Innovation Performance, Policy, and Infrastructure: A Comparison of Japan and the U.S.

By

Tomoko Oshi

B.A. in Business Administration
Aoyama Gakuin University, 1992

SUBMITTED TO THE MIT SLOAN SCHOOL OF MANAGEMENT IN PARTIAL FUFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF BUSINESS ADMINISTRATION
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JUNE 2012

Signature of Author: ______________________________
MIT Sloan School of Management
May 11, 2012

Certified By: ______________________________
Michael A. Cusumano
SMR Distinguished Professor of Management & Engineering Systems
MIT Sloan School of Management
Thesis Supervisor

Accepted By: ______________________________
Stephen J. Sacca
Director, Sloan Fellows Program, MIT Sloan School of Management

Innovation Performance, Policy, and Infrastructure: A Comparison between Japan and the U.S.

By

Tomoko Oshi

Submitted to the MIT Sloan School of Management on May 11, 2012, in partial fulfillment of the requirements for the degree of Master of Business Administration

ABSTRUCT

With flagship corporations in Japan struggling to complete a highly globalized market against increased competition from the US and Asia, the Japanese government has been striving to increase the competitiveness and improve the infrastructure for innovation. In order to regain its standing in the world market, the US government has also been stepping up its efforts to increase opportunities for innovation and strengthen critical partnerships between academia and the private sector. The different approaches taken will be analyzed in terms of their efficacy and ability to convert research into product development and, ultimately, commercialization.

This thesis will explore the nations and companies that are seen as innovative in order to understand the critical factors for success. Also, the drivers of innovation will be looked at in detail and then applied to both a Japanese and US context. As the government plays a fundamental role in fostering innovation, the Japanese public sector's contribution and the US government's approach will be looked at in detail and then compared and contrasted in order to decipher the most effective policies for each country. Additionally, academia's role in promoting innovation will be highlighted, with MIT and Tokyo University acting as key examples for the ability of academic institutions to bridge the academic and business worlds.

From the comparisons of the roles of academia and government in both the US and Japan, several recommendations will be made. These will center on the US's approach to provide a robust framework in which innovation can thrive, which is contrast to Japan's approach, which relies more on government funding for R&D to quasi-governmental research institutions. The addition of the most successful components of strategies employed in the public sector and in academia in the US to Japan's current approach may provide improve collaborations across sectors and enhance the environment for innovation to thrive.

Thesis Supervisor: Michael A. Cusumano
Title: SMR Distinguished Professor of Management & Engineering Systems
MIT Sloan School of Management

Acknowledgements

As I worked on this thesis as a member of MIT Sloan Fellows Program in Innovation and Global Leadership, the professors and colleagues of the Class of 2012 all played a pivotal role in helping me to gain a broader perspective and enhance my academic experience this year. I would like to extend my sincere thanks and appreciation to many individuals:

Professor Michael A. Cusumano for his superb direction of my thesis and his assistance throughout my research activities, which were always decisive, straightforward, and supportive.

Ms Kerianne R. Panos, President of MCML Consulting Services, LLC, for her enormous support in working with me to develop and edit my thesis and the sharing of her cross-cultural and entrepreneurial perspectives.

Professor Ezra F. Vogel, Harvard University, for providing me the opportunity to interview him and sharing with me his insightful perspective on Japanese business leaders.

Professor Hirotaka Takeuchi, Harvard University, for providing me the opportunity to interview him and sharing his insightful perspectives on the relationship between academia and private sector in Japan.

Mr. Stephen J. Sacca, for his superb efforts in coordinating the Sloan Fellows Program.

Finally, I would like to thank my Colleagues in the Class of 2012, MIT Sloan Fellows Program in Innovation and Global Leadership, for their support and encouragement as well as their insightful opinions and comments that truly broadened my perspective and outlook.

Tomoko Oshi
May, 2012
Boston, Massachusetts

Table of Contents

Introduction

On December 24, 2011, the Japanese Government announced its "Strategy for the Rebirth of Japan," which recognized that Japan has continued to face the pressing issue of "the lost decades," during which the country has dealt with the Great East Japan Earthquake, a nuclear power plant crisis, appreciation of the yen and worldwide volatilities in the financial markets. The term "the lost decades" has been widely used in reference to Japan by economists and policy makers around the world. For Japan, the value lost -- and competitiveness lost-- during those decades in terms of its economy has been tremendous. This report was published just six months after the announcement from the Japanese Government estimating the extent of the damage from the Great East Japan Earthquake, which totaled almost $211.25 billion, of 4% of Japan's GDP[1]. To reinvigorate the Japanese economy and restore competitiveness, the report mentioned that "Japan needs creative innovation rooted in the global economy and a future focused on a renewed economic/industrial structure rather than a past-looking perspective that is bogged down with the systems and policies that were once effective. It is imperative to recognize that there is a far greater risk in doing nothing than there is in embarking on something new." [Cabinet Office,the Government of Japan, 2011]

In the past, Japanese companies created by prominent leaders, such as Sony (Masaru Ibuka and Akio Morita), Honda (Soichiro Honda), TOYOTA (Kiichiro Toyoda), certainly left their footprint on the history of global business as achievers/creators of highly innovative products. They embraced the development of a new global market, and succeeded in acquiring a large market share. From this initial push from domestic to global, the presence and power of Japanese companies increased. "The Great Disruption", an essay by Clayton Christensen, Thomas Craig and Stuart L. Hart mentioned that the high levels of Japanese economic growth from the 1960s to the 1980's can be attributed to the disruptive innovation of Sony, Toyota, Nippon Steel Corporation, Canon, Seiko and Honda. Those once innovative Japanese firms seem now stuck in

[1]Reuters news, June 24,2011 http://jp.reuters.com/article/topNews/idJPJAPAN-21870220110624 $1=¥80

Japan's Gross domestic product, current prices 2010: 5,488.424 Billion U.S. dollars /International Monetary Fund, World Economic Outlook Database, April 2012 the high-end market, which they originally created using disruptive innovation. [Clayton Christensen, 2001]

Given these now less favorable conditions, it is difficult to state with confidence that Japanese companies can retain the market share they established in a more globalized business world and maintain the same level of competitiveness. While many the US companies, such as Apple, Microsoft, Google, Amazon and Facebook, maintain powerful presences as innovators in the world, the same may not be said of Japanese companies at this time. Also of note is that established companies in the US, like GE or P&G, continue to introduce new systems and pursue innovation while maintaining strong positions in the global market.

