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Lessons from Singapore on the road towards innovation-driven economy

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I. Earlier research, state of the art review of the research

The accelerated globalizaton in the beginning of the nineties has led to a new organizational innovation in the development of transnational corporations, (TNCs) the emergence of their global networks. The ICT revolution allowed to ócoordinate complex networks at a distance. Great differences in wage costs between developed and developing/emerging economies made the separation of production stages dispersed geographically, which process was called by Richard Baldwyn the 2nd unbundling of globalization (Baldwyn, 2006). TNCs are able to vertically fine-slice parts of their production processes with a punctuality that has never been seen before, and settle individually to optimal places according to competitive advantages (Buckley 2009).The fragmantation of production processes has created trasnational and corss-border production systems, causing intense integration and functional interconnectedness. After the Milleneum changes in the structure of the world economy however, will be (and have been already) less influenced by national economies, but by TNCs optimizing vast resources worldwide within their borderless networks (Magas, 2010:49), while borders remain in place.

Southeast-Asian countries first encountered this new division of labour, when Japanese firms expanded into the region in the second half of the eighties. The new international resource optimalization spread soon and countries nowadays specialize on tasks and business functions instead of products.

It is not generally known in Hungary that *Hungary's embeddedness in vertical integration within global production networks equals the East-Asian region*, internationally referred to as the most densly-webbed area by transnational corporate networks.

In the beginning of the 21st century, two distinct research frameworks have spinned-off from the globalization discipline, the analysis of Global Value Chains (GVCs) and Global Procucton Networks (GPNs). New input – output databases have been developed, financed by international institutions (WIOD-Timmer et. al (2012), TiVA, Eora). Data analysis shows that Southeast Asia has been placed in the middle of global value chains with high ”forward” and ”backward linkages.” (UNCTAD 2013: 134). The most successful countries have managed to increase their semi-finished product speicalizations: China, Singapore and Malaysia (de Backer, Yamano. OECD 2012:6).

The city-state of Singapore has been strongly embedded in networks of transnational corporations and has moved from the third world to the first within 40 years of becoming a souvereign nation. World Economic Forum Reports have considered Singapore as an innovation-driven economy for several years. Hungary’s small open economy has also relied intensively on foreign direct investments (FDI) since the early nineties, however it has lagged behind in catching up with highly-developed countries. This motivates a deeper analysis of the Singaporean development.

The dissertation adresses the following research questions:

- What organizational and hierarchical structures have been developed in the 21st centrury, under which TNCs operate? How do they impact the international division of labour?

- What economic policy and institutional measures may contribute to the move from a ”cheap labour-driven production platform” to an innovation-driven economy?

- Can the stimulation of network synergies, infrastructural capabilities lead to advantages in location decisions of TNCs and their embeddedness in a given area?

Based on the above research questions, the following hypotheses were established:

H1 hypothesis: National economic/industrial policies and institutions of the host economy, which strongly support education and R&D, have a strong and manifest positive effect on linking with higher value-added activities of both foreign subsidiaries and their suppliers to global value chains.

H2 hypothesis: The emergence of scientific, technological and industrial parks as well as related clusters attract TNCs to these locations – and by fostering network synergies – they contribute to their organic embeddedness.

The present research identified important additions to the *main research results of transnational corporations* (Buckley, Casson 1976, Williamson 1975, 2009, Dunning 1977). The quality of institutions of the host country and the role of available social capital are those factors which allow us to distinguish between accelerated development of certain countries and economic stagnation by others (Dunning, 2010, Buckley, 2012). In the 21st century dynamic, non-material capabilities are appreciated (Szalavetz 2011, Teece, 2014) as well as geographical factors, such as industrial clusters (Cantwell, 2014). Locational advantages play an important role in creating competences (Cantwell, Mudambi 2005).

Porter introduced an industrial political point of view into the research on companies' competitiveness by defining competitive advantages (Porter, 1985). For the national economy, economic modernization,"upgrading" means moving towards more complex sources of competitve advantage, and gaining new positions in higher value-added manufacturing segments. He categorizes nations into different evolutionary stages according to their competitiveness. Countries advance by passing resource-based and investment-based stages into the innovation-driven stage of economic development. Szalavetz (2011) points out that a country or region was

declared up to now only „ex post" as innovation-driven. Porter describes innovation–driven economy as one where all factors of his „diamond" model are in motion: companies create highly developed competetiveness factors, companies specialize on their global strategies to produce on global markets, and well-developed support industries emerge (Porter, 1990, 1998).

