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New S&T Policies and Re-positioning of
Universities in the Changing National Innovation
System – A View from Japan

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The growing role of universities in the 'knowledge economy' is well known. A dynamic and well-balanced academic system is a key engine of innovation and economic development. Doubts persist however as to whether Europe's universities are fully capable of fulfilling that role. The members of the Forum approached these issues by focusing on the following research themes: (1) Universities and the changing dynamics of knowledge production; (2) Patterns of the division of labour in research and innovation system; (3) The internal organisation of academic systems: tensions and adaptations; and (4) Diversity, innovativeness, and the governance of academic systems.

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Abstract

This paper discusses the recent dynamics of Japan's national innovation system, investigating 're-constitution' of innovation policies currently occurring in Japan in light of wider changes taking place within the EU and US policy frameworks. What has been occurring in Japan over the last decade is a rather radical transformation of S&T and innovation policies which emphasise the changing roles played by universities. The paper illustrates the changes in the Japanese national innovation system and examines the impacts of recent policies aimed at promoting academic entrepreneurship. The current Japanese government's initiatives, with national industrial and S&T policies centred on strengthening university-business links, are critically examined in light of the development of new Industry-Science Relationships (ISRs). By drawing on the recent experiences of Japan, this paper makes two particular contributions in terms of comparative public policy analysis and institutional analysis. The first contribution is related to the discussion about international policy convergence and processes of policy learning. The second area to which this paper makes its contribution is to provide an insight into the institutional transformation of universities in Japan in response to the top-down triple helix interaction. The paper asks whether such re-positioning of universities as part of the new national ISRs leads to the emergence of a new national innovation system, creating constructed advantage as part of the globalising knowledge economy.

Keywords: industry-science relationships, academic entrepreneurship, Japanese innovation systems

I. Introduction*

This paper discusses the recent dynamics of Japan's national innovation system, focussing on the changing roles played by universities. 'Re-constitution' of innovation policies currently occurring in Japan is investigated in the light of wider changes taking place within the EU and US policy frameworks. It is the aim of this paper to see whether there is policy convergence between the US, Europe and Japan, and whether the institutional convergent processes regarding university-industry interaction have occurred cross-nationally. In the US, it is argued that virtually all of the central components of the innovation system that emerged in the post war US innovation system are undergoing change, even challenging the relevance of the notion of a national innovation system itself. In the EU policy contexts, 'Europeanisation' of innovation policies have been observed, and authors have started to examine the question as to whether, and to what extent, supranational European innovation can be assessed as the 'system' at the EU level (Borras, 2004). What are the challenges that the Japanese national innovation system is facing in the increasingly globalising economy, and what are the new expectations and barriers for the universities to play a role in this?

The changing role of universities in the national innovation system is the focus of this paper. Universities, once seen as nation-building institutions, have increasingly become 'nation-positioning' institutions, a role that is differently played out in different national contexts (Bleiklie and Henkel, 2005). Policy communities at multiple levels have come to view universities as being at the heart of the knowledge-based economy, and universities are increasingly seen as principal drivers of industrial and technological development in different countries. The promotion of the so-called 'triple helix' of interaction between industry, government and universities as a key feature of the knowledge based economy (Etzkowitz and Leydesdorff, 1997) has been noted. In the US, this has been characterised as the intersection of 'bottom-up' and 'top-down' initiatives while in Europe, Japan and elsewhere, the triple helix interaction has been promoted mostly by top-down initiatives from governments (see Etzkowitz, 2003).

Japan, among other countries, is aiming to increase national competitiveness in the global knowledge economies by tapping into institutional innovative capability and establishing new Industry-Science Relationships (ISRs) (OECD, 2002). These new institutional settings in turn hope to foster further knowledge creation and innovation. What has been occurring in Japan over the last decade is a rather radical transformation of S&T and innovation policies. Political discussion in Japan during the 1990s focussed on the main issues confronting Japan's post-war innovation system. One important issue was how to overcome the economic recession that Japan had been confronting since the late 1980s; another important issue was how to develop scientific capacity to weaken the oft-levied accusation of 'free riding on scientific breakthroughs elsewhere' (Woolgar, 2005). A further element which influenced Japanese policy discussion, and which is closely related to the first two, is the international trend of S&T policy over the last decades.

Most OECD and EU countries aim at increasing competitiveness through innovation in the knowledge economy (OECD, 1996; CEC, 2000). Governments throughout the industrialised countries have launched numerous initiatives to link university research to industrial innovation more closely. It is now pointed out, however, that policymakers have overstated the degree to which universities can drive the regional and national economies (Florida, 1999). This paper illustrates the changes in the Japanese national innovation system and examines the impacts of recent policies aimed at promoting academic entrepreneurship. This paper highlights diverse and changing features in the innovation and

* This paper was prepared while the author participated in the European Forum 'The role of universities in the innovation systems', at the European University Institute, Florence, Italy. The author acknowledges the support of the European Forum and Hitotsubashi University during this period. I would like express my thanks for helpful comments received from the Forum participants on earlier versions of this paper.

S&T systems in the US and Europe, and draws some lessons relevant to Japanese policy contexts in terms of international ‘policy borrowing’ and ‘emulation’ (see Stone, 2001), which sometime reflect policymakers’ different ‘perceptions’ and even ‘misinterpretation’ of the political economy in which innovation systems are embedded (for example, see Dosi et al., 2004).

The broad analytical question to be investigated in this paper is as follows: Will the emphasis on academic entrepreneurship and the adoption of a US style legal framework for university-industry technology transfer benefit Japanese industry and Japan’s worldwide contribution to technical and social progress? By drawing on the recent experiences of Japan, this paper makes two particular contributions in terms of comparative public policy analysis and institutional analysis. The first contribution is related to the discussion about international policy convergence and processes of policy learning. The second area to which this paper seeks to make a contribution is to provide an insight into the institutional transformation of universities in Japan in response to the top-down triple helix interaction.

In Japan during the 1980s, local economic development was promoted under the Technopolis Programme by creating linkages between universities and local industry. More recently, efforts have been made to improve university-industry links focusing on the codification of property rights modelled on a US law, the Bayh Dole Act of 1980, that is widely credited with improving university-industry collaboration and technology transfer in the US national innovation system (Mowery and Sampat, 2005). This paper highlights the present disconnection between legal, institutional and cultural changes taking place within the academic system, and points to the roles played by new actors who are transforming the nature of the national innovation system. The current Japanese government’s initiatives, with national industrial and science & technology (S&T) policies centred on strengthening university-business links, are critically examined in light of the development of new Industry-Science Relationships (ISRs). The question is then asked of whether such re-positioning of universities as part of the new national ISRs leads to the emergence of a new national innovation system, creating ‘constructed advantage’ (Foray and Freeman, 1993; Cooke; 2004) as part of the globalising knowledge economy.

The paper is organised in the following structure. Part II highlights international policy and conceptual exchanges occurring in the last decades in the areas of innovation and competitiveness policies between Japan, the US and Europe. It illustrates policy convergence as well as divergence in this process. Part III turns to examine the processes of re-positioning universities in the national innovation system in Japan. It examines the institutional contexts of the Japanese national innovation system, highlighting the recent challenges and the development of ‘triple helix interaction’ as promoted by the government. In Part IV, set against the current changes in Japanese innovation system dynamics, the current policy reform direction is critically examined, and future opportunities and constraints for universities that may present themselves from the current structural change of national innovation policies are identified. The paper concludes by assessing the fundamental public and private nature of the national innovation system, and the roles of universities in it.

