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An Advancement of Knowledge-Based Economy in Japan. The Potential Role of Knowledge Cluster Initiative

Bogusława Drelich-Skulska, Sebastian Bobowski, Anna H. Jankowiak

Wrocław University of Economics

This paper identifies potential implications of knowledge cluster formation for the advancement of the knowledge based economy in Japan. Theoretical background of the knowledge-based economy and knowledge cluster have been used to evaluate and confront Japan's knowledge economy indicators for 20 years with global frontiers and catching-up countries – indicatory analyses have confirmed a narrowing gap of emerging markets with special regard to Singapore and China. Furthermore, major impediments and challenges at both the macro and micro level have been listed to indicate, among others, policy challenges related to the education system, and the institutional and regulatory framework of business and research institutions. Consequently, based on empirical data collected by authors in Tokyo and Nagoya, Japan, a case study of Tokai Region Nanotechnology Manufacturing Cluster has been presented to investigate results of the last ten years of MEXT's Knowledge Cluster Initiative and to draw conclusions. So far, output within such aspects as patents, scientific articles, high-tech sales or commercialisation appear relatively modest when confronted with macro indicators. However, authors associate this situation with the specificity of a knowledge cluster – long-term research projects are expected to provide new ideas and technological solutions in the form of materials, devices, processes to be further developed, applied and commercialised. Therefore, it is the matter of time, possibly decades.

Keywords: knowledge-based economy, knowledge cluster, R&D activities, industry-academia collaboration.

Introduction

The intensity of contemporary manufacturing and service sectors, increasing knowledge and generating more and more added value and employment, provides necessary prerequisites to study knowledge-based economy both as a concept and development scenario. Knowledge has become a strategic resource of economic entities inducing different kinds of interactions and configurations among public and private

Bogusława Drelich-Skulska, professor; Sebastian Bobowski, Ph.D.; Anna H. Jankowiak, Ph.D. – Department of International Economic Relations, Wrocław University of Economics.

actors, such as enterprises, universities, government and associations. On the other hand, cluster structures have become very popular and significant components of regional economic studies and policies.

Clustering has been perceived by Japanese authorities as a strategic policy thrust towards enhancing regional innovativeness and competitiveness – both at the micro and macro level. Therefore, central government ministries, local governments and various private actors attempt to adopt cluster models. At present, Japanese government conducts clustering through two national-level programmes:

- Industrial Cluster by Ministry of Economy, Trade and Industry (METI);
- Knowledge Cluster by Ministry of Education, Culture, Sports, Science and Technology (MEXT).

The former programme, initiated in 2001, was designed to promote networking among economic entities operating regionally, possessing complementary technological capacity and requirements. Moreover, authorities have realised serious impediments in industry-academia dialogue and commercialisation. Knowledge Cluster, on the other hand, has constituted a response to relative lack of dynamism in relations between researchers and industry, concentrating on such aspects as regional R&D systems upgrading, networking of research institutions, finally – providing seed funding for joint activities.

The latter programme, oriented on strengthening the position of research organisations, including universities, in local R&D system to stimulate knowledge transfer to industry, has been found by authors as an attractive field of both theoretical and empirical studies on implications of clustering for the advancement of a knowledge-based economy in Japan.

Research questions are as follows:

- what is the role of knowledge assets at macro and micro level?
- what kind of tendencies might be observed when studying the evolution of the knowledge-based economy in Japan in the last two decades?
- what have been the results of Knowledge Cluster Initiative so far?
- what might be the implications of the cluster programme by MEXT for the advancement of the knowledge-based economy in Japan?

Basing on the insights into conceptual frameworks of a knowledge-based economy and cluster structures on one hand, and empirical research conducted in Japan in 2012 on the other hand, authors will address issues listed above and formulate some conclusions.

Knowledge based economy and knowledge cluster – conceptual frameworks

The knowledge-based economy concept has been developed in order to study with increasing depth the specific features of the contemporary economy dependent on knowledge assets, so different from the traditional industrial economic model based

on – to large extent – physical capital, combined with increasing skilled labour forces. Obviously, knowledge capital has not been marginalised in the era of industrial evolution because it was a vehicle of technical progress, however, the turn of the XX and XXI century has strengthened the importance and, consequently, domination of knowledge assets in the economic system. Critical role of knowledge may be linked both with the economy as such (i.e. automation of production process, communication through the Internet) and economic growth (namely, endogenisation of technical progress).

According to Smith, it is really hard to find a spectrum of measures to estimate the advancement of the knowledge-based economy.[1] It might be assumed that such kind of economic linkages could be manifested through higher intensity of R&D and education spending when comparing to the dynamism of fixed assets investments. Going further, relatively high (50-60%) share of total factor productivity in GDP growth, while the reduced scale of fixed assets growth and employment as production factors, may reflect the stage of development of the knowledge-based economy.

The specificity of a knowledge-based economy, especially in the context of economic growth, may be studied through the prism of knowledge capital absorption that takes place within technological production processes (lower material-, energy-, raw material-intensity, higher devices and machines productivity), provision of new assortments and/or management processes.

In this context, it is important to recognise determinants of increasing absorption of knowledge, its creation and transfer. A crucial role is played by various agencies and organisational units operating within the scientific and business environment – both in terms of conducting research and generating/implementing innovations. Such activities, frequently concentrated spatially within a region, industry or services, contribute to an increase in R&D intensity – in particular, financial flows, new patents and licenses.

When identifying channels of knowledge transfer in macro scale, beyond the direct transfer of knowledge capital taking the form of appropriate information/data carrier, indirect channel related to material import (new technologies) or investment imports (devices and machines), an important place is occupied by inter-industry transfer of knowledge.

However, effective access to knowledge capital is heavily determined by processes of knowledge and databases creation with special regard to those institutionally designed.

Brief characteristics of knowledge-based economy cited above enable to list few major determinants of knowledge and new technologies utilisation:

- total R&D spending (% of GDP);
- total ICT spending (% of GDP);

[1] K. Smith, *What is the 'Knowledge Economy', Knowledge Intensity and Distributed Knowledge Bases*, "Discussion Paper", series 2002–06, The UN University, INTECH, Maastricht 2002.

- number of patent applications (per 1 million inhabitants);
- number of Internet servers (per 1 thousand inhabitants);
- percentage of working age population with higher than secondary education (%);
- share of high-tech industries in manufactured exports (%).

Knowledge assets and competitive potential

Knowledge is defined in the literature in different ways. It is frequently considered to be one of the key components of intellectual capital or even as the only economic resource (while others are found as complementary); factor that reduces uncertainty, determines ability to flexibly respond to market demand; a set of information possessed by an entity, or systemically shaped and developed skills necessary to take advantage of opportunities (process approach).

According to the OECD and World Bank report, knowledge – as the basic component of the knowledge-based economy – is created, absorbed, transferred and effectively utilised by enterprises, organisations, natural persons and societies.[2]

Neoclassical economics, the Austrian school, theory of business by Penrose, evolutional model of technological change by Nelson and Winter, identify knowledge as an important factor of economic phenomena.[3] According to Love, knowledge has been studied recently from the socio-economic perspective (among others as an instrument of management, technology management, strategic management, the economics of enterprise and organisation theory).

Nonaka and Takeuchi have stated, that interactive process of organisational creation of knowledge involves concrete actions, spiritual formation and learning from the others. Authors have identified the process of organisational creation of knowledge as the corporate ability to create new knowledge, disseminate it and materialise in products and systems. According to authors, enterprises take a competitive advantage at international scale both through utilisation and creation of knowledge. They have distinguished between two types of knowledge – explicit and tacit knowledge. The first category, dominant in the West, refers to formal language and structured set of information transferred using simple, clear grammatical and mathematical rules.[4]

Tacit knowledge, namely personal beliefs, values, intangible attributes, according to Nonaka and Takeuchi, is more important while being marginalised as a crucial determinant of collective actions. Indeed, such knowledge, very difficult to formalise, has become an important source of competitiveness. Creation of knowledge within corporate

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[2] C. Dahlaman, T. Andersson (eds), *Korea and the Knowledge-Based Economy. Information Society,* OECD, London: World Bank Institute, 2000, pp. 11–12.