In terms of innovation, who are the game changers in the global business world? Who or what changes the rules of game in terms of innovation? The prevailing view is that the competitive advantage Japanese companies held in the past was no longer viable given the transformations to the global business environment. Professor Ezra F. Vogel of Harvard University mentioned that, compared to past Japanese business leaders, the current business executives seem to be reluctant to take risks. In addition, Professor Hirotaka Takeuchi of Harvard noted that Japanese academia constructs a more closed culture mores than Japanese companies. The issue for Prof. Takeuchi is that Japanese government policies determine the direction of R&D, thereby leading to academia's exclusivity, and an increased distance between the academic and business worlds. After considering these viewpoints, it seems that the themes of "Not Taking Risks" and "Exclusivity" are key points that seem to substantially affect the outcome of innovation. Moreover, these themes also seem to closely relate to tenets in Japanese culture. If culture plays a role in the reason behind a period-specific trend for innovation, it seems then important to foster a cultural shift so as to regain competitiveness and foster innovation. Scholars in the field of linguistics have noted the correlations between linguistic structures and cultural phenomena. Given the numerous differences between Japanese and English, it is evident that value systems and societal norms would greatly differ, and from this, it is possible to extrapolate that the way in which the two societies view innovation would also differ.

"Since innovation is by nature an uncertain process, it is impossible to prove innovation by utilizing data or past experiences. However, innovation processes can be managed by appropriate approaches" [D.Anthony, 2011]. From reading this passage, it became clear that, there may be several underlying reasons for why the Japanese capability to innovate is diminishing. With the exception of cultural differences, it may be also possible to clarify ways to measure innovation and to focus on what factors drive innovation.

The preliminary chapter of the thesis begins by reviewing reports issued by the Boston Consulting Group (BCG) and the European Commission (EC), which focus on the world's most innovative companies and countries. Both assess the ranking of companies and countries while also analyzing the indicators both the two institutes find to be the most effective. Then, four innovation drivers are analyzed and the innovation policies implemented by Japan and the US using those criteria are discussed. The conditions for creating innovation are not only governed by government policies, but are also based on business strategies used in the private sector and research foci of academia. However, since the government plays a central role in determining policy in Japan, emphasis will applied to how the Japanese government determines which policies to develop and implement. Additionally, an analysis of the results of the government's innovation strategy will be undertaken in order to determine their efficacy. A particular focus will be paid to how policy is developed that will generate innovation in both the Japanese and the US Government. Finally, by comparing two national policies and clarifying the differences, possible improvements to Japan's innovation policy will be suggested. Implementing policies to improve innovation drivers will lead an enhancement of the country's innovation infrastructure, which will carry over into a more robust infrastructure in both the private sector and academia.

Chapter1. Is U.S. the Most Innovative Country?

Which country - Japan or the United States - promotes innovation better? People most likely answer it's the US, as there are many innovative companies in the US, such as Apple, Google, Microsoft and Amazon, and these companies penetrated the Japanese market. When you compare the degree of "innovation" among global companies or between countries, are there any objective data to use? What aspect determines whether or not a company or a country is innovative? To investigate this, different set of data is used to assess current status of innovation in Japan and the US.

1.1 World's Most Innovative Companies

According to a Bloomberg BusinessWeek survey, when looking at "(t)he 50 most innovative companies in 2010, compared to 2005, there is a significant change in that the majority of corporations in the Top 25 are based outside the US. In 2009, the Top 25 were occupied over 50% by the US companies (13 to 25), and there were no Chinese companies ranked. However, in 2010, the number of the US and Japanese companies ranked dropped off by one (US: from 13 to 12; Japan: from 4 to 3) and South Korea increased the number of companies ranked in the top 25 (South Korea: from 1 to 2) and one Chinese company ranked for the first time since the survey started in 2005."

Bloomberg BusinessWeek's Most Innovative Companies special report is based on data from the Boston Consulting Group (BCG). BCG e-mailed a 21-question poll to senior executives around the globe. The 1,590 respondents, who answered anonymously, were asked to name the most innovative companies from outside their own industry in 2009. BCG then factored in the financial performance of the top vote-getters. The final list weights the survey results as follows: survey results 80%, stock returns10%, three-year revenue 5% and margin growth 5%. Thus, the rankings were based on subjective perspectives, even though the filter of quantitative business performance was used. Since this survey has been conducted for seven years, it will be possible to compare the results of the ranking from year to year, which will show a trend or pattern in terms of which company has continued to be innovative around the world. (Figure1)

In the 2010 survey, the top five companies were Apple, Google, Microsoft Corporation, IBM Corporation and Toyota Motor Corporation. There were six US-based companies ranked in the top ten (Apple, Google, Microsoft Corporation, IBM Corporation, Amazon.com and General Electric Company), one based in Japan (Toyota Motor Corporation), one based in South Korea (LG Electronics) and one based in China (BYD Company). With the majority of the top ten innovative companies, the US is clearly dominant. In the case of Japan, five companies ranked in the top 50 most innovative companies in 2010: Toyota Motor Corporation (5th), Sony Corporation (10th), Nintendo (20th), Honda Motor Company (26th) and Fast Retailing Company (27th).

Looking at the rankings of the most innovative companies in the world for five years (2006-2010), three trends can be listed. First, despite the notion that the Japanese companies are losing their global competitiveness, several of them have been consistently ranked in top 50, such as automobile, electronics and entertainment (game) companies. In 2010, in addition to the aforementioned companies, apparel companies made it to the list. This demonstrates that the variety of industries started to be part of the innovation, although Japan did not see the increase in number of companies that were ranked in the top 50. Second, companies from South Korea and China were newly ranked in the list. Third, the status of this top 50 list, which the US companies used to occupy, has changed, with 2010 being a clear example. What's common among the non-US companies in the list is that they don't focus on where their headquarters should be located; rather, they strive to continue to expand their business globally. This trend enabled companies to pursue innovation while leading to a fiercer competition for a globalization.

