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Academic Spin-offs in Japan: Institutional Revolution and Early Outcomes

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Academic Spin-offs in Japan: Institutional Revolution and Early Outcomes[*]

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Abstract

Japan has faced two major challenges during the past 15 years: building new sources of competitive advantage and revitalizing the economy. To meet these challenges, the government has, since the mid-1990s, developed social systems to better commercialize intellectual properties, resources, and assets that academic institutions own by means of collaborative research, technology transfer, and academic spin-offs. This study presents an overview of this institutional revolution and reports some early outcomes by using results from two recently conducted major surveys. We also assess the achievements of these efforts, which lead us to point out remaining problems and challenges that policy makers and academic institutions need to overcome. The initial indication of the progress is promising, but some critical questions remain.

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1. Introduction

Japan has faced two major challenges during the past 15 years. The first challenge has been to find new sources of competitive advantage, replacing traditional strength in high-quality, low-cost production systems. Several of the manufacturing industries have established a dominant presence in global competitive markets, making a major contribution to the prosperity of Japan's economy with the great strength in low inventory cost and low defect rates. Representative examples of such industries include shipbuilding, automobile assembly, home electric appliances, and audiovisual devices. However, since the late 1980s, these industries have received severe competitive pressures from East Asia and particularly China, with the improved quality of low-cost manpower in labor-intensive industries. The emergence of this new economic order poses an urgent and crucial concern for Japanese society to find new additional sources of competitive advantage.

The second challenge has been to revitalize the economy. After the bubble economy burst in 1991, the major indicators have consistently signaled serious economic slumps in the past 10 to 15 years. As shown in Figure 1, the drop of the GDP growth rates indicates a consistent downward structural change of Japan's economy since 1991.[1] The average nominal GDP growth rate from 1991 to 2003 was only 0.97%, compared with 6.22% from 1981 to 1990. The figure also shows that the nominal GDP growth rate was less than the growth in real GDP. The average of real GDP growth rates was 3.95% from 1981 to 1990, whereas that from 1991 to 2003 was 1.33%. These figures suggest that Japan's economy has suffered from deflation in the last decade—further evidence of the severity of Japan's economic stagnation. Moreover, the unemployment rate which peaked at an average of 5.4% in 2002 and 2003 sharply increased in the period, more than doubling the average of 2.1% in 1990 (see Figure 2). It has therefore been an urgent task for the Japanese industrial society to create new industries and jobs by reforming traditional business systems that retard the process of adaptation to dynamically changing global

[1] Figure 1 shows the results of 93SNA (fixed-based, base year = 1995). We choose not to use the most recent version of the SNA but the latter for long-term comparison.

competitive environments.

=====FIGURE 1 ABOUT HERE=====

=====FIGURE 2 ABOUT HERE=====

The implementation of typical fiscal and monetary policies has failed to stimulate the stagnating economy. Persistent public overspending by the Japanese government through this period caused the highly accumulated fiscal deficits, which now pose great uncertainty for the future. Furthermore, as shown in Figure 2, the Bank of Japan has ventured into bold monetary policies for monetary easing. Here, the overnight call rate refers to a short-term interbank interest rate, and the main policy interest rate in Japan is comparable with the Federal Funds rate in the US. To reactivate corporate financing, the Bank of Japan has kept setting the policy interest rates to zero, the lowest level any central bank can set, but this monetary policy also did not have substantial impact on revitalization of the economy.

Facing such a severe economic situation, the government has planned to overcome these challenges by building the nation's competitive advantage upon the discovery of scientific knowledge, the innovation of new technologies and services, and the commercialization of both of these aspects. While large corporations certainly have more resources for research and development (R&D) activities that require intensive capital investment, new ventures and small-to-medium enterprises are considered to be more competent for innovation because of their flexibility and speed. Departing from traditional industrial policies that offered favorable resource environments for large corporations, the government now recognizes the possibilities of vigorous growth of new ventures, providing financial support to innovation in the areas of new-business research and new products/technologies/service development by the enactment of the Creative Business Promotion Law in 1995 (Bird and Mitsuhashi, 2003; Harada and Honjo, 2005). Further, in 1999 the Small and Medium Enterprise Basic Law was fundamentally

amended to incorporate the fostering of entrepreneurship. In parallel, the government has developed social systems that enable new ventures to procure capital for their growth and operations by opening stock exchange markets for entrepreneurial firms (e.g., ‘Mothers’ on the Tokyo Stock Exchange and NASDAQ Japan (later reformed to ‘Hercules’) on the Osaka Stock Exchange).

As a part of the plan for building a nation with strengths in innovation, the government has also adopted policies to utilize the knowledge, assets, and intellectual property of academic institutions for commercialization. The nationwide turmoil by university students on many campuses in the early 1970s suggested close but murky connections between industrial corporations and university researchers, resulting in the substantial segregation of academia from business communities. Subsequently, the anticommercial norms restricted the utilization of on-campus scientific knowledge for business and economies through cross-field research collaboration, licensing for technology transfer, and academic spin-offs. However, the policy challenges discussed above now generate social pressures to increase the permeability of boundaries between academics and industries. In addition, Japanese corporations facing today’s highly competitive global environments do not have sufficient resources to allocate to long-term, highly uncertain basic research projects. For these reasons, academic institutions in Japan are now expected to play a more significant role than ever in leading the nation’s policies by developing technologies, products, services, and industries from their cutting-edge scientific knowledge.

As a study on the relationships between the institutional environment and entrepreneurship, this paper focuses on the emergence of academic spin-offs in Japan. We first present a snapshot of the historical transition of the legal and political environments that facilitate the commercialization of assets and resources owned by academic institutions. We also explicate three commercialization approaches, including cross-field research collaboration, licensing for technology transfer, and academic spin-offs. Second, using the results from two

recently conducted surveys, we present an overview of academic spin-offs in Japan. We consider academic spin-offs that entail the transfer of technological, human, and financial resources to be of importance for both the Japanese economy and academics. Knowledge and insights about academic spin-offs in general are available elsewhere (cf. Brett et al., 1991; Feldman, 2003; Lockett et al., 2003; Shane, 2004a; Calson, 2005; Lockett et al., 2005; Lerner, 2005; Phan and Siegel, 2006), but documentation about spin-offs in Japan has been sparse.[2] It is probably interesting and important for theory and practice to examine the case of Japanese spin-offs in detail, which have been rapidly growing as a result or the recent institutional changes (see Figure 3). Third, we assess the progress of the government's strategy for building a nation with strengths in innovation and discuss the potential opportunities and threats for academic spin-offs in Japan.

