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Determinants of Innovativeness in ICT Clusters of Indonesia

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1. INTRODUCTION

Cluster approaches are considered a way to improve firm innovativeness through more knowledge spill-overs and benefits from agglomeration (Porter, 1996; Audretsch & Feldman, 2004; Duranton and Puga, 2004; McCann, 2008). Due to the fact that the existence of more external knowledge or resources (e.g. common infrastructure, specialized labour, and supplies), agglomerations bring a positive effect on firm's innovative performance. This study takes ICT clusters in Indonesia as an example.

Indonesia has a fairly low innovativeness at national level. It ranks 87 out of 127 countries (world), 14 out of 15 SEAO (South East Asia, East Asia, and Oceania) countries, 11 out of 27 low middle income countries in the The Global Innovation Index 2017 (Cornell University, INSEAD, and WIPO, 2017). Further, Information and Communication Technology (ICT) clusters have only been developed in Indonesia since the early 2000s. Following the trend in the European ICT sector, the number of ICT small firms has grown by more than 100% in the last 10 years in Indonesia, however, the share of ICT exports in gross exports is very low at 4 percent, compared with other countries. This situation may be caused by the young age of most clusters, and their low innovativeness preventing them to compete in the international market. However, it is unclear which factors are dominant in affecting firm innovativeness of ICT clusters in Indonesia. This study aims to fill this knowledge gap by focusing on important determinants of innovativeness, such as firm specific factors, network characteristics and regulatory conditions in the Indonesian context. Previous studies of innovativeness in Indonesia (e.g Acs and Audretsch, 1998; Tambunan, 2007; Eisingerich et al., 2010; Van Geenhuizen et al., 2010), have generally suggested a linear relationship between those set of factors and innovativeness. Therefore, this paper extends prior research's viewpoints and suggests t non-linear relationships between innovativeness and a set of factors with empirical evidence in order to provide a recommendations for innovation activity.

The current study explores innovativeness of ICT firms through the question: *To what extent and how do firm specific, external and network factors influence firm innovativeness in a less developed country?*

The rest of the paper is structured as follows: the next section introduces our theoretical approach and a set of hypotheses. The section that folows describes the methodology that we use, namely, we develop and explore a causal model. The fourth section presents the results of the model exploration. The final section provides a discussion of our results and recommendations.

2. THEORY AND HYPOTHESES

Research on region impact on firm innovativeness found that high-tech firms located in metropolitan region were found to be significantly more innovative than firms located in peripheral regions (Acs and Audretsch 1988, Shefer and Frenkel 2005, Taheri and van Geenhuizen 2011).

Hypothesis 1: *Metropolitan region has a positive influence on innovativeness*

With regards to firm characteristics, according to Malerba (2006), Duranton and Puga (2004), and McCann (2008), the probability of innovation changes along the firm life. On the one hand, we may expect that new firms face a "liability of newness" (Stinchcombe, 1965) and older firms may have more experience in business so that they tend to be more innovative. On the other hand, older firms might suffer from a "liability of obsolescence" and also a "liability of senescence" (Barron et al., 1994) causing problems in adapting their strategies to changing business conditions. Other empirical research like Huergo (2004) shows that new firms tend to show higher rates of innovativeness growth which, as time goes by, turn to average to common growth rates, or even decline. Therefore, drawing from those studies, we expect a negative curvilinear of firm age on innovativeness.

Other have focused on the positive effect that firm size has on innovativeness ; that is, the firm's propensity to invest in R&D is positively associated with its size, *ceteris paribus* (Acs and Audretsch 1988, Dosi 1988). However, Shefer and Frenkel (2005) following Schumpeter (1982) have encountered a large number of small firms that engage in innovative activity and it is particularly true for small firms in the high-tech industry. Cohen and Levin (1989), Kamien and Schwartz (1982), and Evangelista et al. (1997) report a mixed result on the correlation between firm size and innovation activity, it has a positive tendency, mean the larger the firm, the more innovative; but not necessarily linear trend.

Hypothesis 2: *Firm age has a negative curvilinear influence on innovativeness*
Hypothesis 3: *Firm size has a negative curvilinear influence on innovativeness*

Further, Acs and Audretsch (1988), Acs, Audretsch et al. (1994), Feldman and Florida (1994) find a positive relationship between the organization, level of investment in R&D and innovations. In contrast, Shefer and Frenkel (2005) explain that such an influence depends on firm size. Indonesia does not have great experience in terms of R&D business activities in general, and in the context of ICT industry in particular, when compared to other larger economies. The lesser experience of developing R&D activities (as in the Indonesia economy), associated with the need for a greater period of learning, may contribute to the relationship between R&D intensity and the innovativeness of Indonesia ICT being nonlinear.