(Figure2)

Rank	2008		Rank	2009		Rank	2010	
1	Apple		1	Apple		1	Apple	
2	Google		2	Google		2	Google	
3	Toyota Motor Corporation		3	Toyota Motor Corporation		3	Microsoft Corporation	
4	General Electric Company		4	Microsoft Corporation		4	IBM Corporation	
5	Microsoft Corporation		5	Nintendo		5	Toyota Motor Corporation	
6	Tata Group		6	IBM Corporation		6	Amazon.com	
7	Nintendo		7	Hewlett-Packard Development Company		7	LG Electronics	
8	Procter & Gamble		8	Research in Motion	Canada	8	BYD Company	
9	Sony Corporation		9	Nokia Corporation	Finland	9	General Electric Company	
10	Nokia Corporation	Finland	10	Wal-Mart Stores		10	Sony Corporation	
11	Amazon.com		11	Amazon.com		11	Samsung Electronics	
12	IBM Corporation		12	Procter & Gamble		12	Intel Corporation	
13	Research in Motion	Canada	13	Tata Group		13	Ford Motor Company	
14	BMW Group		14	Sony Corporation		14	Research in Motion	Canada
15	Hewlett-Packard Development Company		15	Reliance Industries		15	Volkswagen	
16	Honda Motor Company		16	Samsung Electronics		16	Hewlett-Packard Development Company	
17	The Walt Disney Company		17	General Electric Company		17	Tata Group	
18	General Motors Corporation		18	Volkswagen		18	BMW Group	
19	Reliance Industries		19	McDonald's		19	The Coca-Cola Company	
20	The Boeing Company		20	BMW Group		20	Nintendo	
21	The Goldman Sachs Group		21	The Walt Disney Company		21	Wal-Mart Stores	
22	3M		22	Honda Motor Company		22	Hyundai Motor Company	
23	Wal-Mart		23	AT&T		23	Nokia Corporation	Finland
24	Target Corporation		24	The Coca-Cola Company		24	Virgin Group	
25	Facebook		25	Vodafone Group		25	Protect & Gamble	
26	Samsung Electronics		26	Infosys Technologies Limited		26	Honda Motor Company	
27	AT&T		27	LG Electronics		27	Fast Retailing Company	
28	Virgin Group		28	Telefonia	Spain	28	Haier Electronics Group	
29	Audi		29	Daimler		29	McDonald's	
30	McDonald's		30	Verizon Communications		30	Lenovo	
31	DaimlerChryler Corporation		31	Ford Motor Company		31	Cisco Systems	
32	Starbucks Corporation		32	Cisco Systems		32	The Walt Disney Company	
33	eBay		33	Intel Corporation		33	Reliance Industries	
34	Verizon Communications		34	Virgin Group		34	Siemens Corporation	
35	Cisco Systems		35	ArcelorMittal	Indonecia	35	Dell	
36	ING Group	Dutch	36	HSBC Group		36	Nestle	Switzerland
37	Singapore Airlines	Singapore	37	Exxon Mobil Corporation		37	British Sky Broadcasting	
38	Siemens Corporation		38	Nestle	Swizerland	38	Vodafone Group	
39	Costoco Wholesale Corporation		39	Iberdrola	Spain	39	JPMorgan Chase & Company	
40	HSBC Group		40	Facebook		40	Oracle Corporation	
41	Bank of America Corporation		41	3M		41	Petrobras Bransileiro	Brazil
42	Exxon Mobil Corporation		42	Banco Santander	Spain	42	Banco Santander	Spain
43	News Corporation		43	Nike		43	Fiat Automobiles	Italy
44	BP		44	Johnson & Johnson		44	China Mobile	
45	Nike		45	Southwest Airlines		45	The Goldman Sachs Group	
46	Dell		46	Lenovo		46	Nike	
47	Vodafone Group		47	JPMorgan Chase & Company		47	HTC Corporation	taiwan
48	Intel Corporation		48	Fiat Automobiles	Italy	48	Facebook	
49	Southwest Airlines		49	Target Corporation		49	HSBC Group	
50	American Express Company		50	Royal Dutch Shell	Dutch	50	Verizon Communications	

United States	Japan	South Korea	China
india	Germany	United Kingdom	

Figure1. The Most Innovative Companies Top 50 in 2008-2010

Source: BCG 2008,2009,2010 Senior Executive Innovation Survey, modified by author

Rank	2006	
1	Apple	
2	Google	
3	3M	
4	Toyota Motor Corporation	
5	Microsoft Corporation	
6	General Electric Company	
7	Procter & Gamble	
8	Nokia Corporation	Finland
9	Starbucks Corporation	
10	IBM Corporation	

Rank	2007
1	Apple
2	Google
3	Toyota Motor Corporation
4	General Electric Company
5	Microsoft Corporation
6	Procter & Gamble
7	3M
8	The Walt Disney Company
9	IBM Corporation
10	Sony Corporation

Rank	2008	
1	Apple	
2	Google	
3	Toyota Motor Corporation	
4	General Electric Company	
5	Microsoft Corporation	
6	Tata Group	
7	Nintendo	
8	Procter & Gamble	
9	Sony Corporation	
10	Nokia Corporation	Finland

Rank	2009	
1	Apple	
2	Google	
3	Toyota Motor Corporation	
4	Microsoft Corporation	
5	Nintendo	
6	IBM Corporation	
7	Hewlett-Packard Development Company	
8	Research in Motion	Canada
9	Nokia Corporation	Finland
10	Wal-Mart Stores	

Rank	2010
1	Apple
2	Google
3	Microsoft Corporation
4	IBM Corporation
5	Toyota Motor Corporation
6	Amazon.com
7	LG Electronics
8	BYD Company
9	General Electric Company
10	Sony Corporation

Figure2. The Most Innovative Companies Top 10 in 2006-2010

Source: BCG 2006.2007,2008,2009,2010 Senior Executive Innovation Survey, modified by author