II. The Role of Universities in the Innovation Systems – An International Perspective

A. The European Perception

In the recent policy environment of the European Union, a prime policy objective revolves around the ‘competitiveness of Europe versus the rest of the world’ view (Lawton Smith, 2003). This is because in numerous analyses of the EU’s weakness vis-à-vis its competitors, particularly the US and Japan, innovation has been highlighted as a crucial deficit in business competitiveness (CEC, 1995). The pledge by the EU heads of state meeting in Lisbon in March 2000 to make Europe ‘the most

competitive and dynamic knowledge-based economy in the world’ was the goal to catch up to the US in terms of R&D, business environment and financial markets, albeit with greater inclusion (CEC, 2000b).¹

The 2004 European Innovation Scoreboard (EIS), released in November by the European Commission, found that the US and Japan remain ‘far ahead’ of EU nations in the area of innovation. The report said that the level of EU innovation has remained relatively constant since 1996, while innovation performance in the US and Japan has continued to improve, widening what it called the ‘innovation gap’ between the US and the EU. The report traced this gap primarily to significant differences between the US and EU in a handful of key areas, including patents, the education level of the working population, business expenditures on R&D, high-tech manufacturing, and early-stage venture capital.² The role of universities in knowledge transfer has been raised by the European Commission in a recent Communication *The Role of the Universities in the Europe of Knowledge* (CEC, 2003).

Public research systems in the US and Europe are often compared with respect to their divergent levels of involvement in the private economy. The US research system, with its mix of both public and private institutions, has long played a significant role in conducting research that contributes to technological development and industrial performance, whereas in Europe universities were traditionally believed to contribute more to knowledge for its own sake and to the preservation of distinctive national cultures (Riccaboni et al., 2003). Public-private collaboration in Europe lagged behind partly due to legal prohibitions in some countries against faculty collaboration with commercial entities, and cultural predispositions against academic involvement with commerce. Since the late 1980s however, European attention has shifted to technology policy and academic technology transfer. Arguably, much of the recent policy shift in Europe has been driven by the ‘perception’ of a swing of the US policy towards market-based rather than public supported incentives for science and technology (Conceicao, et al., 2004). This perception, underlined by the strong economic performance of the US throughout the 1990s, seems to have been strengthened by a rather *selective* process of ‘policy emulation’ from the US.

Authors give cautious notes pointing out that replicating the US policy in different national and economic contexts can not only be misguided but even ineffective and possibly harmful, especially for European universities. It is important to be reminded that the US ‘has not compromised public support’ to basic research and to university-based research by the public sector through diversified funding mechanisms (Conceicao, et al., 2004), whereas private revenues linked with R&D results are recently getting increasingly important sources for university income. Furthermore, authors point out that the so-called ‘European paradox’ contending that EU countries play a leading role in terms of top-level scientific output but lag behind in innovation, is based on questionable assumptions about the relationship between science and technology, and is indeed misleading policies about basic research (Dosi et al., 2004).

1 In January 2000, the European Commission adopted the Communication *Towards a European Research Area*, which is meant to contribute to the creation of better overall framework conditions for research in Europe. In the recent European policy context, a connection has been forged between the three concepts of a *European Higher Education Area*, a *European Research Area*, and the *Europe of Knowledge*. The European Research Area concept implies that efforts should be deployed effectively at different administrative and organisational layers - European, national, regional and local levels - and by re-examining the role of public and private actors.

2 The report analysed innovation indicators and trends for all 25 E.U. member states as well as Bulgaria, Romania, Turkey, Iceland, Norway, Switzerland, the U.S., and Japan. The EIS ranked the countries in 20 categories and combined those rankings into a composite indicator, offering an overview of relative national innovation performances. Japan ranked first with a relative innovation score of 0.77, followed by Sweden (0.76) and Finland (0.75). The U.S. placed fourth, with a score of 0.70, compared to an average score of 0.44 among all E.U. member states.

B. US-Japan Perceptions

Invariably, the standard of comparison for Japanese innovation policy is the US. The tremendous expectations placed upon the university sector in Japan since the 1990s come directly from the perception that universities in the US have played a major role in building the strong American economy. The US represents a reasonable benchmark for Japan, considering that American universities and industry are at the forefront of many areas of research and innovation, and that due to historical circumstances Japanese universities have been strongly influenced by the US. In particular, as Japan re-developed after the devastation of the Second World War, much of this development drive focused on ‘catching up’ with the West in general, and the US in particular (Pechter, 2001).

Since the 1970s, the American view has been that there is a serious ‘asymmetry’ between the American and Japanese national systems for research. Kodama and Branscomb (1999) describe the ‘oversimplified views’ from the US perspective as follows: in the US, much of the forefront high technology research takes place in association with open research at universities and is published in widely read journals; US policy makers see the Japanese system as driven by a set of very large firms, which do not offer public access to their intellectual assets; The Japanese universities are isolated from industry, are bureaucratic and are far behind the best of their Western counterparts. Knowledge goes from US universities to Japanese industry without a comparable flow in the other direction. In particular, a deep concern with the stagnation of the US economy vis-à-vis that of Japan during the 1980s, and the conviction that economic competitiveness would require greater utilisation of research in industry, especially university-based research, strengthened such a view.

This perception has been reflected in US-Japan relations since 1985 when it was extensively discussed in bilateral meetings of prominent scientists and engineers from both countries (Kodama and Branscomb, 1999). It has led American policy makers to create a demand for ‘symmetrical access’ to the fruits of Japanese research. These different historical trajectories and resulting disparate policy frameworks in the US and Japan are said to have posed barriers to mutual learning in the economic policy formulation process (Pechter, 2001).

C. The US Model

If the US system is to be taken as a reference, it is necessary to understand its history, policy and institutional diversity and mix set of public and private incentives. The US model of university-industry technology transfer is based on the model of knowledge transfer from the so called ‘research universities’. The awareness of the importance and commitment of universities in the innovation process emerged from the recognition that universities support innovation in industry primarily through the production of knowledge and training of human capital. University involvement in technology transfer has become one of the most significant trends in higher education in the US. A series of federal statutes, including Bayh-Dole, the Stevenson-Wydler Act of 1980, the Technology Transfer Act of 1986, and others have made it much easier for federal laboratories and universities to patent the results of federally funded research and license these patents to industrial partners.

The US research university system, as exemplified by the Massachusetts Institute of Technology (MIT) and Stanford, is taken as ‘a role model’ for its responsiveness to economic change and contribution to the creation of wealth by governments elsewhere in the world. In 1992, Frank Press, then president of the National Academy of Sciences, argued that the future key to economic competitiveness for the US would be what he called ‘research-based technologies’ such as biotechnology and information sciences. In 2000, the National Governor’s Association published a number of reports emphasising the economic relevance of research capacities at US universities (Geiger, 2005). The argument goes that innovations are built upon basic science and previous innovations, which have had to be supported by institutions such as the US modern research university on which both private and public R&D and people training depends (Conceicao et al., 2004).

The key element of the US history is that of diversity of policies and increasing ‘institutional specialization’, as well as the clarification of the unique roles of private and public incentives to supporting S&T (Conceicao et al., 2004). On the one hand, the US is known to have the highest business expenditures on R&D among OECD countries. The US innovation system is known to have relied heavily on a high level of private R&D funding and performance, but also on a set of private incentives, venture capital funds for high-tech sectors. The US research universities are characterised as having high levels of industry-science relationships associated with private funding and incentives, such as IPRs, contributing to direct and big economic impacts.

On the other hand, public financing is still the main source in the US innovation and S&T systems. The US higher education system diversity is maintained by a broad set of federal R&D funding agencies, which enables universities to specialise their R&D towards certain agencies (Conceicao et al., 2004; Geiger, 2005). However, Mowery (1999) points out that industry's reliance on publicly funded R&D for long-term research and the increase in patenting and licensing by universities and federal laboratories may hinder long-term industrial development. ³

D. Global Convergence of Public Policies?

The global structures and financing systems of S&T and innovation activities are undergoing a profound change. In many countries policies attempting to stimulate patenting and licensing by universities and public research organisations have attracted much attention (OECD, 2002). It is generally accepted that an effective dissemination of knowledge between public knowledge institutions (such as universities) and the private sector depends on certain regulatory factors (e.g., intellectual property rights (IPR) policy in the public sector) and on the existence and efficacy of mediating institutions. Nevertheless, only a small fraction of the flow of knowledge from universities to industry is mediated by formal licensing agreements involving university-generated patents, while there are distinctive differences among sectors (Cohen et al., 2002). Indeed, university patenting and exclusivity in exploitation of research results are complicated and controversial issues, especially in relation to the principle of free dissemination of publicly funded research. This may also exacerbate differences across universities in terms of financial and research outcomes, and may damage the education mission of universities.

