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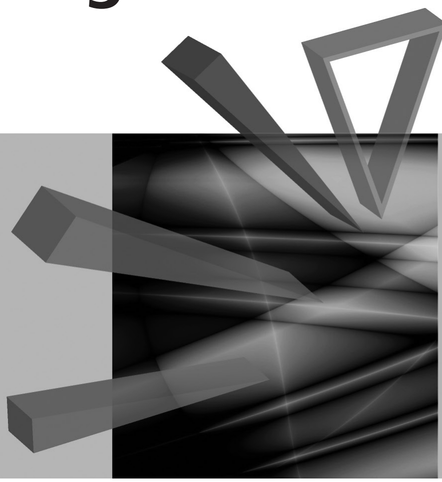
Innovation as a Factor of the Development of the Asia-Pacific Region



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INNOVATION-ORIENTED POLICY IN JAPAN AND CHINA. A COMPARATIVE ANALYSIS

Summary: The article presents an overview of Japan's and China's science and technology policy, major policy measures to promote industrial innovation and recent concerns about innovation systems in both countries. The article reports the reforms undertaken in the area of innovation-oriented policies and their theoretical premises. Finally, the discussion turns to an evaluation and comparison of the main outcomes of the reforms of these systems in Japan and China.

Keywords: innovation policy, national innovation systems, government R&D expenditure, industry–academia cooperation.

1. Introduction

The traditional sources of nation's prosperity, such as natural resources, territory and military, might be far less important today. Currently, successful development is increasingly related to sound policies, good governance, effective management of resources and innovation. Innovation plays a major role in achieving a sustainable and comprehensive economic growth. It is also important in terms of social and environmental development. It is important to say that a wide-ranging set of relevant factors, policies and institutions plays a central role in boosting nation's capacity for innovation. Among them there are nation's institutional environment, regulatory and legal framework and infrastructure for research and development. The relative importance of the factors varies depending on the political regime in which policies are implemented.[1]

One of the key factors in the process of building an innovation-oriented nation is an innovation policy. The purpose of the article is to present an overview of Japan's and China's science and technology policies underpinning countries' innovation. The question is if these countries can manage to expand opportunities for their populations through a full exploitation of nation's capacity for innovation.

[1] A. López-Claros, Y.N. Mata, *The Innovation for Development Report 2010–2011. Innovation as a Driver of Productivity and Economic Growth*, Palgrave Macmillan, 2010.

2. Innovation theory and innovation-oriented policy

Innovation theory has developed since the late 1970s. By the early 1990s policymakers were beginning to treat innovation policies as instruments towards much more wide-ranging policy objectives. The second phase of the research in the 1990s was stimulated by increasing policy interest. Therefore, the theory–policy link has been central to the development of this field.[2] The emergence of innovation at the centre of intellectual debates over growth and competitiveness and of institutions was a result of a number of factors, e.g., the ability of social scientists to influence policy making with regard to technological innovation[3] or the increase in importance of such organisations as the OECD, European Commission and UNCTAD, which came to see innovation and technological change as central to welfare and growth problems.

For innovation policies, it is crucial that innovation does not happen only in a relatively small group of high-technology industries and is distributed evenly across the economic system. Scientific and technological innovations have constantly been taking place in various fields at such astonishing rates that it has become indispensable for people to integrate specialised knowledge on a large scale, dispersed over finely divided disciplines.[4] The implication is that innovation policy must consider the needs of a wide set of sectors and industries. Moreover, firms very rarely innovate without technological cooperation or collaboration.[5] Knowledge creation mostly happens through an interactive process with other firms, organisations or the science and technology infrastructure. Empirical research in a number of countries indicates that publicly-supported infrastructure, such as universities and research institutes, is important collaboration partners.[6] Innovation involves serious uncertainty in technological and economic terms and clustering appears central to competitive advantage. Understanding the specificity of the innovation process is important and may help to design a more effective policy.[7]

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[2] There was an interaction between heterodox social scientists and policymakers seeking new perspectives in the context of the serious and persistent economic crisis of the 1970s. For policymakers, this was in part a crisis of understanding because the anti-inflation policies of the 1980s did little to affect unemployment, growth and productivity problems. L.K. Mytelka, K. Smith, *Innovation Theory and Innovation Policy: Bringing the Gap*, UNU/INTECH, Aalborg 2001, p. 1.

[3] A growing number of "outsiders" doing research on different aspects of the "new innovation paradigm" worked closely with a small number of international organisations and contributed to the evolution of their research programmes. *Ibidem*, p. 4.

