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Lessons from European and East-Asian Science & Technology Parks: preparing the take-off in next generation involved countries

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Policymakers tend to see Science and Technology Parks (STPs) as effective tools in enhancing knowledge-based local/regional growth. Accordingly, the creation of high-technology firms and employment, and the revitalization of the local and regional economy are among the perceived positive impacts of STPs. In addition, the networks based on proximity within the park are seen as supporting the innovative power of on-site firms. In this sense, the concept of STP fits into the stream of innovation studies on knowledge advantages from physical proximity, particularly localized knowledge spillovers (e.g. Autant-Bernard 2001; Varga 2000).

There has been a fast growth in numbers of STPs in the US and the UK in the 1960s and 1970s, and this has inspired policymakers to adopt STPs in continental Europe, such as in Germany, Sweden, France, the Netherlands, and more recently in Southern Europe, for example, Spain, Portugal and Greece, and Eastern Europe (e.g. Sofouli and Vonortas 2007; Ratino and Henriques 2010). Since the early 1980s, Asian governments started to adopt STPs, in particular in quickly innovating countries like Korea, China, Taiwan and Singapore (e.g. Lai and Shyu 2005; Koh et al. 2005; UNESCO 2016). With this growing adoption, STPs have become more diverse in aim and practice, for example, concerning the type of target firms, the set of facilities provided and the stakeholders involved.

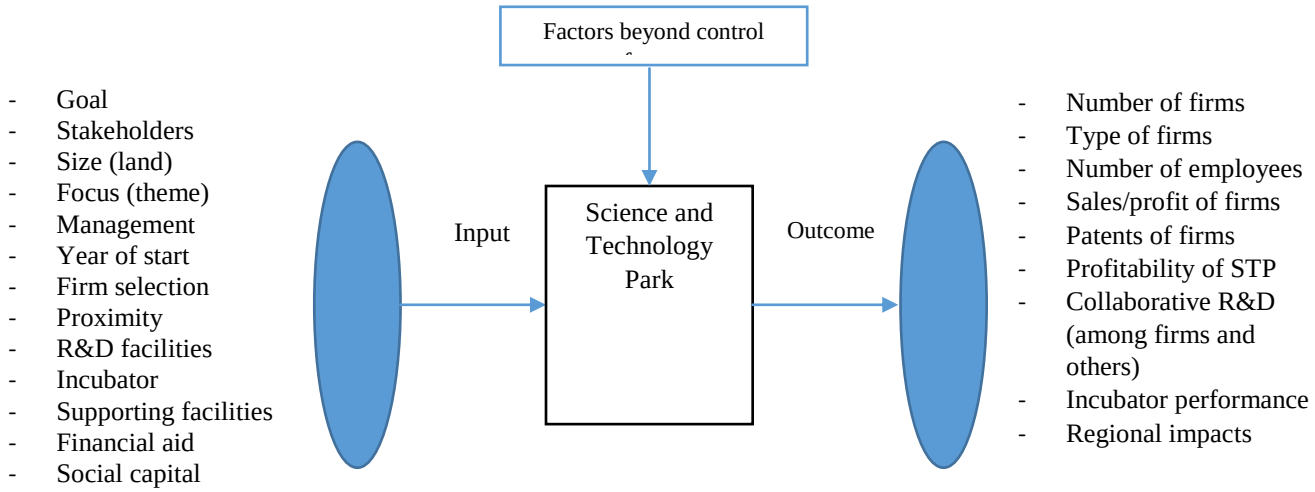
Increasingly, also low innovative countries in Asia start to adopt STP to enhance local/regional innovation and economic growth, among them Indonesia. This raises the question on whether the STP concept used in the recent past can work well in such countries, knowing that there is some doubt on positive impacts of STPs in developed countries and knowing that countries differ in institutional context of STPs. The paper contributes to the literature by increasing clarity on recent STPs' impacts in Europe and by increased understanding of their Asian counterparts, in terms of how the concept is elaborated in practice and what might be missing to make them efficient.

The paper uses meta-analysis of both European and Asian STPs as a method to systematically synthesize findings as part of an evidence-based research approach (Rosenbusch *et al*. 2011). Evidence-based research aims to substantiate research findings based on an aggregation of empirical findings. Meta-analysis is a quantitative and systematic method developed to integrate past empirical findings (Hunter and Schmidt, 2004). It provides the opportunity to determine the

strengths of direct effects and allows the identification of moderating effects. According to Rousseau et al. (2008: 491), "meta-analysis is intended to establish a way to tell what is true, as best we can tell." Using data from meta-analysis on STPs in Asia a benchmark of efficiency will be developed, using input factors and outcomes of STPs in Data Envelop Analysis (DEA) (Coelli, 2005; Thursby and Kemp, 2002). This method is a multiple input-output model that provides ground for improving STPs' performance with limited resources (inputs). The paper is structured as follows. First, we present our conceptualization of STP and discuss STPs on the 'input' side and on the outcome side (section 2). Next, we move attention to results of the meta-analysis of STPs in Europe with regard to outcomes and eventual relationships between input factors and outcome (section 3). With these results in mind, we evaluate STP development in Asia in a preliminary way using DEA and attempt to design a mix of criteria to which STPs in developing countries need to respond (section 4).