II. Research methods

As a start, we explain, why we use "transnational corporation" as the main actor in the dissertation and not other commonly used terms: multinational, global corporations etc. We found in our secondary and primary research that the „mother company" can still be identified, in spite of the complex organizational structures, from where the company coordinates its global strategy.

The research period from 1990 to 2015 has been selected for the longitudinal research due to several factors: the start of the period coincides with the acceleration of globalization, the emergence of complex global production networks of TNCs, the economic rise of China and - significantly to any comparison - the introduction of market economy in Hungary.

The hypotheses are analysed and tested partly through primary sources, statistical data and government document analyses, semi-structured interviews and partly from case studies, and research papers from secondary sources.

Quantitative analysis

For the exploratory/comparative statistical analyses data from international organizations: UN, UNCTAD, UNIDO, World Bank, ASEAN, EU, the Asian Development Bank, national ministries, Economic Development Board of Singapore have been accessed.

Qualitative analysis

The changing organizational system of TNC networks, locational strategies of the mother company, the way of managing and coordinating the company, actions towards upgrading in the global value chains can best be analysed by qualitative methods, such as personal interviews (Parilli et.al. 2014, Yeung 2016).

We selected the method of ”semi-structured interviews” (Babbie, 2003). In this interview form the basic structure is given, ensuring to obtain comparable information, it remains however “flexible enough to allow to emerge those contents, which are not preplanned, but belong to the wider frame of the topics of the interview” (Lehota, 2001:23). We conducted five interviews in 2016 to verify primary and secondary research results gained on Singapore. Interview partners were 3 researchers from Hungary, have lived in Singapore for several years, the commercial attache of the Hungarian Embassy and a regional expatriate manager living for 15 years in Singapore on behalf of a German TNC.

Based on the explored factors during the research on Singapore, we conducted 28 semi-structured interviews in Hungary, with TNC subsidiary managers, their suppliers and production-related service providers, as well as experts working in economic development and in educational institutions. An interview took around 1-2 hours per person. Notes were taken, 18 interview participants agreed to record the interview as well.

III. Research results

III.1. Comparative review of the different frameworks of analyis of TNC networks, creating a research model for empirical research

The most widely-used framework of analysis in the Hungarian literature is the Global Value Chains (GVC) research. It finds its roots in the value chain model (Porter, 1985), and the global commodity chain theory, which examines the chains coordinated by buyers and the producers (Gereffy-Korzeniewiecz 1994, cited by Gereffi, Fernandez-Stark, 2011). While in buyer-driven commodity chains the end of the value chain (sales and marketing) is the main coordinating element, in the case of „producer-driven" commodity chains, it is the beginning (R&D activity, product development) that gives the strength of the value chain.

By 2000 the concept was further developed into the framework of global value chains (GVCs) (Gereffi, Humphrey, Sturgeon, 2005, Sturgeon, Gereffi, 2009, Pietrobelli, Rabellotti, 2011, Gereffi, Lee, 2016). GVC framework concentrates on the sequence of value added from the conception to the end use. From a top-down view, it examines how lead firms govern globally their subsidiaries and suppliers.

Humphrey and Schmitz (2002) introduced the definition of upgrading, describing it as a movement towards higher value added activities, and analyzing what movements occur. Researchers use their widely accepted typology of upgrading. Several research projects have been made in Hungary to examine the upgrading trajectory of foreign subsidiaries concluding mostly with positive results on the scope of upgrading (e.g. Sass-Szalavetz, 2014). Impacts of GVCs on trade is also analysed in the literature (Antalóczy, 2012, Éltető, Völgyi, 2013, Magasházi, 2015a).