[4] H. Chuma, *Increasing Complexity and Limits of Organization in the Microlithography Industry: Implications for Japanese Science-based Industries*, Research Institute of Economy, Trade and Industry Working Paper, Tokyo 2004, p. 1.

[5] J. Suzuki, F. Kodama, Technological diversity of persistent innovators in Japan. Two case studies of large Japanese firms, *Research Policy* 2004, Vol. 33, p. 548.

[6] S. Tamada, Y. Naito, K. Gemba, F. Kodama, J. Suzuki, A. Goto, *Science Linkages in Technologies Patented in Japan*, Research Institute of Economy, Trade and Industry, Discussion Paper Series 04-E-034, Tokyo 2004, p. 2.

[7] L.K. Mytelka, K. Smith, *op. cit*., pp. 9–11.

It is worth noting that there is no unified theory that relates innovation to growth and distribution, and links macro-approaches to the micro level. This is the factor that slowed the application of innovation theory to certain policy areas, except for education, research and technology development. Similarly, the difficulties in the translation of innovation theory into an effective policy instrument emerge from the lack of new measurement tools.[8]

3. Japanese national innovation policy

The Japanese economy is technologically advanced, with the third highest gross expenditure on R&D (GERD) in 2008, which edged to 3.4% of GDP. This is a country with the highest in the OECD area GERD financed by industry. In 2008, the participation of industry in financing GERD increased to 78% and represented 2.7% of GDP. Japanese government's participation in financing GERD declined steadily from 20% to 16%. At the same time, only 0.4% of GERD was financed from abroad.[9]

In comparison to developed countries, Japanese government's involvement in private-sector R&D activities was quite small and was running at about 1.4%, measured in terms of the ratio of government funds flowing directly to industry to the amount of money used by industry. The United States' involvement was running at 9.3%, Germany's – 7.4%, France's – 10.0% and the United Kingdom's – 11.9%.[10] However, the Ministry of Economy, Trade and Industry[11] plays a central role in terms of promoting industrial technologies and its budget is about 17% of the government's total science and technology budget. The budget of the largest science and technology-related ministry in Japan, the Ministry of Education, Culture, Sport, Science and Technology (MEXT), is more than 60%. MEXT focuses on the promotion of science and basic technology and its R&D funds consist of institutional funding to universities, competitive research funds for basic research at universities and large science projects, such as space, nuclear and oceanic science.[12]

METI's main task is to seed grants to create new technology and develop new industrial technology for the next generation. Particularly it:

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[8] *Ibidem*, p. 16.

[9] Japan is the one of the world's three largest economies. From 2001 to 2007 GDP grew by average annual rate 1.8%. It contracted by 1.2% in 2008 and by 5.2% in 2009. *Japan. Science and Innovation: Country Note. OECD Science and Industry Outlook*, OECD, Paris 2010, p. 196.

[10] *Ibidem*, p. 196.

[11] Before: the Ministry of International Trade and Industry (MITI). In the 1980s MITI was cited as a typical success of industrial technology policy.

[12] The other ministries that carry out R&D in their primary area of responsibility by concluding contracts research and providing grants or loans, but their budgets are much lower, include the Defence Agency, the Ministry of Health and Labour and the Ministry of Agriculture. B. Shiozawa, T. Ichikawa, Japan's industrial technology and innovation policies and the effects of "agencification", [in:] *Governance of Innovation Systems: Case Studies in Innovation Policy*, OECD, Paris 2005, pp. 144–155.

– organises the national R&D programme,
– provides the private sector with competitive loans and subsidies to encourage R&D on basic science as well as generic and pre-competitive technologies,
– encourages "industrial cluster programmes" consisting in collaboration between universities and private companies in local regions in order to make effective use of technical discoveries made at universities by providing competitive loans and subsidies,
– provides tax incentives, assistance in human resources development and competitive loans to encourage new start-ups and entrepreneurs.[13]

Innovation policy in Japan is organised at the highest levels of the government by the Council for Science and Technology Policy (CSTP). CSTP was established in 2001 as headquarters for national science and technology policy. The main goal of CSTP is to organise R&D projects in a cohesive and coherent manner. The Council is a platform for the cooperation between government and academic and business sectors.[14] The Japanese government has placed a high priority on the allocation government resources for R&D, the promotion of industrial technology and the encouragement of basic science as well. The reform of the national innovation system that has been carried out since 2001 identifies the following goals: to carry out the reform of national universities, make the work environment of researchers more competitive, enhance industry–university collaboration and promote the development of local regions using local R&D potential as a driving force.[15]

In order to improve the efficiency and effectiveness of METI, Japan implemented changes in administrative structure of their innovation policy and created independent administrative agencies in 2001. METI, which has long been involved in the formulation of R&D projects, reformed two large agencies: the National Institute of Advanced Science and Industrial Technology (AIST) and the New Energy and Industrial Technology Development Organisation (NEDO).