As Rosenberg (2000) argues:

Universities throughout the OECD are becoming the centres for research activities that are now producing new knowledge of great commercial value. This trend is heavily underlined by the current American experience with biotechnology. In this context, a key political issue for the future is how to create a university/industry interface that will provide the financial rewards necessary for high risk-taking in the commercialization of new knowledge while at the same time, preserving the intellectual integrity and autonomy of the university research community that is the source of so much of this knowledge.

Furthermore, university-business links are only *partly* responsible for spurring an acceleration of innovation; benefits that can be expected from university-business cooperation are rather small and of varying effects, depending on the sector in question. Spin-offs are one way of transferring technology from university to industry, but this transfer mechanism is far from being universally successful (Niosi, 2004). The widely observed recent policy direction to promote these entrepreneurial activities by setting up formal mechanisms through ‘international emulation of the Bayh-Dole Act’ (Mowery and Sampat, 2005), may need to be tempered with more realistic expectations. The following part examines these issues in the specific national policy and institutional context of Japan.

³ For example, the science performed in US universities, much of which was funded by the National Institutes of Health (NIH) during the post war period, has aided the US pharmaceuticals industry's innovative performance. If new federal policies limit the dissemination of research results, however, the industry's long-term performance could be impaired.

III. The Role of Universities in the Innovation System – A View from Japan

A. The Japanese Innovation System – Historical Overview

Japan is known to have developed broad national technology strategies with long-term scientific and technological goals. This is reflected in the characterisation of the Japanese innovation system as resulting from ‘technonationalist policies’ (Fransman, 1999; Ostry and Nelson, 1995). The concept of ‘national innovation systems’ (NIS)⁴ was originally developed by Chris Freeman to explain the post second-world war success of the Japanese in terms of economic development and industrial innovation. Freeman (1988) outlined the importance of the major factors within the Japanese society which contributed to its economic and technological ‘miracle’ in the 1970s and 1980s: central government (mainly MITI), large firms (*Keiretsu* relationships), and social and educational institutions. R&D in Japan is carried out in five different categories of institutions. These are: the university system, which consists of national, local government and private institutions; government research institutes, which exist at both national and local levels; public corporations; non-profit foundations; and company R&D laboratories, the latter including development activities in companies, central research laboratories and basic research laboratories (Sigurdson, 1995).⁵

Japan’s national innovation system during the half century following the Second World War was characterised by a rapid intensification of activity in innovation, such as increased R&D expenditure and technology importation, and the increased influence of industries in R&D investment in comparison to the US and Europe (Odagiri, 2004a). During the 1950s and 1960s, under strict government regulations, Japan was an active importer of technologies from abroad. During this high-growth period, many new firms entered the markets with innovative products and processes. The availability of a large number of good-quality professional engineers, not only in R&D but in production engineering and management also, played a vital part in the Japanese industrial success (Freeman, 1988).⁶ Domestic R&D expenditures increased at a rapid annual rate of 16.9 per cent between 1952 and 1971. Consequently, the weight of R&D shifted gradually from improvement of imported technologies to domestic inventions.⁷ As Japan’s industries achieved world class status in the 1980s, government policy began to shift towards a focus on the earlier phases of R&D. Now technology export exceeds import in many industries, suggesting that Japan is now at the forefront of global high tech competition (Odagiri, 2004a).

Table 1 Japan’s domestic R&D expenditures as a percentage to GNP

Year	1955	1961	1980	1998
Percentage	0.84	1.73	2.14	3.26

Source: Odagiri, 2004a.

4 The following working definitions of NIS can be used: National system of innovation consists of ‘the national institutions, their incentives structures and their competences, that determine the rate and direction of technological learning (or the volume and composition of change-generating activities) in a country’. (Patel and Pavitt, 1994)

5 In 2001, based on the 1998 Administrative Reform Basic Law, a number of public corporations and public research institutes were transferred from government control and became Independent Administrative Institutions (IAIs). In 2004, 89 national universities attained ‘incorporated’ status and are known as National University Corporations (NUCs).

6 This success was also based on a high level of *general* education and other forms of social innovation (Freeman, 1988).

7 The number of patent applications to the Japan Patent Office (JPO) increased at an annual rate of 9 percent from 1971 to 1987.

During the 1980s, new forms of research organisations and financing systems were established which cut across ministerial and agency borders and increased the mobility of researchers.⁸ These included, in the government sector, programmes such as the Future Generation Basic Technologies, The Fifth Generation Computer Project and the Exploratory Research on Advanced Technologies (ERATO).⁹ An extensive network of relations has existed in almost all major research projects or programmes as these usually involve major companies, government research institutes and universities, or university professors in their ‘private capacity’ (Sigurdson, 1995, p.4). During the 1980s, the Japanese government initiated two ‘top-down’ international research programmes with European countries -HFSP (the Human Frontiers Science Programme) and IMS (Intelligent Manufacturing Systems) contributing disproportionate unilateral investment to the international scientific communities. These programmes were initiated by the Japanese Government to counter perceptions that Japanese industry was gaining ‘unfair’ commercial advantage by using the results of the investment by other countries in fundamental scientific research at a time when Japanese industry dominated world markets for manufactured products.¹⁰

In terms of R&D/GNP ratio, Japan (at 3.09 percent as of 2001, with the OECD average being 2.3 per cent) is ahead of any other major countries except Sweden and Finland (OECD, 2003). As far as the research budgets are concerned, Japan is seen to be giving strong support to the ‘private’ science of company laboratories, and much weaker encouragement to academic science, as practised in the academic sector of universities and affiliated institutes (Nakayama and Law, 1997). Regarding sources of R&D funding in Japan, 78 percent comes from the private sector, 21.7 percent from government and 0.3 percent from foreign sources. (OECD 2002). Of total R&D expenditure during the 1990s, approximately two thirds was attributable to industries. In terms of R&D performed by the public sector, universities play the primary role while government-sponsored R&D in the academic sector has been relatively impoverished.

The low proportion of R&D expenditure devoted to basic research in Japan has been attributed to the low share of government R&D expenditure, as well as the lower share of basic research conducted at universities compared with other industrialised economies. A large dispersion of the rate of government funding to R&D has been noted among OECD countries, with Japan being considered as one of the ‘countries with a low share of government funding and performance’ (OECD, 2002).¹¹ The government has supported industrial R&D through tax concessions and subsidy programmes but the amount has been small. The shortage of PhD level engineers and the relative weakness of Japanese academic science seem to have inhibited the effectiveness of more technologically ambitious R&D in Japan. In Japanese industrial R&D, an important role has thus been played by large firms both in terms of R&D input and output (Odagiri, 2004a).

Although in the late 1990s Japan continues to be amongst the world leaders, evidence of a slowdown in the growth of R&D productivity in Japan in the 1990s has been provided by a number of

8 The Ministry of International Trade and Industry (MITI) was mostly responsible for policies relating to the manufacturing sector, and financially supported a number of R&D projects. For Japanese research consortia, see Branstter and Sakakibara, 2002; Hayashi, 2003; Hane, 1992.

9 Research collaboration was cited by US and European policy makers during the 1970s and 1980s as a key policy underpinning Japan’s rapid technological advance. Both the EU and the US implemented policies and programmes to encourage such research collaboration during the 1980s. One exemplar of such programmes is SEMANTECH R&D consortium, established in the US in 1987 with public and private funding.

10 By the time that HFSP and IMS had been established and were making an impact however, Japanese industry was no longer dominant: in other words, the foreign policy motivation for these programmes had disappeared (de Miranda et al., 2004).