With regards to manager's characteristics, Porter (1990) states that managerial leaders with scientific or technical backgrounds were more likely to engage to innovation. In common, people with strong scientific or technical background usually undergone upper level of education level, hence, we may suggest that manager's education positively influence firm innovativeness. Moreover, Dahl and Moreau (2002) argue that managers who have more operational expertise, which, combined with other supporting factors might translate into innovative solutions. In contrast, Martínez-Ros and Labeaga (2002) found that managerial ability and experience seem to be more important in the development of new products but the experience effect is smaller after two or more periods engaging in innovations. This implies that the influence of manager's experiences is curvilinear and most probably negative.

Hypothesis 4: *The degree of embededness of R&D has a positive influence on innovativeness*
Hypothesis 5: *R&D amount has a positive curvilinear influence on innovativeness*
Hypothesis 6: *Manager's degree of education has a positive linear influence on innovativeness*
Hypothesis 7: *Manager's amount of experience has a negative curvilinear influence on innovativeness*

With regard to influence from FDI on firm innovativeness, technology-driven multinationals usually exploit cheap skilled labour in developing countries for export production (Fromhold-Eisebith and Eisebith 2002), not enhancing innovation. In contrast, Tambunan (2007) found that FDI is important as a source of technology transfer to firms in Indonesia. FDI helps them to upgrade their capabilities and hence to improve their performance. Further, using data from 25 OECD and 20 non-OECD countries over the period 1970–2004, Kottaridi & Stengos (2010) find that FDI inflows have a non-linear effect on growth, they are growth enhancing in developing countries and a two-regime FDI effect for high-income economies, a counter-productive and a positive one. It appears that only in high FDI shares can the economies reap benefits from foreign production whilst for low and middle shares the effect is detrimental. Meanwhile, Fromhold-Eisebith and Eisebith (2002) and Tambunan (2007) highlight the positive influence of regulations on firm innovativeness. Moreover, according to Edquist (1997), complicated feedback mechanisms and interactive relations of regulations characterise the translation from basic research to the development of new processes and new products that leads to innovation. The proces by no means follows a linear path . Therefore, we expect a curlineary influence of regulations on innovativeness.

Hypothesis 8: *FDI share in ownership has a positive curvilinear influence on innovativeness*
Hypothesis 9: *Positive perception on regulation has a negative curvilinear influence on innovativeness*

With regard to network, Hieber (2002) identifies that value chain networks are an identified network consisting of independent firms working together based on common interest and partnership oriented business relations. He argues that the best is that there is no predominating partner in the network, which leads to balance of power and none of the network partner takes advantages of its position. In contrast, Van Geenhuizen et al. (2010), in a study of a furniture cluster in Indonesia, found that the position in the value chain matters since small firms in developing countries that usually in the lowest position in value chains have low level of innovativeness.

Furthermore, Eisingerich al. (2010) reveal that the network characteristics such as network strength and network openness, can also determine the firm legitimacy in their network. Further, Eisingerich al. (2010), believe that strong networks may provide access to resources which would otherwise be beyond the scope of a single firm. Bell (2005) also argues that another benefit of strong networks is that, through repeated interactions, constituent firms are able to better assess their partners' resources and capabilities, making complementarities more visible and helping firms to organize transactions in ways that maximize the synergies between them. In the studies in developing countries, Tambunan (2007) and Van Geenhuizen et al. (2010) assert that the network of organizational ties influences firm innovativeness. Furthermore, Belso-Martinez & Molina-Morales (2013) in their study on product innovation in Spain, the collaboration of intra and extra-cluster linkages presents an inverted U-shaped relationship because knowledge creation requires an optimal number of ties, not a maximum of those. Supported Arthur (1989), Soetanto (2015) using the empirical data from new technology-based firms located at the Daresbury SIC also reveals trend of a curvilinear relationship between network openness and innovativeness leads to firms' performance. In the general sense, Teece (1994) explain argue that the formal and informal structures of firms and their external linkages have an important bearing on the rate and direction of innovation. Drawing from the empirical findings and Teece (1994) we may expect the curvilinear influence in network strength and openness also happen in Indonesia context.

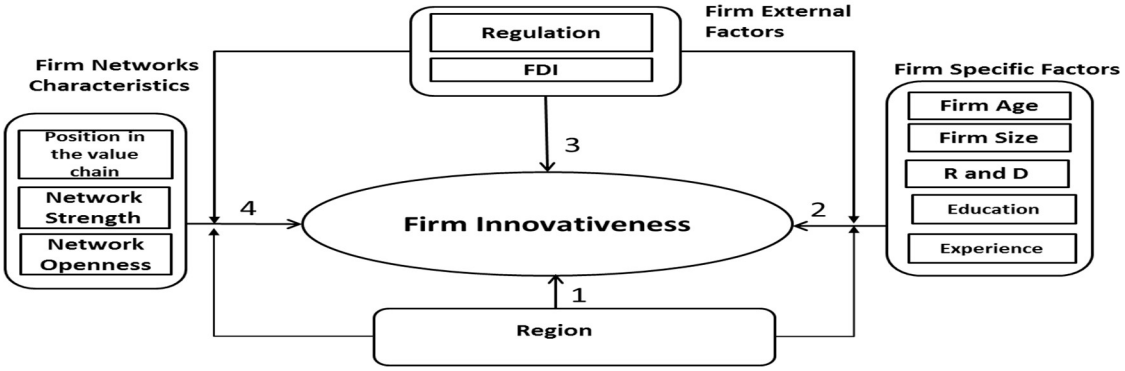
Hypothesis 10: *The level of the* p*osition in the value chain has a positive linear influence on innovativeness*

