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Unravelling Social Capital Value in Science Parks: Growth versus R&D orientation

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Abstract: Science and Technology Parks (STPs) have fueled many debates on their effectiveness in policies to enhance innovation and regional economic growth. Some authors put emphasis on advantages of physical proximity between on-site firms and the university, while others pay increasingly attention to benefits from social capital between the stakeholders involved. According to theory, social capital works as a 'glue that binds' stakeholders who may originally have different interests, visions and different power positions. Adopting the last point of view, the aim of the paper is to increase understanding of the role of social capital in performance of STPs. The paper explores the relationship between growth and innovativeness of STPs and social capital-related power position, trust, and shared visions, using regression analysis. We make use of a survey-based sample of almost 50 STPs in various Asian countries. With regard to stakeholders and social capital, we distinguish between STPs' management, local university, local government and national government. We control for variation on country-level regarding innovativeness and planning culture and for variation in STPs' land-size. Our results show that higher STPs' growth (numbers of firms) tends to go along with some shortage in social capital, mainly on the local level concerning university and government. This situation may point to different opinions about growth, connected to physical limits regarding land and road system. In contrast, social capital on the local level but also national level, tends to be positively associated with degree of R&D orientation of STP firms.

Keywords: Science and technology parks, Asia, social capital, power perceived by STP, growth, innovation

1. Introduction

The number of Science and Technology Parks (STPs) has been quickly growing around the world in policies to enhance innovation and regional economic development. Particularly in Asia, the establishment of STPs started in the early 1980s, for example, in Japan, Taiwan, Korea, China, India, Indonesia, etc. Since the early application of STPs, collaborative relationships and innovation between university, business and government - known as "Triple Helix"- is an important aim for a part of STPs. Previous studies have indicated that such collaborative learning and innovation are supported by physical proximity at STPs. For example, a study on Spanish STPs elucidates that firms located on STPs benefit from the location in increasing their business growth and innovation capacity (Diez-Vial and Fernández-Olmos 2017). Also, a study on Italian STPs forwards that firms rely on physical distance with university to improve innovativeness, specifically regarding to R&D expenditure and patenting activity (Lamperti et al, 2017).

At the same time, the emergence of open innovation and advanced information and communication technology has caused fierce debates on the role of physical proximity, among others, because knowledge can also be electronically or virtually transferred over long distances (Chesbrough and Appleyard 2007) and transferred through travelling of persons (Van Geenhuizen and Nijkamp 2012). Hence, the studies on STPs today increasingly focus on the benefits from quality relationships amongst STPs stakeholders involved in planning and management of STPs, known as social capital. Social capital is an asset that may act as a "lubricant" for interaction between organizations and boosting organization growth and innovation performance (Maurer et al, 2011). Social capital is seen as consisting of three dimensions, namely, the structural, relational, and cognitive dimension (Nahapiet and Ghoshal 1998). The structural dimension is associated with social interaction, while the relational dimension refers to personal relationships or trust. The cognitive dimension is concerned with shared visions among stakeholders. The main stakeholders considered in this paper are STPs' management, local universities, and the local and national government.

Previous research on STPs and social capital has focussed on relationships between social capital dimensions and on-site firms innovative performance. For instance, social capital dimensions have been used to measure technology transfer by on-site firms in Malaysia STPs. Accordingly, on-site firms benefit from structural and relational dimension of social capital, through network diversity, collective action, and personal relationships (Abidin et al, 2014). Further, in 21 Spanish STPs, social capital has been observed to gain positive effects

particularly between on-site firms and universities in improving new product development and knowledge acquisition (Jimenez-Moreno et al, 2013). Also, in Turkish STPs, it was observed that strong networks or ties, as part of the structural dimension, have positively influenced knowledge sharing and product development of firms (Koçak and Can 2013). In contrast, a study undertaken by Patthirasinsiri and Wiboonrat (2017) in Thailand indicates a lack of social capital for newly established STPs with regional stakeholders.