11 Japanese government funding for General Expenditure on R&D (GERD) has been recently increasing from 18.2 to 19.6 percent between 1991 and 2001, while in other countries the figures are higher but the tendency is towards an overall decrease: from 49.0 to 38.7 percent in France, from 35.7 to 31.5 percent in Germany, from 35.0 to 30.2 percent in the UK, and from 38.9 to 26.9 percent in the USA (Angelino and Collier, 2004).

observers. Recent interviews conducted with Japanese R&D managers indicate the following trends of R&D activities in Japan (Branstetter and Nakamura, 2002):

1. greater reliance on R&D partnerships *outside* the traditional vertical *keiretsu* networks within Japan,
2. greater reliance on foreign (especially U.S.) R&D partnerships and acquisitions of high-tech firms,
3. greater emphasis on cooperation with universities, at home and abroad,
4. decreasing emphasis on centralized 'in-house' R&D, and a gradual downsizing of resources invested in central R&D facilities, and
5. increased interest and investment in 'corporate venturing' programs.

In short, throughout the 1990s, both the influence of technonationalist policies through the MITI and the dominance of large firms through *Keiretsu* have been in decline, posing a big challenge to the Japanese innovation system. There is also a widespread sense among Japanese R&D managers, industry observers, and government officials that the Japanese approach to technological innovation is no longer working effectively, and fundamental reform of the national innovation system must take place.

B. Governance of University-Industry Links – Historical Overview

After two decades of stagnated economic recession, the Japanese government is now looking into new innovation policies which promote technological innovation and try to mobilise universities as key actors in the innovation processes, both at national and local levels (Kitagawa, 2005). Recent university reforms since the beginning of 1990s have been part of the wider transformation of Japanese research and innovation systems. Reform issues have centred round changing the legal governance structure of national universities into 'incorporated' status, so that they can have increased independence to become more entrepreneurial, promoting institutional diversification and efficiency. With continuing fiscal pressure in the public sector, higher education institutions (HEIs)¹² are required to undergo further 'downsizing' and display greater 'efficiency'. The recent policy emphasis on 'triple helix interaction' between university-industry-government needs is best understood with the aid of a sufficiently historical perspective. University-industry collaboration in Japan is by no means only a recent phenomenon. Universities have played various important roles in Japan's industrial and technological development since the mid-19th century in various forms (Odagiri, 1999; see also Hicks, 1993 for discussion).

Prevailing global perceptions have held that Japanese universities are inferior to their Western counterparts in terms of research, just as most advanced research in Japan is widely believed to occur not in universities, but in the research laboratories of the leading private firms (Fransman, 1999). Some authors have attributed low quality of university research to the restrictive organisation of universities and their chronically low level of funding along with restrictive government regulations governing university-industry interaction. However, such interpretations warrant closer investigation bearing in mind institutional differences in different national contexts, and in relation to the recent policy assumptions behind university reforms and institutional changes that have occurred in Japan.

So far the role played by universities in the Japanese national innovation system has been a matter for speculation. The nature of government support to Japanese universities is more similar to European university systems than American ones. In the American system, core funding plays a much smaller role than it does in German or British universities. In the post-war decades,¹³ university-industry cooperation occurred, but was largely informal and consultative, based on networks of human relations (Hicks, 1993). In a labour market that was short of skilled labour, ties to university professors

12 HEIs in Japan include universities, junior colleges, colleges of technology, and special training schools. In this chapter, in terms of research activities, the term 'university' is considered as loosely synonymous with HEI unless otherwise stated.

13 Anti-war, anti-industry movement during the 1960s hindered the development of formal university-industry links as academics were not enthusiastic about engaging in industrial collaboration.

were very important to firms for success in recruiting. In exchange for access to students, industry contributed human and physical resources to the university laboratory (Hane, 1999). The old system of university-industry cooperation seems to have fitted well within a national innovation system where innovation occurred primarily in the in-house laboratories of large firms. In 1977 however, the need for an enhanced role of the universities in the economy was highlighted in a report published by the Council for Science and Technology Policy (CSTP), entitled *The Basic Principle of an Overall Science and Technology Policy from a Long-term View* (CSTP, 1977).

Since the 1980s, university funding in Japan has grown very little while Grants in Aid for Scientific Research have increased.¹⁴ Universities faced severe financial tightening with no budget increases. In terms of finance structure, ‘outside funds’ such as donations from private businesses and research contract revenues began to increase in the early 1980s induced by institutions’ need to offset lagging government contributions, and due to government policies promoting industry-university collaboration (Asonuma, 2002). However, the share of business funding in higher education research in Japan is less than half of the OECD average. This figure was 1.5 per cent in 1985, and has hovered at 2.3 per cent since 1990. Table 2 below shows the percentage of business funding in research performed by the government and university sector in the UK, Japan, and the US against the OECD average as of 1999.

Table 2 Comparing UK, Japan, US and OECD average percentages of business funding in research in 1999.

Sector	Japan	UK	US	OECD average
Government	1.8	21.1	0.0	4.1
HE	2.3	7.2	6.3	6.1

Source: OECD, 2001

Since the 1980s, large firms started to outsource their R&D functions to reduce costs, and in fact, many Japanese large firms are said to have conducted R&D in collaboration with universities overseas rather than with those in Japan.¹⁵ The American National Science Foundation (NSF) reported: ‘a MITI official estimated that Japanese industry in 1983 spent twice as much for research at universities outside Japan as it did at universities in Japan’ (as cited from Hicks, 1993). Although the specific expenditure figures obtained by NSF were of dubious quality, Japanese universities generally have ‘a reputation for low quality research’ (Hicks, 1993), and this would seem to make them unattractive research partners for companies. The share of universities in total patents in Japan is less than 0.1 percent which compares to about 3 percent for US universities (OECD, 2002). These trends might confirm that Japanese research and innovation systems have been principally led by private companies while the public sciences in Japan have been impoverished in terms of financial and human resources and its outcomes.

Restrictive government regulations are said to have caused low levels of university-industry collaboration in Japan. However, the situation had been changing since the 1980s. In 1983 the Ministry relaxed its rules and created four mechanisms through which national university faculty could cooperate with industry. These are namely joint research, contract research, secondment of

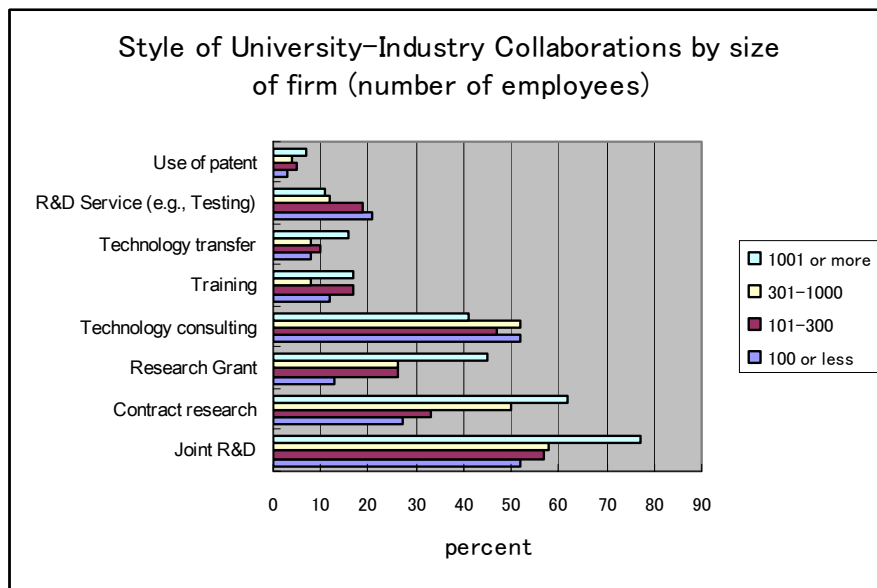
14 This trend was similar in the UK. Core funding (general university funds) in the UK decreased from 80 percent of academic research funding in 1975 to 72 percent in 1987, and in Japan decreased from 77 percent in 1975 to 74 per cent in 1987 (Hicks, 1993).