AIST and NEDO became independent agencies in 2001 and 2003, respectively. This status gives them more operational freedom and more flexible R&D project management. At the same time, it requires greater transparency and increases their responsibility for project management. The most important change of the system

[13] *Ibidem*, p. 147.

[14] The structure of the CSTP consists of the Prime Minister as a leader and 14 regular members. The other members are the Chief Cabinet Secretary; the Minister of Science and Technology Policy; the Minister of Education, Culture, Sports, Science and Technology; the Minister of Economy, Trade and Industry; the Minister of Finance; the Minister of Public Management, Home Affairs, Post and Telecommunications; and the Chairman of the Science Council, and also seven members selected from academic and business sectors, who have distinguished scientific knowledge and technological expertise. *Ibidem*, p. 140.

[15] The main cause of the large-scale administrative reform of the Japanese government system was a series of scandals involving public officials and increasing public distrust of the administration. *Ibidem*, pp. 140–147.

Table 1. Characteristics of AIST and NEDO after the reform

	AIST (from April 2001)	NEDO (from October 2003)
Characteristics	Research institute	Funding agency
Research	Basic research	National projects
Numerical indicators of evaluation	Number of papers Impact factor (IF) Number of patent licences Number of collaborative research projects	Proportion of successful projects Number of papers, patents

Source: B. Shiozawa, T. Ichikawa, Japan's industrial technology and innovation policies and the effects of "agencification", [in:] *Governance of Innovation Systems: Case Studies in Innovation Policy*, OECD, Paris 2005, p. 165.

of NEDO is that R&D management will be free from the budgetary system, which allows NEDO to call for new project proposals from industry at any time.[16]

The "agent system" introduced for national research institutes and national corporations, resulted in an increase in the independence of all Japanese national universities, which are required to operate, in principle, in a self-sustaining manner. In the previous system, Japanese universities were not active in forming co-operative relationships with private companies; the Ministry of Education, Culture, Sport, Science and Technology (MEXT) appointed all professors and staff and funded all the national universities as well.[17] The change in the system was necessary in order to:

– generate sufficient output in relation to the large input that universities were producing,
– create a competitive working environment of universities to provide professors and staff with strong incentives to generate useful outcomes,
– create universities sensitive enough to meet external needs regarding their educational curricula and research themes,
– guarantee the transparency of university activities to the public and the evaluation of their performance by others.[18]

The industry–academia cooperation has been strengthening by organising numerous government-sponsored gatherings. Those industry–academic–government collaboration summits are held at both national and regional levels. Universities are also encouraged to establish a technology licensing organisation.[19]

In 2010 the Japanese government adopted The New Growth Strategy, which includes targets for 2020, e.g.:

[16] L. Stenberg, *Government Research and Innovation Policies in Japan*, Swedish Institute for Growth Policy Studies, Ostersund 2004, p. 11.

[17] Since April 2004, professors and staff of national universities have been non-public-servant-type employees. *Ibidem*, p. 142.

[18] *Ibidem*, p. 142.

[19] *Ibidem*, p. 148.

– more world-leading universities and research institutions,
– full employment for science and technology doctorates holders,
– utilisation of intellectual property of SMEs,
– more efficient use of information and communication technologies in both production and consumption,
– increasing GERD to over 4% of GDP.[20]

4. China's national innovation system

The origin of the Chinese innovation system can be traced back to the mid-1980s, when S&T industrial parks, university science parks, technology business incubators and spin-offs from public research organisations were started. Previously, civil research and development activities were for decades limited in scale, scope and depth and separated from production.[21]

A prominent role in the governance of the innovation system and S&T is played by the Ministry of Science and Technology. The top-level co-ordination mechanism is the State Council Steering Group for Science, Technology and Education. A direct role in designing and implementing S&T and innovation policies is performed by ministerial level agencies, such as the National Development and Reform Commission, the Chinese Academy of Science, the Chinese Academy of Engineering, the Ministry of Finance, the Ministry of Commerce and sectoral line ministries, such as the Ministry of Information Industry.[22]