Hypothesis 11: *Positive perception on network strength has a negative curvilinear influence on innovativeness*

Hypothesis 12: *Positive perception on network openness has a negative curvilinear influence on innovativeness*

The conceptual framework of the study is presented in Figure 1. It includes Region, firm specific (firm age & size, R&D organization, amount of R&D and manager characteristics), network (value chain position, network strength, and network openness) and external factors (Regulatory Conditions and FDI), with region as control factors, specifically on the direct interactions (arrows no 1, 2, 3 and 4).

Figure 1. Conceptual Framework



3. METHODOLOGY

3.1 Data Collection

We conducted a web-based survey in Indonesia in November 2016 until June 2017, by distributing a survey with structured questions to around 1,500 ICT-based firms, randomly selected from clusters in different regions, like Jakarta, Surabaya, Semarang, Makassar, Yogyakarta, Denpasar, Balikpapan, and Bandung. The response rate is around 13.33%, meaning that we collected 200 valid responses. This low response rate possibly generates a non-response bias to our study. The target respondents were the middle-level managers or upper-level managers of large firms (LFs), and the top manager of small/medium sized enterprises (SMEs) who have good understanding of their company. In the preparation stage, we tested the reliability and the validity of our measurement tool using Cronbach's Alpha test and Pearson product moment correlation (Appendix 1).

3.2 Measures

Dependent Variables : Number of Innovations. Following Schumpeter (1982) and The European Commission (CEC 1995), we used the number of innovations to asses firm innovativeness in a given years, which are two years. We count for product, process and marketing innovations, but not organizatinal innovations, due to its complexity and multidimensionality. The assumption underlying this approach is that the more the number of innovations in the last two years, the more innovative the firm, *ceteris paribus*.

Independent Variables. *Region* was measured in two levels (''Outer Jakarta", has a lower level than,"Jakarta"). Jakarta as part of a core metropolitan area and outer Jakarta as lower density area. *Firm age* was measured in the yearly basis, while *Firm size* measured the number of employees in 2017. To test for the hypothesized curvilinear association, we also included *firm age squared* and *firm size squared*. We measured *R&D embededness* based on the existence of R&D unit and collaborations with other parties. *R&D amount* was measured based on percentage of R&D share on sales in the last 2 years. We measured *manager's education* in three levels; having master/PhD degree will be in highest rank, following by bachelor level and high school and diploma level. Meanwhile, *manager's experience* was measured based on the number of years of experience in the firm. *FDI share* was asked directly during the survey, while *Regulation perception* was measured based on manager's perception/satisfactions to government regulations. *Value chain position* was measured in a rank where become "supplier" has a lower rank than manufacturer/service provider. *Network Strength perception* and *Network Openness perception* (Eisingerich, Bell et al. 2010) were both measured in continuous level based on manager's perception of the strength of firm's network and openness. We measured *Network Strength perceptions* based on the average of manager perception on their strength of relationships with four parties; government, Large firms, Small and medium enterprises and universities or other research institutions. We tested the curvilinear association by taking the square of independent variables.

The definition of our variables and measurement is presented in Appendix 2 , while the descriptive statistic is presented in Table 1.

Table 1. Descriptive Statistic

Variables		Avg	SD	Min-Max
Number of Firms	200			
Number of Innovations		4.15	**2.21**	**0-13**
Control variables				
Region	Jakarta: 55% Outer Jakarta: 45%			
Firm Specific Factors				
Firm Age		**12.55**	**9.49**	**1-50**
Firm Size		**241.55**	**702.55**	**1-5000**
R&D embededness	No R&D(14%) R&D but no unit(46%) Have R&D unit (31%) Collaboration(10%)			
R&D amount:		**0.19**	**.20**	**0-.9**
Manager's Education	High School & Diploma (12%) Bachelor (40%) Master or higher(48%)			
Manager's experience		**8.62**	**6.52**	**1-31**
Firm External Factors				
FDI share in ownership		**10.50**	**23.03**	**0-100**
Regulations perception		**5.30**	**2.34**	**1-10**
Firm Network Characteristics				
Position in the supply chain	Manufacturer/Service Provider(65%) Supplier (34%)			
Network Strength perception		**5.12**	**2.07**	**1-10**
Network Openness perception		**7.95**	**1.95**	**1-10**

3.3 Statistical Methods

We employed ordinary least squares (OLS) regression in our research, therefore our data should not violate OLS assumptions which are: the linear regression model is "linear in parameters", a random sampling of observations, conditional mean should be zero, no multi-collinearity, and no homoscedasticity or no autocorrelation in data (Hair et al., 2009). Optional assumption is that error terms should be normally distributed.