15 For example, the Hitachi Cambridge Laboratory (HCL) was established in 1989 as an ‘embedded laboratory’ in the Cavendish Laboratory, Cambridge University. In the early 1990s, many major export-oriented companies indicated a desire to engage heavily in overseas R&D, but claim that the ongoing economic recession, a weak yen and resulting low profit levels have forced them to downscale their plans for globalising R&D.

industrial researchers to the university, and donations. A recent survey conducted by RIETI¹⁶ gives an overview of R&D collaboration between firms and universities (RIETI, 2003; see also Motohashi, 2005). Although Japan's national innovation system is characterised by a focus on in-house R&D conducted mainly by large firms, the survey results show that external collaboration in R&D efforts is becoming fairly widespread with firms of different sizes. One of the most common routes of the information flow from academic research to industrial innovation is through the publication of papers. However, university-industry links take a variety of forms such as joint research, consultation, commissioned research as well as licensing and spin-out. Figure 1 shows the style of university-industry collaboration by size of firms.

Figure 1

(adapted from Motohashi 2005)



Large firms primarily use such collaborations with universities for joint research projects aimed at strengthening their in-house technological capabilities and achieving long-term benefits, while a higher percentage of small and medium enterprises (SMEs) use technical consulting and take part in joint R&D targeting projects closer to the final product stage (Motohashi, 2005). The technology-based, R&D focused SMEs can tap into external R&D alliances such as university-industry collaboration (Motohashi, 2004). These firms are expected to link knowledge 'exploration' and 'exploitation' systems (Cooke, 2004), thus promoting the processes of innovation in the knowledge-based economy.

C. Changing S&T Policies and New Regulatory Forms- Post 1995

In 1995, with the passing of the Science and Technology Basic Law by the Japanese parliament, the first Science and Technology Basic Plan (1996-2000) was formed, which emphasises the increase in Science and Technology budget and enforced links between universities and industry. Consequently, the Japanese research system in general has undergone rapid transformation. To succinctly illustrate the Japanese policy contexts, Box 1 presents the principle legal frameworks underlining new industry-science relationships in Japan since the mid 1990s. Between FY 2001-5, 24 trillion yen are to be spent on science and technology, assuming 1 percent of GDP and 3.5 percent of the nominal GDP rate.

¹⁶ The survey was conducted in February 2003 for information for the FY2002.

Box 1: Japanese legal-institutional frameworks promoting industry-science relationships

1995 The Science and Technology Basic Law
 1996 The First Science and Technology Basic Plan (1996-2000)
 1998 The Law on Promoting Technology Transfer from Universities to Industry (TLO Law)
 1998 The Administrative Basic Law
 1999 The Law on Facilitating the Creation of New Business
 2000 The Law to Strengthen Industrial technology
 2001 The Second Science and Technology Basic Plan (2001-2005)
 2001 General Council for Science and Technology Policy (GCST)
 2001 Hiranuma Plan, aimed at increasing 'venture businesses born in universities'
 2002 Basic Law on Intellectual Property
 2004 Incorporation of National Universities
 2006 The Third Science and Technology Basic Plan (2006-2010)

After the 1995 Basic Law, recent university reforms were accelerated to encourage further development of university-industry links which was hitherto legally and structurally constrained in Japan. The so-called Japanese Bayh Dole Law, a legal framework to promote university-industry technology transfer was enacted in 1998, and 27 Technology Licensing Organisations (TLOs) have been established as of April 2002. Some TLOs form private companies limited and some form incorporated foundations. The TLOs are separate organisations from the national universities in the legal sense. MEXT has created a budgeting scheme whereby national universities promoting university-industry co-operation and patenting can be allocated additional funds (OECD, 2003).¹⁷ To further open the university system to society, in 2000 a law prohibiting the exchange of personnel between universities and industry was amended, which facilitated national university faculty members' research or work as consultants with private companies.

Since the late 1990s, with the decline of demand to existing industries, intensifying technological competition on a global scale especially from neighbouring Asian countries,¹⁸ and the rapid progress of scientific knowledge, Japan now aims at advancing *science-based industries*. Science-based industries (SBIs) are the industries in which the development is pursued by means of innovation based on sciences. This is based on the recognition that scientific advance has been playing a pivotal role in the emergence of new SBIs as such as those based on biotechnology,¹⁹ nanotechnology and information technology (IT). Recent policies inducing regional industrial agglomeration to raise industrial competitiveness (e.g. cluster strategies) have emerged in such a political-economy. In 2001, based on the recommendation of the CSTP, the government initiated the Second Science and Technology Basic Plan, in which four areas were given strategic priorities as new Science-Based Industries (SBIs). These are namely the life sciences; information and telecommunication; the environmental sciences, and nanotechnology and materials. The new General Council for Science and Technology (GCST) was established, replacing the CSTP.²⁰

The number of filed patent application, patent grants, and licensing and option contracts all grew as a result of these government efforts (see Figure 2(a) below). Furthermore, since 2003, 43 universities have received financial support from the government to set up 'Headquarters for Strategic IP Management' so that each institution can deliver its own policy for income generation based on their IPRs. In practice, many institutions have difficulties in setting appropriate mechanisms linking university departments, TLOs and such new IP offices, and also in attracting human resources (e.g.

17 Organisations such as the Japan Science and Technology Corporation (JST) have started sponsoring programmes aimed at national universities and national laboratories, to encourage the development of research into marketable products, with university administrators acting as liaison between the faculty members and JST.

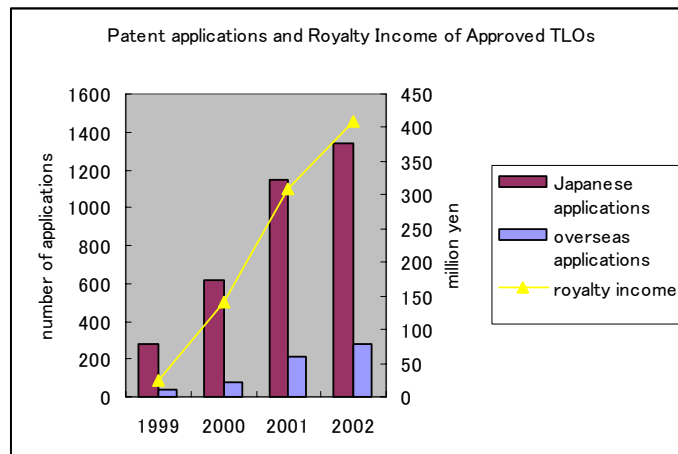
18 The policy emphasis shifted to revitalising the industry in order to overcome the 'hollowing out' of the manufacturing base caused by the shift of production from domestic sites to overseas nations, primarily located in China and other Asian countries.

19 Pharmaceuticals is a good example of SBIs related to biotechnology.

20 Both CSTP and GCST are attached to the Cabinet Office.

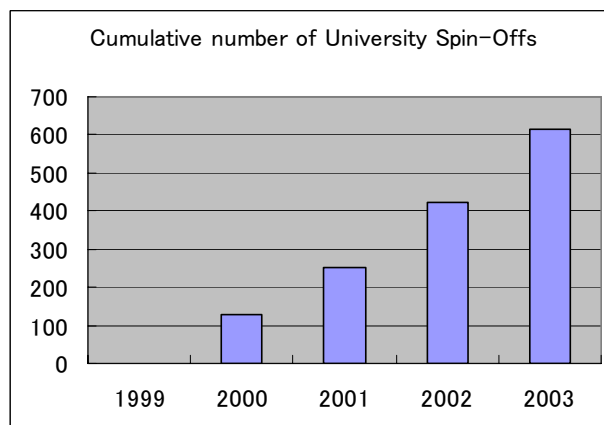
academics with industrial experiences, IP managers, industrial liaison officers). The government has been supporting new spin-off company creation from universities by de-regulation and by providing subsidies to R&D activities. In 2001, the *Hiranuma Plan* was launched, aimed at increasing ‘venture businesses born in universities’, targeting to ‘create 1000 within 3 years’. In the data provided by MEXT, as of 2000 there were 127 new enterprises spun-off from universities, which compares to 368 in the US in 2000 and approximately 200 in the UK. In 2001, 251 and in 2002, 424 small business companies were created from universities in Japan. As of 2003, the total number of spin-off firms from universities in Japan reached 614. See Figure 2(b) and 2(c). Figures 2(a), 2(b), and 2(c) adapted from Kneller, 2004.