Previous studies defined academic spin-offs in different ways (Nicolaou and Birley, 2003; Pirnay et al., 2003). For instance, Shane (2004a) defined a university spin-off as "a new company founded to exploit a piece of intellectual property created in an academic institution" and viewed it as "a subset of all start-up companies created by the students and employees of academic institutions (p. 4)". In this study, we define academic spin-offs as new ventures founded on the basis of knowledge, inventions, and capabilities generated in academic institutions (see the end of Section 3 for more descriptions). Here, academic institutions refer to organizations registered as universities, colleges, technical junior colleges, or interuniversity research institutes. Using survey results conducted by a university research center at the University of Tsukuba and the Ministry of Economy, Trade, and Industry (METI), we provide aggregated data that describe the growth and status quo of academic spin-offs in Japan.

2. Governmental Policies and Institutional Revolutions

Since the mid-1990s, an extensive series of governmental policies has been legislated to

[2] Remarkable two exceptions are Lynskey (2006) and Kneller (2007), presenting historical descriptions about the birth and growth of Japanese university spin-offs.

promote cross-field research cooperation and technology transfer from academia to the private sector. These revolutions in the legal and political environments have created fertile opportunities for the birth of academic spin-offs by accelerating flexible resource mobilization and the deregulation of traditional researchers' rights and responsibilities in the academic institutions. Table 1 summarizes a brief history of the institutional revolutions for the development of relating to academic spin-offs.[3]

=====TABLE 1 ABOUT HERE=====

The first stage of the reforms aimed at promoting business–academic–public sector cooperation for science and technology, which is followed by the creation of business environments that facilitate the transfer of innovation and technologies from academic institutions to the private sector. The reforms complete with the development of social systems that nurtured academic spin-offs.

The Science and Technology Basic Law was enacted in 1995, and the (first) Science and Technology (S&T) Basic Plan was formulated in 1996. The former codified the government's recognition of the importance of science and technology for the long-term development of the economy and the improvement of social welfare. The establishment of the latter included the government's plan to direct JPY 17 trillion (USD 145 billion) for research and development activities over the next five years (FY1996–2000). These regulatory changes reflected the government's long-term strategy of creating a society with rich technological renovation and continuous management reorganization. The latter also included the announcement of plans for the promotion of collaboration among industry, academia, and government. The Basic Plan was followed by the Second S&T Basic Plan for FY2001–2005 and the Third S&T Basic Plan for FY2006–2010. Both of these included plans for increasing

[3] For more detailed descriptions of recent policies, see Branscomb et al. (1999), MEXT (2005 and 2006), Shiozawa and Ichikawa (2005), Lynskey (2006), and Jones and Yokoyama (2006).

government funds in R&D and further enriching the coordination between industry, academia, and government.

In 1998, the parliament passed the Law for Promoting Technology Transfer from Universities to Industry, aimed at helping academic institutions establish and manage technology licensing offices (TLOs) and at facilitating the transfer of research outcomes from academia to private enterprises through patent applications. TLOs also commercialize patented innovation by extensively engaging in marketing activities. Another important legislation is the Law on Special Measures for Industrial Revitalization in 1999, often called the Japanese-version of the Bayh-Dole Act. This law not only reduced patent fees for TLOs but also allowed academic institutions to keep patents, as their properties, for the invented innovations from government-funded research projects. The law thus facilitates licensing transactions and provides incentives for commercialization.

Another important law legislated in 2000 was the Industrial Technology Enhancement Act, which allowed researchers in national and public academic institutions to flexibly receive and use private research funds. The law also permitted these institutions to earn auxiliary revenues and serve as directors on the boards of private enterprises. By deregulating the mobilization of human resources from academia to industry, this law is considered to be the government's first step in promoting academic spin-offs. It is notable, however, that the amount of time and resources that researchers in academic institutions could use for commercial purposes was highly limited until the legislation of the National University Incorporation Law in 2004 that gave corporate status to all of the national universities and relaxed researchers' status as public servants by allowing their dual employment (Oba, 2005).[4]

In 2001, Takeo Hiranuma, a former Minister for the Economy, Trade, and Industry, announced a comprehensive master plan that covers a broad category of economic activities

[4] In April 2004, national universities were renamed national university corporations. Public universities have also started reforming and renaming to public university corporations. To avoid any unnecessary terminological confusion, we consistently use the old versions of the official names throughout the paper.

ranging from the promotion of entrepreneurship to the improvement of women's working condition. This plan also ambitiously sets a target of the creation of 1,000 academic spin-offs within three years, reinforcing the government's strategy for fertilizing the legal and economic environments for spin-off activities.

The Basic Law on Intellectual Property in 2002 and the Intellectual Property Strategic Program in 2003 outlined the basic concepts for the creation, protection, and usage of intellectual properties and recapitulated the roles and responsibilities of the academic institutions in the era of intellectual property management. The Basic Law provided the legal basis for the establishment of the Intellectual Property Policy Headquarters in 2003 for planning and implementing policies of intellectual properties and suggested the academic institutions to found internal units, called "intellectual property headquarters at universities", for managing intellectual properties onsite. Furthermore, in 2005, the government announced guidelines, titled 'How to Handle Cases where National Universities and Interuniversity Research Institute Corporations Acquire Stocks as Compensation for Donation of Licensing', that allow the academic institutions to obtain stocks compensation for permission to use their intellectual properties.

As we noted above, the reforms consisted of three stages: (1) the promotion of cross-field research, (2) the transfer of technologies and innovation from the academic institutions to the commercial sectors through licensing, and (3) the creations of academic spin-offs. Along with these stages, the reforms' objectives have expanded. Building a nation with strength in innovation is no longer the sole goal, and, as implied in the Hiranuma Plan, the government expects academic spin-offs to play the critical role in generating new industries, employment, and national wealth.

3. Two Surveys and an Overview of Academic Spin-offs in Japan

These institutional reforms have created business environments in which researchers in

academic institutions found academic spin-offs based upon their innovation, technologies, and capabilities. In the following sections, we assess the development and status quo of academic spin-off activities in Japan by using the results of two surveys conducted by a university research center at the University of Tsukuba and the METI.

3.1. ILC survey

One part of the data that we use in this study was collected by the Tsukuba Industrial Liaison and Cooperative Research Center (ILC). This is a series of the annual surveys of academic spin-offs in Japan from 2000 to 2005, sponsored by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The most recent results are available as 'Research on Challenges of and Policy Implications for Academic Spin-offs' in Japanese. We gained ILC's permission to partially gain access to the original data and will report results that we originally compiled.

As with the ILC's past surveys, the year-2005 one consisted of two waves. The objective of the first-wave survey was to collect information from universities about the names and addresses of university spin-offs and the types of support provided such as venture capital funds and incubation facilities. The first-wave survey started in August 2005. The ILC mailed questionnaires to 87 national universities, 73 public universities, 552 private universities, 11 interuniversity research institutes, 55 national technical junior colleges, five public technical junior colleges, and three private technical junior colleges. The original sample covered the entire population of colleges and universities certified by MEXT. The total number of responses in the first wave was 584. The average response rates were 83.6%. The response rates vary with the types of universities and institutions, ranging from 66.7% for private technical colleges to 100% for national universities and national and public technical colleges. In the first-wave survey, 1,141 university spin-offs were identified.