While extensive research has been carried out on social capital and on-site firms' performance, no study exists which addresses social capital among various STP stakeholders such as local university, local government, and national government. An analysis of social capital between different stakeholders and influence on STPs' performance is the first contribution of our study to literature. Moreover, so far we know, the previously mentioned studies do not cover different parts of Asia in assessing social capital's influence on STPs' performance. Our study also contributes to literature by focussing on social capital mainly approached through the perception of the parks' management, as the most central stakeholder. Given the knowledge gaps on social capital at STPs in Asia, the current study addresses the performance of STPs in the past years and the conditions that help understanding this performance. Hence, our research question is as follows: (1) what is the level of social capital between various stakeholders and (2) to what extent do social capital dimensions - among other factors - influence growth of firms and innovation in STPs? This paper is structured as follows: section 2 explores a theoretical background, section 3 describes the methodology, and section 4 and 5 presents the results and additional findings. Finally, section 6 states the conclusion.

2. Theoretical Background: STP growth, firm innovativeness, and social capital

Numerous empirical studies reveal factors that influence STP performance, particularly firm growth and innovativeness. For example, parks land-size provide a positive influence on firm performance (Albahari et al, 2018). Moreover, the countries level of innovation plays an important role on firm innovation behaviour. For example, firms in less innovative countries, like in Turkey, are not much engaged in R&D activities (Pamukçu and Utku-İsmihan 2009). Conversely, highly innovative countries tend to have high technology firms engaged in R&D activities on their STPs (Savrul and Incekara 2015).

As previously indicated, since the early 2000s social capital has attracted major attention. Social capital refers to resources embedded in social relationships (Burt 2000), including three dimensions, namely structural, relational, and cognitive dimension (Nahapiet and Ghoshal 1998). The structural dimension of social capital is defined as the overall pattern of linkages between stakeholders (Nahapiet and Ghoshal 1998). In this study, we focus on the hierarchical position between stakeholders, namely power position (Adler and Kwon 2002). For example, the selection of type of firms that get access to the park, particularly their R&D level, may be influenced by stakeholder(s) that have a dominant power.

The relational dimension refers to personal relationships between stakeholders involved, particularly trust (Nahapiet and Ghoshal 1998). By developing trustworthiness with relevant stakeholders, STPs can find more challenges to accelerate their growth and innovativeness through knowledge transfer and interaction with the university (Montoro-Sánchez and Diez-Vial 2005). Conversely, a higher growth of firms in STPs will provide better opportunities for stakeholders to interact and build trust. Trustworthiness may be influenced by stakeholders' perceived image of the organization (Schlesinger et al, 2017). In this sense, we may assume that a (perceived) good image of the university will enhance trust building between park's management and university.

The cognitive dimension refers to shared visons and missions among stakeholders (Nahapiet and Ghoshal 1998). This dimension indicates that stakeholders take advantage of shared visions and missions to maximize the flow of information and improve STP performance (Montoro-Sanchez and Diez-Vial 2013). In addition, the mission of STPs which encompasses or contradicts individual stakeholders' missions, is a part of the cognitive dimension. Based on the previous arguments, a framework of analysis is developed for the study (Figure 1).

We take as point of departure that the relationships between performance of STPs and social capital works in two directions, i.e. social capital influences STP performance, while STP performance can also create (or destroy) social capital.