1.2 Which Countries are the Most Innovative?

BCG reported which countries are the most innovative in two categories: innovation inputs and innovation performance. Former refers to the effort a country makes to generate innovation and how well the country would cultivate the output. [James P. Andrew, 2009]

Innovation inputs consist of three categories: fiscal policy, other policies and innovation environment. Fiscal policy for innovation includes three topics: R&D tax credit, taxation level and government R&D funding. Other policies to support generating innovation are: education policy, trade policy, regulation and intellectual property policy, immigration policy and infrastructure policy. Innovation infrastructure is measured by the state of education, work force quality, infrastructure quality and business surroundings. All these thirteen areas of innovation inputs suggest that innovation should consist of funds for R&D, quality of human resources and less regulations and more protection for intellectual property rights. If an innovative ecosystem would include a plenty of money for R&D, the seeds of innovation are planted - highly talented people would be part of R&D and take initiatives to create such ecosystem. During the commercialization of innovation phase, the environment for competitiveness with less regulation and more protection for intellectual property rights will drive the creation of innovative products and services. (Figure 3)

The BCG concluded in the report that the most innovative country in 2008 was Singapore. The US was ranked eighth and Japan was the ninth, yet China was not ranked in top 20. According to the report, China was ranked at twenty-seventh and its score was less than half of U.S. and Japan (China 0.73, US 1.80, Japan 1.79.) In 2008, thirteen countries were European out of twenty countries ranked in the list. (Figure 4)

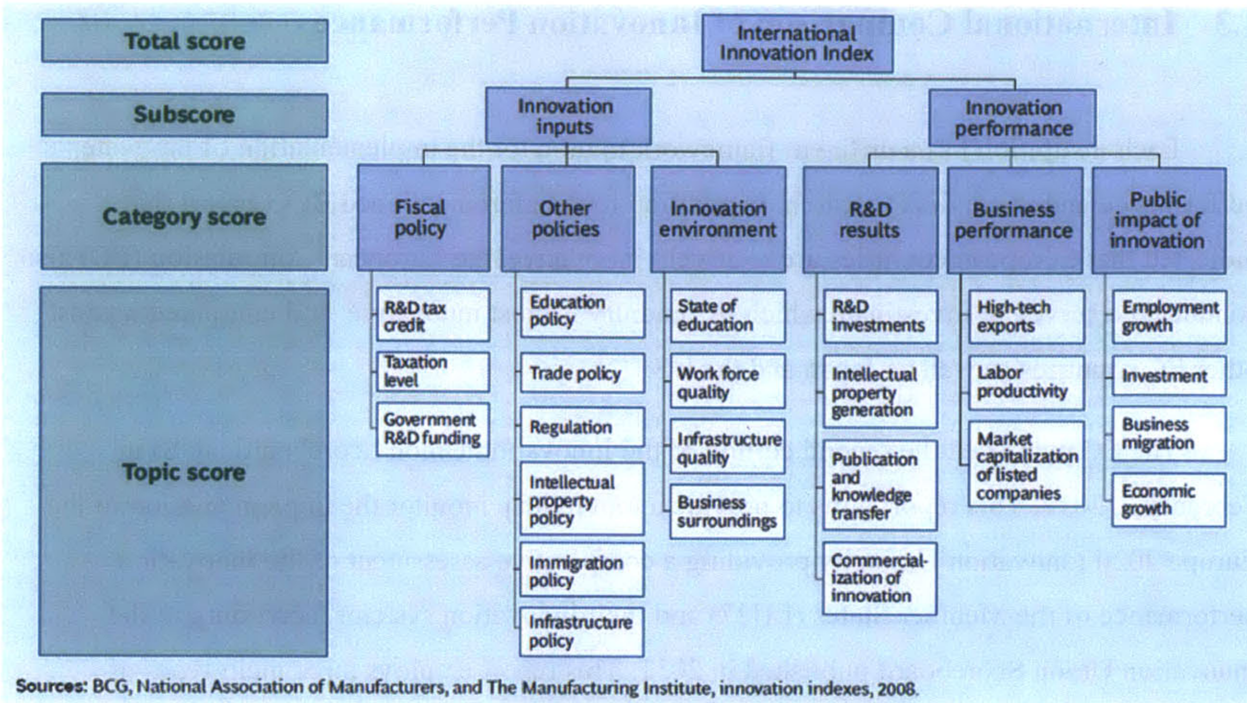


Figure3. The International Innovation Index

Source: BCG, National Association of Manufacturers, and The Manufacturing Institute, innovation indexes, 2008.

Overall ranking			Large-country ranking		
Ranking	Country	Score	Ranking	Country	Score
1	Singapore	2.45	1	South Korea	2.26
2	South Korea	2.26	2	United States	1.80
3	Switzerland	2.23	3	Japan	1.79
4	Iceland	2.17	4	Sweden	1.64
5	Ireland	1.88	5	Netherlands	1.55
6	Hong Kong	1.88	6	Canada	1.42
7	Finland	1.87	7	United Kingdom	1.42
8	United States	1.80	8	Germany	1.12
9	Japan	1.79	9	France	1.12
10	Sweden	1.64	10	Australia	1.02
11	Denmark	1.60	11	Spain	0.93
12	Netherlands	1.55	12	Belgium	0.86
13	Luxembourg	1.54	13	China	0.73
14	Canada	1.42	14	Italy	0.21
15	United Kingdom	1.42	15	India	0.06
16	Israel	1.36	16	Russia	-0.09
17	Austria	1.15	17	Mexico	-0.16
18	Norway	1.14	18	Turkey	-0.21
19	Germany	1.12	19	Indonesia	-0.57
20	France	1.12	20	Brazil	-0.59

Sources: BCG, National Association of Manufacturers, and The Manufacturing Institute, innovation indexes, 2008.
Note: Countries in the large-country ranking are the top 20 countries in the world by GDP. Because of rounding, two or more countries may appear to have the same overall score. For the purposes of these rankings, Hong Kong is considered a national entity.

Figure4. The 20 Countries on the International Innovation Index

Source: BCG, National Association of Manufacturers, and The Manufacturing Institute, innovation indexes, 2008.