The objective of the second-wave survey was to collect firm-level information from

university spin-offs identified in the first wave. The second wave asked the spin-offs the types of resources that had been transferred from universities, the magnitudes and types of challenges that they faced in the pre- and post-startup processes, and the support that they received from universities and other external constituents. After removing 52 spin-offs that went bankrupt or were acquired by other corporations, the ILC sent questionnaires to the remaining 1,089 university spin-offs. Of these, 275 returned the questionnaires, yielding the response rates of approximately 25%. This means that we have at most detailed information on 275 spin-off firms. The ILC did not report any mean-comparison tests useful for checking for any potential bias such as significant differences between responding and nonresponding firms. However, because it is very likely that poorly performing or failing university spin-offs are less likely to respond, the results based on the second wave of the survey reported here should be interpreted with some caution. Regardless of this potential bias, we believe that this is still most likely the best source of data on university spin-offs.

3.2. The METI survey

Since 2002 the METI has also conducted annual surveys of academic spin-offs. In this paper, we use the results of the 2005 survey, which also reports the number of academic spin-offs by university type, university, business domain, and regional area. The METI 2005 survey was conducted from November 2005 to March 2006. METI first made a comprehensive list of academic spin-offs in Japan by sending questionnaires to universities, technical junior colleges, and its affiliated organizations. Of the 882 organizations to which it sent questionnaires, 410 responded. METI then complemented the obtained data with information that it procured from regional offices of METI, newspapers and magazines, and academic and local associations for new ventures. Finally, in order to increase the comprehensiveness further, METI made phone calls, sent emails, and visited websites to confirm the existence of the academic spin-offs that they identified in this process. The final number of academic spin-offs identified in the METI

survey is 1,503.

Using data from the ILC and METI surveys together, we plot the growth of the cumulative number of Japanese academic spin-offs in Figure 3.

=====FIGURE 3 ABOUT HERE=====

The numbers of academic spin-offs identified in the first-wave of the ILC survey and the METI survey were 1,140 and 1,503, respectively. These figures are different possibly for three reasons. First, this may be due to the different sampling schemes in the two surveys. Second, it is probable that the METI survey may have more updated data because while the ILC survey reports data at the end of the calendar year (though the data collection in the 2005 report exceptionally ended in August), the METI survey reports data at the end of the fiscal year. Further, while the ILC first-wave survey covered the periods beginning August 2005 through September 2005, the METI survey covered ones beginnings November 2005 through March 2006. These differences in the timing of data collection may account for the differences. Third, and most importantly, the two surveys used different definitions of academic spin-off. The METI survey included new ventures that faculties in academic institutions founded using their inventions and scientific discoveries and those having strong ties with academic institutions. Examples of the latter include: (1) new ventures engaging in collaborative research projects with academic institutions within the five years of their founding; (2) new ventures using technologies transferred from academic institutions within the five years of their founding; (3) new ventures started by founder who were inspired by entrepreneurship programs offered from academic institutions; and (4) venture capitalists that provide the services of funding and technology transfers to academic institutions. On the other hand, academic spin-offs in the ILC survey included new ventures that: (1) started using patents owned by academic institutions or faculties; (2) started using nonpatented research outcomes and technologies from academic

institutions; (3) established by faculties, students, and staff as founders or significant supporters; (4) received supports and financial investments from academic institutions and the TLOs; or (5) build strong relations with academic institutions. The METI's definition is apparently broader, counting even new ventures as spin-offs that had sheer joint projects with academic institutions regardless of the involvement of faculties as founders. Thus, the ILC's definition is more conservative and fits more with the common operationalization of academic spin-offs.

While the differences in the definition requires some caution, the number of academic spin-offs reported in both surveys exceeded 1,000 in 2005, a threshold suggested in the Hiranuma Plan in 2001. However, we argue later that this achievement does not necessarily guarantee the actual healthy growth of the spin-offs.

4. Early Outcomes: Overview of the Results from the Two Surveys

This section provides an overview of the results from the ILC and METI surveys to advance our understanding of the status quo of academic spin-offs in Japan. First, Table 2 summarizes the distributions of academic spin-offs by the type of institutions.

=====TABLE 2 ABOUT HERE=====

A caveat to be used here is that spin-offs founded by faculties from multiple institutions are double-counted in this table. This table demonstrates that national universities account for the majority of academic spin-offs in Japan (62.9% in the ILC survey and 70.1% in the METI survey).

Using the data from the ILC survey, we present a list of the academic institutions with more than nine spin-offs in Table 3.

=====TABLE 3 ABOUT HERE=====

This table reproduces a finding in Table 2 that national universities offer fertile ground for academic spin-offs in Japan. Of the top 31 universities ranked by the number of spin-offs, 22 were national universities. This table also demonstrates that not many but only some institutions, whether national or private, actively establish spin-offs.[5] Of the 1,141 spin-offs identified in the ILC survey, 426 (37%) are from the top 10 universities, and 779 (68%) are from the top 31 universities.

The smaller numbers of faculties per university together with higher teaching load in private university are two possible reasons for their limited engagement. Using the 2005 School Basic Survey by MEXT, we summarize an outlook of higher education in Japan in Table 4.

=====TABLE 4 ABOUT HERE=====

Of the 87 national and 553 private universities, a total of 61,000 and 89,000 faculties were employed, respectively, suggesting that the private universities tended to have the smaller faculty body. As shown in column IV in Table 4, the number of faculties per institution for private and national universities was 700 and 162, respectively. Also, column VI indicates that the number of students per faculty in national and private universities was 10.3 and 23.6, respectively,[6] showing the greater teaching load and fewer research resources in private universities.

We compile the results from the two surveys in Table 5 and 6 to show the distributions of spin-offs by business domains and by geographical areas, respectively.

=====TABLE 5 ABOUT HERE=====

[5] Previous studies using data from other countries also found this pattern (e.g., Gregorio and Shane, 2003; Shane, 2004a; Landry et al., 2006).
[6] The result is primarily due to the difference in the amounts of national expenditures provided to national and private universities.

=====TABLE 6 ABOUT HERE=====

Due to the absence of coded data about the industry domains of spin-offs in the ILC survey, we manually classified them by inspecting the reported business descriptions. Caution should also be used in interpreting results about the distributions of business domains from the METI surveys, which double-counted some firms and report the data of more than 1,503 firms. It appears from Table 5 that high-tech areas such as biotechnology, life sciences, information technology (IT), material sciences, and nanotechnology are highly populated by academic spin-offs, suggesting that spin-offs facilitate commercialization and the transfer of the outcomes of basic and advanced research generated in academic institutions. Table 6 shows the high concentration of spin-offs in the metropolitan areas, which is probably due to the concentration of population, economic activities, and even academic institutions in these areas.