[3] R.R. Nelson, S.G. Winter, *An Evolutionary Theory of Economic Change*, Cambridge: Harvard University Press, 1982; I. Nonaka, H. Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, Oxford: Oxford University Press, 1995, p. 53.

[4] I. Nonaka, H. Takeuchi, op.cit., p. 14.

structures is, therefore, a consequence of complementarity and interactions between explicit and tacit knowledge.

Increasing role of both knowledge and human capital[5] is, however, associated with the deeper integration of science, technology and education with manufacturing and service industries, rising science and technology potential and development of modern enterprises. Human knowledge might be utilised by enterprise, organisation or a region, however, the major sources of knowledge are scientific research conducted by skilled specialists. Part of knowledge is generated through manufacturing processes. Technical (technological, construction) knowledge may be embodied in new products and processes. Although, it requires both creative, skilled employee teams as well as appropriate institutional and organisational conditions. Therefore, human capital is important but not enough to generate and utilise knowledge. Handy has perceived knowledge as the new basis for ownership, wealth and freedom. Hence, it is crucial to recognise it and identify its opportunities.[6] Drucker has projected, that knowledge may become the only significant resource of future organisations and societies.[7]

According to the new concept of the corporation by Simon, major structural components of the company's strategy are the anticipation of future business opportunities, knowledge, capabilities, coalition, transformation, renovation etc.[8] Customers pay attention to the value not to the competition, therefore enterprises should cultivate innovations of value.[9] The business model should evolve, adjust to expectations and priorities of the customers in order to avoid ageing just like products facing technical ageing (relocation of profit zones, renovation of business model). The major goal of the company is to create and provide new values in the form of innovative products and services.

Holsapple and Joshi have developed a model assuming the central role of knowledge in the creation of the value, defining five components of the chain of knowledge.[10]

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[5] For more studies on the role of human and social capital in the knowledge based economy see: P. Romer, 'Increasing Returns and Long-Run Growth', *Journal of Political Economy*, 1986, No. 94, pp. 71–102; R. Lucas, 'On the Mechanics of Economic Development', *Journal of Monetary Economics*, 1998, No. 22, pp. 3–42; R. Nelson, E. Phelps, 'Investment in Humans, Technological Diffusion, and Economic Growth', *American Economic Review*, 1996, No. 56, pp. 69–75; S. Iyer, M. Kitson, B. Toh, 'Social Capital, Economic Growth and Regional Development', *Regional Studies*, 2005, Vol. 39, No. 8, pp. 1015–1040; R. Florida, R. Cushing, G. Gates, 'When Social Capital Stifles Innovation', *Harvard Business Review*, 2002, Vol. 80, No. 8, pp. 20–31; T. Tura, V. Harmaakorpi, 'Social Capital in Building Regional Innovative Capability', *Regional Studies*, 2005, Vol. 30, No. 8, pp. 1111–1125; S. Young, *Moral Capitalism: Reconciling Private Interest with the Public Good*, Berrett-Koehler Publishers, San Francisco 2003, pp. 2–3.

[6] Ch. Handy, *The Age of Paradox*, Cambridge: Harvard Business School Press, 1994, pp. 182–183.

[7] P.F. Drucker, *Post-Capitalist Society*, New York: Harper Business, 1994.

[8] H.A. Simon, 'Organizations and Markets', *Journal of Economic Perspectives*, 1991, No. 5, pp. 25–44.

[9] F. Krawiec, 'Strategia innowacji wartości w firmie' (Strategy of value innovation in a company), *Przegląd Organizacji*, 2002, No. 12, pp. 13–16.

[10] B. Woźniak (ed.), *Łańcuch tworzenia wartości dodanej przedsiębiorstwa* (Corporate chain of the added value of enterprise), Wydawnictwo Akademii Ekonomicznej im. Karola Adamieckiego, Katowice 2007, p. 90.

- acquisition of knowledge;
- selection;
- generation of knowledge;
- adaptation of knowledge to internal needs;
- practical application.

Indeed, valuable knowledge is useful and applicable, convertible into new technological and construction solutions, that determine competitiveness and transform knowledge into innovation. The role of innovation cannot be neglected. Many high-tech companies have lost their value because of lack of awareness as to the impact of innovations and R&D on the company's value. The major challenge is to make a choice between different market opportunities (technologies) to provide new value in the form of innovative products and services. Competitive advantage[11] is strongly combined with financial performance, so the value of the company.

Cluster structures

Clusters are, according to Porter, the exemplification of a typical paradox, that "the competitive advantage in the global economy is based increasingly on local resources, such as knowledge, relationships and motivations that are not available for distant competitors".[12] He defined clusters as a geographical concentration of interconnected companies, specialised suppliers, service providers, businesses operating in related sectors as well as related institutions (such as financial, training, research, standardisation institutions and trade associations) in specific areas while competing[13] and cooperating with each other. Thus, a departure from the traditional understanding of the role of location,[14] on one hand, reflects significant changes

[11] For studies on resource-based view of the firm (RBV) see: B. Wernefelt, 'From Critical Resources to Corporate Strategy', *Journal of General Management*, 1989, Vol. 14, No. 3; I. Dierickx, K. Cool, 'Asset Stock Accumulation and Sustainability of Competitive Advantage', *Management Science*, 1989, Vol. 35, No. 12; J.B. Barney, *Gaining and Sustaining Competitive Advantage*, New York: Addison-Wesley Publishing Company, 1997, pp. 143–144.

[12] M.E. Porter, 'Clusters and the New Economics of Competition', *Harvard Business Review*, November-December 1998, p. 78; Rosenfeld, when defining clusters in relatively similar way as Porter, has articulated an important aspect of common opportunities and threats challenged by partners, potentially a source of internal dynamism and interactions within cluster structures [see: S.A. Rosenfeld, 'Bringing Business Clusters into the Mainstream of Economic Development', *European Planning Studies*, 1997, Vol. 5, No. 1; E.J. Visser, R.A. Boschma, 'Learning in districts: Novelty and lock-in in a regional context', *European Planning Studies*, 2004, Vol. 12(6), p. 801].

[13] Porter argued, that spatial concentration enables quicker reaction to innovative activities of rivals, than in the case of more spatially dispersed companies [M.E. Porter, 'Location, Competition, and Economic Development: Local Clusters in a Global Economy', *Economic Development Quarterly*, 2000, Vol. 14, No.1, pp. 15–34]; competition has been found by Castells and Hall as positive determinant of cluster formation and development in case of Silicon Valley [M. Castells, P. Hall, *Technopoles of the World, The Making of 21st Century Industrial Complexes*, London: Routledge, 1994, p. 22].