1.3 International Comparison of Innovation Performance

Each institution has a different framework to monitor the implementation of innovate performance and to conduct research. In addition to the aforementioned BCG report that indicated that European countries are relatively innovative, the European Commission (EC) also conducted a survey to investigate which EC country is most innovative, and compared against other EC countries as well as Japan and the US.

The EC published the second edition of the Innovation Union Scoreboard (IUS) in February 7, 2012. This report aims to provide a tool to help monitor the implementation of the Europe 2020 Innovation Union by providing a comparative assessment of the innovation performance of the Member States (EU27) and their innovation systems, according to the Innovation Union Scoreboard published in 2011. This report employs three main types of indicators and eight innovation dimensions, capturing a total of twenty five different indicators. (Figure 5)

The report reveals that the main drivers of innovation performance that also constitute the innovation infrastructure are Human Resources, open, excellent and attractive research systems, and finance support within the country. In the contrast, the three innovation efforts that firms make are investments, linkages and entrepreneurship, and intellectual assets. The three main drivers and the three innovation efforts are the foundation of "inputs to innovation."

The EC measured outputs of innovation performance with two dimensions and eight indicators. The two dimensions are how much the country can increase innovators, and how much economic impact an innovation would cause to the country. Innovators usually use SMEs to measure products, processes, marketing and organizational innovations. Economic impacts are measured by employment in knowledge-intensive activities, medium and high-tech products exports and licenses, and patent revenues from abroad. On the other hand, Japan measures innovation performance by using more limited means: the ratio of research expenses to Gross Domestic Product (GDP), and the number of patents. The US measures innovation performance by placing a disproportionate emphasis on indicators that are more difficult to quantify the exact effects of innovation, such as customer satisfaction and economic growth. The indicators that the

EC adopt to measure innovation performance are the most rational and objective. [Innovtion Union Scoreboard, 2011]

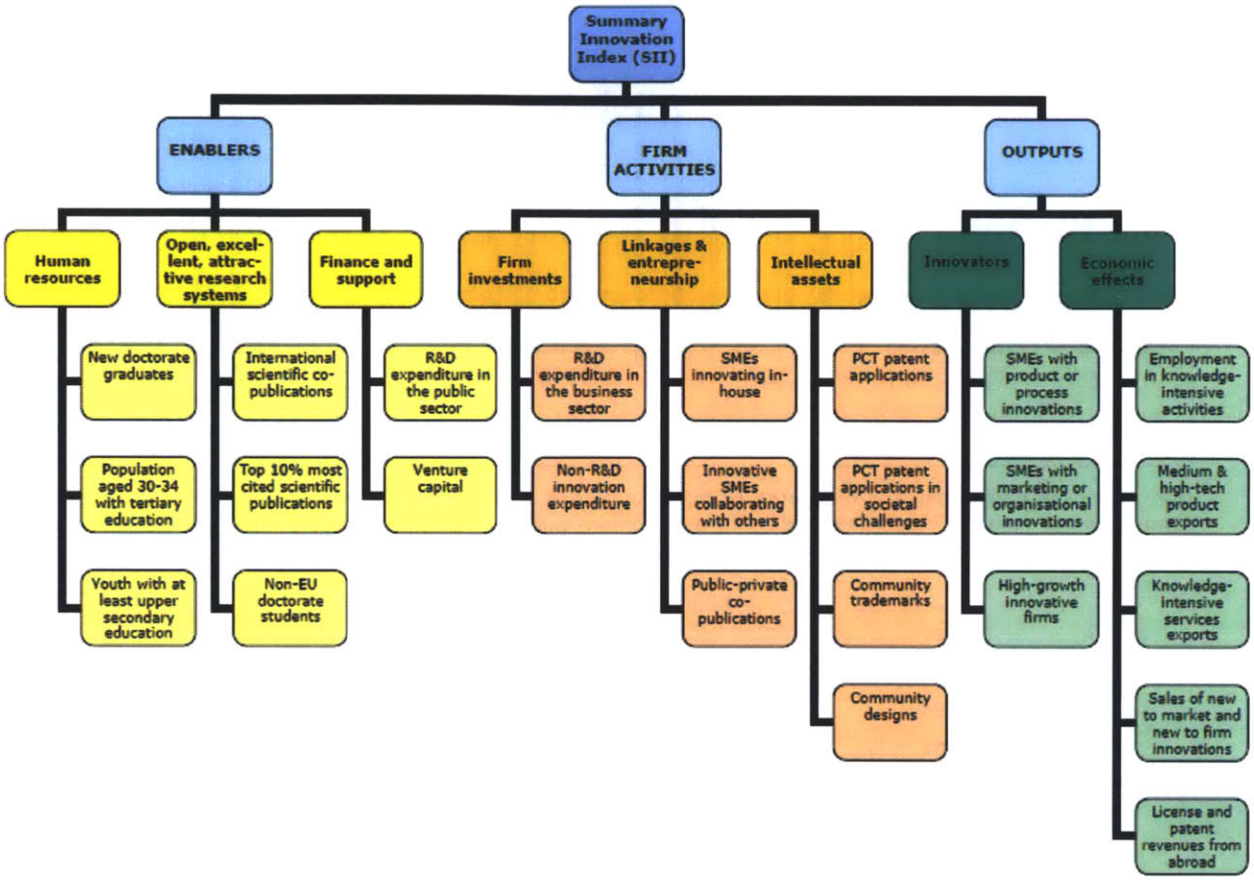
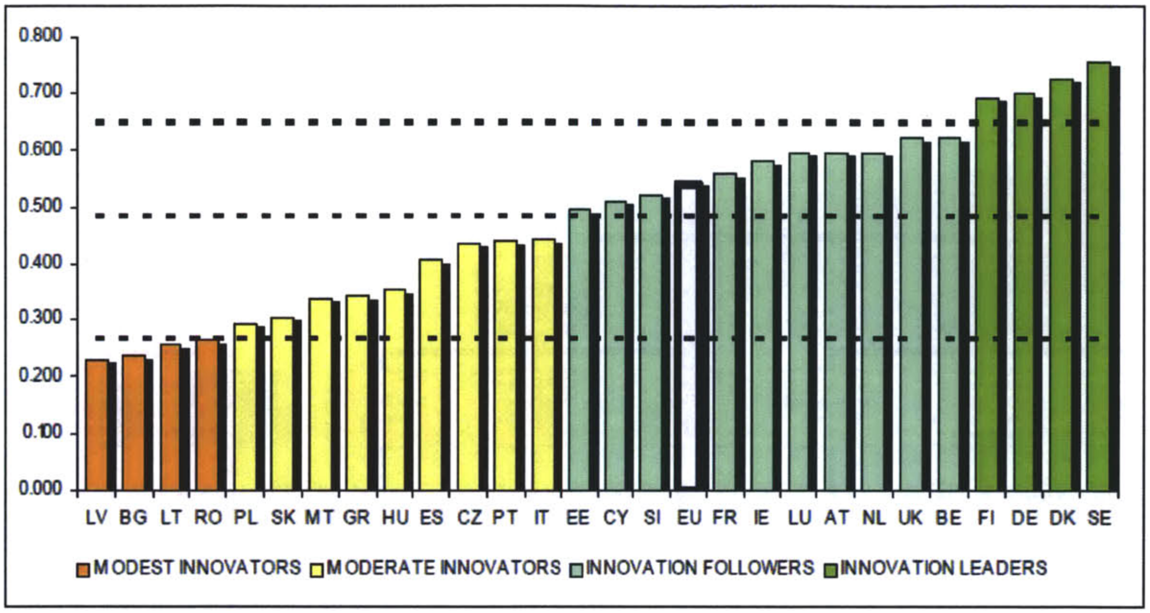