Using the reported data and compiling the individual data from the ILC survey, we report more detailed characteristics of academic spin-offs in Table 7.

=====TABLE 7 ABOUT HERE=====

Table 7 reproduces our findings in Table 2 and 3 about the fewer spin-offs from private universities: 86% of private universities had no academic spin-offs, compared with 22% of national universities. It was found that 67% of spin-offs take the business form of stock corporations. The primary forms of relationships of spin-offs with academic institutions entail the transfer of human resources and nonpatented technology, whereas the transfer of patented technology and financing are less prevalent.

Table 8 compiles the data from the ILC survey, showing the extent of support that academic institutions provided to spin-offs in the pre- and post-startup processes, indicated by the presence of specialized internal units for supporting spin-offs and that of on- or off-campus

incubation facilities.

=====TABLE 8 ABOUT HERE=====

It appears that national universities were more active in providing support to spin-offs, which may lead to our earlier finding about the higher rates of spin-offs from national universities.

Finally, we compiled the data from the ILC second-wave survey and report the current situations of academic spin-offs in Table 9.

=====TABLE 9 ABOUT HERE=====

The sales of the 205 spin-offs averaged JPY 94.9 million. Of the 205 firms, 22 firms (11%) had no sales. Of the 186 spin-offs that reported profits in the survey, 69 (37%) were in the red and 95 (51%) were in the black. Some 22 (12%) spin-offs had zero profit. The average number of employees was 7.8 with a standard deviation of 11.0. Approximately 30% and 50% of the spin-offs were in the seed and early stages of the venture life cycle, respectively. More than 60% of the spin-offs received support from academic institutions in either the pre- or the post-startup process. In summary, we can conclude that most of the spin-off firms are still premature.

5. Discussion

Since the implementation of the Bayh-Dole Act in 1980, university patenting and licensing have proliferated in the US. This policy has been viewed to be successful in promoting the commercialization of research outcomes from academia, even though issues still remain such as conflict of interests, confidentiality, he quality of patents, the distribution of benefits from commercialization (Jaffe and Lerner, 2001; Jensen and Thursby, 2001; Mowery et al., 2004; Shane 2004b; Rosell and Agrawal, 2006). In the last several decades, the US has celebrated the

establishments of more than 5,000 spin-offs since 1980 and observed rapid growth and financial success for some spin-offs, particularly in the high-tech sectors (e.g., AUTM, 2007; Shane, 2004a). In recent years, approximately 500 academic spin-offs have been founded per year.

To follow the US's remarkable success, the Japanese policy makers have implemented institutional change and formulated new strategies to develop social systems for private and academic collaboration. This resulted in the substantial increase in the number of spin-offs in the last few years. However, further commercialization of intellectual properties requires more efforts in the following areas. First, the further promotion of academic spin-offs requires effective coordination, collaboration, and synergies among government agencies, including the MEXT, the METI, and the Cabinet. The three agencies have different purposes and interests: the MEXT is responsible for policy on education, science, and technology; the METI is in charge of the formulation of industrial policies and so is interested in the promotion of new ventures in general; the Cabinet (i.e., the Intellectual Property Policy Headquarters) has taken the leadership in the strategic development of Japanese intellectual property. As each of the agencies tends to pursue its objectives independently, it is not clear whether efforts by the three agencies are well coordinated to efficiently and effectively stimulate the commercialization of intellectual properties.

Second, faculties engaging in spin-offs need to resolve trade-off problems in allocating their time and resources to research, teaching, and business. There exists no normative environment that strongly supports profit making of faculties through the establishment of spin-offs. No consensus has been established yet as to how faculties should balance their efforts for research and business (Bock, 2003; Mowery et al., 2004; Shane, 2004a). The lack of consensus often causes internal conflict in academic institutions, where research-oriented faculties may criticize business-oriented faculties for their time- and effort-allocation and demand more internal work for the institutions.

Third, declining birthrate and a growing proportion of elderly people in the Japanese

society also pose a critical threat to academic institutions. Figure 4 shows the projected population of Japan until 2055.[7]

=====FIGURE 4 ABOUT HERE=====

The expected population peaks at 127.8 million in 2007 and declines sharply down to about 89.9 million by 2055. Accordingly, 18- to 24-year-old demographics decline from 10.1 million to 4.8 million, less than half of the current level, casting a shadow on the growth potential of universities as educational institutions. With the increase of competition for resources among university, they now need to cautiously formulate long-term strategies and astutely allocate resources to a wide range of activities including research, teaching, community services, and commercialization.

While the numerical target set in the Hiranuma Plan has been achieved, little is known about problems that more than 1,000 premature spin-offs are now experiencing. The good news is their low failure rates: 4% in the ILC survey and 3% in the METI survey. The bad news, however, is that only 16 of the spin-off firms have gone public as of March, 2006. We believe that, as a result of a series of legislative changes, the society is now equipped to increase the number of academic spin-offs, but it is time to redirect our attention from quantity to quality and consider strategies for economic prosperity through the use of intellectual properties as well as entrepreneurship.

[7] Several different versions of the population forecasts are available. The ‘medium variant projection’ here refers to one based on a ‘normal’ scenario concerning fertility and survival rates.

References

Association of University Technology Managers (AUTM) (2007) “The AUTM U.S. Licensing Survey, Fiscal Year 2005”.

Bird, Allan and Hitoshi Mitsuhashi (2003) “Entrepreneurs and Entrepreneurial Processes: Historical and Theoretical Perspectives of Entrepreneurship in the Japanese Contexts”, *Asian Perspective* 27, 125-176.

Bock, Derek (2003) *Universities in the Marketplace*, Princeton University Press.

Branscomb, Lewis M., Fumio Komada, and Richard Florida (eds.) (1999) *Industrializing Knowledge: University-Industry Linkages in Japan and the United States*, MIT Press.

Brett, Alistair M., David V. Gibson, and Raymond W. Smilor (eds.) (1991) *University Spin-off Companies*, Rowman & Littlefield Publishers, Inc.

Calson, Bo (2005) “Universities, Entrepreneurship and Public Policy: Lessons from Abroad”, Shane, Scott (ed.), *Economic Development through Entrepreneurship*, 198–217, Edward Elgar.

Feldman, Maryann P. (2003) “Entrepreneurship and American Research Universities: Evolution in Technology Transfer”, Hart, David M. (ed.), *The Emergence of Entrepreneurship Policy*, 92–112, Cambridge University Press.

Gregorio, Dante Di and Scott Shane (2003) “Why do some Universities Generate More Start-ups than Others?”, *Research Policy* 32, 209–227.