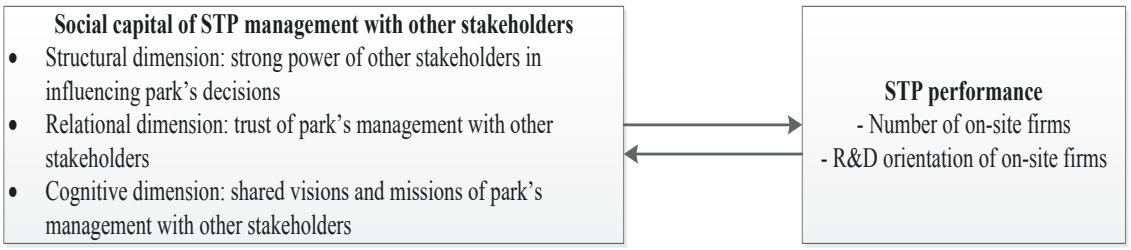

Figure 1: Preliminary framework of the study

3. Methodology

To explore the relationship between social capital and STP performance, a database of STPs in Asia is used. The database was created through an online questionnaire, distributed and collected from February to July 2018. A total of 46 completed questionnaires was returned, meaning a response rate of 23%. The current study needs to be seen as a pilot study, as the data collection is still ongoing to make the results more robust. In addition, various sources of desk-research provided useful data: articles in journals, annual reports of STPs, STPs' website, and conference proceedings, thereby enabling triangulation of information. As method of analysis we applied regression analysis (OLS) in an exploratory way. To respond to the statistical assumptions, we performed a set of standard tests such as normal distribution (including transformation for some variables), normality of residuals, heteroscedasticity, and multicollinearity (Hair et al, 2006). We transformed some of the data to gain a normal distribution. In conclusion, none of the test outcomes signalled serious concern.

We measured social capital dimensions through the perception of the park's management. This management acts as a central stakeholder in STP development in most cases. The picture, however, tends to be one-sided, but in the context of an online questionnaire, having more than one stakeholder involved in the data collection appeared an almost impossible task. We measured the perceptions of parks' management in terms of strong power positions, trust, and shared visions, this in relation to local university, local government, and national government. A situation of strong power was measured through the question whether 'strong power of a stakeholder is influencing decision-making by the park's management. About the relational dimension, we asked 'the mutual commitment and trust of park's management with other stakeholders. Related to the cognitive dimension, we asked whether shared visions between STP management and related stakeholders do exist or not. Besides, we asked about the image of the university as a part of the relational dimension, and the presence of STP's mission to increase regional economic growth and competitiveness, as a part of the cognitive dimension.

The social capital dimensions were measured using a 5-point Likert scale. In the preparation of the estimations, we experimented with merging some of the resulting classes (rescaling) to explore the best model. We also deleted a few model indicators (for example, concerning the structural dimension) in order to gain the best model structure. Given the small sample, we have to work with partial models (Table 2 and Table 3) to explore the best models, rather than use hierarchical regression and testing particular hypotheses (Petrocelli 2003, Wampold and Freund 1987). Accordingly, we first include control factors and next add specific sets of social capital indicators (partial models) one by one, like concerning power position, trust and shared visions. In a final estimation, we explore a model merely based on social capital connected to the local university.

4. Descriptive Results

The STPs in the sample are in 13 countries in Asia, with strong representation by China, Indonesia, Iran, and Turkey. Broadly speaking, the location is for 28% in South East Asia, 26% in West Asia, 24% in South Asia, and 22% in East Asia. As different country levels of innovation and planning traditions are involved, we control for their influence in our modelling of growth and innovation.

Regarding the dependent variable, growth of number of on-site firms, there is large variation, namely, between 1 and 55, with an average of 3.51. The second dependent variable is innovation, measured through R&D orientation of on-site firms, and this ranges as percentage share of all firms between 1 and 100**,** with an average of 26% and a relatively high standard deviation of 34. The three control variables provided the following results. We used scores from the Global Competitiveness Index 2017-2018 to grasp innovativeness

level of countries, with scores between 8 and 76. Regarding long term orientation in planning (country culture), we used data from Hofstede Insight Website (see https://www.hofstede-insights.com/), and divided the STPs in our sample into three classes: 37% a low orientation, 30% a medium orientation and 33% a strong orientation. In terms of size of the STPs land, there is huge variation, namely, between 1 and 10,000 hectares with an average of 704.6 hectare, but we corrected for this in calculation of firms' growth, namely, as growth per hectare.