4. RESULTS

Appendix 3 shows the correlations for the variables used in the models. The data were also examined for violations of assumptions of normality and multicollinearity. Examining pairwise correlations showed that, with the exceptions of the squared terms, the correlations were fairly lo, with the VIF =1.16.

The results of the linear regression models are reported in Table 2. Model 1 is the base model containing only '*Region*', while model 2 is base model with firm specific factors, model 3 is base model with firm external factors, model 4 base model with firm network factors and model 5 shows the result of the full model (in only linear relation(a) and also in (b) linear and curvilinear relation). All over, our complete model with linear and squared relation (model 5(b)) provides result of R2 of .40, while our base model gives R2 of .06, or having ΔR2 of .27.

For variables in model 5(b), the coefficient for *firm age* is negative and not significant (β = -.24 also when squared (β = .09). These results contrary to Hypothesis 1a. The coefficient for *firm size* is positive and significant (β = 1.66 and p< .005) also for firm size squared (β = -.83 and p< .005) on the reverse direction. These findings contrary to our hypothesis 3 that firm size has a positive curvilinear trend on innovativeness. Hypothesis 1 for region influence is also provided by the result of variable *Region* with positive and significant coefficient (β = .21 and p< .005).

On firm specific factors, we found that the result of *R&D embededness* is not significant. This result is contrary to our hypothesis 4. In addition, our findings for *R&D amount squared* are significant with β= .13 however *R&D amount* in linear relationship has no significant value(hypothesis 5). The variable *manager's education* is positively significant (β = .21 and p< .05) in the complete model. For *manager's experience*, the coefficient is not significant; when squared the cofficient is negative and significant (β = -.42 and p< .05).

For firm external factors, *FDI percentage* is only significant when squared (β = -.53 p< .1 in model 5b and β = -.27 p<.1 in model 3). This indicates an inverted u-shaped relationship of FDI on innovativeness (hypothesis 3a). Meanwhile, for *regulation perception squared* the result is significant in model 5b (β = .27 and p< .05).

For firm network factors, all the coefficients in our complete model are significant. The finding on *value chain position* provide support for hypothesis 10 with positive coefficient and significant values (β = .23 and p< .001). The coefficient for *Network Strength perception squared* is negative (β = -.10 p< .05), but not significant in linear relationship. The coefficient for *network opennes* is positive but not significant, while *network opennes squared* is negative and significant (β = -.33 p< .1). These findings different for our predictions that Network Strength perceptions and Network Openness perception have positive curvilineary relationship with innovativeness (Hypothesis 11 and 12). Summary of the result is presented in Table 3.

Table 2 Results of Ordinary Least Square (OLS) Regression

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	
	Base Model	Specific	External	Network	Full model	
					(a) Linear	(b) linear+ curvilinear
	β(s.e.)	β(s.e.)	β(s.e.)	β(s.e.)	β(s.e.)	β(s.e.)
Region	.25(.10) †	.26(.11)†	.25(.11)†	.19(.10)***	.19(.11)***	.21(.10)†
Firm Specific factors						
Firm Age		-.29(.01)			-.26(.00)	-.24(.01)
Firm Age sq.		.09(.00)			.10(.00)	.09(.00)
Firm Size		1.19(.00)†			.31(.00)†	1.16(.00)†
Firm Size sq.		-.86(00)†				-.83(.00)†
R&D organization		.06(.05)			.05(.02)	.02(.01)
R&D amount (% share of sales)		.01(.00)			.09(.00)	.18(.01)
R&D amount (% share of sales) sq.		.09(.00)*				.13(.10)*
Manager's Education		.17(.08)**			.16(.07)**	.21(.08)**
Manager's Experience		-.37(.02)			-.14(.01)*	-.29(.03)
Manager's Experience sq.		-.43(.02)**				-.42(.00)**
Firm External Factors FDI share			.95(.12)**		.40(.03)	.50(.11)
FDI share sq.			-1.00(.01)**			-.53(.01)*
Perception on regulation			.06(.02)		.17(.02)*	.10(.01)
Perception on regulation sq.			.19(.01)*			.27(.01)**
Firm Network Characteristics Value chain position				.20(.05)†	.18(.05)**	.23(.05)***
Network Strength perception				.32(.07)	-.29(.02)**	.22(.07)
Network Strength perception sq.				-.03(.01)*		-.10(.01)**
Network Openness perception				.14(.10)	.09(.02)	.23(.10)
Network Openness perception sq.				-.23(.01)*		-.33(.01)*
N	**200**	**200**	**200**	**200**	**200**	**200**
F	**10.43**	**4.00†**	**5.01†**	**7.20†**	**5.38†**	**5.21†**
R^2	**.06**	**.20**	**.12**	**.20**	**.31**	**.40**
ΔR^2		**.14**	**.06**	**.14**	**.18**	**.27**
Root MSE	**.51**	**.50**	**.51**	**.47**	**.47**	**.45**