Harada Nobuyuki and Yuji Honjo (2005) “Does the Creative Business Promotion Law Enhance SMEs' Capital Investment? Evidence from a Panel Dataset of Unlisted SMEs in Japan”, *Japan and the World Economy* 17(4), 395-406.

Jaffe, Adam B. and Josh Lerner (2001) “Reinventing Public R&D: Patent Policy and the Commercialization of National Laboratory Technologies”, *RAND Journal of Economics* 32, 167–198.

Jensen, Richard and Marie Thursby (2001) “Proofs and Prototypes for Sale: The Licensing of

University Inventions", *American Economic Review* 91, 240–259.

Jones, Randall and Tadashi Yokoyama (2006) "Upgrading Japan's Innovation System to Sustain Economic Growth", *OECD Economy Surveys: Japan – Volume 2006 Issue 13*, 160–207, OECD.

Kneller, Robert (2007) "The Beginning of University Entrepreneurship in Japan: TLOs and Bioventures Lead the Way", *Journal of Technology Transfer* 32, 435–456.

Landry, Rejean, Nabil Amara, and Imad Rherrad (2006) "Why are some University Researchers more likely to Create Spin-offs than Others? Evidence from Canadian Universities", *Research Policy* 35, 1599–1615.

Lerner, Josh (2005) "The University and the Start-Up: Lessons from the Past Two Decades", *Journal of Technology Transfer* 30, 49–56.

Lockett, Andy, Mike Wright, and Stephen Franklin (2003) "Technology Transfer and Universities' Spin-out Strategies", *Small Business Economics* 20, 185–200.

Lockett, Andy, Donald Siegel, Mike Wright, and Michael D. Ensley (eds.) (2005) *The Creation of Spin-off Firms at Public Research Institutions: Managerial and Policy Implications*, *Research Policy* 34, 981–1122.

Lynskey, Michael J. (2006) "Transformative Technology and Institutional Transformation: Coevolution of Biotechnology Venture Firms and the Institutional Framework in Japan", *Research Policy* 35, 1389–1422.

Ministry of Economy, Trade, and Industry (METI) (2006) *Basic Research on Academic Spin-offs, 2006*. (in Japanese)

Ministry of Education, Culture, Sports, Science and Technology (MEXT) (2005) *White Paper on Science and Technology 2005*.

Ministry of Education, Culture, Sports, Science and Technology (MEXT) (2006) *White Paper on Science and Technology 2006*.

Mowery, David C., Richard R. Nelson, Bhaven N. Sampat, and Arvids A. Ziedonis (2004) *Ivory*

Tower and Industrial Innovation, Stanford University Press.

Nicolaou, Nicos and Sue Birley (2003) “Academic Networks in a Trichotomous Categorization of University Spin-offs”, *Journal of Business Venturing* 18, 333–359.

Oba, Jun (2005) “The Incorporation of National Universities in Japan: Initial Reactions of the New National University Corporations”, *Higher Education Management and Policy* 17, 105–125.

Phan, Phillip, H. and Donald S. Siegel (2006) “The Effectiveness of University Technology Transfer”, *Foundations and Trends in Entrepreneurship* 2, 77–144.

Pirnay, Fabrice, Bernard Surlemont, and Frederic Nlemvo (2003) “Toward a Typology of University Spin-offs”, *Small Business Economics* 21, 355–369.

Rosell, Carlos and Ajay Agrawal (2006) “University Patenting: Estimating the Diminishing Breadth of Knowledge Diffusion and Consumption”, NBER Working Paper 12640.

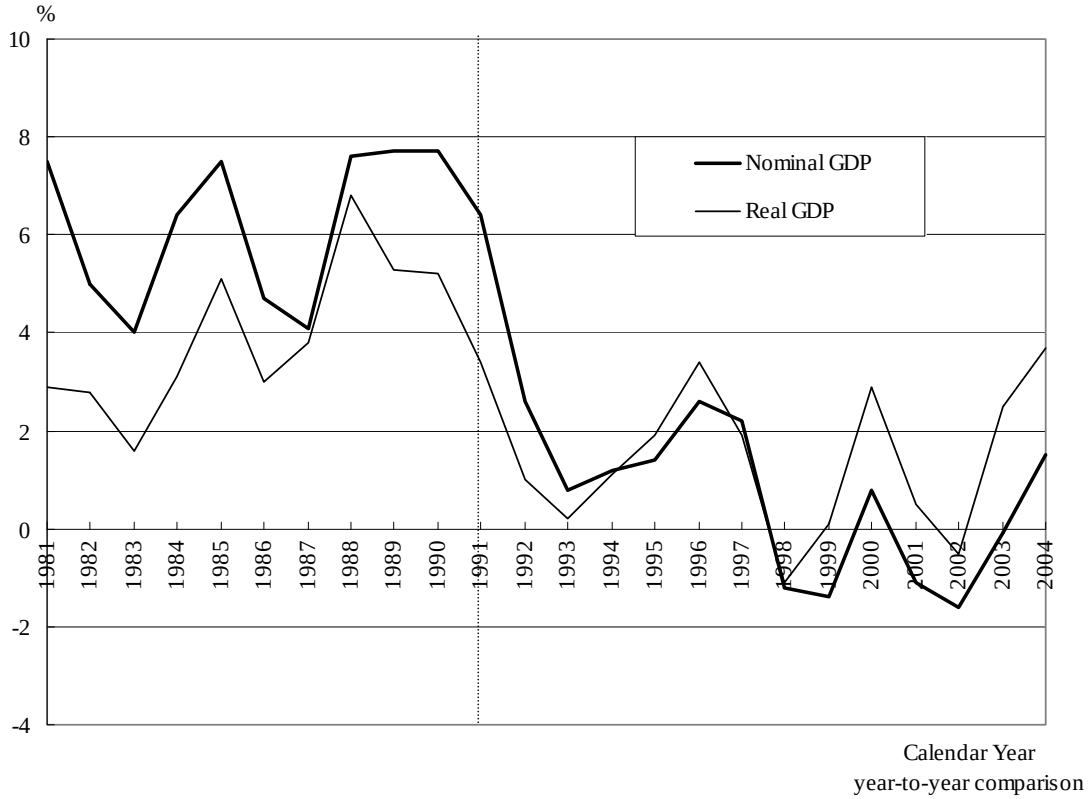
Shane, Scott (2004a) *Academic Entrepreneurship*, Edward Elgar.

Shane, Scott (2004b) “Encouraging University Entrepreneurship? The Effect of the Bayh-Dole Act on University Patenting in the United States”, *Journal of Business Venturing* 19, 127–151.

Shiozawa Burno and Tagui Ichikawa (2005) “Japan’s Industrial Technology and Innovation Policies and the Effects of ‘Agencification’”, *Governance of Innovation Systems* 2, 139–176.