Figure 2(a)



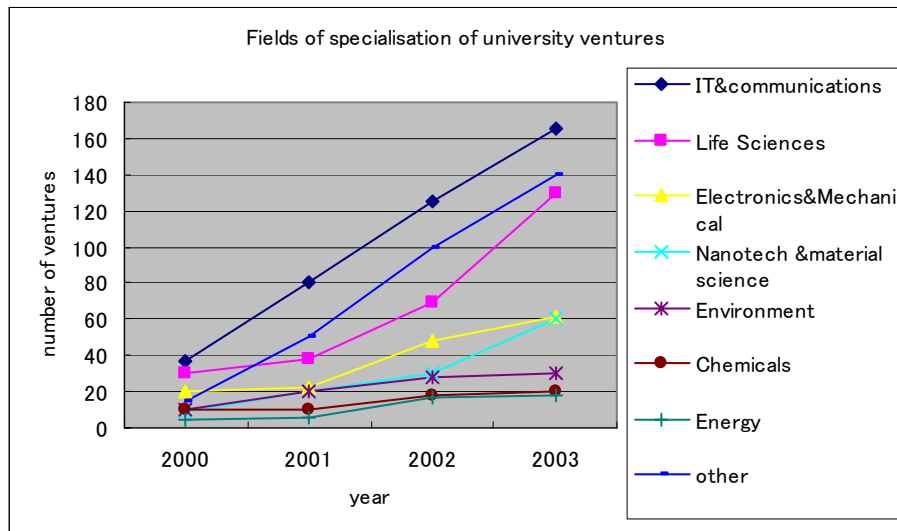
Source: METI (adapted from Kneller, 2004)

Figure 2(b)



Source: Tsukuba University Survey 2003 (adapted from Kneller, 2004)

Figure 2(c)



Source: 2003 Tsukuba University Survey (adapted from Kneller, 2004)

Kneller (in Estkovitz et al., 2005) points out that many of the university start-ups are virtual companies with low invested capital, sales and numbers of employees. However, some of these start ups draw on the research of major university laboratories and networks of researchers that span several universities. Some of the most successful start-ups, in terms of market capitalisation following initial public offerings (IPOs), owe their success largely to the laboratories from which they arose and to the researchers in those university laboratories.

D. Incorporatisation and the New Roles of Universities in the National Innovation System – Post 2004

In May 2001, METI proposed a drastic plan for reforming universities as part of national industrial policy. In June 2001, *Basic Principles for Structural Reform on Universities*, known as the *Toyama Plan*, was released by MEXT, in which the direction of further university reforms was delineated.²¹ The Incorporatisation Law was passed through the House of Representatives and enacted in October 2003, with incorporatisation occurring in April 2004. Consequently, three main changes were made to the structure and management of national universities. Firstly, the responsibility of recruiting university staff was transferred from the government to the 89 newly-established National University Corporations (NUCs). Secondly, assets and financial obligations, were transferred to NUCs. Thirdly, the presidents of NUCs assumed responsibility as the head of corporate bodies with new management structures such as executive boards, academic senates and administrative councils. Along with the 89 NUCs, there are 77 public (i.e., owned by prefect and municipal governments) and about 480 private universities in Japan. Furthermore, in 2004, as part of the de-regulation policy, MEXT approved the establishment of universities owned by stock companies.

Since their incorporatisation, NUCs are obliged to formulate 6 year mid-term plans and objectives, the implementation of which is assessed annually. The overall budget allocated from MEXT will be based on the results of these assessments. NUCs receive two types of grants from the national

²¹ Three major changes were proposed: firstly, the reorganisation of national universities including the merger of some institutions; secondly, the introduction of putative business methods to national universities through a process of incorporatisation; and thirdly, the introduction of competitive mechanisms into the university sector, including national, public and private universities (Yamamoto, 2004).

government: grants for operating costs and subsidies for capital expenditures, and have full discretion to use the grant, while the flexibility of the capital subsidy is constrained. NUCs are able to engage in long-term borrowing (Yamamoto, 2004). The government has announced that operating grants will be reduced by 1 percent each year for all NUCs. Each institution is expected to develop supplementary income sources which may or may not include increases in tuition fees, competitive research funding and income from industry. The universities are under obvious pressure to develop more efficient financial management techniques to cope with the incorporation.

Growing 'triple helix' university-industry-government links are reflected in the current composition of governance bodies of NUCs. Each university has a management council responsible for deciding administrative policy, and an education and research council in charge of overseeing academic activities. Management councils have jurisdiction over personnel and accounting policies, comprising the key pillar of the universities' management organs. More than half the members of management councils are legally required to come from outside the university sector, and most universities have placed between 5 and 12 non-academic personnel on their councils, many of whom are from business sector, former officials from private universities and former government ministers (*The Yomiuri Shinbun*, 27 March 2004).

As a corporate body, universities can now own and manage their intellectual property rights (IPRs). As of 2004, ownership and transfer of discoveries in most Japanese universities is 'nearly identical to the US Bayh-Dole system' (Etzkowitz et al., 2004). This is an example of 'international emulation of the Bayh-Dole Act' (Mowery and Sampat, 2005). Although there has been public funding for TLO activities, this is in decline. University staff have voluntarily made financial investment in TLOs, but after April 2004, universities are allowed to invest in TLOs directly as organisations.

IV. Discussions – Projections Towards the Future

A. *The Extent of the US Influence and Rationales for the Reforms*

Japan has had a long tradition of industry-academia cooperation under its national innovation system and this has made its own achievements, even though many of the linkages have been 'invisible and non-contracting ones'. The real issue is not the lack of interaction between the university and industry but what is done with such interaction. Recently, Japan seems to have taken the 'US model' with particular emphasis on licensing and start-ups from universities for economic growth while this process is often seen as 'formalisation' of existing linkages between university faculties and industry. A senior official of the METI remarked (as cited in *The Japan Times*, 27 December 2001):

What we intend to do is expand the current cooperative system (that usually exists between individual professors and businesses) into one between a university and a company on the organisational level.

Under the recent 'incorporation' national universities, efforts to come to terms with economic relevance have spurred a quest to build organisational links between the scientific and commercial spheres of university activities.

The direction of current Japanese policy reform is based on assumptions that university-based market-oriented activity in the US has been a key factor in American economic growth over the past decade. However, there is no consensus in the Japanese policy discussion as to what in the US innovation system is really responsible for the current strength of the American economy, and specifically what role the US university system played in the US economic growth. Pechter (2001) argues that the particular direction of reform in Japan is perhaps 'unjustifiably towards the American university-industry policy framework'. University-based market-oriented activity in the US national innovation system emerged from circumstances markedly different from those in Japan. Pechter suggests that for Japanese policy makers, rather than making mostly bilateral comparison with the US,

multilateral national comparison may be equally important and perhaps even more relevant to Japan's policy formulation.

The notion of university-industry links needs to be reconsidered within a broader vision than that of the policy frameworks currently at work. Fundamental issues arise due to the ways in which different policy frameworks and 'institutions of innovation' are perceived. The policy and institutional environments for the national innovation system are different from those in the 1980s. It will not suffice only to expand the old system or to emulate parts of foreign systems. The future design of the national innovation system is critical. Not only the regulatory frameworks of IPRs, but also wider issues such as funding systems of university R&D, recruitment and promotion of university researchers, social attitudes towards entrepreneurship, corporate policies on outsourcing R&D, and mechanisms for supporting start-ups warrant closer investigation (see Etzkowitz et al., 2004).