* p<0.1; ** p<0.05 ;***p<0.001;†p<0.005

Table 3. Hypotheses vs Result

Hypotheses	Result	Possible Reason
Hypotheses 1	Confirmed	
Hypotheses 2	Not Confirmed	Firm continuously adjust the strategy to face changing environment
Hypotheses 3	Confirmed	
Hypotheses 4	Not confirmed	Innovation is more dependent upon R&D intensity than the level of embededness of R&D
Hypotheses 5	Confirmed	
Hypotheses 6	Confirmed	
Hypotheses 7	Confirmed	
Hypotheses 8	Confirmed in inverse direction	FDI influence differs in each country depend on the initial conditions of host country
Hypotheses 9	Confirmed	
Hypotheses 10	Confirmed	
Hypotheses 11	Confirmed	
Hypotheses 12	Confirmed	

5.DISCUSSION AND RECOMMENDATIONS

The purpose of our study was to theoretically and empirically examine the direct relationships of firm specific factors (amount of R&D, manager's characteristics and value chain position), external factors (Regulatory Conditions perception and FDI) and network factors (value chain position, network strength and openness) on innovativeness. Our study provides evidence that innovativeness is dependent upon specific factors (R&D amount, managers' education and experience), external factors (FDI percentage and perception on regulation) and network characteristics (value chain position, network strength perception and network openness perception), but not dependent upon firm age, and R&D embededness. It also provides evidence that the relationships of firm size, R&D amount, manager's experience, FDI share, perception on regulation, network strength perception and network openness perception are non-linear.

Our study contributes to previous research in several ways. First, we applied the notion of increasing/diminishing returns (Arthur, 1989) to firm size, R&D amount, manager's experience, FDI share, perception on regulation , network strength perception and network openness perception. Second, we found evidence that network strength perception has a more significant effect on firm innovativeness than network openness perception (network strength is statistically significant at .001 while network openness significant at .1) . In addition, the modelling results brought the following trends to light. The model on specific, external and network is the strongest, R^2 of 0.40 (adjusted R^2 = .33) compare to an $R^2$of 0.13 (adjusted R^2 = .10) of the base model most probably because in actual firm uses its specific and external (including network) to growth and improving innovation activity. Next, older firms are not necessarily more the more innovative. This is probably because new-born firms tend to show higher rates of innovativeness , which, as time goes by, tend to converge on average to common (activity-specific) growth rates (Huergo and Jaumandreu 2004). However, size of the firm still matters in our case, probably because firms tend to use their specific capabilities to gain new resources. Additionally, our result on region influences in line with Duranton and Puga (2004). In presence of increasing returns, firms tend to locate close to large markets found in metropolitan areas. Overall, the somewhat contradictory results and influence of non-linearity indicated a set of complex mechanisms

in influencing innovativeness. This situation calls for further research such as case study and in-depth interviews.

Our results confirm that the relationship between innovativeness and R&D amount is non- linear but positive means that the influence of R&D amount to innovativeness growth unsignifcantly until it reaches certain point. Our interpretation with this result is our sample of high-tech firms are heavy on know-how and light on resources, and hence, they typically have R&D costs that are large relative to their unit production costs. This also strengthened by Indonesian factor, in which it has no great experience on R&D business. With respect to manager's experience, our study shows the negative curvilinear impact of experience on innovation activity. This result support the findings from Long et al. (2017). They show that managers of Chinese firms who have successful entrepreneurial experience are more innovative, and accumulate experience and evaluate innovativeness of entrepreneurial opportunities rationally. This result has managerial implications: for including experienced managers (in-sectors experience) in the managerial team. There needs to be a balance between experienced and less experienced managers because the last condition potentially causing path dependence. The effect of experienced managers is positive in the begining, however, at certain point it has no influence, and may cause negative effect on innovativeness later on.