In 2006, the share of R&D expenditure of the three key performers in the China's National Innovation System was as followed: government research institutes 19.7%, the higher education sector 9.2% and the business sector 71.1%. The share of government funding is respectively: 66.5%, 20.4% and 13.0%.[23]

China remains specialised in low-tech, but there was a spectacular rise in China's high technology exports, whose share in total exports increased from 5% in the early 1990s to over 30% in 2005. High-technology industries (e.g., information and communication technology) are primarily under foreign control.[24]

[20] The integral part of the science and technology strategy is green innovation and "life innovation". *Japan. Science…*, *op. cit*., p. 196.

[21] *China. Synthesis Report. Reviews of Innovation Policy*, OECD, Paris 2007, p. 21.

[22] In the 1990s, several government restructuring and downsizing efforts reduced the number of ministerial agencies from 40 to 29 and the number of government employees by 47% on average. *Ibidem*, p. 49.

[23] M. Schaaper, *Measuring China's Innovation System. National Specificities and International Comparison*, STI Working Paper 2009/1, OECD 2009, p. 19.

[24] High technology exports are heavily concentrated on office machinery and TV, radio and communication equipment. As of 2004 China is the world's largest exporter of ITC goods but these exports mainly originate from foreign-owned enterprises, which account for 88%. The foreign-owned enterprises also account for most of the imports of high-technology products. *China. Synthesis Report…*, *op. cit*., p. 12.

China is one of the major destinations for foreign direct investment (after the UK and Canada). China's FDI inflows relative to GDP grew from 0.2% in 1982 to 4.3% in 2007.[25] Since 2005, China's inward FDI stock relative to GDP has been larger than that of Japan. Outward FDI stocks are also lower than those of Japan. Japanese and American investments in China represent less than 10% of FDI stocks for Japan and less than 3% for the US because the initial levels were very low.[26] To date, China has largely relied on the supply of foreign technology and most Chinese enterprises are still far from being innovation leaders.[27]

The intensive investment in resources has contributed significantly to a rapid socio-economic progress registered in China in the last decade, but the capabilities for making productive use of accumulated investment in R&D have developed at a much slower pace. Since the end of the last decade China has been making significant progress towards developing the country's innovative capacities. The Chinese government has implemented structural and organisational reforms in key R&D-performing sectors: government research institutes, higher education and business sectors, which can be summarised as follows:

– restructuring government research institutes through downsizing and re-orientation of government support towards basic and applied research,
– expansion of the higher education sector by increasing the number of new entrants at all levels and more concentrated financial support to key research--intensive universities,
– strengthening the innovation capacity of enterprises and increasing openness of the market to facilitate interaction among key performers,
– encouraging science–industry linkages among key performers.[28]

The reforms resulted in reducing the number of institutes and S&T personnel without formal qualifications[29] and also in strengthening government support to institutes with research capacity in basic and applied research. The higher education sector has become a supplier of S&T human resources to the business sector, from which it receives a substantial amount of funding. The higher education sector also receives financial resources from the government, which supports basic and applied research. It is worth pointing out that the higher education sector is now strongly oriented towards engineering and applied research in high-technology areas.[30] Government research institutes are still playing a key role in supporting basic and

[25] T.M. Greaney, Y. Li, *Assessing Foreign Direct Investment Relationships between China, Japan, and the United States*, University of Hawaii, University of Electronic Science and Technology of China, p. 2, www.faculty.maxwell.syr.edu (accessed: 20.04.2012).

[26] *Ibidem*, p. 17.

[27] *China. Synthesis Report…*, *op. cit*., p. 16.

[28] M. Schaaper, *op. cit*., p. 17.

[29] The number of government institutions declined from 5867 in 1991 to 4169 in 2003. In 2003, the number of S&T personnel was reduced to 410 000 comparing to 800 000 in 1991. *Ibidem*, p. 20.