Tsukuba Industrial Liaison and Cooperative Research Center (ILC) (2006) *Research on Challenges of and Policy Implications for Academic Spin-offs, 2006*. (in Japanese)

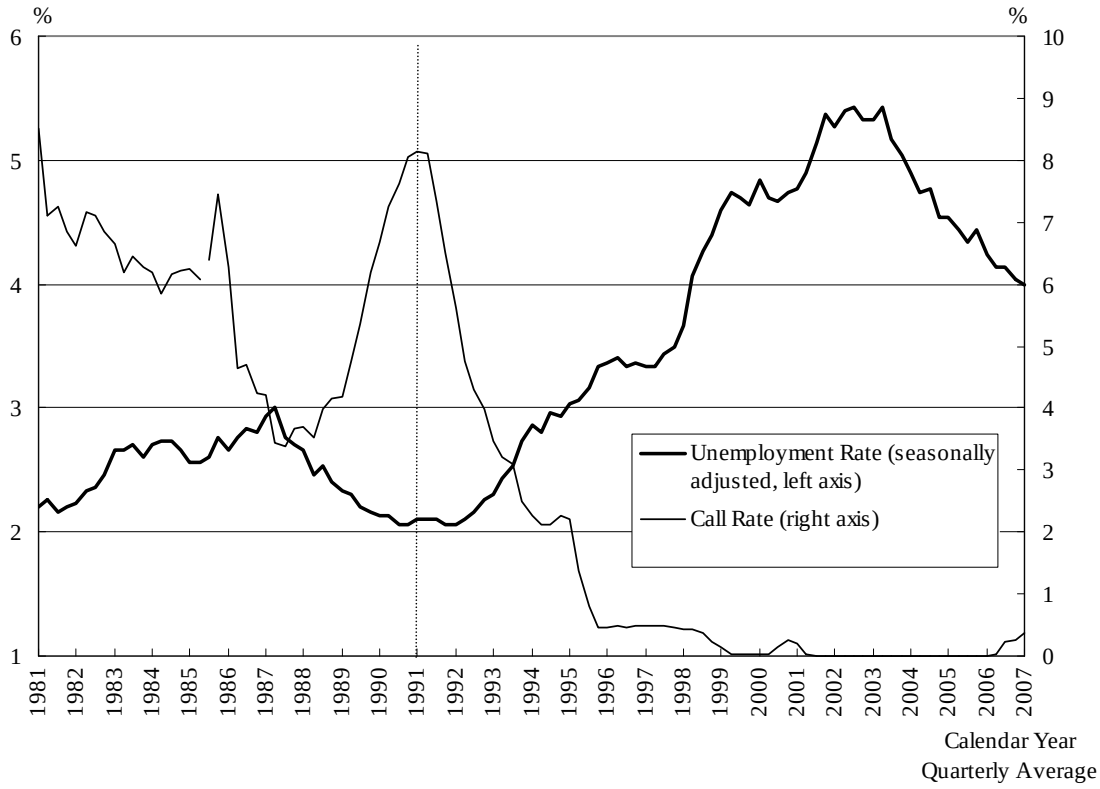
Figure 1: GDP Growth Rate in Japan



Source: Economic and Social Research Institute, Cabinet Office 'System of National Accounts'

Notes: 93SNA, Base year = 1995.

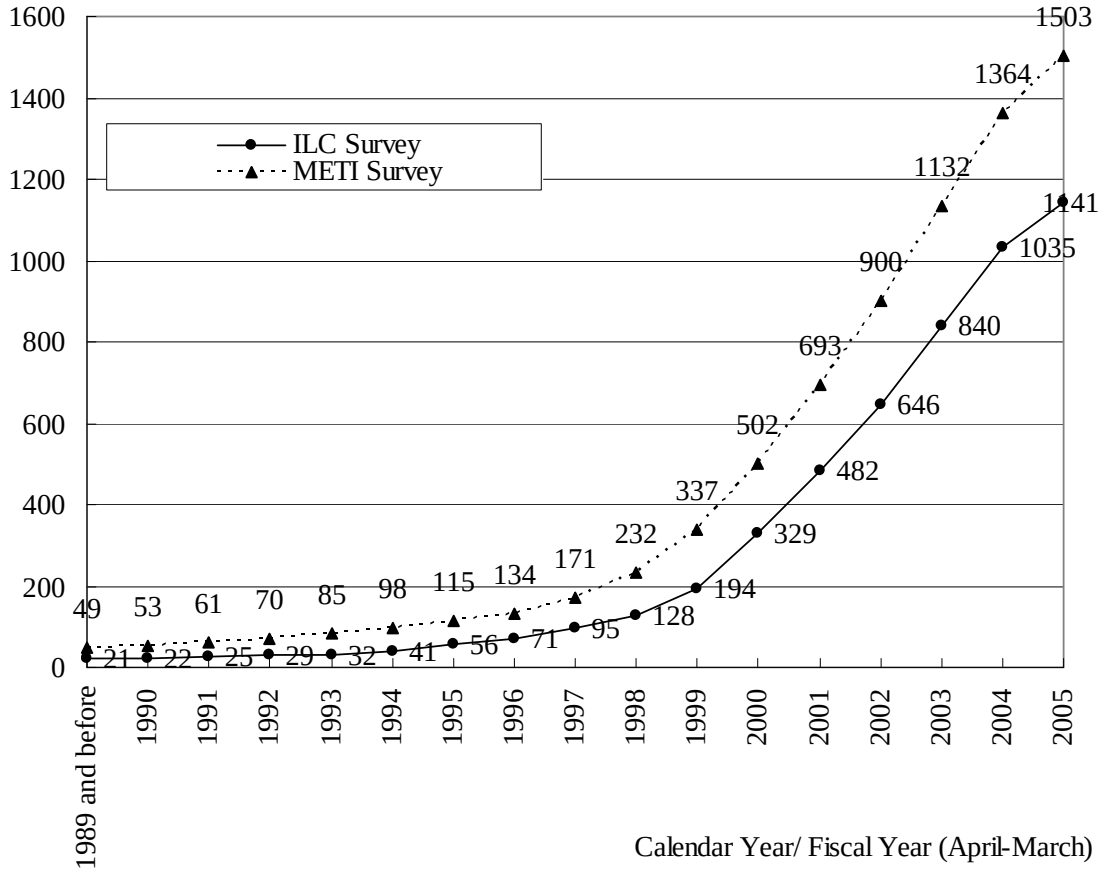
Figure 2: Unemployment Rate and Call Rate



Source: Statistics Bureau, Ministry of Internal Affairs and Communications 'Labor Force Survey', and Bank of Japan