Figure5. Framework of the Innovation Union Scoreboard

Source: The Report, Innovation Union Scoreboard 2011, 7 February 2011

According to the EC report, EU27 and other European countries fall into four performance groups:

- Innovation leaders: *Switzerland, Sweden, Denmark, Germany and Finland*
- Innovation followers: *Belgium, UK, Iceland, The Netherlands, Austria, Luxembourg, Ireland, France, Slovenia, Cyprus and Estonia*
- Moderate innovators: *Norway, Italy, Portugal, Czech Republic, Spain, Hungary, Greece, Malta, Croatia, Slovakia and Serbia*
- Modest innovators: *Romania, Lithuania, Former Yugoslav Republic of Macedonia, Bulgaria, Latvia and Turkey* (Figure6)



Note: Average performance is measured using a composite indicator building on data for 24 indicators going from a lowest possible performance of 0 to a maximum possible performance of 1. Average performance in 2011 reflects performance in 2009/2010 due to a lag in data availability.

AT	Austria	IS	Iceland
AU	Australia	IT	Italy
BE	Belgium	JP	Japan
BG	Bulgaria	KR	South Korea
BR	Brazil	LT	Lithuania
CA	Canada	LU	Luxembourg
CH	Switzerland	LV	Latvia
CN	China	MK	Former Yugoslav Republic of Macedonia
CY	Cyprus	MT	Malta
CZ	Czech Republic	NL	Netherlands
DE	Germany	NO	Norway
DK	Denmark	PL	Poland
EE	Estonia	PT	Portugal
ES	Spain	RO	Romania
EU27	EU27	RS	Serbia
FI	Finland	RU	Russia
FR	France	SA	South Africa
FYROM	Former Yugoslav Republic of Macedonia	SE	Sweden
GR	Greece	SI	Slovenia
HR	Croatia	SK	Slovakia
HU	Hungary	TR	Turkey

Figure6. European Countries' Innovation Performance

Source: The Report, Innovation Union Scoreboard 2011, 7 February 2011, modified by author.

The EU Innovation Union Score Board (IUS) was obtained by studying EU countries, Australia, the BRICS (Brazil, China, India, Russia and South Africa), Canada, Japan, South Korea and the US. For this study, a set of twelve indicators were used.

The level of Human Resources was measured by the number of doctorate graduates per population who age from twenty five to sixty four. The level of open, excellent and attractive research systems were defined by the per-population availability of international scientific co-publications and publications that are among the top 10% most cited publications world-wide. The level of finance support was measured by the R&D expenditure in the public sector and the GDP. The level of firm investments was determined by the R&D expenditure in the business sector and the GDP. The level of linkages and entrepreneurship was measured by how many public and private companies exist, and how many co-publications are available, per population. The level of intellectual assets was determined by patent applications per GDP. The level of economic effects was determined by medium and high-tech product exports as percentage of total product exports, knowledge-intensive services exports as percentage of total service exports and license and patent revenues from abroad as percentage of GDP. [Innovtion Union Scoreboard, 2011] (Figure 7)

Main type / innovation dimension / indicator	Data source	Most recent year	Date not available for
ENABLERS			
Human resources			
1.1.1 New doctorate graduates (ISCED 6) per 1000 population aged 25-34	OECD / Eurostat	2009	CN, IN, SA
1.1.2 Percentage population aged 25-64 having completed tertiary education	OECD / World Bank / Eurostat	2008	
Open, excellent and attractive research systems			
1.2.1 International scientific co-publications per million population	Science-Metrix / Scopus	2010	AU, CA, SA
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	Science-Metrix / Scopus	2007	AU, CA, SA
Finance and support			
1.3.1 R&D expenditure in the public sector as % of GDP	OECD / Eurostat	2009	
FIRM ACTIVITIES			
Firm investments			
2.1.1 R&D expenditure in the business sector as % of GDP	OECD / Eurostat	2009	
Linkages & entrepreneurship			
2.2.3 Public-private co-publications per million population	CWTS / Thomson Reuters	2008	
Intellectual assets			
2.3.1 PCT patents applications per billion GDP (in PPS€)	OECD / Eurostat	2008	BR, IN
2.3.2 PCT patents applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	OECD / Eurostat	2008	SA
OUTPUTS			
Economic effects			
3.2.2 Medium and high-tech product exports as % total product exports	UN / Eurostat	2010	
3.2.3 Knowledge-intensive services exports as % total service exports	UN / Eurostat	2009	SA
3.2.5 License and patent revenues from abroad as % of GDP	World Bank / Eurostat	2010	