In the beginning of the Millenium in many respects similar, however distinct analytical framework appeared, i.e. the Global Production Network (GPN). It defines its roots in Actor-Network Theory (ANT) analyses the cultural, sociological and geographical aspects of impact that development has on the territories these networks encompass (Henderson, et.al 2002, Ernst, Kim

2002, Coe, Dicken, Hess, 2008, Parilli, Nadvi Yeung, 2013, Yeung 2016). GPN brings together a wide array of economic actors, most notably firms, state institutions, labour unions, consumers, non-governmental organizations in the transnational production of economic value (Coe-Yeung, 2015:15). Researchers with the GPN framework usually collect information leaning on qualitative methods of case studies and can draw conclusions mainly on the national level (Parilli et.al. 2013, Yeung, Coe 2015).

The most recent framework, GIN brings another crucial element into the analysis: innovation networks and innovation strategies. In the GIN approach (Ernst, 2009, Cooke, 2012) one of its proponents, Dieter Ernst considers the particular network of innovations on a global scale, and identifies the leading poles of innovations and knowledge setting up four categories: global centres of excellence, advanced locations, catching up locations and "new frontier" locations. Emphasis is put on higher value-added activities, engineering services, product development and the cross-border flow of research and development (R&D), the geographical distribution, and dynamics of which is the basis for balance of power between the actors of the network (Parilli, Nadvi, Yeung, 2013: 981). In the new geopgraphy of knowledge – as Ernst states – East-Asian locations: Taiwan, Korea, Singapore and Malaysia (latter two in the electronics industry, chip design) emerged already as advanced locations, he mentioned East-European countries as "new frontier locations" such as Romania, Armenia, Bulgaria among others (Ernst, 2009:35-36) giving hope to emerging economies worldwide.

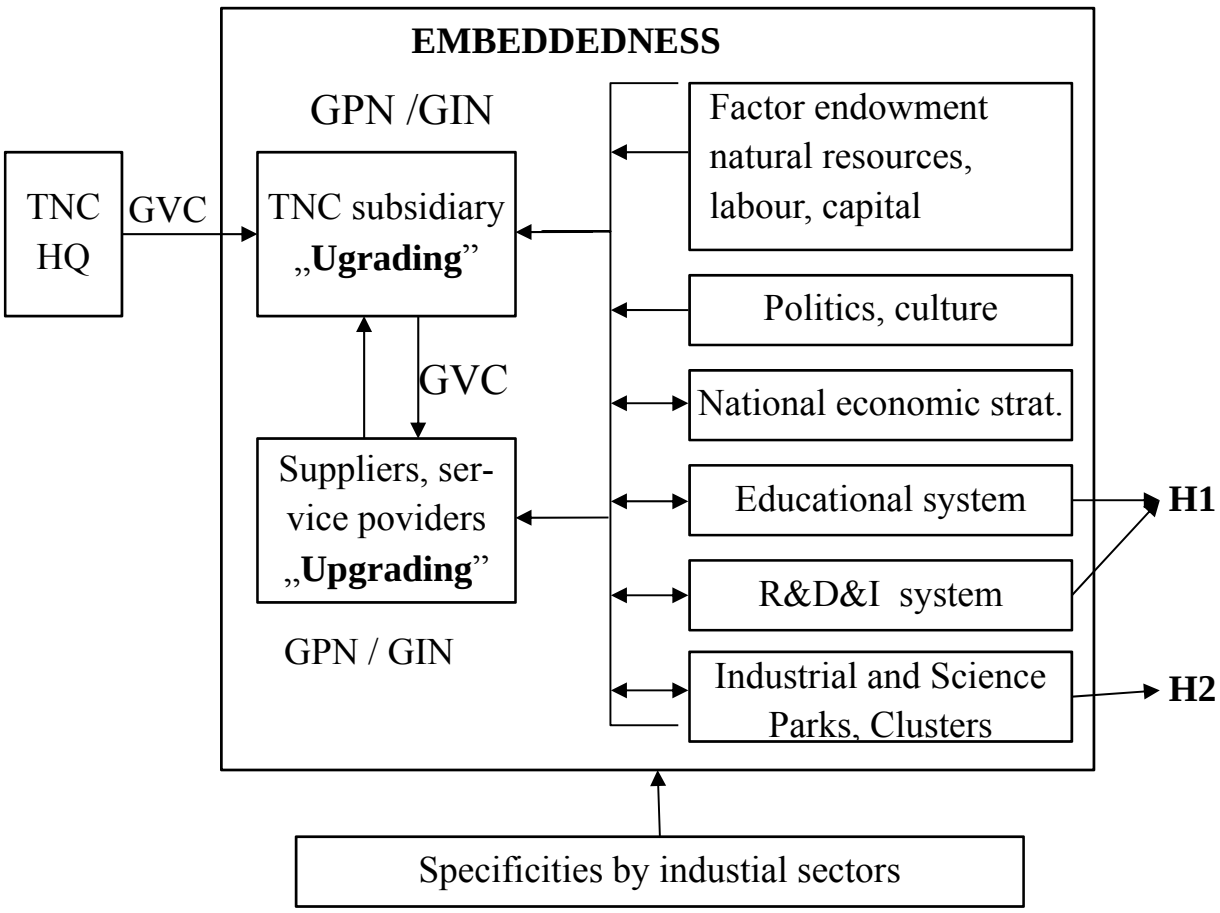
There is an argument in the academic literature, whether there is any real diference between the two frameworks (de Backer, Yamano. OECD 2012:8). Having reviewed theories, frameworks and empirical research results based on the research framework, we have concluded, that there are important differences between the frameworks outlined above. They have a common

