively. It's worth mentioning that none are in high tech industries.

Table 1. Descriptive Statistics

Variables	Type	Min.	Max.	Mean	S.D.	Cronbach's α
Continuous variables						
• Openness to knowledge partners (KGEOI)	Index: 5 items	0	15	3.51	4.00	.76
• Openness to business partners (BUSOI)	Index: 4 items	0	12	6.21	3.41	.78
• Percentage of employees with a university/ technical degree (PEREMPTEC)	Continuous: %	0	100	56.17	34.86	-
• Public financial support (FINSUPP)	Index: 5 items	0	4	0.11	0.41	.95
• Number of employees (SIZE)	Continuous: number	1	250	43.64	58.05	-

Categorical variables				
• Firm is part of a larger group (FORNOWN)	Yes (27.1%)			
• Improved knowledge management systems (KMGTSYS)	Yes (46.3%)			
• Firm location (LOC)	Cairo (22.3%)	Alexandria (8.5%)	Others (69.2%)	
• Technological Intensity (TECHINTEN)	Low (57.3%)	Low-Medium (23.2%)	Medium-High (19.6%)	High (0%)

Results

Two OLS regressions are estimated to further investigate the relationship between OI and the predictors considered in this research. These regressions included KGEOI and BUSOI as dependent variables. Table 2 depicts the summarized results for both models. The computed values of the F statistic for the KGEOI and BUSOI models are 14.43 and 9.61 respectively, which are both statistically significant at the 1% level. This suggests that the null hypothesis, that the parameter coefficients (except the intercept) are all equal to zero, is strongly rejected. Consequently, both models are globally significant at 1% level. Furthermore, the models' R^2 are 0.27 for the KGEOI model and 0.19 for the BUSOI one. This means that the predictors explain globally 27% and 19% of the variation of the dependent variable in each model, respectively.

The main predictor of firm's knowledge open innovation (KGEOI) is public financial support, which makes the largest significant contribution, followed by improved management systems and the location 2 (i.e. firms located in other governorates versus those located in Cairo). Being located in Alexandria has no significant impact on KGEOI when compared to those firms located in Cairo. Foreign ownership, the technology intensity of the industry the firm is in, and the percentage of employees with a university or technical degree are all not significant.

Table 2. Estimated OLS regression models of factors explaining open innovation

	Dependent Variable: KGEOI	Dependent Variable: BUSOI
Independent variable	β (SE)	β (SE)
Absorptive Capacity		
• Percentage of employees with a university/ technical degree (PEREMPTEC)	0.005 (0.006)	0.010 (0.005)*
• Improved Knowledge Management Systems (KMGMTSYS)	1.112 (0.396)*	1.19 (0.364)**
• Public financial support (FINNSUPP)	1.706 (0.43)**	0.212 (0.387)
• Number of employees (SIZE)	0.489 (0.512)**	0.612 (0.139)**
• Foreign ownership of firm (FORGNOWN)	0.700 (0.517)	0.867 (0.465)*
Location		
• Alex vs. Cairo (LOC1)	-0.172 (0.871)	1.22 (0.799)
• Others vs. Cairo (LOC2)	-2.65 (0.459)**	0.072 (0.418)
• Technology intensity of firm's industry (TECHINTEN)	-0.229 (0.242)	0.238 (0.220)
No# of observations:	426	433
R square	0.269	0.194
F-Statistic	14.430 **	9.612**

* 5% Significance, ** 1% Significance

On the other hand, the main predictor of firm's business open innovation (BUSOI) is improved knowledge management systems, followed by the firm's size. Both the absorptive capacity and the foreign ownership of the firm have a significant positive impact on BUSOI, while the location of the firm has no significant impact on its openness to business partners for innovation. The technological intensity of the industry the firm is in has no significant impact on BUSOI. Moreover, contrary to the case of KGEOI, the availability of public financial support has no significant impact on BUSOI.

Discussion and Conclusion

The research results indicate that the firm's characteristics and management systems have an impact on its ability to collaborate openly to innovate. The size of an enterprise has a positive effect on its ability to collaborate in innovation. This is true for both openness to knowledge institutions and openness for business partners. It seems that as a firm grows it has the ability to shift to an open innovation business model. This may be explained by the fact that as a firm grows it matures, seeking innovation beyond its borders. It may also, at this point of maturity, have resources available for sharing with collaborative partners.

The second variable is the location of the enterprise. Those firms outside the Cairo and Alexandria governorates have shown a negative ability to collaborate in a more

open manner when it comes to innovation. This is only true in the case of collaborating with knowledge partners. This is easily explained in a country like Egypt where centralization limits conferences, seminars, workshops, research centers and even large universities to the main large cities prohibiting firms in other cities to get access to these resources. Yet, when it comes to collaborating with business partners, the firm's location is not of relevance. The business environment for firms in Egypt is a greater facilitator of innovation.