Figure7. Indicators Used in the International Comparison

Source: The Report, Innovation Union Scoreboard 2011, 7 February 2011

The US, Japan and South Korea surpassed the average EU innovation performance. The US and Japan decreased innovation performance and South Korea showed a remarkable growth in innovation performance. (Figure 8)

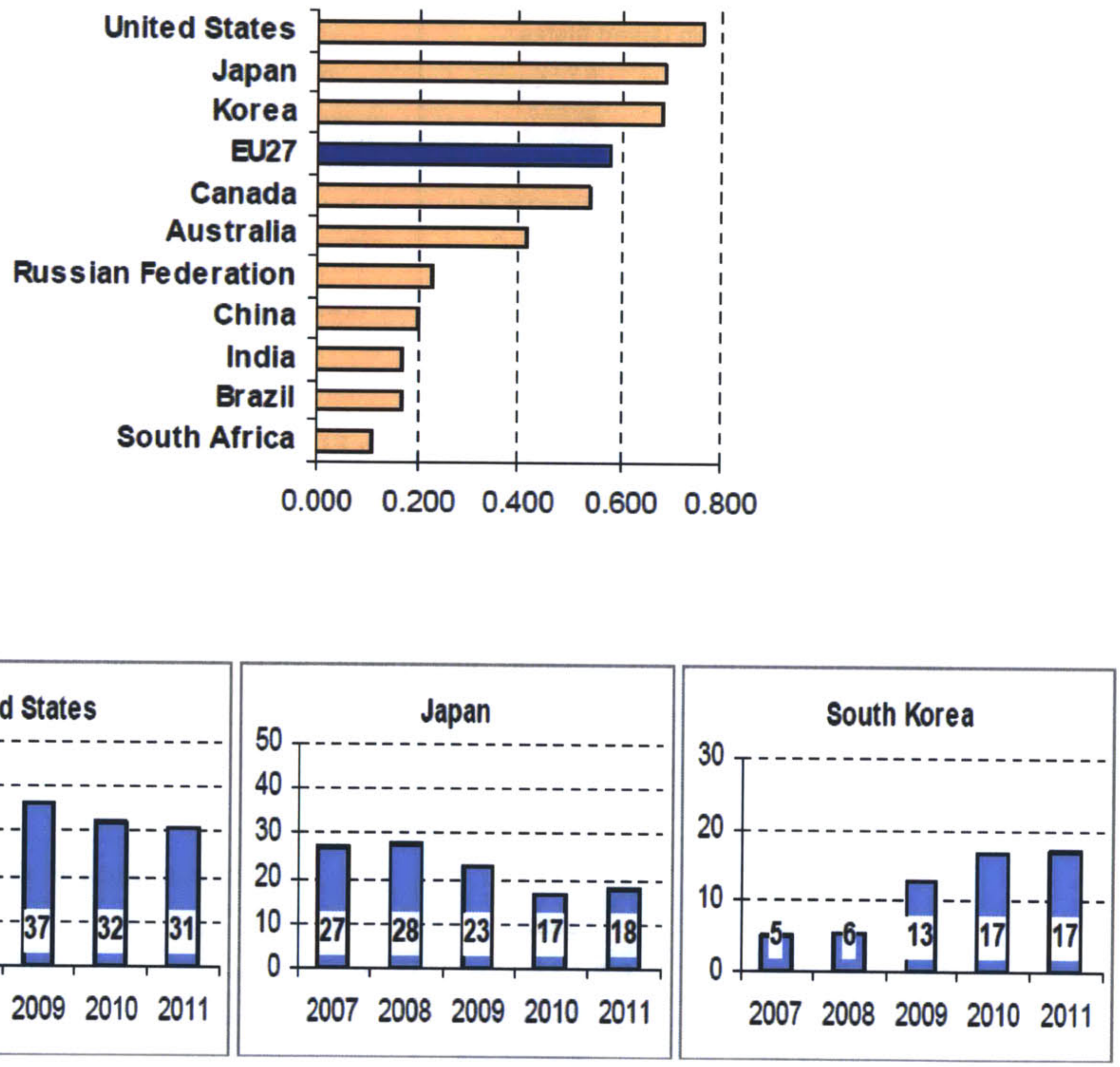


Figure8. Innovation Performance in the International Comparison

Source: The Report, Innovation Union Scoreboard 2011, 7 February 2011, modified by author.

According to the EU IUB report, the US performs better on ten indicators out of twelve, compared to the EU. In particular, the US leads performance in tertiary education, R&D expenditure in business sector and public-private co-publications. The U.S. has increased its lead in doctorate degrees, R&D expenditure in the business sector and knowledge-intensive services exports. (Figure 9)

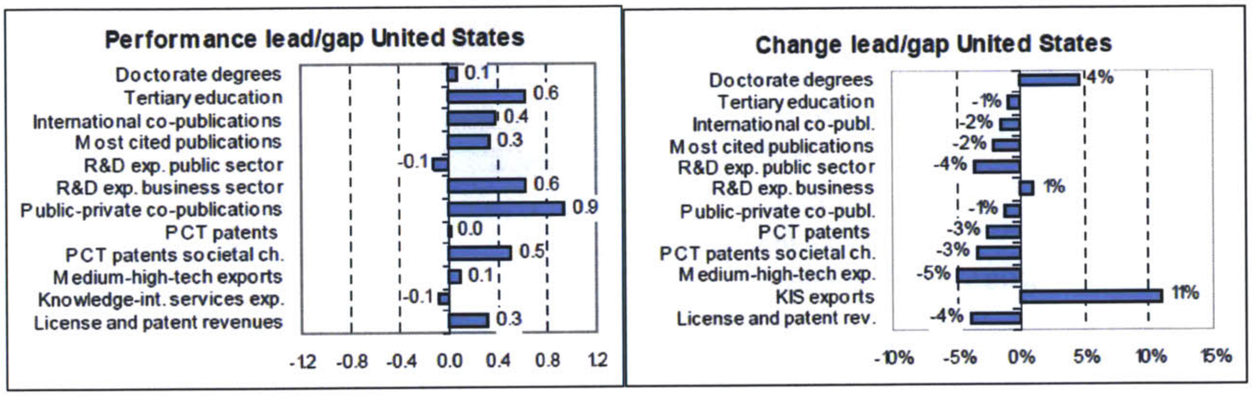


Figure9. Innovation Performance in EU27-the US Comparison

Source: The Report, Innovation Union Scoreboard 2011, 7 February 2011,modified by author