[30] *Ibidem*, p. 4.

strategic research, and the research related to the prevision of public goods as well. In 2005 the expenditure on natural science and engineering accounted for 94.7% of GERD of government research institutes.[31]

The large expansion of the education sector, especially at the tertiary-level, and the rapid growth of R&D expenditure in this sector can be attributed to the stronger financial support from the government. The higher education sector plays an important role in establishing academia–industry linkages (which are at the heart of the most innovative networks and clusters) through, e.g., direct participation in the technology market, co-operation with the business sector or establishing national university S&T parks.[32] But the industry–science relationships in China suffer from insufficient demand from firms, an academic research culture that does not emphasise economic relevance, low mobility of researchers, and the competition between public research and industry for public support.[33]

A dominant role in terms of inputs, outputs and patent applications is played by the business sector (medium and large-sized enterprises). Since 2000, Chinese R&D expenditure has been increasing very fast but mostly it has involved experimental development. At the same time, basic and applied research is much lower than in OECD countries. This reflects the increasing role of China's business sector as a performer of R&D.[34] The development in the business sector is characterised by a high degree of internationalisation. Foreign and joint-venture enterprises have large shares in some medium- and high-tech intensive sectors. But the majority of foreign--invested enterprises are engaged in manufacturing activities with limited R&D.

In 2006, China adopted the national medium- and long-term programme for science and technology development. In the programme, S&T is considered the key driving force for sustainable economic growth and for transforming China into an innovation-oriented nation. The main goal of the programme is to become an innovation-based country by 2020 and to raise the ratio of R&D to GDP to 2% by 2010 and to 2.5% or more by 2020.[35] This strategic objective is also fostering an enterprise-centered technology innovation system and enhancing the innovation capabilities of Chinese firms, lowering dependence on foreign technologies (30% or less), rising the number of patents granted to domestic inventions (to achieve world's top five) and increasing the number of citation in scientific papers internationally (to achieve world's top five as well).[36]

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[31] Since 1999, the applied research institutes of the central and regional governments have become independent agencies from the governments. Some of them are managed and operates as firms. *Ibidem*, p. 19.

[32] By 2005, 50 national parks were established, containing 6075 start-up firms, hosting 110 200 entrepreneurs. *Ibidem*, p. 23.

[33] *China. Synthesis Report*…, *op. cit*., p. 42.

[34] M. Schaaper, *op. cit*., p. 3.

[35] The National Guidelines for the Medium- and Long-term Plan for Science and Technology Development (2006–20).

[36] *China. Synthesis Report*…, *op. cit*., p. 48.

5. Conclusions

Both countries, Japan and China, are presently undergoing very radical changes in their research and innovation systems. Both countries played a key role in encouraging science–industry linkages in the process of reforming national innovation systems. One of the main areas of these reforms is the institutional status of key R&D performers, such as government R&D agencies and universities. In both countries the main goal to achieve is to increase effectiveness and efficiency of these organisations.

Thanks to the agencification, AIST and NEDO have been released from government regulation, which is an incentive to improve their performance by enhancing their efficiency and flexibility. The Japanese government focused its efforts primarily on efficient and effective use of budgets as well as on encouraging collaboration between universities and private companies.

The improvement of agencies' abilities to gather necessary information from industry and universities as well as find the right balance between monitoring costs and incentives (flexibility) continues to be a challenge for METI. It is supposed that AIST needs further involvement by METI, while in NEDO's case a greater flexibility will be a factor on the way to make national R&D project more efficient.

The rapid increase in China's expenditure on R&D and its large stock of human resources, together with the increase in R&D-intensive FDI, have strengthened China's image as an emerging knowledge-based economy. Nevertheless, China's innovation system can be considered a NIS (national innovation system) under construction and it consists of a very large number of "innovative islands" with limited synergies between them. Therefore, an important objective should be promoting more market-based innovative clusters and networks.

Despite playing a dominant role in an emerging national innovation system, the efficiency and innovation capacity of Chinese business sector is still insufficient. China's industrial enterprises do not sufficiently utilise the R&D resources of the higher education sector and research institutes.

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POLITYKA INNOWACYJNA W JAPONII I W CHINACH. ANALIZA PORÓWNAWCZA

Streszczenie: W artykule przedstawiono główne cechy charakterystyczne polityki Japonii i Chin w zakresie nauki i technologii, podstawowe instrumenty wykorzystywane w celu promowania innowacji, wątpliwości dotyczące systemów innowacyjnych funkcjonujących w obu krajach, jak również teoretyczne przesłanki prowadzonej przez oba kraje polityki innowacyjnej. W artykule zaprezentowano zmiany, jakich dokonano w obszarze polityk innowacyjnych w ostatnich latach oraz podjęto próbę oceny i porównania osiągniętych efektów.

Słowa kluczowe: polityka innowacyjności, narodowy system innowacyjności, wydatki rządowe na B+R, kooperacja akademicko-biznesowa.