thread, as all are examining the impact on regional development. However, they shed light on different aspects of the processes that are taking place simultaneously in the global, regional and local space.

As up to now these frameworks are applied in the literature separately, we set out to create a multifaceted research model, capitalizing on the synergies among the models. We aimed at establishing a model, which could be helpful to in analyze the Singaporean development, such as an inividual corporate strategy's impact on the location, and their interactions. We adopted a similar apporach, when planning the qualitative research in Hungary.

Figure 1

. Research model



Source: compiled by the author

We find that from the GVC framework ”upgrading” is the most important aspect, from the GPN framework network synergies, embeddedness is the key element to be integrated into the model (Figure 1).

III. 2. Singapore’s advancement towards the stage of innovation-driven economy

In the main chapter of the dissertation we review with a new apporach the relations between national developmental aspects – such as education, R&D politics, science parks and clusters – and company behaviour, industrial sector advancement. We do not only *contribute to the research on Southeast-Asian countries by studying a 25 years period on Singapore, amidst frequent changes in the world economic division of labour, but we do that with the above ”double” view.*

We selected TNC networks in the manufacturing industry of Singapore, even though its reexport and financial hub role is internationally significant. Singapore has modernized its manufacturing industry in the past 25 years with the help of long term strategic planning, and it has been in the focus to this day. Manufacturing industry has contributed 20-30% to the GDP, which is similar the ratio in the smaller V4 countries. The high value-added service sector has grown in line with the development of the manufacturing industry.

In the next paragraphs we examine the two hypotheses and summarize the results.

We *tested H1. hypothesis* by *reviewing two fundamental functional areas towards the innovation-driven economy – education and R&D&I* - as well as by company strategies.

Singapore's jump to the top in the international higher education rankings has taken place in the past 25 years. The Prime Minister announced in 1991 the new, long-term economic development strategy „Next Lap". The Next Lap, a 30-year economic development strategy stated - first in the economic history of the city state - that the prime goal of economic policy is the development of education, and particularly higher education.

Higher education has changed significantly in the period between 1990-2015. The 1996 education policy has brought about major support on the road towards the innovation-driven economy. New universities were established in collaboration with top foreign universities to complement the existing two Singaporean universities NUS and NTU. Such examples are the Singapore Management University (SMU with Wharton) and INSEAD, which opened its Singapore campus in 2000 to support world-class business education. The Singapore University of Technology and Design was set up together with MIT in 2012, a multidisciplinary new university combining natural and social sciences between NUS and Yale in 2015.

Following our research on the manufacturing industry, we selected two examples of industrial sectors to illustrate our findings on the H1 hypotehesis.

The education policy towards targeted, future-oriented manufacturing sectors brought major results and created advanced capabilities within a very short period, already after 6-7 years. It strongly applies to the accentuated technical education (engineers in electronics, IT services). We can state that the described policy measures' impact on moving towards higher value-added activities in the electronics industry was confirmed by productivity results and patent submission data.