The result on FDI share is subject to diminishing returns. We interpret this finding as technology spill-overs which leads to innovativeness are not automatic consequences of FDI. FDI inflows in emerging economies such as Indonesia are likely smaller than in developed countries, and those foreign firms that enter are likely to use simpler technologies. This technology contributes only marginally to local learning and skill development. The low innovativeness performance could be, between others, an expression of the low level of the positive externalities of FDI on local firms' innovativeness. Having in view that, the multinational companies do not opt for partial relocation of their R&D departments to the Indonesian subsidiaries or for their placement in areas that could facilitate the transfer of knowledge and technology to the local industry. In line, according to Shrolec (2009) and Masso et al. (2012), multinational companies are likely to limit the spill-over of their knowledge to non-affiliated companies to protect their ownership advantage therefore it cannot be taken for granted that FDI increases innovativeness. It may also happen because the subsidiary no longer give adequate benefit to parent company. With regard to regulations, we also found evidence that managers' perception of regulatory conditions has a positive but non-linear influence on innovativeness. It may imply that government regulations and innovation have an interactive relations, but the positive impact will be achieved up to a certain level. With respect to policy making and management, the regulatory process must take into account the effects of regulation on innovation as well as the implications of technical change for the rationale and design of regulation. According to OECD (1996), the regulation/innovation interface is mutual and dynamic, therefore, an understanding of this interface is crucial to regulatory reform efforts.

Our findings also indicate that position in the value chain has a positive and significant efect to firm innovativeness. This result implies that firms in the higher position, need to transfer knowledge to those in the lower position, so that they both have the same level of innovativeness. The firm in the lowest position of value chain tend to be less innovative because they have difficulties in achieving new knowledge supporting innovations (Van Geenhuizen et al. 2010). This situation indicates a low availability of new knowledge and/or a low capability to access new knowledge. Further, we found a non-linear influences of network strength on innovativeness. Our finding implies that network strength will increase innovation in the beginning, and will start to decrease innovation after a certain point has been reached. According to Belso-Martinez & Molina-Morales (2013) at a certain level or under specific conditions, trust, norms, and other values derived from interactions among nearby actors may affect

negatively on innovative capability because of the costs of the loyalty and commitment in these relationships. This effect may reduce firm's capability building or access the information necessary to compete when environment changes.

Finally, our study also indicates the curvilinear impact of network openness on firm innovativeness. This findings support Soetanto (2015) in regards that the influence of network openess to innovativeness is not linear. This leads to managerial impications that firms need to balance network openness. Indeed, a network has a positive impact on helping the firms develops innovation performance. However, as developing very high level of openness may potentially prevent firms' progress, in contrast, very low level of network openness will not add more advantages as the cost for nurturing relationship rises.

Limitation and Extentions

Our paper is one of the few empirical efforts in examining the relationships between innovativeness and a set of combinations of specific, external and network factors of firm in Indonesia by applying the notion of increasing / diminishing return. Other study in this type of study was conducted in countries that have different characteristic with Indonesia, so that it may not applicable to Indonesian context. The insights gained from our study are important,but the study has several limitations. First, due to low response rate in our study, we cannot avoid non-response bias on the findings. In the further research, other ways in data collecting could be applied to increase the response rate and reducing the non-response bias. Second, some of our measurements are based on the manager's perceptions (regulatory conditions, network strength and network openness) which may lead to response bias. The responses given might not always reflect a true and detailed understanding of the issue. To deal with this issue, in-depth interviews should be conducted to decrease the response bias and to understand unexplained mechanism. Finally, our study assumed that all factors have direct relationships to firm innovativeness. Future research is needed to further understanding the influences of interaction effect on innovativeness, and how these influences can be managed in practice to improve firm innovativeness.

REFERENCES

Acs, Z. J. and D. B. Audretsch (1988). "Innovation in Large and Small firms: an Empirical Analysis." The American Economic Review: 678-690.

Arthur, W. Brian. (1989). "Competing Technologies, Increasing Returns, and Lock-in by Historical Events." *The Economic Journal* 99.394: 116-131.

Audretsch, D. B. and M. P. Feldman (2004). "Knowledge spillovers and the geography of innovation." Handbook of Regional and Urban Economics 4: 2713-2739.

Barron, D. N., West, E., & Hannan, M. T. (1994). A Time to Grow and a Time to Die: Growth and Mortality of Credit Unions in New York, 1914-1990. American Journal of Sociology, 100(2): 381–421

Bell, G. G. (2005). "Clusters, Networks, and Firm Innovativeness." Strategic Management Journal **26**(3): 287-295.

Belso-Martinez, J. A., & Molina-Morales, F. X. (2013). Non-linear relationships of specific and external resources on a firm's innovation: The case of the Spanish Vinalopó footwear cluster. *Growth and Change*, *44*(3), 494-521.

CEC (1995). "Green Paper on Innovation." COM (95) 688

Cohen W.M. and Levin R.C. (1989), Empirical Studies of Innovation and Market structure, in R. Schmalensee and R.D. Willig (Eds.), Handbook of Industrial Organization, Vol. II, Amsterdam: Elsevier Science Publisher B.V

Dahl, D.W & Moreau, P. (2002) The Influence and Value of Analogical Thinking during New product Ideation**,** Journal of Marketing Research, 39 (1) (2002), pp. 47-6

Dosi, G. (1988). "Sources, Procedures, and Microeconomic Effects of Innovation." Journal of Economic Literature: 1120-1171.