Regarding to social capital, we observe the following trends. Related to power, 53% of park managements agree that the local university and local government exert a strong influence on their decisions. However, this tends to be somewhat different for the national government: strong power is less often present (42%). Regarding to trust, the park managements tend to take different positions, with a trend of 'neutrality' as evidenced by, first, more or less similar scores for the three stakeholders and secondly, a relatively high score for a neutral opinion. The last is strongest for the local university (43.5%) and this is reflected in the opinion about a good image of local university: 52% neutral**.** It needs to be mentioned that a relatively neutral position may indicate that trust is too sensitive to be forwarded by park's management. Finally, the variable shared visions of the management of STPs with other stakeholders indicates a high level of shared visions. However, the level for the local government is somewhat lower compared to the other stakeholders, 59% versus 74% respectively, which may indicate different or controversial visions. Further, 50% of STPs have a mission to increase regional economic growth, indicating quite some differentiation between the STPs in our sample.

As a preliminary conclusion, local stakeholders (university and government) tend to influence STPs' management most often, in an overall trend of social capital being high to neutral (or moderate). However, based on shared visions, it seems that social capital with the local government is sometimes on the lower side. Details of descriptive statistics are given in Table 1.

5. Regression outcomes

We estimate two models, namely growth (Table 2) and R&D orientation (Table 3). We distinguish between the base-model including control factors (model 1), partial models including social capital indicators, and a specific university model. As a result of comparing the two models, we find that by including the power variables in the R&D orientation model (Table 3) explained variation increases by 22%, which is nihil in the growth model. The shared visions model tends to be relatively weak both for growth and R&D orientation.

Table 2 presents the estimation results on growth. The significance of STPs land-size (squared) is remarkable because growth is already corrected for land-size of the parks. Apparently, a larger size comes with additional scale advantages that make larger parks even more attractive. The trust-model (Model 2) is the strongest model, adding 19% explanation of variation to the base model. The signs of the coefficients are, however, negative, suggesting that quickly grown parks put a pressure on price of land and use of infrastructure, and tend to be out of control of local university and local government, reasons for relatively low/moderate trust between STPs' management and local government (indicated by weak shared visions). Alternatively, the negative signs concerning trust may indicate 'too much trust' and path dependency, causing inefficient behaviour and lack of action to get growth higher (Boschma, 2005), but a slow development may also come with the advantage of keeping negative external impacts under control. Such situations are also indicated by the shared visions model (local university) (Model 3). Nevertheless, there is positive association with presence of STPs' missions to increase regional economic growth and competitiveness, suggesting that STPs are a potentially important source of technological spill-overs and regional economic growth (Audretsch and Thurik, 2001).

On-site firms' R&D orientation (Table 3) tends to be in line with the countries' innovation level (base-model). There are two relatively strong models, namely, the power position model (model 2) and trust model (model 3), and both models add each 22% to explained variation. Accordingly, there seems an important role for the local university in supporting R&D orientation, however, such role is not true for the local government. Trust as well as shared visions with local university and a good image of the university are found positive and significant. Trust with universities can enable parks and their firms to improve R&D activity (George et al, 2002). In addition, a good image of university, particularly in performing research and attracting funds to invest in R&D, tends to help on-site firms to increase R&D level. Shared visions between park and local university may increase R&D orientation (Siegel et al, 2003). The results also suggest that strong power

position of the national government (model 2) may stimulate STPs to increase R&D orientation, e.g. through supportive measures (incentives). Further, cognitive social capital (model 4) - through shared visions with the three stakeholders and STPs' mission in regional economic growth - seems not to play an important role in R&D orientation. Only the local university tends to matter in this sense.

We may preliminary conclude the following derived from searching for the best model of STP performance: growth of STPs in terms of number of firms tends to be differently related to social capital compared to R&D orientation of on-site STP firms. There is not only difference in direction of the relationships (mainly negative for growth and positive for R&D orientation) but also in stakeholders that are involved. In addition, power position tends not to be important for growth, but it tends to be important for on-site R&D activity. We may assume that in general STPs intent to enhance higher levels of innovativeness of their firms, and therefore we formulate the following two hypotheses on R&D orientation, covering the three dimensions of social capital and seen from the viewpoint of STP management.