[14] Jacobs and Lakhuisen pointed out that Porter is trying to convince governments to rely on traditional specific competition forces instead of imitation of the others' successes [E.J. Visser, O. Atzema, 'With or

in the field of technology and competition, on the other hand – points to the serious implications in the acquisition of resources in the global scale. It turns out that the cluster structures may become, when reaching an appropriate critical mass,[15] an instrument of competition policy under the dynamic knowledge-based economy.[16]

In the literature, there are many different classifications of clusters. According to Markusen,[17] there are three basic forms: industrial districts (the dominance of the SME sector companies, strong, flexible specialisation, the occurrence of a system of relationships based on trust, the possibility of the creation of a significant potential for innovation), *hub and spoke* (coexistence of large firms affiliated hierarchically with a wide range of SME sector firms, a source of potential – TNCs, cost advantages, flexibility) and satellite (dominating, large group of SME companies dependent on external companies, location cost advantages).[18] In the context of global resourcing in the area of R&D, key role may be attributed to cluster structures involving large corporations – a source of capital for research activities in regions of lower socio-economic development.[19]

Modern theoretical approaches move away from Marshall's industrial district to the extended manufacturing cluster model based on SMEs while taking into account the growth of service clusters operating in high-technology sectors, increasing the importance of TNCs, network-affiliated international companies, and finally – the contribution of public and private institutions.[20]

In this context, it is important to distinguish between two business structures: networks and clusters that intertwine each other because of the relocation of R&D activities (Table 1).

Without Clusters: Facilitating Innovation through a Differentiated and Combined Network Approach', *European Planning Studies*, 2008, Vol. 16, No. 9, p. 1174].

[15] Critical mass, next to spatial proximity, knowledge flows and interactions were listed by Ketels as major features of contemporary clusters [O. Solvell, G. Lindgvist, Ch. Ketels, *The Cluster Initiative Greenbook*, Stockholm: Bromma Tryck AB, 2003, p. 15].

[16] According to Porter, clusters affect competition in three ways: by increasing business productivity, stimulating innovation, determining future productivity growth and initiating the process of creating new businesses to strengthen the cluster [M.E. Porter, 'Clusters and the New Economics of Competition', op.cit., p. 80].

[17] For other classifications of clusters see also: M.E. Porter, *The Competitive Advantage of the Nations*, New York: The Free Press, 1990; S.A. Rosenfeld, *Bringing Business Clusters…,* op.cit.

[18] G.-M. Isbasoiu, *Industrial Clusters and Regional Development. The Case of Timisoara and Montebelluna*, Urbino: RTN Urban Europe Program and University of Urbino, 2007, p. 7.

[19] D. Barkley, M. Henry, *Advantages and Disadvantages of Targeting Industry Clusters*, REDRL Research Report 09–2001-01, Regional Economic Development Research Laboratory, Clemson University, Clemson, SC, September 2001.

[20] *Competitive Regional Clusters. National Policy Approaches, OECD Reviews of Regional Innovation*, OECD, Paris 2007, pp. 25–26.

Table 1. Clusters and networks according to Rosenfeld

Clusters	Networks
attract necessary specialised services at lower cost to a region	allow firms access to specialised services at lower cost to a region
open membership	restricted membership
based on social values, that foster trust and encourage reciprocity	based on contractual agreements
generate demand for more firms with similar and related capabilities	make it easier for firms to engage in complex business
both cooperation and competition	cooperation
collective visions	common business goals

Source: own study based on S.A. Rosenfeld, *Bringing Business Clusters into the Mainstream of Economic Development*, op.cit.

However, Visser and Boschma, defining clusters as a geographical concentration of companies of similar type not necessarily linked with other through subcontracting, cooperation or specialisation, while the networks as strategic, intentional, preferential, sometimes repeatable and cooperative interactions that may but do not have to operate in the neighbourhood, do confirm, that definition of a cluster may be modified depending on the context of long-term, endogenous process of geographical concentration of innovation activities.[21]

Consequently, large enterprises oriented on acquiring strategic resources seek for distant low-wage locations to absorb and create knowledge and innovations. Networking enables engaging local capabilities, infrastructure and unrelated companies in R&D activities, however, cluster structures encourage concentration of processes in order to stimulate spillovers and maximise net effects. Moreover, networks enable the exchange of implicit knowledge while inducing learning processes.[22]

Knowledge cluster theory

Organisation for Economic Cooperation and Development (OECD) argues in its report on the issue of competitive regional clusters that "countries are seeking ways to strengthen or develop the potential enabling concentration of innovative companies associated with the structures of the knowledge economy (…) clusters are considered as effective and pragmatic instrument of managing resources and building

[21] E.J. Visser, R.A. Boschma, op.cit.

[22] K. Koschatzky, 'Networks in Innovation Research and Innovation Policy – An Introduction', in K. Koschatzky, M. Kulicke, A. Zenker (eds), *Innovation Net-works – Concepts and Challenges in the European Perspective*, Technology, Innovation and Policy 12, Heidelberg: Physica-Verlag, 2001.

partnerships".[23] OECD, conducting research dedicated to innovation clusters – critical for the knowledge-based economy – indicates the role of both business entities as knowledge-generating agents and consumers while distinguishing the traditional and modern concept of a cluster (Table 2):

Table 2. Characteristics of traditional and knowledge cluster

Clusters	Traditional	Knowledge
phase of life	mature sectors, shaped concentration	young sectors, new concentrations
type of relationships / transactions	long-term relationships, shaped by locally oriented supply chains	temporary coalitions for joint R&D activities induced by the market
innovation activities	gradual innovations, absorption of technologies	technological innovations

Source: own study based on: *Regional Clusters in Europe: Observatory of European SMEs,* European Commission and Enterprise Directorate-General, No. 3, Brussels 2002.

The increase of cluster structures associated with the knowledge-based economy will generate significant multiplier effects, encouraged increasingly by external location determinants and structural transformation of the regions (very often specific agglomerations), resulting in the intensification of R&D activities.[24]

According to Feser, cluster theory concentrates on specialisation advantages associated with agglomeration effects – both urbanisation and localisation.[25] Following Jacobs, urbanisation advantages are generated by the agglomeration of companies from different industries, able to supply various products and services.[26] Whereas, localisation advantages,[27] are as follows:

- external networked suppliers and distributors;
- spatial concentration of well-skilled labour forces;
- knowledge spillover understood as a flow of highly specialised knowledge about products and production processes.

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[23] *Competitive Regional Clusters…*, op.cit., p. 11; Furman, Porter and Stern point to cluster structures environment as one of the key components of the innovation potential of a country next to its institutional, resources and political frameworks [J.L. Furman, M.E. Porter, S. Stern, 'The determinants of national innovative capacity', *Research Policy*, 2002*,* Vol. 31, p. 905].

[24] For further studies see: P. Dicken, *Global Shift: Transforming the World Economy*, London: Paul Chapman, 2003.

[25] E.J. Feser, 'Old and New Theories of Industry Clusters', in M. Steiner (ed.), *Clusters and Regional Specialization, on Geography, Technology and Networks,* London: Pion, 1998, pp. 18–40.

[26] J. Jacobs, *The Economy of Cities*, New York: Random House, 1969.

[27] H.B. Parr, 'Agglomeration economics: ambiguities and confusions', *Environment and Planning*, 2002, No. 34, p. 719.

As it was stated by Martin and Sunley, contemporary cluster concepts reflect general paradigm shift from the industrial to knowledge economy.[28] Rallet and Torre, following assumptions by Howells and Kiese, that tacit knowledge is a prerequisite for interpreting explicit knowledge[29] and therefore they are complementary, have found the geographical proximity of companies as an important determinant of dynamic external effects generated by entities using locally available implicit knowledge.[30]

Glaeser et al. have confronted Porter externalities with Marshall-Arrow-Romer and Jacobs externalities. The latter has identified the knowledge spillovers originated in the diversity of knowledge from different industries (i.e. urbanisation advantages).[31] However, Marshall-Arrow-Romer dynamic localisation externalities, refer to internalisation of local monopolies, such as workforce mobility. Therefore, following empirical studies by Glaeser et al., Feldman and Audretsch stated that Jacobs externalities were responsible for economic growth, and thus, clustering lacks legitimacy.[32] However, Paci and Usai did prove that urbanisation and localisation advantages do not have to be supplementary because there is a possibility of different kind of combinations of both sectoral specialisation and regional diversification.[33] Moreover, Jacobs externalities have been found as dominant in case of high-tech industries within metropolitan regions.