Duranton, Gilles, and Diego Puga. (2004)."Micro-foundations of Urban Agglomeration Economies." *Handbook of Regional and Urban Economics* 4: 2063-2117.

Edquist, C. (1997). *Systems of Innovation: Technologies, Institutions, and Organizations*. Psychology Press.

Eisingerich, A. B., et al. (2010). "How Can Clusters Sustain Performance? The Role of Network Strength, Network Openness Perception, and Environmental Uncertainty." Research Policy 39(2): 239-253.

Evangelista R., G. Perani, F. Rapiti and D. Archibugi (1997) Nature and impact of innovation in manufacturing industry: some evidence from the Italian innovation survey, Research Policy , 26, 521-536

Feldman, M. P. and R. Florida (1994). "The Geographic Sources of Innovation: Technological Infrastructure and Product Innovation in the United States." Annals of the Association of American Geographers 84(2): 210-229.

Fromhold-Eisebith, M. and G. Eisebith (2002). "The Indonesian Technology Region of Bandung: High Potential, Low Profile." International Development Planning Review 24(1): 41-57.

Hair, Joseph F., et al. Multivariate Data Analysis: A Global Perspective. 7th ed. Upper Saddle River: Prentice Hall, 2009

Hieber, R. (2002). *Value chain management: a collaborative performance measurement approach* (Vol. 12). vdf Hochschulverlag AG.

Huergo, E. and J. Jaumandreu (2004). "Firms' age, Process Innovation and Productivity Growth." International Journal of Industrial Organization 22(4): 541-559.

Kamien M.I and Schwartz N.L. (1982), Market Structure and Innovation, Cambridge University Press, MA

Kottaridi, C., & Stengos, T. (2010). Foreign Direct Investment, Human Capital and Non-linearities in Economic growth. *Journal of Macroeconomics*, *32*(3), 858-871.

Long, D., et al. (2017). "The Effect of Experience and Innovativeness of Entrepreneurial Opportunities on the New Venture Emergence in China: The Moderating Effect of Munificence." Journal of Entrepreneurship in Emerging Economies 9(1): 21-34.

Malerba F., (2006) Innovation and the evolution of industries, Journal of Evolutionary Economics, April, Volume 16, Issue 1-2, pp 3-23

Martínez-Ros, E., & Labeaga, J. M. (2002). Modelling innovation activities using discrete choice panel data models. *Innovation and Firm Performance. Econometric Explorations of Survey Data*, 150-171.

Masso, J., Roolaht, T., & Varblane, U. (2012). Links between foreign direct investment and innovation activities in Estonia. In *Innovation Systems in Small Catching-Up Economies* (pp. 235-256). Springer New York.

McCann, Philip. (2008). "Agglomeration economics." *Handbook of research on cluster theory* : 23-38.

OECD (1996). "Regulatory Reform and Innovation."

Porter, M. E. (1998). "Cluster and the New Economics of Competition."

Rogers, M. (2004). "Networks, Firm Size and Innovation." Small Business Economics 22(2): 141-153.

Schumpeter, J. A. (1982). "The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle (1912/1934)." Transaction Publishers.–1982.–January 1: 244.

Shefer, D. and A. Frenkel (2005). "R&D, Firm Size and Innovation: an Empirical Analysis." Technovation 25(1): 25-32.

Soetanto, D. (2015). Network Openness Perception and Learning Ambidexterity of New Technology-based Firms at Incubators. New Technology-Based Firms in the New Millennium, Emerald Group Publishing Limited**:** 227-245.

Srholec, M. (2009). Does foreign ownership facilitate cooperation on innovation? Firm-level evidence from the enlarged European Union. *The European Journal of Development Research*, *21*(1), 47-62.

Stinchcombe, A., 1965. Social structure and organizations. In: March, J.G. (Ed.), Handbook of Organizations. Rand McNally, Chicago, 142-193

Taheri, M. and M. van Geenhuizen (2011). "How Human Capital and Social Networks May Influence the Patterns of International Learning among Academic Spin-off Firms." Papers in Regional Science 90(2): 287-311.

Tambunan, T. (2007). "Transfer of technology to and technology diffusion among non-farm small and medium enterprises in Indonesia." Knowledge, Technology & Policy 20(4): 243-258.

Teece, D. J. (1996). Firm organization, industrial structure, and technological innovation. *Journal of economic behavior & organization*, *31*(2), 193-224.

Van Geenhuizen, M., et al. (2010). "Knowledge acquisition and innovation: potentials for upgrading of very small and small firms in furniture manufacturing in Indonesia." International Journal of Foresight and Innovation Policy 6(4): 207-224.