Hypothesis 1: Power position of the local university and national government is positively associated with higher innovativeness.

Hypothesis 2: Trust with the local university and local government, and shared visions with the local university are positively associated with higher innovativeness.

Table 1: Descriptive statistics

Variables	Result	Remarks
Dependent Variables		
Average growth of number of firms per year/hectare (log10)	Min= 1; Max= 55; Avg= 3.51; Std. Dev.= 10.20	-
R&D orientation of on-site firms (transformed, log10+1)	Min= 1; Max= 100; Avg= 26.14; Std. Dev.= 34.01	-
Independent Variables		
Control variables		
Country innovation level	Min= 8; Max= 76; Avg= 48.15; Std. Dev.= 22.47	-
Country long-term planning orientation	1= 37.4%; 2= 30.0%; 3= 32.6%	Rank (1= low; 2= medium, and 3= strong orientation)
Land-size (transformed, inverse log)	Min: 1 ha, Max: 10.000 ha, Avg: 704.58 ha, Std. Dev.: 1951.65 ha	-
Social capital dimensions perceived by park's management		
Structural: strong power in parks decisions by		
Local university	1= 46.7%; 2= 53.3%	Rescaled to: 1-2 (1= not applicable at all; 2= strong power)
Local government	1= 46.7%; 2= 53.3%	
National government	1= 57.8%; 2= 42.2%	
Relational: trust of parks management with		
Local university	1= 21.7%; 2= 43.5%; 3= 34.8%	Rescaled 1-3 (1= not applicable at all; 2= neutral; 3= strongly applicable)
Local government	1= 28.3%; 2= 41.3%; 3= 30.4%	
National government	1= 28.3%; 2= 37.0 %; 3= 34.7%	
Good image of local university	1= 21.7%; 2= 52.2%; 3= 26.1%	
Cognitive: shared visions of parks management with		
Local university	1= 2.2%; 2= 8.7%; 3= 15.2%; 4= 32.6%; 5= 41.3%	Scale 1-5 (1= not applicable at all, 2= somewhat not applicable, 3= neutral, 4= somewhat applicable, 5= strongly applicable)
Local government	1= 8.7%; 2= 6.5%; 3= 26.1%; 4= 26.1%; 5= 32.6%	
National government	1= 2.2%; 2= 2.2%; 3= 21.7%; 4= 28.3%; 5= 45.6%	

Variables	Result	Remarks
Presence of STP' mission in regional economy	0= 50%; 1= 50%	Rank (1= yes; 0= no)

Table 2: Regression analysis of growth of STPs' number of firms

Variables	Model 1 (base)	Model 2	Model 3	Model 4 (university)
	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)
Control variables (base model)				
Country innovation level	.26 (.01)*	.15 (.01)*	.32 (.01)*	.13 (.01)*
Country long term planning (culture)	-.23 (.25)	-.23 (.23)	-.22 (.25)	
Land-size (square)	.33 (.01)***	.38 (.01)***	.27 (.01)**	.31 (.01)***
Social capital (STPs' management with related stakeholders)				
Relational: trust to				
Local university		.12 (.24)		.10 (.27)
Local government		-.39 (.26)***		
National government		.04 (.26)		
Good image of university		-.28 (.13)*		-.28 (.13)*
Cognitive: shared vision with				
Local university			-.29 (.14)*	-.27 (.18)*
Local government			-.05 (.26)	
National government			.14 (.24)	
Presence of STP's mission in regional economy			.22 (.14)*	
N	46	46	46	46
F	2.10	2.41	1.62	2.35
R^2	.13	.32	.24	.30
Δ R^2		+.19	+.11	+.17
*p<0.1; **p<0.05; ***p<0.01				

Note: we deleted the structural dimension (power position) because of lack of significance.