However, spatial proximity of cluster actors shouldn't be overestimated. Global interactions inducing learning processes and engaging local capabilities might be perceived as complementary to local ones.[34]

Knowledge-based economy in Japan

Japan has been traditionally a source of experiences, lessons and inspirations for developing world, with special regard to practices in both manufacturing processes

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[28] R. Martin, P. Sunley, 'Deconstructing clusters: Chaotic concept or policy panacea?', *Journal of Economic Geography*, 2003, No. 3, pp. 5–35.

[29] J.R.L. Howells, 'Tacit Knowledge, Innovation and Economic Geography', *Urban Studies*, 2002, No. 39, p. 872.

[30] A. Rallet, A. Torre, 'Is geographical proximity necessary in the innovation networks in the era of global economy?', *GeoJournal*, 1999, No. 49, p. 374; therefore, learning processes might be initiated within the clusters as a consequence of: competition, informal contacts, workforce mobility and cooperation in the process of knowledge creation [see: M.S. Dahl, C.Ö.R. Pedersen, 'Knowledge flows through informal contacts in industrial clusters: myth or reality?', *Research Policy*, 2004, No. 33, pp. 1673–1686; P. Maskell, 'Towards a Knowledge-based Theory of the Geographical Cluster', *Industrial and Corporate Change*, 2001, No. 10, pp. 921–943].

[31] E.L. Glaeser, H.D. Kallal, J.A. Scheinkman, A. Shleifer, 'Growth in Cities', *Journal of Political Economy*, 1992, No. 100, pp. 1126–1152.

[32] M.P. Feldman, D.P. Audretsch, 'Innovation in Cities: Science-Based Diversity, Specialization and Localized Competition', *European Economic Review*, 1999, No. 43, pp. 409–429.

[33] R. Paci, S. Usai, 'Externalities, knowledge spillovers and the spatial distribution of innovation', *GeoJournal*, 1999, No. 49, pp. 381–390.

[34] A. Malmberg, P. Maskell, 'Localized Learning Revisited', *Growth and Change*, 2006, No. 37, p. 9.

and management as well as social equity. Between the 60s and the end of the 80s Japan was recognised as an incredibly successful state and one of the global technological and economic frontiers next to the United States and the largest European players. Another ten years have been found as "lost decade" because of economic stagnation and relatively poor FDI inflow, accompanied by a massive worldwide expansion of U.S. IT companies.[35]

This has been reflected by deteriorating competitiveness rankings of Japan through the years. For example, according to the *World Competitiveness Yearbook* by International Institute for Management Development, Switzerland, Japan has been the most competitive economy in the world in the period 1989–1993, after another 9 years it has dropped to 30th place.[36]

Last global crisis has sustained relatively poor performance of Japanese economy in IMD rankings – 24–27th place in years 2010–2018,[37] then far behind Asian emerging markets. The above refers also to the United States, where the turbulences have originated in 2007. The Japanese share in the world manufacturing trade has decreased from over 16% in 1985 (more than the US' share) to less than 10% nowadays,[38] Ando and Motohashi, using trade specialisation indexes methodology, have proved dramatic deterioration of the Japanese position within various industries, with special regard to car manufacturing, production of computers and TV equipment since the late 80s.[39] Meanwhile, Japanese manufacturing companies listed on the Tokyo Stock Exchange have experienced a significant decrease in ROE (return on equity) indexes – from 8,5 to less than 2% after less than two decades.[40]

Corporate governance within the Japanese economy is heavily limited and regulated by the government. The latter used to play actively by targeting of priority industries,[41]

[35] While in the period 1973–1990 IT's contribution to growth in Japan has reached 4,03% GDP (2,98% in USA), in the period 1995–2003 the proportions has changed dramatically: Japan – 1,28%, USA – 3,55% GDP [see: D.W. Jorgenson, K. Motohashi, 'Information Technology and the Japanese Economy', *Journal of Japanese and International Economies*, 2005, Vol. 19, No. 4, pp. 460–481]; Jorgenson has linked a substantial portion of the U.S. growth resurgence after 1995 to advances in IT; meanwhile, relation between IT and productivity growth in Japan in the 90s has deteriorated significantly.

[36] IMD World Competitiveness Rankings, https://www.imd.org/wcc/world-competitiveness-center-rankings/world-competitiveness-ranking-2018/ (accessed on 10 September 2018).

[37] International Institute for Management Development website, http://www.imd.org/wcc/ (accessed on 12 September 2018).

[38] World Bank database, 2018; http://data.worldbank.org/ (accessed on 12 September 2018).

[39] H. Ando, K. Motohashi, *The Japanese Economy, the Structure of Competitiveness: Modularization Strategy Challenges the 'Age of Speed'*, Tokyo: Nihon Keizai Shimbun, 2002.

[40] T. Shibata (ed.), *Japan. Moving Toward a More Advanced Knowledge Economy. Assessment and Lessons*, Washington: World Bank Institute, 2006, p. 3.

[41] In fact, many huge sectors such as agriculture, chemicals, consumer packaged foods, medical products, software and nearly all services have never achieved any international market position because of trade barriers and other restraints for competition, while retailing, wholesaling, truck transportation, construction, energy, healthcare services, telecommunications, housing and food preparation have never been restructured or consolidated to increase efficiency because of acting as a source of jobs, stability, self-sufficiency and small family businesses.

aggressive promotion of exports, extensive guidance, approval requirements and regulations, selective protection of the home market and declining industries, official sanctioning of cartels, restrictions on FDI, antitrust law enforcement, government-led industry restructuring,[42] highly regulated financial markets, government-sponsored cooperative R&D projects.

Japanese education system does not provide enough specialists in such fields as chemistry and chemical engineering, finance, software engineering and aeronautical engineering because of lack of strong research programs in many important fields, determined by scarce funds and inadequate universities' facilities.[43]

It should be noted, that in 2004 Japan's public universities were transformed into independent administrative (public) corporations after over 100 years of governmental control, while prefectural universities have undergone a similar reform a year later. Some universities, among others, decided to merge to gain economies of scale, established Technology Licensing Offices, incubators, collaborative industry research centres, and other programs to promote research commercialisation and regional development.[44] Moreover, numerous academic incentives and evaluation systems were established.

Japanese corporations used to offer some attractive training programs covering, however, only the small fraction of the workforce employed able to get some general knowledge, far from requirements of the modern knowledge-intensive economy.[45]

Entrepreneurship and new businesses formation are facing regulatory barriers, among others, reporting requirements, high taxation and limited access to venture capital. Many Japanese companies were internationally successful before the 90s because of their operational effectiveness within such aspects as production processes, technologies, marketing methods, management techniques that contribute to quality

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[42] Restructuring efforts should be especially strengthened within such archaic industries as retailing, truck transportation, mining and housing, combined with safety net to ease the effects of restructuring on workers.

[43] In fact, Japanese government has given priority to professional programs in business and social sciences, however, their popularity was relatively low, while the number of postgraduate students in engineering has increased significantly because of reward system provided by some traditional Japanese companies for postgraduate degree holders; it is worth noting that foreign companies got used to set a higher salary for MBAs from the beginning, while traditional Japanese enterprises prefer to use gradual system – however, in the era of high mobility of executives traditional approach to university education in not advantageous anymore (T. Kato, 'Outcome and Assessment of Adult Learners in Post Graduate Education in Japan', in Y. Honda (ed.), *Professional Careers of Adult Learners in Post Graduate Education and the Relevance of Post Graduate Education: Focusing on the Social Science Studies (Including MBA)*, ISS Research Series 12, Tokyo: Institute of Social Science, University of Tokyo, 2000).

[44] *Competitive Regional Clusters…*, op.cit., p. 236.

[45] Therefore, new, well-balanced occupational capacity development program should be established at the national level to meet requirements of knowledge based economy, that would induce expansion of professions based on expertise, much beyond strong company-led training systems (for further studies see: R.E. Cole, K. Tominaga, 'Japan's changing occupational structure and its significance', in H. Patrick, L. Meissner (eds), *Japanese Industrialization and Its Social Consequences*, Berkeley: University of California Press, 1976).

Table 3. Selected indicators of the knowledge-based economy for eleven countries and Japan, 1991–2016

High-technology exports (% of manufactured exports)						Research & development expenditure (% of GDP)					
	1991	**2001**	**2006**	**2011**	**2016**		**1996**	**2001**	**2006**	**2011**	**2015**
China	N/A	21	31	26	25	China	0,6	1,0	1,4	1,8	2,1
Denmark	15	21	20	14	16	Denmark	1,8	2,4	2,5	3,0	3,0
Finland	7	24	22	9	8	Finland	2,5	3,3	3,5	3,6	2,9
France	19	23	21	24	27	France	2,3	2,2	2,1	2,2	2,2
Germany	13	18	17	15	17	Germany	2,2	2,5	2,5	2,8	2,9
Ireland	38	48	35	23	29	Ireland	1,3	1,1	1,2	1,5	1,5[e]
Japan	**24**	**27**	**22**	**17**	**16**	**Japan**	**2,8**	**3,1**	**3,4**	**3,2**	**3,3**
Korea	19	30	32	26	27	Korea	2,4	2,5	3,0	3,8	4,2
Malaysia	38	58	54	43	43	Malaysia	0,2	N/A	0,6	1,0	1,3
Singapore	41	61	58	45	49	Singapore	1,3	2,1	2,2	2,2	2,2[e]
United Kingdom	25	34	34	21	22	United Kingdom	1,8	1,8	1,8	1,7	1,7
United States	32	33	30	18	20	United States	2,6	2,7	2,6	2,8	2,8
Patent applications, residents						**Researchers in R&D (per million inhabitants)**					
	1991	**2001**	**2006**	**2011**	**2016**		**1996**	**2001**	**2006**	**2011**	**2015**
China	7.372	30.038	122.318	415.829	1.204.981	China	447	581	931	978	1.176
Denmark	1.061	1.757	1.503	1.574	1.552	Denmark	3.178	3.632	5.300	7.026	7.484
Finland	2.123	2.390	1.816	1.650	1.260	Finland	5.153[a]	7.114	7.674	7.414	6.817
France	12.597	13.499	14.529	14.655	14.206	France	2.667	2.987	3.431	3.940	4.169[e]
Germany	32.256	49.989	48.012	46.986	48.480	Germany	2.800	3.209	3.390	4.211	4.431
Ireland	786	1.019	838	494	202	Ireland	1.765	2.315	2.883	3.282	4.575
Japan	**335.564**	**382.815**	**347.060**	**287.580**	**260.244**	**Japan**	**4.946**	**5.187**	**5.416**	**5.160**	**5.231**
Korea	13.253	73.714	125.476	138.034	163.424	Korea	2.212	2.950	4.231	5.853	7.087

Table 3 – continued

Patent applications, residents						Researchers in R&D (per million inhabitants)					
	1991	**2001**	**2006**	**2011**	**2016**		**1996**	**2001**	**2006**	**2011**	**2015**
Malaysia	106	271	531	1.076	1.109	Malaysia	89	274[b]	365	1.639	2.261
Singapore	N/A	523	626	1.056	1.601	Singapore	2.547	4.205	5.677	6.496	6.659[c]
United Kingdom	19.230	21.423	17.484	15.343	13.876	United Kingdom	2.489	3.082	4.196	3.979	4.471
United States	87.955	177.513	221.784	247.750	295.327	United States	4.254[a]	4.624	4.721	4.011	4.232[c]
Scientific and technical journal articles											
	1996	**2001**	**2006**	**2011**	**2016**		**1996**	**2001**	**2006**	**2011**	**2016**
China	6.186	59.412	181.690	334.045	426.165	**Japan**	**50.345**	**84.948**	**105.130**	**110.570**	**96.536**
Denmark	4.368	6.650	8.367	11.590	13.471	Korea	4.770	17.120	36.030	54.717	63.063
Finland	4.329	7.053	8.892	10.345	10.545	Malaysia	362	1.078	3.155	14.004	20.332
France	29.746	48.001	61.646	72.036	69.431	Singapore	1.141	4.495	7.985	10.099	11.254
Germany	39.213	65.881	83.335	100.879	103.122	United Kingdom	46.213	66.829	84.991	98.480	97.527
Ireland	1.253	2.602	4.700	7.433	6.834	United States	193.161	270.130	371.105	424.938	408.985

[a] data from 1997 [b] data from 2000 [c] data from 2014; **high-technology exports (% of manufactured exports)** – products with high R&D intensity, such as in aerospace and computer industries, pharmaceuticals, scientific instruments, and electrical machinery; **research & development expenditure (% of GDP) –** current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development; **patent applications, residents –** worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem; **researchers in R&D (per million inhabitants) –** professionals engaged in the conception or creation of new knowledge, products, processes, methods, or systems and in the management of the projects concerned; postgraduate PhD students engaged in R&D are included; **scientific and technical journal articles –** published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

Source: World Bank database, op. cit.

improvement and costs reduction. However, in the late 80s, Western companies started to imitate Japanese practices and ideas of productivity improvement, including total quality management, just in time inventory control, continuous improvement, cycle time reduction, lean production and close supplier relationship, thus, the international gap has narrowed significantly.[46] Frequently, Japanese corporations have not been able to develop distinctive strategies that are, according to Porter, fundamental for the success in an advanced economy. They started to imitate each other and, as a result, lost competitive advantage in international markets.

The business environment within many industries in Japan has become unproductive, uncompetitive and static because of government protectionism and bureaucracy, combined with a limited awareness of international customers' needs, poor information, poor scientific, technical and physical infrastructure, limited local competition, poor quality of human and capital resources or their limited availability.

Nevertheless, Japanese corporations have maintained an advantage of working across institutions, namely the ability to form linkages with outside constituents referred to as an innovation system.

Indicatory analysis

Selected indicators provided in Table 3, covering the period 1991–2016, might be helpful in recognizing tendencies and condition of the knowledge-based economy in Japan and a few other countries, both inside and outside Asia.

Some of the indicators, such as R&D expenditure in relation to GDP (on average, more than 3% in Japan), may confirm consequent preferential treatment of knowledge creation and diffusion by Japanese authorities, in accordance with knowledge-based economy concept by Smith,[47] leaving the majority of countries, including the US, far behind. It should be noted, however, that Asian emerging markets, such as Republic of Korea and Singapore, as well as many European competitors, have increased R&D spending recently to a larger extent (Singapore has almost doubled R&D expenditure share in relation to GDP, China and Malaysia have multiplied this ratio, however, starting with relatively low levels of R&D funding in the early 90s – less than 0,6% of GDP), while the Republic of Korea has exceeded Japanese ratio (3,8% in relation to 3,2% in 2011, respectively).

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[46] H. Takeuchi, 'The Competitiveness of Japanese Industries and Firms', in T. Shibata (ed.), *Japan. Moving Toward a More Advanced Knowledge Economy. Assessment and Lessons*, Washington: World Bank Institute, 2006, pp. 35–37.

[47] However, two other determinants of advancement of the knowledge-based economy mentioned by Smith, namely investments in fixed assets and employment should be considered through the prism of one important fact: Japanese SME challenge market restraints in the form of underdeveloped infrastructure with special regard to physical, technical and scientific infrastructure but also scarce skilled human resources with specialized, technical knowledge – crucial production factor in the context of knowledge-intensive business activities.

High-technology exports share in total manufactured exports remains relatively low since the 90s – on average, less than 20%, when compared to rapidly growing Malaysia, Singapore and China, but also France, Ireland and the United Kingdom. Moreover, Japanese indicators have not deteriorated so significantly through the years when compared to Scandinavian competitors, UK and the US, possibly because of low original economic dynamism, competitiveness and relatively modest scale of the global recession in this part of Asia – between years 2006 and 2011 Japanese indexes have declined by 5%, like Chinese indexes, while in case of Finland, Singapore and UK – by 13%, Ireland and the US – by 12% and Malaysia – by 11%, respectively. In terms of patent applications by residents, Japan has been successfully caught up with by China with the tremendous number of 1,2 million applications in 2016, while the Republic of Korea has reduced the distance significantly since the 90s.

R&D research material in Japan remains relatively extensive, although, through the prism of its intensiveness, far behind scores of the Finnish economy (a sparsely populated country with 6,8 thousand researchers per million people in 2015) as well as Korean and Singaporean – the latter two tripled their ratios since the mid-90s. Interestingly, both the British and the US indicators have remained far behind Japanese, while Danish deteriorated significantly in the last few years. To some extent, the demographic context should be considered here, however, it is mainly a confirmation of relative inefficiency of Japanese education system.

Finally, the US domination in terms of publishing activity leaves Japan, similarly as the European competitors, namely France, Germany and UK, far behind. Noteworthy, the number of the Chinese-originated journal articles in years 1996–2016 increased from 6,2 to 426,2 thousand, then already more than the United States-originated ones.

Japan is an example of the knowledge-based economy, deeply rooted and "trapped" in national specificities – some traditional strengths and advantages have become weaknesses in the era of globalisation.

New cluster policy by MEXT, manifested through the Knowledge Cluster Initiative, should be perceived as a new concept of working across institutions, forming favourable business environment, encouraging entrepreneurship, stimulating research activity and competition between companies and universities, inducing industry-government-academia dialogue, while leaving, to some extent, top-down approach and centralisation behind. Direction appears to be obvious – more advanced knowledge-based economy.

Overview of MEXT's cluster policy[48]

Ministry of Education, Culture, Sports, Science and Technology, when designing cluster policy and in fact linking cluster initiatives with the concept of knowledge-based

[48] Analysis of cluster policy by MEXT based on: S. Bobowski, 'Polityka klastrowa w Japonii w XXI wieku' (Cluster policy in Japan in the 21st century), in B. Drelich-Skulska, A.H. Jankowiak, S. Mazurek (eds), *Klastry*

economy, has complemented activities of Ministry of Economy and Ministry of Trade and Industry (METI).[49] As it was mentioned above, while METI is oriented on the support of commercialisation of research results and development of sales channels, MEXT is focused on the support for formation of intellectual assets and development of human resources regionally. In contrast to METI's cluster regions, MEXT has identified 18 regions for funding, focusing around specific universities and geographically concentrated research areas, restricted in fact to specific cities and urban agglomerations.[50]

Between 1996 and 2020 four Basic Plans of Science and Technology were designed and implemented in order to reach four different stages of transformation of cluster policy:

- First Basic Plan of Science and Technology (Financial Years 1996–2000) – Foundation of Regional R&D;
- Second Basic Plan of Science and Technology (Financial Years 2001–2005) – Start of the Cluster Policy;
- Third Basic Plan of Science and Technology (Financial Years 2006–2010) – Implementation of Cluster Policy;
- Fourth Basic Plan of Science and Technology (Financial Years 2011–2015) – Development of Cluster Policy;
- Fifth Basic Plan of Science and Technology (Financial Years 2016–2020) – Building a Regional Innovation Eco–system.

According to MEXT, enhancing industry-academia-government collaboration at the regional level should induce both developments of world-class clusters (Knowledge Cluster Initiative) and small clusters based on regional strengths (City Area Program).

Knowledge Cluster Initiative by MEXT is a component of the Regional Innovation Program, initiated in late 2010, in parallel with the Third Basic Plan of Science and Technology. The next program, implemented by MEXT in 2013 was The Centre of Innovation (COI) program, which is supposed to operate till 2022. COI in parallel with Fourth and Fifth S&T Basic Plan.

The aim of the Fifth Basic Plan is as follows:[51]

- Acting to create new value for the development of future industry and social transformation;

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jako nośnik innowacyjności przedsiębiorstw i regionów. Czy doświadczenia azjatyckie można wykorzystać w warunkach gospodarki polskiej? (Clusters as a carrier of innovativeness of enterprises and regions. Can Asian experience be used in the conditions of the Polish economy?), Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, 2014, pp. 107–160.

[49] However, some interviewees admitted that the distribution of competences among MEXT and METI is, to some extent, fluid and smooth.

[50] T. Kodama, *Cluster Promoting Initiatives in Japan*, presented at the conference *Innovation and Regional Development* sponsored by the OECD, EU Erik Network and the Tuscany Region, Florence, Italy, November 2004.

[51] MEXT The 5th Science and Technology Basic Plan, Government of Japan, 2016, pp. 8–9.

- Addressing economic and social challenges;
- Reinforcing the "Fundamentals" for STI (science, innovation and technology);
- Building a systemic virtuous cycle of human resources, knowledge, and capital for innovation.

When analyzing the evolution of MEXT cluster policy through the years, it should be noted that government policy has put more and more emphasis on decentralisation of development policies in order to combine local assets and advantages with strategic goals of sustainable growth and societal development boosted by innovations.

Moreover, regionally designed innovation policies within the framework of MEXT policy were designed to direct and activate local potential of development. However, decentralisation might be found as relative when recognizing direct linkages between local initiatives, their performance and significance, as well as governmental support based on a top-down system of evaluation and selection.

Cluster concept by MEXT

MEXT perceive cluster as a network among industry, academia and government focused on generating and promoting innovative chain reactions.

According to MEXT, cluster structure should be based on close cooperation and frequent communication among the participants, provide new technological "seeds", while attracting external human resources, companies, information and capital.

Regional Innovation Cluster Program

Knowledge Cluster Initiative, supporting the formation of world-class clusters, is expected to encourage and deepen regional independence of innovation policies. Local governments are expected to design core organisations responsible for collaboration with universities, companies and other relevant organisations to initiate joint research projects while being provided with projects of other ministries and agencies i.e. R&D projects undertaken by METI or Japan Science and Technology Agency (JST) and local organisations – business groups and universities. Core organisations take the responsibility for the implementation of regionally designed cluster vision while local government submits its vision to MEXT for evaluation to get subsidies.

Case study: Tokai Region Nanotechnology Manufacturing Cluster[52]

Tokai Region Nanotechnology Manufacturing Cluster is an interesting example of The Second Stage Knowledge Cluster Initiative, challenging energy conservation,

[52] Based on: S. Bobowski, 'Knowledge Cluster Initiatives By MEXT – Case Of Tokai Region Nanotechnology Manufacturing Cluster In Japan', in A.H. Jankowiak, S. Mazurek, B. Skulska (eds), *Clusters, Networks and Markets in the Asia-Pacific Region*, Wrocław: Publishing House of Wrocław University of Economics, 2013, pp. 27–41.

environment preservation, renewable energy, global competitiveness and a paradigm shift in the industrial sector. Tokai Region, covering Aichi, Gifu, Mie Prefectures and Nagoya City, is the leading Japanese automobile, aircraft, machinery and their components' centre, accumulating nearly 10% of Japanese GDP.

Cluster Program of Tokai Region was built on two pillars:

1. R&D on advanced nano-manufacturing technology for environmentally friendly materials and devices;
2. Sustainable innovation cluster, assuming efficient industry-government-academia network, knowledge exchange networking (needs/seeds) between academia and industry while providing facility support through government policy.

Tokai Region Cluster is a very well-organised and promoted project, with Nagoya Industries Promotion Corporation, core agency, located in Aichi Prefecture and R&D foundation from Gifu Prefecture cooperating under Knowledge Cluster Initiative Headquarters.

Although transfers of basic research results from academia to the industry in the business phase are forbidden, knowledge might be exchanged among industry and academia in the first four phases, while technology transfer from academia to industry should take place in the mass-production technology phase.

Research themes constitute the directly correlated transfer services and technologies. Research conducted under Theme 1 provide plasma diagnostics and plasma surface treatment to Theme 2, plasma MBE (Molecular Beam Epitaxy) and plasma etching to Theme 3, Theme 2 exchanges surface & interface technology with Theme 4, while Expansion Program induces international collaboration within Theme 1 and Theme 3.

R&D management in Tokai Region Cluster

Nagoya Model provides a set of definitions of each R&D phase of potential interactions and contributions of academia and industry. According to this model, research units operating within Tokai Region Cluster i.e. Nagoya University and the Toyohashi University of Technology, should be oriented on applicable studies to be potentially used by industry, subordinate applied research to complete product target and support prototype production through knowledge exchange. Mass production technologies, developed within academia, are to be transferred to industry in the 4th R&D phase, while the inflow of knowledge from academia to industry in the last phase – product commercialisation – is uncertain.

Tokai Region Cluster has developed various platforms and organisations for technology transfer. Different research institutes, laboratories and universities are concentrated around knowledge hubs and centres coordinated by Tokai Region Cluster Headquarters within four dimensions: Materials, Devices, Nano-Characterisation and Plasma Technology.

Foreign partners in plasma technologies are engaged within International Plasma CoE Network – Plasma Nanotechnology Centre located at the Nagoya University and cooperate closely with research units from South Korea, United States, Australia, Germany, France, Ireland, Netherlands, United Kingdom and Italy.

International collaboration is combined with intensive regional activities supported by local governments such as instalment of regional innovation facilities, theme-based workshops such as seminars regarding cluster achievements and related topics, schooling and coaching, support of Public R&D, Technology Transfer to the Regional SMEs.

Therefore, management within Tokai Region Cluster might be studied through the prism of plan-do-check-adjust (PDCA) cycle, because every implemented action and the executed task is preceded by brainstorm session, inputs consideration, objectives planning, followed by evaluation, data analysis and formulation of recommendations. Local governments take the responsibility for visualisation of cluster initiative outcomes and effective utilisation of regional activities. Finally, R&D processes are managed using multiphase Nagoya Model. Various Innovation Platforms and Organisations are designed in the form of networks to locate R&D facilities near industries.

Tokai Region Cluster results

Regional Cluster Initiative has already resulted in a few successful R&D results within Theme 1, 2, 3 and 4. Four separate research fields, led by specialists from Nagoya University and Nagoya Institute of Technology, should encourage the advancement of plasma nanotechnology and utilisation of nanomaterial and device technologies at key junctures, promote the use of environment-friendly advanced materials and processing technologies by regional SME.

Meanwhile, Expansion Program is expected to reinforce personal development and international collaboration, to promote international industry collaboration and research seminars aimed at smooth transfer of research achievements within the academia-industry-government network.

Since 2009 five annual International Symposiums on Advanced Plasma Science and its Applications for Nitrides and Nanomaterials (ISPlasma) were organised in order to create a world leading international foundation for advanced plasma nano-technology science. In March 2010, Tokai Region Cluster Headquarters have concluded a partnership agreement with the research and development foundation MINATEC located in France – the world leader in the field of nanotechnology.

According to the roadmap provided by Tokai Region Cluster Headquarters, R&D activities within optical/power device components, fundamental plasma nanotechnology, nanomaterials and processing, conducted through the network of five industry-academia-government partnership centres and six collaboration centres should contribute to the development of next-generation industries, offering green vehicles, aircrafts,

environment-friendly materials & processing, medical devices and environmental conservation etc.

So far, there are no data as to the number of cluster participants and qualitative results of networked R&D activities, so as the impact of regional knowledge clusters on the innovativeness and competitiveness of both enterprises and the regions.

Conclusions

Theoretical studies on the concepts of knowledge-based economy and clustering have been important foundations for empirical studies of the Tokai Region Cluster.

Macro-level

When studying contemporary knowledge-based economy in Japan, it appears, that long-term stagnation and extraordinary active role of government have contributed to the distortion of the business environment, reflected by rising infrastructure shortages, rising costs of capital, ineffective competition and shrinking labour forces that discouraged productivity.

Following the knowledge-based economy concept, authorities have decentralised innovation policies in order to stimulate local potential, with special regard to intangible assets, expected to induce R&D activities that should result in new patents and licenses.

The traditional channel of knowledge transfer in macro scale – material and investment imports, especially from the United States, has been replaced by inter-industry transfer of knowledge within clusters of enterprises, universities and other organisations.

Knowledge Cluster Initiative is expected to globalise Japanese clusters so to provide local entities with more outward-looking orientation, assets and information from different parts of the globe. This may induce such a critical and scarce ability to project international trends and changes, design modern strategies and react flexibly to external tendencies. Consequently, Japanese SMEs may utilise different assets both internal and external, combine traditional operational effectiveness with distinctive strategies[53] to build the international market advantage also within service industries that lack strong global Japanese presence.

Research themes provided by Tokai Region Cluster do confirm the awareness of the importance of innovations for economic success and social welfare. An emphasis put on green, energy-efficient technologies, materials and devices reflect traditional Japanese attachment to sustainability, harmony and nature. Consequently, resource structure is expected to renovate in Japan, reorienting to a lesser extent to

[53] Among major barriers to compete with distinctive strategies Japanese entrepreneurs have listed: limited availability of well-educated staff, poorly developed marketing channels and unsophisticated local customers.

hard assets, while forming and developing a soft one with special regard to tacit knowledge in the form of attitudes that may inspire creative actions of individuals within the clustered entities – as it was mentioned before, skilled, specialised personnel provide new ideas and innovations, not organisations such as enterprises or universities. Therefore, further investments in human resources are expected, both in enterprises, administration and universities, to provide more skilled specialists with detailed knowledge, professional public servants and mobile, well-equipped researchers able to address business expectations and needs.

Undoubtedly, Japanese workforce do represent very strong attachment to traditional values and culture, deeply rooted in ideas of collectivism, lifelong learning, reciprocity, discipline, seniority and responsibility – components of innovation capital – citing the definition of Williamson – that have contributed to past Japanese successes in the field of technology and prosperity under social equity. Addressing the concept of social capital by Iyer, Kitson and Toh, Japanese labour force does represent a unique spectrum of attitudes, that combined with specificity of social networks in Japan, namely culturally determined interactions among individuals and other types of capital, determines their productivity ensuring an added value and competitiveness of the economic system.[54]

Micro level

Unsophisticated local customers have discouraged many Japanese enterprises from the implementation of distinctive strategies and therefore, more offensive and innovative market orientation and R&D activities. However, when studying cultural specificity of local businesses, relying on knowledge as a vehicle of progress and *kaizen* concept, assumptions of strategic map model by Kaplan and Norton, linking comparative advantage of an enterprise with intangible assets, ability to learn, accumulation of experience, might be cohesive while exchange of information and spillovers fit into the concept of knowledge cluster.