Appendix 1 Linear Regression Diagnostic

Diagnostic	Remark	Number of Innovations
Detecting unsual and influental cases	Aplying different methods we asses outliers ; residuals; scatter plots; leverage; Cook's D	Deleted 12 outliers due to inconsistency and/or extreme values
Reliability and Validity	Cronbach's Alpha Coefficient ;Pearson Product Moment correlation	α= 0.819 Corrected Item Total Correlation > r table (0.195)
Test for normality of residuals	Kolmogorov - Smirnov Test	Monte carlo sig : 0.82 (>0.05) p value = 0.04 (<0.05)

Test for homosceasticity of residuals	Rvplot, graphical method with residuals plotted versus fitted/predicted values White's test	rvplot, no pattern of heteroscedasticity found White's test : Chi^2 : 17.72 p-value: 0.05 No indication of heteroscedasticity
Test for multicolinierity	Variance inlation factor (VIF)	Mean VIF = 1.16
Test for model specification error	Ramsey Test Dubin watson Test	F count = 552.12 d linear 1.842 (between d_l &d_u) d quadratic 1.906 (upper d_u) Quadratic model is better than linear

Appendix. 2 Definition of Variables and measurement

Variables	**Definition**
Number of Innovations	continuous variable indicating the number of innovations produced by the firms in the last 2 years
Region	variable in 2 levels based on location
Firm Specific factors	
Firm Age	continuous variable as number of years since firm foundation to 2017
Firm Size	continuous variable as number of full time employees in 2017
R&D embededness	variable in four levels based on the organization of R&D activities
R&D amount	continous variable of percentage share of sales
Manager's Education	*variable in 3 levels*
Manager's experience	continuous variable as number of years of employment in business
Firm External Factors	
FDI share in ownership	continuous variable indicating percentage of investment from abroad companies in the firm ownership
Perception on regulation	continuous variable indicating the perception of the managers on the influence of regulation to innovativeness
Firm Network Characteristics	
Position in the value chain	variable in 2 levels based position of the firm in the value chain (as the service provider/manufacturer, or supplier).
Network Strength perception	continuous variable indicating the perception of managers on the strength of firm network with other
Network Openness perception	continuous variable indicating the perception of managers on firm willingness to accept new ideas or collaborations

Appendix 3. Correlations

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Nr of innovations	1																			
2. Region	.15**	1																		
3. Firm Age	.04	-.16*	1																	
4. Firm Age Sq.	-.10	-.06	.69**	1																
5. Firm Size	.15*	-.18**	.53**	.47**	1															
6. Frim Size Sq.	-.24**	-.08	.22**	.30**	.45**	1														
7. R&D organization	.11	.09	.04	.17*	.12	.16*	1													
8. %R&D spend. to sales	.16*	-.21**	-.18*	-.06	-.03	.22**	.41**	1												
9. %R&D spend. to sales sq.	-.06	-.25**	-.27**	-.08	-.06	.18*	.07	.63**	1											
10. Manager's education	.03	.08	.17*	.33**	.17*	.08	.20**	.12	.05	1										
11. Manager's Experience	.04	.52**	.30**	.15*	.18*	-.15*	.04	-.18*	-.31**	.01	1									
12. Manager's Experience sq.	-.05	.43**	.41**	.23**	.23**	-.19**	-.04	-.18*	-.25**	.11	.77**	1								
13. % FDI	.14*	.10	.26**	.34**	.26**	-.00	.05	.10	.04	.16*	-.07	.04	1							
14. % FDI sq.	-.13	.02*	.10	.19**	.08	.10	.07	.04	-.00	.10	-.04	.04	.72**	1						
15. Perception on regulation	.15*	.08	.12	.04	.03	.03	.13	.08	-.01	.02	-.06	.00	.10	.16*	1					
16. Perception on regulation sq.	.24**	.02	.09	.02	.02	-.01	.14*	.08	-.03	.03	-.06	-.01	.07	.19**	.83**	1				
17. Value chain position	.14*	-.04	.04	.05	.11	-.03	.03	.06	-.07	.14*	-.04	.01	.00	-.02	-.00	.03	1			
18. Network Strength	.35**	.06*	.12	.17*	.13	.13	.13	.15*	.13	.14*	-.08	.04	.11	.08	.12	.17*	.07	1		
19. Network Strength perception sq.	-.33**	.03*	.13	.17*	.13	.15*	.15*	.17*	.09	.12	-.14*	-.16*	.17*	.09	.11	.15*	.02	.84**	1	
20. Network Openness perception	.27**	-.04	-.13	-.16	-.24**	-.00	-.15	-.06	.03	-.24**	-.11	-.15	-.21**	-.13	-.23**	-.21**	-.04	-.26**	-.34**	1
21. Network Openness perception sq.	-.18**	-.12	-.01	-.00	.07	.08	.12	.12	.11	.21**	.04	.00	.07	.01	-.00	.07	.12	.26**	.33**	-.98**

Pearson Correlation *. Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed)