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THE ROLE OF INNOVATION IN DEVELOPMENT – EXPERIENCES IN LEAPFROGGING AND CATCHING UP THROUGH REGIONAL CLUSTERING: EAST ASIAN PERSPECTIVE

This paper analyzes the role of innovation in development by examining the experiences in leapfrogging and catching up through regional clustering in East Asian countries. The first part of the paper discusses the role of innovation in development itself through literature review providing the conceptual framework for further research. The identification of clusters as a possible measure and a stimulus for innovation to foster economic development follows. The experiences in leapfrogging and catching up through clustering in East Asian countries is presented further by evaluating conditionality for effectiveness of innovation to promote development advancement, importance of clustering in fostering technological innovation and possibilities for cooperation between and within clusters using the regional and industry approach.

Keywords: *economic development; leapfrogging; clustering; technology transfer; innovation; East Asia.*

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РОЛЬ ІННОВАЦІЙ В ЕКОНОМІЧНОМУ РОЗВИТКУ: ПРАКТИКА СТРИБКОПОДІБНОГО ТА НАЗДОГАНЯЮЧОГО РОЗВИТКУ ШЛЯХОМ РЕГІОНАЛЬНОЇ КЛАСТЕРІЗАЦІЇ НА ПРИКЛАДІ КРАЇН СХІДНОЇ АЗІЇ

У статті проаналізовано роль інновацій в економічному розвитку шляхом оцінювання досвіду стрибкоподібного та наздоганяючого розвитку та відповідної їм регіональної кластерізації у країнах Східної Азії. Надано огляд актуальної літератури на тему інноваційного розвитку, що являє собою концептуальну основу для подальшого дослідження. Кластери описано як спосіб інноваційного розвитку та одночасно як його стимул. Досвід стрибкоподібного та наздоганяючого розвитку країн Східної Азії демонструє ефективність інновацій в такому контексті, важливу роль кластерів у даних країнах та значні можливості для взаємодії як всередині кластерів, так і між ними в межах окремої галузі або регіону в цілому.

Ключові слова: *економічний розвиток; стрибкоподібний розвиток; кластерізація; трансфер технологій; інновація; Східна Азія.*
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РОЛЬ ИННОВАЦИЙ В ЭКОНОМИЧЕСКОМ РАЗВИТИИ: ПРАКТИКА СКАЧКООБРАЗНОГО И ДОГОНЯЮЩЕГО РАЗВИТИЯ ПУТЁМ РЕГИОНАЛЬНОЙ КЛАСТЕРИЗАЦИИ НА ПРИМЕРЕ СТРАН ВОСТОЧНОЙ АЗИИ

В статье проанализирована роль инноваций в экономическом развитии путём оценки опыта скачкообразного и догоняющего развития и сопутствующей им региональной кластеризации в странах Восточной Азии. Дан обзор актуальной литературы по вопросу инновационного развития, что представляет собой концептуальную основу для дальнейшего исследования. Кластеры описаны как способ инновационного развития и одновременно как его стимул. Опыт скачкообразного и догоняющего развития стран Восточной Азии демонстрирует эффективность инноваций в таком контексте, важную

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роль кластеров в данных странах и широкие возможности для взаимодействия как внутри кластеров, так и между ними в рамках отдельной отрасли или региона в целом.
Ключевые слова: *экономическое развитие; скачкообразное развитие; кластеризация; трансфер технологий; инновация; Восточная Азия.*

Introduction. The quest for catching up has been an issue of great concern for numerous developing countries in the contemporary global economy and a matter of controversy and discussion of economists and policy makers since Adam Smith's "An Inquiry into the Nature and Causes of the Wealth of Nations". At the same time the enormous existing stock of knowledge in the contemporary world on one hand and low level of economic development on the other enable developing countries to catch up with developed ones. Development experiences of numerous economies – especially in East Asia – demonstrates such a possibility. However, not all developing countries proved to be successful on this track. It is thus substantial to deepen the understanding of this successful industrial and technological upgrading in particular countries and industries, its backgrounds, sources and obstacles within the process of innovation building, catching up and leapfrogging. Therefore, the goal of this paper is to analyse the role of innovation in development by examining the experiences in leapfrogging and catching up through clustering from the perspective of particular East Asian countries.

Innovation and leapfrogging – theoretical perspective. The paradigms of catching up and leapfrogging are widely discussed in literature since their beginnings in economic thought going back to A. Gerschenkron (1962). The clear distinction between catching up or catch up and leapfrogging has been drawn by D. Chen and R. Li-Hua (2011: 94). The first refers to the relationship of speed and location between a forerunner and a latecomer and signifies that the latecomer reaches and surpasses the forerunner after some time. Leapfrogging however means that latecomers advance more rapidly and refers to a non-continuous advance mode in the course of which some phases or steps are skipped. The authors further correctly implied that the former contains the latter (Ibidem). The leapfrogging phenomenon was in depth analysed in the 1980s by J. Kleer at al. (1989) who indicated that significant breakthough in economic processes, however, can lead both to accelerate and set back development, what results from multidimensionality of phenomena relating not only to economic sphere, but also to political, social, technical and cultural ones. Thus, there might be a successful jump, and also unsuccessful. This means that it does not always have to create – despite periodic acceleration – the conditions for the development of a sustained nature. This will depend on external and internal factors, among which institutional aspects draws partucular attention with the dominant importance of the social capabilities and the state being able to govern/control the desired changes (Ibidem: 193; Nawrot, 2014: 24), playing at the same time the eneterpreneurial role. The significance of social capabilities was strongly emphasized by M. Abramovitz (1986: 388) who argued that it might be central impediment for succesful leapfrogging and catching up, indicating that country's potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced. Interaction between social capability and technological opportunity is thus crucial.

Within the discourse it is unqestionable that industrial development and technological advance of developing countries require new technologies and innovations. This raises the question on the absorptive capacity of a developing country and thus capabilities necessary to facilitate the existing or emerging windows of opportunities. It coincides with the issue of diffusion of technology and furthermore the most effective mode and speed of technological accumulation. In the view of the foregoing, the study attempts to examine the process of clustering as a measure and the indicator of innovativeness and its role in development advancement. Consequently it is crucial to understand and identify the capabilities, which facilitate private sectors' ability for growing and mushrooming in certain locations while exploiting the comparative advantages of particular destinations basing on the existing factors and complementarity building through regional platform.

The existing body of literature deeply assesses the issue of clustering discussing: the conceptualization of clustering; different types of clusters; its impact on innovation; its role in creating innovating ecosystem; determinants of cluster creation; regional perspective; industry perspective; Triple Helix role in cluster process focusing on the interaction of state, universities, private sector among others (Porter, 1990, 1998; Rocha, 2004; Lee and Tee, 2009; Garanti, 2013). The next part of the paper will thus move to selected case studies in order to synthetically examine the process of cluster creation and its consequences for innovation ecosystem enhancement.

Case studies. Taking into account the undertaken context of possibility of leapfrogging and catching up it seems significant to include in the analysis different countries and also industries of distinguished character. Therefore, for the purpose of the study 3 countries from the region, namely Singapore, Malaysia and Thailand, were chosen and also 3 industries – automotive, electronics and biomedical. The reason for that is to find not only the determinants of successful implementation and functioning of clusters but also to look at possible cooperation between and within clusters. Additionally, the chosen industries represent different value added and stock of knowledge what differentiates the implementation process and in the regional context enables the relocation of production and clusters expantion. Furthermore, it aims to determine the possibility of cooperation between clusters from different industries as well as between those not necessarily in geographical proximity.

1. Automotive industry in Thailand. The expansion of automotive industry in Thailand began in the 1960s along with the promotion of import substitution policy, which was supposed to intensify industrial production in the country. In 1961 the production reached 525 cars, while domestic sale was 6080 units (Techakanont, 2008: 5). In the 1970s, further expansion of production and higher share in the market were observed and only in the 1980s very intensive development of this sector began. This mainly resulted from the change in government policy from import substitution to export-oriented strategy in Thailand and other ASEAN countries. Crucial importance should be also attributed to the deregulation of automotive industry and appreciation of Japanese yen in 1985.

As a consequence Japanese and US automobile assemblers, like Mitsubishi, Toyota, Auto Alliance (joint venture of Ford and Mazda), GM or Isuzu shifted their production to Thailand and in 2006 the annual production amounted to 1176840 units, and the total export reached 539206 units (Ibidem). This was a very significant

change comparing to the export volume of 14020 units in the mid 1990 (Ibidem). Producers started to launch new models at Thai markets like new Ranger (Ford), Triton (Mitsubishi), BT-50 (Mazda), Frontier (Nissan), or Hilux Vigo. Consequently, Thai automobile industry referred to as "The Detroit of Asia" and is considered to be one of the most important hubs for automotive production in Asia and the Pacific where all major world assemblers are present – from Japan: Honda, Toyota, Isuzu, Nissan, Mitsubishi, Hino; from the USA: GM, Ford; from the EU: BMW, Volvo, Daimler, Volkswagen, Citroen, Peugeot.

Crucial importance in the evolution of automotive clusters and global production networks in Thailand lies in the activities of international automobile producers, especially those from Japan. This resulted in the first place from the localization of foreign direct investment and further from the support given to local producers. Significant contribution in that matter was local content requirement policy implemented by Thai government, resulting in more investments of assembly companies in Thailand and more support for local supplying firms in order reach the quality standards. Major benefits from being a part of automotive production network were technical assistance from auto-makers, economies of scale and improvement in engineering capabilities. Being a part of assemblers' production network gave opportunities to learn and improve technological level and as a result productivity increased significantly and the defects rate decreased. Consequently, effective absorption of advanced technology in the industry was observed.

All these were combined with government support for a priority branch, as automotive industry was identified and has been now for years. As an additional stimulus, the concentration on specific market segment, namely light pick-up tracks and vans, can be mentioned here. Eastern Seaboard area close to Bangkok was designated as the location for automobile cluster becoming the major venue for automotive industry not only in Thailand but in the whole Southeast Asian region. Among government incentives supporting the creation of the cluster and contributing to the industry growth the following should be worth mentioning:

- corporate tax exemption and reduction;
- decrease in duties on capital goods (machinery, part etc.);
- decrease in duties on imported raw material;
- deduction from tax income;
- acceleration of building infrastructure facilities;
- creating social facilities (education, healthcare);
- local content policy at the beginning of cluster creation which resulted in the development of specialised subcontractor.

2. Electronics industry in Malaysia and Singapore. Intensive development of electronics industry has been observed in numerous destinations in East Asia for years. They constitute the major share in export and import of majority of economies from the region, which specialize in their production. The interconnections between industrial clusters in electronics industry could be observed on the example of clustering processes in Malaysia and Singapore.

Singapore is one of the main hubs in the global electronic industry. Factors strengthening the competitive advantage of Singapore as a good environment for cluster creation and at the same time determining its location are:

- accessibility and high quality of telecommunication infrastructure and transport;
- qualified labour force;
- R&D centres;
- research and science institutes of international level;
- additional services like packing, storage etc.;
- favourable geographical location – as a centre in South East Asia and central location between North East Asia, Australia and India;
- state economic policy.

The abovementioned factors are similar to those identified by numerous experts in the field, what additionally makes Singapore as an attractive location for cluster development – not only in electronic industry.

Local entrepreneurs as "MMI Holdings" gained competitive advantage as suppliers of such global leaders as Seagate, Conner Peripherals, Western digital or Maxtor. Their production activity in the cluster resulted in emergence of Singapore as one of the global producers in IT industry in the 1990s. Relocation of operational centres of the world leaders in the production of HDD, like Seagate or Flextronics to Singapore strengthened the position of "MMI Holdings" as a supplier and a partner in the global production network. Geographical proximity of operational centres results in cost reduction and better cooperation in product development process from the early stages of product life cycle. Better knowledge about the product allows more effective cooperation among engineers and other workers of enterprises participating in the cluster.

Concentration of enterprises in hard disc drives production was additionally combined with the branch characterised by short life cycle of products. It resulted in the necessity of close location of assemblers.

Functioning of the electronic cluster in Singapore influenced greatly the creation of clusters in neighbouring countries. "MMI Holdings" located its production in Malaysia (Johor, Penang) and in Thailand (Navanakorn) and afterwards in China (Tianjin, Wuxi, Suzhou, Yixing). Global corporations and their local partners from HDD industry can benefit from lower costs and geographical proximity of neighbour economies. Penang became an integrated centre of computer and semiconductor production, indicating its share in the global production network through the cooperation with Intel, Dell, AMD, HP, National Semiconductor, or Seagate. High level of logistic services and good infrastructure of Penang played important role as well. Companies like DHL, BAX, Menlo Logistics, Ryder, or Eagle Global Logistics offer their services in the cluster. Penang Development Cooperation – PDC also plays an important role by intensifying the share of local enterprises in the chain of suppliers and offering good connection with Singapore, Tokyo and Taipei.

Thailand and Indonesia are additionally good locations for electronic industries, what results from low cost of production, high level of manufacturing and geographical proximity of those economies. Common location of enterprises from the same branch increases the potential of a region that attracts new firms, stimulating the development of the cluster and production networks expansion.

3. Biomedical science industry in Singapore. An example of cluster creation in the region is chemical and biomedical industry in Singapore. The significant factor in its

emergence is the role of the government, who took a target to establish in Singapore a strategic centre of chemical production in Asia and the Pacific basin. The state long-term vision was to establish the main research and innovation hub in pharmaceuticals, medical technologies, biotechnology and medical science services. Biomedical Science (BMS) has been chosen as the fourth pillar of the economy next to electronics, chemical industry and technical engineering in order to build knowledge-based economy.

Public sector invested 7.2 mld USD in Jurong Island Chemical Complex, combining 7 offshore islands of Singapore into a single landmass serving as an industrial park (Kuroiwa and Heng, 2008: 111). The public expenses on R&D rose from 2.5% in 2005 to 3% in 2010 (Ibidem: 166). The share of chemical and petrochemical industry in GDP reached 32,5% in 2006 exceeding electronics (31,6%), which had dominated for years. The production in biomedical science industry achieved 24.6 mld USD, what constituted 10% of the total domestic production. It is worth indicating that BMS cluster has contributed to 25% of value added in 7 years since its foundation in 2000 (Ministry of Trade and Industry, 2007: 179).

At the initial phase of the cluster development the concentration was on building the fundamental competencies necessary for good environment. 3 key agencies were settled down to work in close coordination to develop the BMS cluster:

- Biomedical Research Council (BMRC) of the Agency for Science, Technology and Reasearch (A*STAR) – funds and supports public research initiatives;
- Economic Development Board's (EDB) Biomedical Science Group (BMSG) – promotion of private sector manufacturing and research and development activities;
- EDB's Bio*One Capital – investment arm.

The undertaken initiatives resulted in the foundation of crucial science infrastructure and supported private entrepreneurs by providing venture capital and necessary institutional solutions. Not without the significance was the high quality of human capital. Numerous science parks and research centres were found intensifying the process of learning and innovations diffusion. Additionally, worth mentioning is the complex known as Biopolis, located in close proximity to National University of Singapore, Nanyang Technical University, National Univeristy Hospital and Singapore Science Park. Supplementary research centres were located at National University of Singapore and Nanyang Technical University. Cooperation was settled with some world ranking colleges like University of Illinois, Urbana-Champaign, Sweden's Karolinska Institute, or Scotland's University of Dundee.

Local high schools participate in the global education projects opening branches in such a strategic location like Bangalore, Bio Valley, Silicon Valley, Stockholm, or Shanghai in order to meet the requirements of labour market and supply specialized labour force. Among the initiatives undertaken by the government in order to create the optimal environment for cluster development were also:

- 1 mld USD dotation for Life Science Investment Fund (supporting cooperation between corporations within the branch);
- 1 mld USD dotation in order to attract world R&D centres;
- INTECH – Initiatives in New Technology Scheme (stimulating new technologies development);

- TAP – Training and Attachment Programme;
- tax reduction to attract foreign direct investment;
- Start-up Enterprise Development Scheeme (SEEDS) (investment support);
- Biomedical Science Investment Fund (BMSIF), PharmBio Growth Fund, Life Science Investment Funds, Singapore Bioinnovation Fund.

Among the world leaders from the industry who were encouraged and have opened their research and development centres or started production were Eli Lilly, Novartis, GlaxoSmithKline, Pfizer, GSK Biologicals, Schering-Plough. Creating a production park of plug and play character – Tuas biomedical Park of 370 ha area provided with road infrastructure, telecommunication, electricity was an additional merit for cluster emergence.

Findings. As different patterns of economic growth and development can be observed across East Asia, consequently clusters in the region were emerging differently depending on a country and an industry. Clusters development was both stimulated to different extent by state and was a result of market forces. Significant factor in cluster creation should be attributed to incorporating into the global supply chains on one hand and relocation of production at the regional level on the other what resulted in the expansion of production networks (Suehiro, 2008: 44–47; Baldwin, 2014: 208–209). The main factors stimulating that process was closely linked to specialisation of local enterprises, which took advantage of geographical proximity of transnational corporations, evolving from parts and components suppliers for TNC to their competitors at international market. As a result, in numerous East Asia locations dynamic and competitive industrial environment was created. After obtaining specialised skills and competences producers from Japan, Hong Kong, South Korea and Taiwan started searching for locations in less developed countries in the region, creating regional production networks (Kuroiwa and Heng, 2008: 21). The main factors stimulating the expansion of production networks in East Asia were the geographical proximity of particular economies in the region and high-quality labour. The crucial role should be attributed to cultural values resulting in the quality of human capital. Economies heterogeneity in the region led to the differentiation of competitive advantages and provided international segmentation of production processes. Because of particular comparative advantages at a given production stage, enterprises from different countries were specializing in particular stages of production. In the second half of the 1990s the relocation of labour intensive branches of production were additionally intensified by the currency appreciation, i.e. Japanese yen and high dynamics of foreign direct investment flows, which were also stimulated by the integration initiatives of ASEAN (Nawrot, 2009: 173).

Production networks spread in the whole region of East and South East Asia, mainly concentrating in textile, electronic and automobile industries. The expansion of production networks resulted in geographical concentration of enterprises and formation of industrial clusters. Most of the existing clusters in the region are related to global production networks and simultaneously represent sectors with different technological requirements. It has resulted from diverse factor endowments and gives a chance to particular economies in the region to take use of comparative advantages by incorporating into global production networks and industrial clusters. Most of the existing clusters in the region are of a satellite character with the crucial presence of

transnational corporations and dominant share of small and medium local enterprises.

Several East Asian economies, in particular Taiwan, Singapore, Malaysia are characterized by relatively high level of human capital what accelerates innovation possibilities of local firms contributing to specialized production of higher added value products. Thus, analysing the structure of trade it is clearly seen that vast production of goods requiring high qualification and knowledge – like in ICT sector – is actually made in technologically more advanced countries, or at their enterprises abroad. Very important role in creating innovating environment was played in by the institutions supporting different branches and without their impact the effects would have been limited. The impact of enterprises themselves and huge research centre, as well as economic policy should be also mentioned as a vital input.

The experience shows that innovation sup building can start from the grassroots at the country level but also from the beginning be a result of intensive international interaction enabling technology transfer. Consequently, different channels for knowledge creations and transmission can be identified.

With the advance of East Asian economies there are substantial changes in the international labour division is observed at present. They result from the aspiration as well as necessity of particular countries to produce higher value added products, and serve as a source of new technologies and innovations what higher wages in the region only serve to underpin.

The economies in the region are becoming consequently more integrated and dependent on each other. It resulted from trade of parts and components rather than final products. Clustering was stimulating the rise of competitiveness in the region through the reduction of R&D. There is however the necessity to move up the value chain within clusters.

Clustering enabled industrial upgrade through participating in the global value chains, stimulating the rise of entrepreneurship and productivity. This experience in clustering provides valuable lessons for other developing countries. The described phenomenon shows the possibilities to build innovativeness and innovative ecosystems what results in leapfrogging and catching up at the industry and the country level. There are numerous questions and concerns related to the choice of the industry, sector, position in the value chain, length of a technology cycle and the importance of regional cooperation etc.

Conclusions. Analyzing past experiences in economic growth and development of East Asian countries the technological and industrial upgrading seems to in the core of the undertaken issue. As J.Y. Lin (2012: 117) stresses the countries in this region were able to use "off-the-shelf" technology and enter into the existing industries what facilitated economic growth and development. It seems that the critical factor in the entire process can be attributed to the emergence of innovation ecosystems or, in other words, ecosystems facilitating innovation process or innovativeness with private sector and entrepreneurship at its core being stimulated, among other factors, by geographical concentration of enterprises – clustering. The importance of regional dimension in that course cannot be omitted. Industrial clusters emerged in numerous locations of the region being very much connected with regional production networks and serving as corridors for transmitting countries' comparative advan-

tages and existing knowledge. The significant issue was thus the reallocation of production to cheaper destination within East Asia. As a result, production networks and industrial clusters were growing in importance enabling final products to be assembled at lower-cost destinations in the region. Moreover, the created innovation ecosystems were significantly stimulated through the interplay between different actors including public-private partnership, academia, civil society and individuals what additionally the promoted global flow of knowledge. Accumulation of knowledge and capabilities was thus essential to build internationally competitive industrial destinations. The process was however long and incremental and as exemplified in the presented cases the state and its institutions were essential facilitators and catalyzers of those processes. Additional incentives resulted from deepening the cooperative efforts through regional initiatives, including AFTA (ASEAN Free Trade Area), ACFTA (ASEAN China Free Trade Area) or AICO (ASEAN Industrial Cooperation).

It will be however interesting to go beyond the existing framework that might be significant from the developing countries perspective, indicating a shift from geographical proximity to intellectual proximity at the regional and global levels, based on shared values and enabling transmission of information and knowledge into building useful and effective new solutions. Defining new channels of transmission using information technologies will be further necessary. The concept of clusters redefinition is further needed with the proposal of virtually connected innovation hubs open for global opportunities, fully exploiting new technologies beyond geographical borders. These directions are intended for exploration in further research.

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