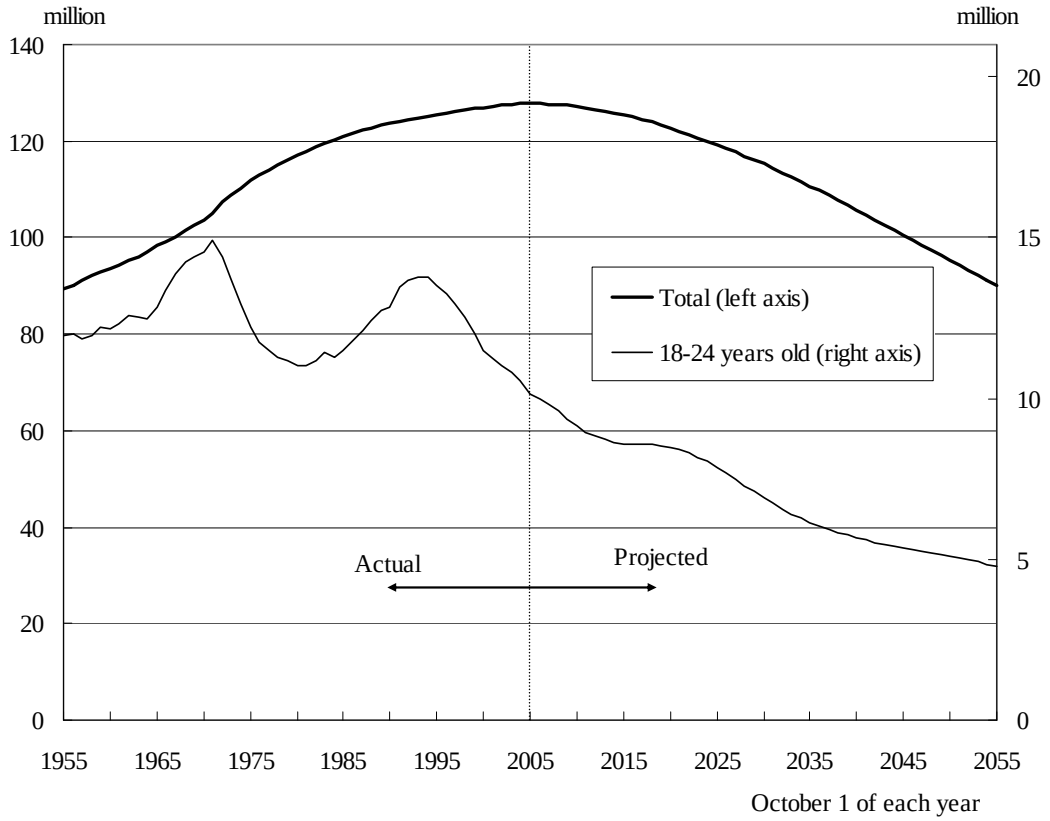
Notes: Call rate (percent per annum); up to 1985.2 Collateralized Overnight, on and after 1985.3 Uncollateralized Overnight.

Figure 3: Cumulative Numbers of Academic Spin-offs Established in Japan



Source: ILC (2006) and METI (2006)

Figure 4: Projected Japanese Population (Medium Variant Projection)



Source: National Institute of Population and Social Security Research 'Population Projections for Japan: 2006–2055', 2006.

Table 1: Summary of Regulatory Reforms

1995	Science and Technology Basic Law	Guidelines for promotion of science and technology Formulation of the Science and Technology Basic Plan
1996	Science and Technology Basic Plan (FY1996–2000)	Increase in the total government investment in R&D: JPY 17 trillion Promotion of coordination between industry, academia and government
1998	Law for Promoting Technology Transfer from Universities to Industry	Establishment of approved TLO system
1999	Law on Special Measures for Industrial Revitalization	Japan's version of Bayh-Dole Act Reduced patent fees for TLOs and procurement of patents from government-funded research projects
2000	Industrial Technology Enhancement Act	Increased flexibility of researchers' status
2001	Second Science and Technology Basic Plan	Raising the total government investment in R&D to JPY 24 trillion Reform of coordination between industry, academia and government
	Hiranuma Plan	Policy target of reaching 1000 academic spin-offs
2002	Basic Law on Intellectual Property	Basic ideas about creation, protection, and exploitation of intellectual properties Establishment of the Intellectual Property Policy Headquarters in the Cabinet
2003	Intellectual Property Strategic Program	Outlines of academic institutions' responsibilities and rights in intellectual property rights management Establishment of intellectual property headquarters at universities
	National University Incorporation Law	Obtaining corporate status Staff without civil servant status
2004	Incorporation of National Universities	Implementation of the Incorporation Law (April, 2004)
2006	Third Science and Technology Basic Plan (FY2006–2010)	JPY 25 trillion on total government investment in R&D Building a sustainable and progressive industry–university–government collaboration system

Table 2: Distributions of Academic Spin-offs by Type of Institution

	ILC Survey		METI Survey	
Type of Institution	#	%	#	%
National University	718	62.9	1054	70.1
Public University	69	6.0	115	7.7
Private University	406	35.6	592	39.4
Interuniversity Research Institute	2	0.2	–	–
Technical Junior College	19	1.7	31	2.1
Total	1141	–	1503	–

Source: ILC (2006) and METI (2006)

Note: Firms from multiple institutions are double-counted in this table.

Table 3: Major Academic Institutions Ranked by the Number of Spin-offs

Names of Institutions	Type of Institution	Number of firms: ILC Survey	Number of firms: METI Survey
Waseda University	Private	75	75
Osaka University	National	50	71
Keio University	Private	46	50
Kyoto University	National	44	59
University of Tsukuba	National	42	57
University of Tokyo	National	41	92
Kobe University	National	34	33
Nihon University	Private	33	29
Tohoku University	National	31	48
Kyushu University	National	30	44
Kyushu Institute of Technology	National	29	40
Tokyo Institute of Technology	National	28	39
Hokkaido University	National	27	36
Kochi University of Technology	Private	23	27
Tokyo University of Agriculture and Technology	National	21	28
Yamaguchi University	National	20	23
Ryukoku University	Private	19	32
Hiroshima University	National	19	28
Ritsumeeikan University	Private	18	30
Nagoya University	National	18	28
University of Tokushima	National	16	25
University of Aizu	Private	16	19
Okayama University	National	13	19
Kinki University	Private	12	17
Nagoya Institute of Technology	National	12	13
Kyoto Institute of Technology	National	11	18
Iwate University	National	11	15
Gifu University	National	10	12
Doshisha University	Private	10	12
Nagaoka University of Technology	National	10	11
Otaru University of Commerce	National	10	6

Source: ILC (2006) and METI (2006)

Note 1: Only academic institutions reporting equal to or more than nine spin-offs in the ILC survey are included in this table.

Note 2: Firms from multiple institutions are double-counted in this table.