B. S&T Policies, Funding and Transformation of Universities

From an institutional management point of view, a central concern for universities and their departments is where funding comes from, and what activities can and should be supported from existing budgets. A number of international studies have revealed how different micro-decisions and micro-incentives generate perceptible differences in institutional behaviour (see Geuna, 2001). The degree of autonomy allowed to individual universities is a critical factor in this process. The degree of national science research concentration and the patterns of research funding allocation have also had major impacts. All these factors are currently undergoing transformation in Japan.

Chronically low level of funding for basic research might mean that sufficient funds have not been available for university research in Japan, and might explain the low quality of research in general. However, the real picture is more complicated. Arguably, the Japanese university reform since the beginning of the 1990s has reinforced the differentiation between institutions. New types of budgetary funds and research funds established during the 1990s served to strengthen competition among national universities (Asonuma, 2002).²² The government is seeking to create 'world class universities' by creating a mechanism for differentiated financial allocation which is justifiable to both universities and society.²³ These recent provisions for funding research *excellence* may indicate a gradual, new polarisation between 'research intensive' versus 'less research intensive' universities in the Japanese higher education system, giving a greater advantage to older research-oriented universities. In terms of S&T budget increase, the 1995 Basic Law stated the expansion of various R&D funds. However, these are insufficiently implemented due to severe financial restraints. Only competitive funds have been significantly increased while fundamental funds such as unit R&D funds and those for equipment and facilities costs and maintenance have been cut off (Ohtawa, 1999).

Japan has been making conscious efforts to promote academic entrepreneurship in order to transform its innovation system to one which fits with the globalising knowledge economy. In terms of the development of new institutional mechanisms and intermediary organisations such as IPR policy, TLOs and IP Headquarters, and the recent legal reform of national universities which allows improved mobility between the public and private research sectors, the Japanese innovation system seems to have gone through 'top-down restructuring' (Etskowitz et al. , 2004). For universities, new institutional mechanisms such as TLOs and IP strategy offices will have to be strategically positioned within the overall structure, strategies and budgeting of each university. The responsibility of the TLO so far is exclusively concerned with the management of IPs, and the need for the extension of service coverage to such activities as a liaison function and supporting incubator facilities is seen as essential.

22 Competitive grant schemes targeted at younger and foreign researchers and short-term posts were introduced, including ERATO and the International Frontier Research system at the STA Institute of Physical and Chemical Research.

23 In 2001, MEXT introduced the idea of 'Top 30 universities towards global top standards', which was later to be renamed as 'Center of Excellence in the 21 century'(COE 21) scheme.

For the new NUCs, developing more flexible employment arrangements which allows university researchers to work for companies part-time and receive industry funds is one of the key strategies. The recruitment of specialists to support patenting, licensing, spinning off, and other triple helix interactions is also important.

In terms of university-business links, structural and cultural issues are brought to bear in relation to the current university reforms in Japan. Universities have become an integral and significant part of national/regional industrial and science strategies. The reforms may give more autonomy to universities with possible concentration of power to the presidents, opening up opportunities for some universities to engage in more entrepreneurial activities. Some universities are responding by internationalising their strategies, while others are regionalising some of their missions and diversifying their funding base. Some universities have created new incentive mechanisms for university researchers to conduct business oriented research. However, an emphasis on commercial orientation with a short timescale may only serve to hinder the overall research capability of a university if it is not integrated as part of the long- term strategic mechanisms of the whole institution.²⁴

C. Training and Human Resource Development Issues

One of the most important functions played by universities in the innovation and learning system in Japan is to provide graduates to enter the workforce. The shortage of Ph.D.-level engineers and the relative weakness of Japanese academic science would pose a fundamental problem for the Japanese innovation system to be competitive in the knowledge economy. Morgan (2003) observed high rates of returns for Japanese R&D investment in graduate students. A shift in the university system with more emphasis on 'quality and research at the graduate level' (Kodama and Branscomb, 1999) has been observed (see also Clark, 1995; Ushioji, 1997).

After the US, Japan has the second largest national S&T system in the world as measured by absolute R&D expenditures and number of researchers. This has been sustained from an indigenous supply of highly skilled scientists, engineers and technicians. However, with an aging population and shortages in areas such as software engineering, Japan is beginning to enact policies aimed at attracting highly skilled labour from abroad, particularly from India and China. Japan has more than doubled (37 in 1996 to 1225 in 2000) the number of post-doc places provided to foreign, mainly Asian scientists. Over half of all the foreign engineers in Japan come from China, which almost doubled between 1994 and 2001, followed by Korea and India (Wyckoff and Schaaper, 2005).

The expanding global market for highly-skilled labour, and newly emerging forms of circulation of knowledge pose several policy questions. A key pull factor for attracting the highly-skilled from abroad is world-class universities. Attracting foreign students requires the co-ordination of a wide range of sectoral policies, including accommodating immigration laws, developing a supportive social structure for the foreign students and providing financial aid. Most fundamentally, it is 'the quality of the education and research' that pulls in the top-students (Wyckoff and Schaaper, 2005). For Japan to fully exploit opportunities in the knowledge economy, focusing on global markets as well as increasing the indigenous supply of scientists by better connecting from the primary and secondary schooling to university education and PhD training is critical.

D. The Growth of Entrepreneurialism, New Science-Based Industries and Start-Ups

The increasing importance of Science Based Industries (SBIs), which possess strong linkages with scientific research activities as their main feature, reflects the increased contribution of academic research to industrial innovation. Targeting resources in strategic research areas exemplified by SBI

²⁴ In terms of possible evaluation criteria of the industrial competitiveness of university activities, discussions have only just begun (see METI 2003).

technology areas is imperative in terms of future national S&T policy direction. In terms of enhancing innovation processes, more research is needed regarding the roles played by the ‘new technology-based firms’ (NTBFs) in terms of stimulating R&D collaboration efforts with universities (see Audretsch, 1999; Motohashi, 2004). In order to develop such university-business collaboration into a robust system of innovation, a longer-term perspective should be taken, following the stages of development of firms, university research and the organisational capacity of other intermediary organisations. Critical questions exist as to the specific roles of universities in business support and providing ‘industry-specific public goods’ (Foray, 2003) in relation to other innovation support organisations. Industry-specific public goods (ISPG) include resources such as basic research, training programmes, technical services, certification and quality control facilities, generic advertising and commercial information. In the context of major technological transitions, the issue of providing the new ISPGs and developing appropriate mechanisms to support these become significant.²⁵

The changes in the Japanese legal system in order to encourage innovation and entrepreneurship over the last decade have been substantial, and seem to be leading to a new entrepreneurial culture at universities (Etzkowitz et al., 2004). The rise of start-ups raises a bigger societal question. Indices of entrepreneurship in Japan remain among the lowest for developed countries. Under the new legal system, the outlook for academic entrepreneurialism is gradually improving, encouraging the formation of new technology based firms. The greater focus of funding R&D in SMEs may increase entrepreneurial activity and facilitate innovation processes widely. Large firms also need to change their R&D strategies in order to meet fast scientific changes. The question remains as to whether large firms are gradually becoming less autarkic and linking more with early stage innovation and research breakthrough at universities. Universities need to negotiate with industry in order to realise the economic potential of their discoveries and their intellectual property.

E. Towards Joined-up-Multi-Level Systems of Innovation

In light of the sustainability of the innovation system, close attention needs to be drawn to the uneven economic, human resource and institutional infrastructures within the national innovation system. Reservations have been expressed about the role played by universities in peripheral areas given the high concentration of existing R&D efforts in core academic institutions such as the University Tokyo and other former ‘imperial’ universities. Wider structural problems are also foreseen with regards to meeting skill shortages in peripheral regions given greater job opportunities in the national industrial heartland. The national government may take a more strategic and integrated approach to enhance innovation at local and regional levels by giving more incentives to universities to play more active roles. Especially in local contexts, universities have to recognise and re-design the existing linkage between universities, public research institutes and local business.