As it was identified by Nonaka and Takeuchi, tacit knowledge, i.e. intangible assets such as attitudes and values, are relatively more important, recognised and appreciated by Japanese enterprises which are more attached to the idea of collectivism, than Western ones. The latter, have paid traditionally more attention to explicit knowledge, potentially easier to formalise, transfer, and adapt. Again, well-skilled human resources should be combined with a favourable business environment to stimulate innovations and knowledge creation. Potentially, internationalisation of clusters should contribute to better implementation of further stages of Kaplan and Norton's chain of value creation

[54] Indeed, it is hard to match specificity of Japanese workforce with social capital concept by Putman, assuming financial incentives and individual interests as the basic motives of collective actions and reciprocity; on the other hand, traditionally hierarchical and complex corporate structures in Japan linked with discipline and respect for superiors and elders might affect creativity of social capital, as it was studied by Tura and Harmaakorpi.

through utilisation of intangible assets, namely specification of R&D priorities, sources of value and identification of different alternatives and risks, previously marginalised and unacknowledged at international scale within many industries in Japan.

Addressing Simon's concept of modern corporation, Japanese enterprises have already developed mechanisms of building value on the foundation of knowledge and accumulation of experience, however, they do need to create wider coalitions, namely networks of business, academic and institutional partners, transform and renovate to be more flexible, open-minded and outward-oriented to expand internationally. Thus, regulatory regime and domestic resource base require upgrading.

Finally, Japanese business' tendency towards cooperation within a network of small and medium-sized partners such as suppliers and designers, may be linked with a taxonomic model of business assuming continuous widening of corporate boundaries to engage different outside entities within the process of value and knowledge creation.[55] Undoubtedly, cultural foundations do play an important role in shaping such kind of informal linkages between unrelated partners involved in different stages of the chain of value sharing both explicit and tacit knowledge that should interact to create an optimal and complementary combination.

Knowledge cluster

Knowledge cluster concept by MEXT has been referred to in the context of the network to emphasise specific nature of linkages among cluster partners. The Japanese concept of innovation cluster of the networked type that is expected to engage organisationally linked high-tech enterprises using ICT, might be treated, as it was defined by OECD, as a source of technological innovations within new concentrations.

Knowledge clusters concept by MEXT does provide a new kind of temporary coalitions for joint R&D activities induced by the market, oriented, following Dicken, on multiplier effects encouraged increasingly by determinants of external locations, possibly related to the concept of world-class clusters by MEXT, operating within international R&D networks.

Moreover, structural transformation of the regions, that is expected to intensify R&D activities under the knowledge cluster concept, is directly managed through decentralised innovation policy of Japanese government, encouraging local authorities to configure and combine local capabilities and potential under internally designed cluster vision. Different prefectures, concentrating specific industries, universities and supporting organisations, seek ways of global expansion through partnerships and resource management. However, as it was stated above, delegation of power resulting in specific combination of bottom-up approach to strategy and top-down evaluation

[55] Usually, in this context an example of Toyota is brought to illustrate the ability of traditional Japanese corporation to work closely on a product and process innovations with outside small and medium-sized partners within a cluster frameworks.

to get subsidies from the central government, put into the question the importance of enterprises as catalysts of clustering while considering the risk of duplication or imitation of the others' ideas and visions to be successful, as was pointed out by Porter. Quantitative results of knowledge cluster policy by MEXT provided above, while lacking qualitative one, do not fully reflect the scale of success or failure. It is the matter of time, possibly decades.

Finally, when studying Tokai Region Cluster it should be noted, that its dynamism is deeply rooted in spatial concentration of entities. Again, the idea of knowledge clusters by MEXT was based on central government's selection and evaluation. Tokai Region Cluster, covering three prefectures plus agglomeration area of Nagoya, has been constructed and centred around dynamic research centres, mainly Nagoya University, Toyohashi University, Meijo University, Gifu Technological Innovation Centre (Gifu), Aichi Centre for Industry & Science Technology, Aichi Knowledge Hub, NITECH Research Centre. Research is inspired and conducted in close cooperation with local enterprises with special regard to Toyota Motor Company represented both in core organisation and headquarters of the knowledge cluster. Combining business and scientific representatives within the single institutional structure is expected to intensify dialogue and multi-directional flows resulting, as Rallet and Torre assumed, in dynamic external effects induced by locally available implicit knowledge – the traditional source of advantages of Japanese enterprises and regions.

Undoubtedly, the Tokai Region Cluster has been built on specialisation advantages within automobile, aircraft and machinery industries in accordance with the theoretical approach by Feser. Moreover, spatial boundaries set by the regional government upon the approval of the central authorities, provide a wide spectrum of opportunities related to agglomeration effects. Recognizing the importance of research entities in the cluster structure of Tokai Region and knowledge spillovers as the source of interactions, agglomeration effects related to continuous learning process should have dynamic and long-term character as it was defined by Revilla Diez.

However, the character of advantages generated within the Tokai Region Cluster cannot be simply linked with Porter externalities because there is no evidence to suggest their influences on internal competition within clustered industries. Case study provided above did not examine the aspect of competition because of relatively poor data so far. Therefore, agglomeration advantages require further studies, with special attention paid to the character of knowledge transferred within the structure and market environment.[56]

Empirical studies did not provide clear judgment as to the character of agglomeration advantages generated by Tokai Region Cluster. Authors, following premises of specialised

[56] L. Orsenigo, 'Clusters and Clustering: Stylized Facts, Issues, and Theories', in P. Braunerhjelm, M. Feldman (eds), *Cluster Genesis: Technology-Based Industrial Development*, Oxford: Oxford University Press, 2006, p. 201.

knowledge spillovers, spatial concentration of SME centred around large enterprises i.e. Toyota Motor Co., finally – concentration of highly–skilled staff, have identified some parallels with the Marshall-Arrow-Romer localisation advantages. Moreover, a combination of representatives of a few economic industries providing potentially very complex and diversified offer entitles matching with the Jacobs urbanisation externalities. However, linking agglomeration of companies with economic growth effects may result in deprivation of Tokai Region Cluster of its legitimacy of as a cluster structure.

Possibly, case study made by authors reflects a kind of combination of sectoral specialisation and regional diversity, as it was proved by Paci and Usai, although central role of research centres, R&D activities contracted by core organisation to be further applied and advanced to match business' requirements, finally – specificity of machinery industry as the common denominator of engaged businesses, lead to the conclusion, that Marshall-Arrow-Romer externalities possibly dominate.

Furthermore, efficient modern devices, green materials, nano- and plasma technologies, may become the subject of diffusion within external industries and sectors that would blur the boundaries of the cluster–made knowledge and innovations. Assumptions related to the internationalisation of R&D activities and, consequently, global expansion of clustered industries, appear to confirm this statement.

The available national–level quantitative results may indicate and confirm direction towards more advanced knowledge-based economy, albeit without unequivocal symptoms of a qualitative leap. Numerous R&D investments, combined with a number of new international patents – unfortunately without recognition of patent applications, scientific articles, commercialisation of ideas and sales of innovative products – reflect relatively poor influence and share of the Knowledge Cluster Initiative's "output" in macro scale. So far, for instance, less than 4 thousand patents were provided for 10 years, with the annual average number of patent applications of 300 thousand, while just over 11 thousand scientific articles for over a decade appear to be a modest result when challenged with the average annual number of nearly 50 thousand. Other indicators would possibly confirm this tendency.

Authors associate this phenomenon with the knowledge cluster specificity – multilayered research projects are expected to result in added value and visible improvements of Japanese competitive potential within knowledge-intensive products in a longer perspective, when being developed, applied and commercialised. Therefore, authors do expect gradual, steady evolution of a knowledge-based economy in Japan instead of rapid revolution beyond the capabilities and attitudes of Japanese stakeholders.