Table 4: Outlook for Higher Education in Japan

Type of Institutions	I # of institutions	II # of faculty members	III # of students	IV # of faculty per institution	V # of students per institution	VI # of students per faculty
National University	87	60,937	627,850	700.4	7216.7	10.3
Public University	86	11,426	124,910	132.9	1452.4	10.9
Private University	553	89,327	2,112,291	161.5	3819.7	23.6
Technical Junior College	63	4,469	59,160	70.9	939.0	13.2
Total	789	166,159	2,924,211	210.6	3706.2	17.6

Source: Ministry of Education, Culture, Sports, Science, and Technology '2005 School Basic Survey'

Note 1: The number of students includes undergraduates and postgraduates.

Note 2: Interuniversity research institutes are not included in the survey.

Table 5: Academic Spin-offs by Business Domain

ILC Survey

	#	%
IT	332	29.1
Life science	165	14.5
Consulting	109	9.6
Electronics and machinery/robotics	112	9.8
Food science	57	5.0
Nanotechnology and material science	56	4.9
Health support	52	4.6
Environment	45	3.9
Civil engineering and urban planning	31	2.7
Chemical	28	2.5
Energy	28	2.5
Others	126	11.0
Total	1141	100.0

Note: Data compiled by the authors from the ILC 2005 first-wave survey.

METI Survey

	#	%
Biotechnology	568	37.8
IT (Hardware)	175	11.6
IT (Software)	455	30.3
Material	161	10.7
Machinery and equipment	255	17.0
Environment	137	9.1
Energy	49	3.3
Education	58	3.9
Others	288	19.2
Total	1503	-

Source: METI (2006)

Note: The total number of firms exceeds the 1,503 firms in the METI survey because of classification into more than one business domain.

Table 6: Regional Distribution of Academic Spin-offs

	ILC Survey		METI Survey	
Area	#	%	#	%
1 Hokkaido	51	4.6	59	3.9
2 Aomori	4	0.4	4	0.3
3 Iwate	16	1.4	21	1.4
4 Miyagi	23	2.1	35	2.3
5 Akita	4	0.4	12	0.8
6 Yamagata	8	0.7	10	0.7
7 Fukushima	22	2.0	23	1.5
8 Ibaraki	40	3.6	53	3.5
9 Tochigi	5	0.5	5	0.3
10 Gunma	11	1.0	11	0.7
11 Saitama	11	1.0	17	1.1
12 Chiba	9	0.8	17	1.1
13 Tokyo	283	25.5	369	24.6
14 Kanagawa	64	5.8	104	6.9
15 Niigata	8	0.7	12	0.8
16 Toyama	5	0.5	3	0.2
17 Ishikawa	14	1.3	17	1.1
18 Fukui	1	0.1	3	0.2
19 Yamanashi	5	0.5	7	0.5
20 Nagano	2	0.2	4	0.3
21 Gifu	15	1.4	11	0.7
22 Shizuoka	14	1.3	21	1.4
23 Aichi	41	3.7	64	4.3
24 Mie	9	0.8	13	0.9
25 Shiga	25	2.3	38	2.5
26 Kyoto	57	5.1	92	6.1
27 Osaka	84	7.6	107	7.1
28 Hyogo	36	3.2	45	3.0
29 Nara	1	0.1	3	0.2
30 Wakayama	10	0.9	11	0.7
31 Tottori	6	0.5	7	0.5
32 Shimane	3	0.3	10	0.7
33 Okayama	21	1.9	23	1.5
34 Hiroshima	23	2.1	36	2.4
35 Yamaguchi	19	1.7	23	1.5
36 Tokushima	15	1.4	18	1.2
37 Kagawa	8	0.7	11	0.7
38 Ehime	4	0.4	6	0.4
39 Kochi	18	1.6	20	1.3
40 Fukuoka	71	6.4	89	5.9
41 Saga	4	0.4	7	0.5
42 Nagasaki	7	0.6	16	1.1
43 Kumamoto	8	0.7	9	0.6
44 Oita	7	0.6	10	0.7
45 Miyazaki	7	0.6	6	0.4
46 Kagoshima	6	0.5	11	0.7
47 Okinawa	4	0.4	10	0.7
Total	1109	100.0	1503	100.0

Source: METI (2006) and author compilation from the ILC 2005 first-wave survey.

Note 1: Headquarters information used to construct table.

Note 2: Headquarters information unavailable for some firms in the ILC survey.

Table 7: Description of Academic Spin-offs

	National University	Public University	Private University	Interuniversity Research Institute	Technical Junior College	Total
Total no of institutions	87	73	556	11	63	790
# of responses to the survey	87	52	373	11	61	645
# of institutions establishing spin-offs	68	21	78	1	14	182
%	78.2	28.8	14.0	9.1	22.2	23.0
# of spin-offs	718	69	406	2	19	1141
Types of organizational form						
Stock corporation	512	41	263	2	12	767
Private limited company	186	24	115	0	6	321
Others	20	4	28	0	1	53
Relationships with academic institutions (multiple choice)						
Transfers of human resources	463	47	308	0	5	767
Transfer of nonpatented technology	423	36	163	2	8	588
Transfer of patented technology	299	15	108	0	11	400
Financing	122	7	56	0	2	169

Note 1: The rows sum to more than 1,141 spin-off firms because of the double counting of firms established by multiple institutes.
Note 2: Data compiled by the authors from the ILC 2005 first-wave survey.

Table 8: Support for Start-ups from Academic Institutions

	National University	Public University	Private University	Interuniversity Research Institute	Technical Junior College	Total
Support units for spin-offs						
Exist (either on- or off-campus)	66	19	81	4	28	198
Do not exist	20	33	288	6	33	380
Missing	1	0	4	1	0	6
Incubation facilities						
Exist (either on- or off-campus)	42	8	37	0	10	97
Do not exist	33	33	235	9	32	342
Missing	12	11	101	2	19	145

Note: Data compiled by the authors from the ILC 2005 first-wave survey.

Table 9: The Status Quo of Academic Spin-offs

Firm characteristics	Mean	Median	S.D.	#
Sales (in millions of yen)	94.9	18	253.6	205
Profit (in millions of yen)	–11.3	0	111.9	186
Capital (in millions of yen)	99.8	10	320.4	266
Number of executives	4.2	4	2.2	215
Number of employees	7.8	4	11.0	255

Current stage in new venture life cycle (%)	
Seed/start-up	31.4
Early stage	49.1
Expansion stage	15.9
Later stage	0.7
Other	2.9
Total	100.0

n = 273

Supports for spin-offs from academic institutions (%)	
Did not receive	36.1
Received	63.9
Types of supports received (multiple choice)	
Provision of physical space	24.3
Training	21.9
Provision of capital	6.1
Provision of business information	19.8
Use of devices and equipments	25.1
Approval of dual employment	25.5
Other	3.6

n = 269

Source: ILC (2006) and author compilation from the ILC 2005 second-wave survey.