We identify four core attributes of STPs: (1) a property-based initiative close to and connected to a university/research institute, (2) managed by a professional organization (3) that supplies high quality premises or units to businesses (tenants), in (4) a policy context of mixed public/private stakeholders with expectations on innovation and economic performance impacts on regional/local communities (Gower et al. 1996; IASP 2016). Despite communalities, STPs can be very different, summarized in the following list: age of the park, size of land and buildings, type of stakeholders involved, specialized or not, type of targeted business activity, incubator and R&D facilities, financial aid and (operational) linkage with the university. There are also differences in regional location and proximity to the university. We add differences in social capital to this list, as STPs are more recently also seen as the result of inter-organizational relations between the stakeholders involved (incl. management team), as well as the result of interaction among firms, and among universities, STP management and firms (Nahapiet, 2008).

Figure 1 A simplified model of input factors and outcomes of STP



On the outcome side of STPs, we tentatively list criteria that can be seen as indicators of expected impacts, on different levels, namely, the firm, park and regional economy (Figure 1). We also distinguish factors that are beyond control of policy makers, like macro-economic factors, (in some cases) economic situation in the region, and institutions and culture, for example, risk-taking in innovation and entrepreneurship.

Our next step is exploration of *ex-post* evaluation studies in Europe. We observe few studies on impacts on the region regarding innovation and economic growth, in particular ones using the logic of direct, indirect and derived impacts of STPs. Systematic evaluation of STPs contribution to research and technology creation in the region, is also scarce (Minguillo et al. 2015). Further, some studies focus on STP supply and growth performance of STPs, while others focus on the level of on-site firms. If the park is taken as unit of analysis, evaluation may focus on whether the goals concerning supply characteristics, like type of business accommodation and services, or aggregate employment or profitable exploitation have been achieved. More recent schedules for evaluation that connects with the need for a more comprehensive evaluation and monitoring, is given by Dabrowska (2011) and the European Commission (EC 2014).

Regarding the performance of firms, most evaluation studies use a comparative analysis of on-site and off-site firms in a quasi-experimental approach (Siegel et al., 2003). In such analysis, on-site firms are expected to be more innovative, grow quicker and have a higher survival rate, in particular, benefit from higher levels of networking with other on-site firms and the university. Such positive effects, however, are seldom unambiguously proved. Overall, the results tend to be mixed, that is, a positive effect or no effect, or not conclusive. Thus, the Westhead studies (1994-2003) did not find differences in performance between on-site and off-site firms except for R&D intensity and survival rate, while Colombo and Delmastro (2002) and Lindelöf and Löfsten (2003) found various positive impacts on on-site firms' performance. With regard to networking benefits, the outcomes tend to be equally mixed. Thus, Bakouros et al. (2001) found both positive impacts and absence of impacts concerning university-industry interaction, and modest on-park synergy impacts, while Lindelöf and Löfsten (2003) even found negative results, namely less collaboration by on-site firms. An important observation is that the expected causality can often not be established. Colombo and Delmastro (2002) found overall positive results but the partially better growth performance of the firms might be caused by a positive selection of on-site firms.

We may conclude this part as follows. The results on performance of firms are somewhat ambiguous concerning positive impacts and concerning the causality between on-site location and firm performance. Further, a clearly forgotten dimension in evaluation studies is growth of the park decomposed into different types of firms and/or other organizations, like locally established firms and existing firms attracted from other regions (i.e. from abroad), and national (public) research institutes, causing different growth dynamics. Also, scarce attention has been

paid to relations between the input side and outcomes on firm performance, like social capital regarding the stakeholders (incl. STP management) and firms' networking with other on-site organizations. Overall, social capital has received small attention on the input side, while the firms' networks as outcomes have been studied quite often.

Next is our exploration of attributes and a first evaluation of STPs in Asia. We identify 76 STPs in Asia in the literature, starting with journals on regional economics, planning and innovation, and next retrieving additional information from conference proceedings, annual reports, books and STPs websites, allowing for triangulation of data. We observe, like in European STPs, that social capital and institutional aspects of Asian STPs have received weak attention on the input side. Some studies in Asia indicate that particular STP stakeholders suffer from lack of legitimacy and network power to get things organized and done.

By contrast, institutional aspects regarding the region, are sometimes clearly emphasized because governments in Asia tend to ensure reaping the fruits of STP. For example, in Korea a legal system has been put in place, in which the STP can act as catalyst of regional economic development (SEO 2006). Studies on Chinese STPs report extensive support to STPs themselves on the input-side like tax-breaks and financial guarantee (Zhou 2005). By contrast, evaluation of STP in Asia using firm performance indicators are (still) scarce, with Fukogawa (2008) on networks in Japan as a notable exception. A recent exception is Liu (2015) who investigates the efficiency of STP in China using various input factors and outcomes.

We may preliminary conclude that evaluation studies on Asian STPs stay behind in focusing on institutional and social capital factors (stakeholders' legitimacy) on the input-side and of performance of firms and networks on the side of outcomes. Such evaluation studies are nevertheless necessary as they inform policymakers about the extent to which and how goals are being achieved, in such a way that policies can eventually be changed to be more effective and efficient given limited resources. Against this backdrop, the paper continues with the selection of a sample of STPs in Asia and performs Data Envelop Analysis (DEA) in order to unravel the optimal efficiency and factors that influence efficiency. Outcomes of DEA and qualitative case study context provide recommendation on how to improve performance with limited resources in next generation STPs.