The third variable is the firm's ownership structure. A firm (partially) owned by foreign investors or part of a larger global group shows positive tendency towards innovating openly than that of a firm with a complete Egyptian nationality. This is particularly true for collaboration with business partners. It may be induced that the firm's employees are subjected to companies with foreign cultures while doing business with clients or suppliers, by which tacit knowledge is transferred. Companies with foreign ownership, through friction with their counterparts, acquire new technologies in processes and management that may affect their ability to shift towards a more open model of innovation. On the other hand the fact the company has a percentage of foreign ownership does not affect its ability to innovate openly with knowledge partners; as it is based in Egypt; where collaboration is with local universities and research centers.

The results show also that another internal variable, the firm's absorptive capacity, depicted by its employees' competencies and the use of advanced knowledge management systems shows a partial positive influence on a firm's ability to innovate openly. The results only assure partially the previously discussed hypothesis. As the firm's ability to acquire knowledge, increases, it shows an increased ability for open innovation with business partner but not with knowledge partners. On the other hand having improved knowledge management systems has a clear positive effect on the firm's ability to innovate openly with knowledge institutions and business partners. Therefore, our research shows that in Egypt, this relationship is only partially supported.

The results of the study also suggest that the industrial ecosystem may have a high influence on a firm's ability to innovate openly beyond its boundaries. The unavailability of finance from public (foreign or national) support remains hindering to the open innovation model in SMEs in LDCs like Egypt when collaboration is with knowledge institutions. Yet when firms are collaborating with business partners, unavailability of public financial support will not hinder the partners from continuing to collaborate in innovation openly.

The technological intensity of the firm's industry has shown no evident effect on the firm's ability to innovate openly regardless who the collaboration is with; knowledge institutes or business partners. This may be due to lack of variability in the sample, as there were no firms in the high tech industries and more than half were from low tech industries. A better variation, showing firms from all tech intensities would be recommended to better test this variable.

Our research results suggest that further research on OI in SMEs in LDCs is needed to investigate the complicated relationship between partners in open innovation taking account the type of partner and depth of the relation. The study also suggests that

further research is needed to develop a better understanding of the affect of absorptive capacity on a firm's ability to innovate openly especially in SMEs in LDCs.

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Appendix 1. Definition of Variables

Measure		Sub Items	Method (range)
DEPENDANT VARIABLE			
Knowledge Open Innovation (KGEOI)	Significance of the following information sources to the enterprise's innovation activities during the three years 2005- 2007, measured with a Likert importance scale (0= not relevant to 3=High)	Universities and Technician Government or public research institutes Conferences, trade fairs, exhibitions Scientific journals and trade/ technical publications Professional and industry associations	Sum 0 to 12
Business Open Innovation (BUSOI)	Significance of the following information sources to the enterprise's innovation activities during the three years 2005- 2007, measured with a Likert importance scale (0= not relevant to 3=High)	Suppliers of Equipment, materials, component or software Clients or customers Competitors or other enterprises in your sector Consultants, commercial Labs or private R&D	Sum 0 to 15
INDEPENDENT VARIABLES			
Foreign Ownership (FORNOWN)	Is a binary variable coded 1 if at the time the survey was conducted the firm was partially owned by a foreign counterpart and 0 otherwise.		
Public Financial Support (FINNSUPP)	Corresponds to the public financial support available to enterprises for innovation activities during the three years 2005-2007 measured from the following levels of government.	Metros and Municipalities Governorate National Government National Funding agencies Foreign government/ public resources	Sum 0-5
Technology Intensity (TECHINTEN)	Corresponds to the technological intensity of the industry where the firm operates measured with an ordinal variable coded 1, 2, 3, and 4 if at the time the survey was conducted the enterprise was operating in a low tech, medium-low tech, medium-high tech, and high tech industry, respectively.		
Absorptive Capacity Percentage of educated employees	Percentage of total employees that had a university or technician degree or diploma in 2007.		

(PERCUTEC) Improved Knowledge Management systems (KMNGTSYS)	Represents the use of advanced knowledge management systems measured by a binary variable coded 1 if during the three years 2005 to 2007 the enterprise introduced new or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within the company, and 0 otherwise.
Control Variables Firm Size (LNSIZE*)* Location (LOC)	Represents the size of the firm measured by the logarithm of the number of employees in 2007. Corresponds to the location of the firm measured with a categorical variable coded 1, 2, and 3 if the firm is located in Cairo, Alexandria, and other governorates respectively.

Appendix 2. Correlation Matrix

	LNSIZE	PEREMPTEC	LOC	TECHINTEN	FINSUPP	KMGMTSYS	FORNOWN
LNSIZE	1						
PEREMPTEC	0.037	1					
LOC	-.067	-.024	1				
TECHINTEN	-0.201	-0.002	-.076	1			
FINNSUPP	0.096	0.017	0.021	-0.014	1		
KMGMTSYS	0.283	0.099	-.130	0.045	0.060	1	
FORNOWN	0.252	0.243	-.152	0.041	0.000	0.262	1