Table 3: Regression analysis of on-site firms' R&D orientation

Variables	Model 1 (base)	Model 2	Model 3	Model 4	Model 5 (university)
	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)
Control variables (base model)					
Country innovation level	.42 (.01)***	.35 (.00)**	.46 (.00)***	.29 (.00)*	.37 (.01)**
Country long term planning	-.33 (.10)*	-.25 (.08)*	-.44 (.09)***	-.29 (.09)*	-.25 (.10)*
Land- size (square)	.13 (.01)	.05 (.00)	.13 (.01)	.16 (.01)	
Social capital dimensions (STPs' management with related stakeholders)					
Structural: strong power in influencing park' decisions by					
Local university		.50 (.12)***			.46 (.27)*
Local government		-.17 (.13)			
National government		.23 (.11)*			
Relational: trust to					
Local university			.24 (.09)***		.14 (.01)*
Local government			-.18 (.09)		
National government			-.19 (.10)		
Good image of university			.21 (.08)*		.17 (.08)*
Cognitive: shared vision with					
Local university				.38 (.10)***	.13 (.07)**
Local government				-.24 (.10)	
National government				-.05 (.09)	
Presence of STP's mission in regional economy				-.00 (.13)	
N	46	46	46	46	46
F	1.80	3.20	2.68	1.43	2.34
R^2	.12	.34	.34	.22	.34
Δ R^2		+.22	+.22	+.10	+.22

Variables	Model 1 (base)	Model 2	Model 3	Model 4	Model 5 (university)
	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)	β-coeff (s.e)
Control variables (base model)					
*p<0.1; **p<0.05; ***p<0.01					

6. Conclusion

In attempts to understand STPs' performance, recently, there has been a shift in emphasis from physical proximity to social capital. Our study was concerned with social capital between STPs' management and three stakeholders, namely, local university, local government, and national government, in exploring the growth and R&D orientation in Asian STPs. Our results indicate somewhat high levels of social capital regarding the structural and cognitive dimensions, particularly power, except for national government, and shared visions, except for local government. Regarding to the relational dimension (trust), there tends to be quite some differentiation between the parks, though with a trend for neutrality and for similarity in scores for the three stakeholders.

The growth of firms tends to be mainly influenced by availability of land in STPs, providing additional positive scale advantages to firms. Regarding to social capital, the growth models suggest negative influence of social capital between STPs and the local government and local university, which may point to opposing interests and situations 'out of control'. Social capital may decrease if there are too many firms in STPs, causing pressure on local prices and congestion in local traffic. Alternatively, strong social capital in STPs may easily enhance the choice for low or medium growth since such growth provides better opportunities for direct interaction. Further, social capital tends to 'act' differently in growth compared to innovation. In particular, there is a positive interplay between STPs' R&D orientation and social capital with the local university (Siegel et al, 2003) and in some sense also with the national government.

Given the results, we may advise that STP managements increase awareness on the role of social capital in performance. Relatively modest levels of social capital may enhance STPs to grow quickly, but it depends on the goal of the park whether a quick or slower growth is desirable. Innovation in the park seems less controversial, in that increasing social capital tends to enhance the innovation level of on-site firms. This makes 'steering' through building social capital different for growth compared to innovation. In general, it seems that in gaining more benefit from social capital, STPs need to be more adaptive and eventually pro-active with stakeholders' visions and intentions to (re)formulate goals of growth and innovation.

The current study suffers from some shortcomings which can be addressed in future research. First, our results may have been affected by non-response in particular parts of Asia, which makes generalization for entire Asia problematic. Future research will increase the number of STPs and extent generalisability. Secondly, although we consciously focussed on perceptions of social capital by STP management, as the key stakeholder, it may have given strong one-sided views, calling for including perceptions of other stakeholders, like universities and local government, the last to better understand potential controversial issues. Third, there is the need to rigorously testing some current findings, including the preliminary hypotheses we formulated, like the ones on trust and to test more sophisticated growth and innovation models. For example, the innovation indicator we used is on the input side, while innovation also needs to be measured on the output side (e.g. patents); however, this can lead to contradictory results (Albahari et al, 2017). Another future research could include, aside from local social capital, presence of multi-national companies and relationships of the STP abroad, in order to extend the preliminary framework of the study.

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