Value added per employed increased in the IT, electronics and optical industry by 209% between1990-1995 and by 198% between 1995-2000. Balderbos (2006) created a unique data-base on patent applications of 186

TNCs worldwide. 29 TNCs were identified, originating patent applications from subsidiaries seated in 10 Asian countries, including the newly industrialized entities, Singapore, Taiwan, South-Korea and Hongkong, as well as China and India. We analyzed the background tables of the paper and showed, that of the five top, most active TNCs altogether 64% of their patents originated in Singapore in the 1996-2003 period (Hewlett Packard, Siemens, Thomson, Matsushita, ST Microelectrnics). All of the TNCs came from the electronics industry and started their electronic assembly operation two decades before. Data support that upgrading through R&D activity has taken place with a major role of TNCs.

The success of higher education in engineering and its spillover effect on the economy had already had some basis before the nineties:

- 20 years of production experience of the electronics industry
- the educational reform of 1979 substantially improved secondary-level technical education (technicians, highly skilled workers)

The development of tertiary education proceeded hand in hand with the future-oriented economic strategic goals. In 2015, after secondary school 28% of the students studied in technical high schools and universities, nearly double than in Hungary. The radical improvement of the quality is reflected in the progress of the two major Singaporean universities in higher education ranking. The NUS is the seventh in the world in engineering studies and tenth in IT, while its general ranking achievement was ”only” 24th. The second university, NTU was established in 1991 as an independent technical university. Today it is a university with wide range of study fields and jumped 119 places forward in the ranking between 2011 and 2016, from the 174th to the 55th place. It leads the league of the fastest growing young universities. Finally it is to be noted here, that in 1990, only 4,7 % of the resident

population above 25 years of age had a university degree. In 2015 this share amounted to 28,2 %.

The development of tertiary education is organically connected to research and development. At the end of the seventies, only 0,2-0,25 % of the GDP went into R&D expenditure and 0,9 % in 1990 (Wong, 2009). Mid-term strategic planning was introduced in 1991, a coordination institution was put in place and public R&D expenditure was increased. The first two research insitutes were created in the field of productivity enhancement, technological advancement and development of higher value-added products and the second in data storage, where Singapore (also refered to as the ”winchester city”) had extraordinary export market position.

The R&D institutional system was further developed from 2000 onwards, leading to a radical “R&Đ attack” – as one of the Hungarian researcher working in Singapore phrased in the interview. The refurbished, renamed research management body, A*STAR has by now built 22 research institutes within its framework. Under the new professional management, with high autonomy and 5 years budget A*STAR ensured the efficient utilizaton of R&D funds, has taken care of providing foreign and local researchers for the industry. A*STAR’s programs promotes higher value-added activities of local suppliers through „Technology Upgrade (GET-Up”), SimTech research institute provides researchers, research engineers for 1-2 year for local companies to help managing R&D projects.

We confirmed the R&D results by primary case studies as well. In the beginning of the 21st century, Philips decided to move the global audiovisual headquarter from Eindhoven to Singapore. The Singaporean product development engineers frequently visited the assembly facility in Győr during new product introduction. According to the literature, by 2011 Singapore has

become a new location of the internationalizing R&D activity of TNCs together with China and Israel. (Dunning, Lundan 2008).

We have examined the impact of the “R&D attack” on the value added of the manufacturing industry 5 years apart. The regression results show a significant relationship between the growth of R&D expenditure and value added. We carried out the regression calculations on the manufacturing value added/employed and average wages as well. Both cases showed a strong relationship during the period between 1990-2015. Public initatives boosted private R&D investments, too. The share of private investment increased from 55 % to 64 % after 1995.

Another complex example is the creation of biomedical research and industry in Singapore since 2000. The government took a ”venture capitalist” approach, as the private sector was not yet ready to embark on such a risky venture. With a large concentration of funds on this nieche segment from 2000-2010, they created special educational modules both in the secondary and tertiary education. It took approximately 6-7 years, when foreign companies started to join in the development of the new biomedical and biotechnological industry by bringing the production of biomedicine into new specialized industrial parks, and it took ten years to house their biomedical research units as well.

The development of tertiary education took place in collaboration with foreign universities. NUS with DUK university established from 2009 master and doctoral programs. A new university was set up in 2013 with a joint bachelor program of Imperial College London and NTU. In 2015 more than 8 % of the students studied health science, which is higher than the Hungarian share.

We examined the results of creating the biomedical science industry with developing educational and R&D framework. We analysed the impact on

higher value-added activities of firms through statistical analysis and primary case studies as well. The share of pharmaceutical and biomedical industry increased in 1990 - 2015 from 5 % to 15 % of the manufacturing value added. The value in 2015 was 14 times of the pharmaceutical value added in 1990. The sector has achieved by far the highest value added per employed, 6,5 times the value of the electronics industry in 2015. An outstanding example of TNCs joining the strategy is the 5 years cooperation agreement between the Singapore government (EDB) and Procter & Gamble, signed in 2014. Research projects with a total value of 60 million USD will be supported in the medical research area of the universities in the next years.

We illustrated the global economic realignments affecting the biomedical industry, too by preparing a case study on the *US-based research firm, AMRI*. AMRI is a contracted initial exploratory research service provider partner of biomedical manufacturers. *Following changes in global demand AMRI entered Hungary in 2006* and built a *brand new laboratory by 2009 in Budapest*. *In 2010-ben AMRI closed its laboratory in New York and moved its activity to India and Singapore*. In *2012 they closed the Hungarian subsidiary as well, and moved the activity to Singapore, too*.[1] Finally the Washington–based laboratory moved to Singapore as well. Although the moves were market driven, important comments were added by interviewed researchers on the Singaporean biomedical environment.

Further case study support was provided by the Taiwan-based LiteOn electronical company. In 2007 LiteOn bought a division of Philips, based in Germany, and thus obtained the Győr-based car-hifi factory as well. Following the crisis LiteOn moved the production from Győr to China. In order to move towards higher value added, the company established a new

[1] Source: OutsourcingPharma.com 2010.03.22. accessed 16.12.2017, researcher interview

division for biotechnological production in 2011. LiteOn opened its first biotechnology related R&D facility outside Taiwan in Singapore in 2016.

We verified further the results with *semi-structured interviews conducted with three Hungarian researchers working in Singapore in the field of health science*. It was unanimously confirmed that *the main locational advantage of Singapore* - also compared to Hungary - *lies in the HR factor*. There is a considerable advantage of Singapore both in knowledge and work attitude of the researchers, which is supported by the very high level of education. A further *important element is the strict patent protection regime* maintained in Singapore, *essential for the pharmaceutical industry*. *Based on all of the above, we find the H1 Hypothesis proven.*

The *H2 hypothesis* formulated in the dissertation *was fulfilled only partially*. It has become a central question in the past 25 years, to what extent scientific and technological parks attract kowledge-intensive activities into their location, and whether network synergies emerge among the tenants supporting their long-term embeddedness.

The example of the Singapore Science Park, established in 1981 showed, that low-intensity R&D in the economy, the lack of institutional system coordinating efficiently R&D efforts, and the broad industry focus of the Science Park hindered the emergence of network synergies in spite of generous subsidies and aesthetic environment even after 20 years (Phillip, Yeung 2003).

A different trajectory is shown on the example of the Science Park Biopolis, designed specifically for the needs of biomedical science research in 2003. By then there was a strong institutional and financial support behind the R&D efforts in Singapore. Biopolis ten years after its opening could boost of vibrant research and innovation environment, with network synergies among 4500 researchers working in similar research fields. Beside the 5 public

biomedical research institutions of A*STAR, 40 private laboratories of leading international biomedical companies had facilities in Biopolis. The innovation cluster program of A*STAR was introduced in 2013 to help to create further network synergies. Procter&Gamble opened a 46000 m2 innovation center in Biopolis in 2014-ben, creating 250 laboratories to be rented out to SMEs and startups.

Further specialized parks for future-oriented manufacturing industries – such as Seletar Aerospace Park, Tuas Biomedical Park, or new highly technology intensive chemical factories on Jurong Island prove as well that they contribute to a large extent to the creation of clusters of the target industry and their embeddedness.

Examples targeting the road towards innovation-driven economy in Hungary, is outlined in the fifth chapter of the dissertation. Our interviews showed, that lack of focus partly caused that today there are 200 industrial parks and 200 clusters with altogether weak results. In both areas there are new initiatives to sharpen the focus. The Scientific and Technological Park Program, selected 10 eligible Parks in the first and up to now only round in 2014. The cluster development initiatives of the responsible public authority plans to focus on 35-40 ”accredited innovation” clusters from 2017. It is not yet clear what resources eligible parks and clusters may receive to nice sounding titles. Results can be researched on the mid-term only.

III.3. Qualitative Research carried out on network synergies of a TNC subsidary in an industrial park setting

A *novelty of the dissertation, that we carried out a qualitative research based on the established research model, we tested the model* (Figure 1). The research involved a Tier 1 automotive supplier TNC subsidiary, its supplier and five service providers as well as three public institutions connected to the

case study. All suppliers/service providers have operated more than 15 years in the Park. The subsidiary's place in the global production network was examined, as well. We found that the Mexican ultimate owner company implemented a divisional organizational structure. The five divisions are integrated horizontally; there are no industry connections between the divisions. The automotive division's global value chain, as well as national and local network connections were identified and analyzed in detail. The GPN analysis revealed that the subsidiary started to open towards the location and intensified its network connections as late as in 2011 for two reasons:

- sharp increase in the turnover – due to global, primarily Asian demand – turned the subsidary to a large company status allowing more autonomy,
- tightening of qualified labor supply on all levels.

The case study provided a good opportunity to show how universities, schools, institutions, suppliers and service providers can group around the subsidiary, how the network connections started to be built up and what advantages they brought to different participants.

An equally important part of the case study is the analysis of the upgrading of the subsidiary and its major partners on product, process and functional level showing an impressive co-evolution in turnover and productivity increase between 2000 and 2015.

We believe that the test of the research model by the TNC network case study provided evidence on the advantages of multifaceted analysis of the environment of the subsidiaries and it suppliers with impact on the subsidiary's embeddedness. We found that Industrial Park Győr contributed positively to the network synergies. The large share of SMEs supported the resilence of the Park itself. In 2000, half of the people employed at the area

worked for Philips, which was closed down by the Taiwanese new owner in 2010. The Innonet Innovation Centre in the middle of the Park since 2000 has created further network synergies and supported resilence of its start-up tenants during the crisis. All in all, the positive contribution of the Industrial Park to the embeddedness of the Tier1 subsidiary could be confirmed.

III.4. Policy recommendations based on lessons from Singapore

1. The *key factor to Singapore's success is the outstanding efficiency of its state institutions*. Their organizational structure incorporates modern organizational development techniques learnt from transnational corporations, too. Singapore can serve today as a benchmark in terms of its institutions for institutional development of the Hungarian educational and R&D institutional system.

2. In *Singapore's business environment legal security – also patent protection constitutes a major locational advantage* –, as interviews and secondary sources confirmed. Plans to attract TNCs from the field of pharmaceutical production of R&D, biotechnology should be supported with strict and transparent patent law with relevant insitutions in Hungary as well. The World Economic Forum Competitiveness Index background data shows that *Singapore stepped forward in the cathegory of patent law and its institutions from the 4th to the 2nd place among 140 countries between 2005 to 2015*, while *Hungary with aspirations to foster the pharmaceutical sector stepped back from the 33rd place to the 88th. Reasons should be investigated and the problems tackled.*

4. Singapore's economic development agency, *EDB and its R&D Development Agency A*STAR applies very innovative methods to enhance capabilities of the suppliers.* We outlined several examples, from which we mention here two. A senior employee of a transnational corporation, spends half a year working full time at their supplier – salary fully paid by EDB – to

help increasing the efficiency of production, or professionally upgrading functional areas (financial and management controlling). *A*STAR sends in researchers, research engineers to lead and support promising R&D projects at companies with minimum 30 % Singaporean ownership*. The Hungarian engineering service provider SME companies, with excellent contact to TNCs and good technical capabilites – as we revealed in our research – have substantial growth potential due to upcoming automatization wave. *Methods, as described above could accelerate their development to utilize the mannigfold market opportunities.*

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