During the 1980s, under the Technopolis Programme, linkages were developed between university and industry, as public research institutes combined with an improved social infrastructure. Under the Programme, with 26 regional high-tech sites across the country, local universities made a significant contribution in terms of R&D to the development of a research infrastructure in the designated sites, in conjunction with co-ordinating and support organisations (Masser, 1990). Incubator facilities were developed in most sites, and most national universities opened ‘local collaborative research centres’ which supported the combined efforts of local businesses and universities. Some new Technical Universities were developed in relation to the Technopolis Programme, some of which have made a notable contribution to local innovation (e.g. the Nagaoka University of Technology; see Masser, 1990). However, during this period there were structural constraints for university researchers, who were prevented by their legal status

25 The European Union Framework Programmes are good examples of policy instruments to encourage collective actions to produce ISPG mechanisms in the domain of innovation and technology (Foray, 2003).

from engaging in any formal co-operation with private firms. That the university system was not open to society at large and that human resources of support organisations were insufficient, represented critical factors explaining the limited development of industry-science relationships (ISRs) based on the Technopolis Programme during the 1980s. This resulted in a lack of intra-regional networking between the newly attracted firms and suppliers, universities and public research institutions in regions (Hassink, 2000).

The development of Japanese university-industry collaboration since the late 1990s has become characterised by a growing co-operation not only between the university and industry, but also between the two ministries, namely METI and MEXT, especially with regard to strengthening Intellectual Property strategies and local industrial cluster strategies. For example, a law aimed at promoting university-industry technology transfer (1998) was jointly prepared by MITI and MEXT in order to provide a legal basis to facilitate the technology transfer from universities to industries. Recent years have witnessed an apparent devolution of planning functions of S&T policies from the national to local governments. One aim of the second, current Science and Technology Basic Plan (2001-5) is to promote science and technology in each geographic region.²⁶ Both MEXT and METI have initiated local cluster development strategies, and universities are conceived to be the critical actors in the local development processes. Developing strategic linkages between the basic research funded by the MEXT programme and its industrial application supported by the METI programme is the key in achieving this. Through the implementation of 'local cluster strategies', complex patterns of inter-firm and inter-organisational relationships have been promoted at the local and regional levels.

Triple helix interaction has been developing at the local level as 'grass roots entrepreneurship' (Etzkowitz et al., 2004) involving local industry, authorities and universities. A recent legal change of national universities and the legal status of staff working at national universities may affect the geographical dimension of the triple helix interaction: NUCs can now receive financial support from local authorities, which was prohibited in the past when they were national institutions. This may trigger new relationships between universities and their localities, as there will be more financial incentives for universities to work closely with their surrounding regions, triggering innovation at the regional level. Local innovation initiatives have already taken various forms, sometimes encompassing regions in neighbouring countries in East Asia, often with universities as main players (see Kitagawa, 2005b). The Japanese innovation system needs to be examined in light of the growing dynamics of economic linkages throughout the Asia and Pacific Economies, which encompass multiple spatial levels, within the globalising knowledge economy.

V. Concluding Remarks

This paper has discussed Japan's national innovation policy environments from a historical and comparative perspective. The broad discussions in this paper concerning the policy initiatives and ongoing institutional developments in Japan highlighted the fundamental transformation of S&T and innovation policies. Japanese S&T policy has shifted its emphasis over the past 60 years. The structure and the financing of S&T activities have been experiencing profound change over the past decade following the 1995 enactment of the Science and Technology Basic Law. This change can be briefly characterised as a shift to a) a stronger emphasis on academic entrepreneurship; b) a dynamic innovation process with science-based industries (SBIs); and c) the regionalisation of innovation policies with enhanced local university-industry links.

26 While the METI 'Industrial Cluster Project' is at the regional level and the MEXT 'Knowledge Cluster Initiative' is at prefectural level, they are designed and implemented separately, so there needs to be more cooperation between the two ministries to synergise effects between the two cluster initiatives. See, <http://www8.cao.go.jp/cstp/english/basicplan01-05.pdf> 31/01/05

The development of a new research system throughout the 1990s is seemingly leading to the emergence of new Industry-Science Relationships (ISRs) and new system(s) of innovation in which universities play more significant roles as *economic resources*. S&T policies reflect the past R&D activities as well as the socio-economic needs of society. With industrial changes and recent government policy directions, the Japanese innovation system is currently undergoing rapid transformation. The adoption of a US style legal framework for university-industry technology transfer seems to be promoting an entrepreneurial culture within Japanese universities in terms of number of university start-ups, patent applications and royalty income, although such activities still remain peripheral to most academic communities in Japan. Careful monitoring is required as to the long term effects of such a legal framework within the Japanese institutional contexts. From a policy and comparative point of view, attention is drawn to the following concluding points.

In the US and also in Europe and Japan, a shifting emphasis on ‘market-based incentives for science and technology’ has been noted as a recent policy trend. Although there may be gains to be had from private sector funding of university R&D, there are also costs associated with universities’ reliance on the private sector. Universities tend to expect that closer links between research and application and being ‘useful’ to society will be reciprocated in the form of direct and immediate financial return. Some authors point out that this tendency leads to a blurring of public and private spheres and an institutional ‘convergence’ between what universities, public research institutes and private research sector do. Some raise alarm by arguing that such a convergence may threaten the institutional integrity of the university and the future of scientific research (Nelson, 2004; Georghiou, 2004; Conceicao et al., 2004). The right balance of public and private financing for each sector in a particular innovation system needs therefore to be struck.

The high-level of R&D activities by the private sector in post-war Japan could be seen as pre-empting the international trends of widespread private R&D (Nakayama and Law, 1997). However, Japan has had very limited private sector investments so far in university R&D and national investments in the university sector has failed to keep up with overall economic growth. In the case of Japan, the fundamental issue is one of fundamental policy choice as to ‘how Japan chooses to run its university system’ (Pehter, 2001). Firstly, it is necessary to assess the costs and benefits of private sector funding to university R&D. Secondly, the level of current funding in the Japanese innovation system needs to be re-evaluated.

In Japan, and elsewhere, the current emphasis on academic entrepreneurship must be accompanied by continued public support for basic university research and teaching. The particular challenge for Japan’s innovation system concerns how the hitherto impoverished basic public research can be enhanced in the increasingly competitive global knowledge economy, while promoting academic entrepreneurial activities at the same time. Each national innovation system needs to be reconsidered in terms of the fundamental and unique role that universities have played in the cumulative systems of knowledge generation and diffusion (see Conceicao et al., 2004). A policy incentive combining ‘excellence’ and ‘relevance’ seems to be important in order to encompass the wide range of activities in universities. In addition to improving standards in teaching and research, a ‘third mission’ would be the commercialisation of university research. More attention needs to be drawn to the increasing important roles played by universities in acting as a ‘talent magnet’ attracting highly skilled ‘knowledge workers’ (Florida, 1999).

As the S&T system becomes more global with the globalisation of the economy, even more coordination of economic policies at the global and/or transnational level will be necessary. There needs to be a robust set of R&D data, as well as data about the highly-skilled at the local, regional, national and transnational levels, including data about international flows of knowledge. Policy makers need to be equipped with internationally comparable indicators for international, national and sub-national policy making for multi-level systems of innovation. For policy makers and those agencies concerned with policy evaluation there is a huge task lying ahead given the complexity of the roles played by universities in the national innovation system. This will entail a process of

synthesising national research, innovation and learning systems, which are in turn linked through overarching national industrial, S&T, and territorial policies, located within the globalising economy. International policy emulation is useful only when it is combined with robust sets of policy objectives and the re-contextualisation and fundamental re-constitution of national innovation policies in the global knowledge economy. Last but not the least, for S&T policies to be effective a culturally and institutionally sound set of social innovation needs to be promoted.

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