Japan is superior in seven indicators, in particular, R&D expenditure in the business sector and Patent Cooperation Treaty (PCT) patent applications. Japan has increased its lead in doctorate degrees and PCT patents. (Figure 10)

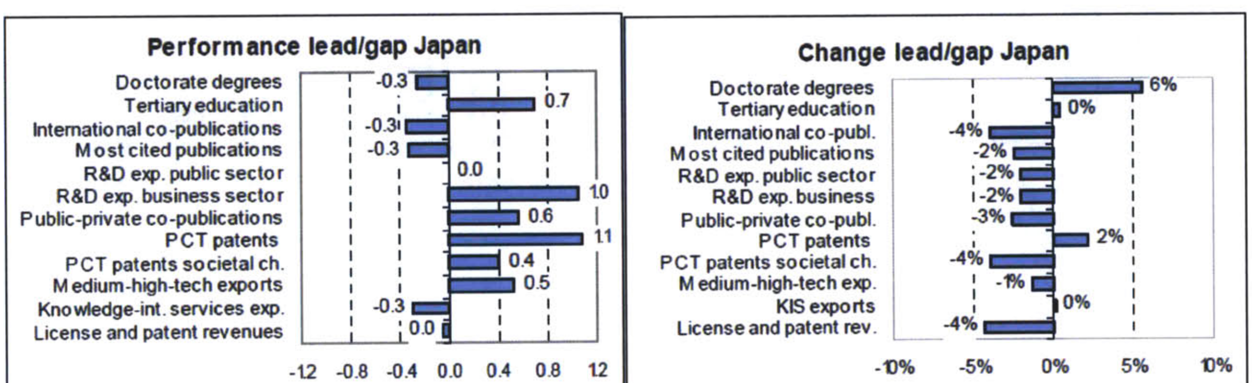


Figure10. Innovation Performance in EU27-Japan Comparison

Source: The Report, Innovation Union Scoreboard 2011, 7 February 2011, modified by author.

South Korea leads its performance in seven indicators, also in R&D expenditure in the business sector and PCT patent applications. It also leads performance in knowledge-intensive services exports, which is one of the indicators that Japanese performance is lower than the EC.

South Korea has increased its lead in tertiary education, R&D expenditure in the business sector, PCT patents and knowledge-intensive services exports. (Figure11)

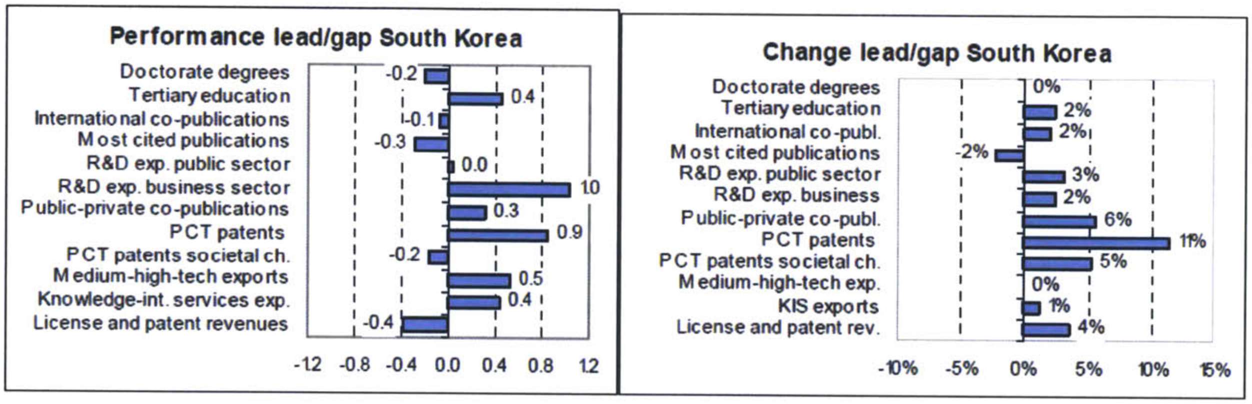


Figure11. Innovation Performance in EU27-South Korea Comparison

Source: The Report, Innovation Union Scoreboard 2011, 7 February 2011, modified by author.

The results of the survey demonstrate that South Korea is promoting innovation. By contrast, the US and Japan have lost their competitiveness in driving innovation. [Innovtion Union Scoreboard, 2011]

1.4 Measure the Success of Innovation

How do companies measure their success in innovation? More importantly, what drives innovation? In order to analyze critical drivers that generate innovation, measurements should be employed to accurately compare among companies or countries.

The BCG report proposed ten alternatives to measure innovation: customer satisfactions, overall revenue growth, percentage of sales from new products or services, higher margins, new product success ratios, return on innovation spending, projected and actual performance, number of new products and services, time to market and patents.

The survey showed that two most important measurements for innovation are customer satisfaction and overall revenue growth. The latter is possible to quantify but the former is too vague to understand its exact effect on innovation. For example, the number of customers who use new products or services can be quantified, thus the data can be used to measure the level of innovation. However, customer satisfaction is too subjective; companies need to establish quantifiable measurements to assess customer satisfaction. Once the measurement for customer satisfaction is established and is measured accurately, it could act as a driver of innovation.

Innovation is necessary for companies and countries to pursue sustainable economic growth. True innovation is only possible when generated to reflect consumer trends so that as a result, innovation could serve as something new that impact people and society in positive way.

The EU IUB survey used more concrete measures to determine the success of innovation. As previously discussed, the IUB used three categories of measurements: enables, firm activities and outputs. Enables and firm activities are elements of inputs for innovation, and the measures for the IUB survey emphasized on inputs rather than outputs.

The category of enables consists of three factors: human resources, open, excellent and attractive research systems and finance support. The factor of human resources used two indicators: new doctorate graduates per 1000 population aged 25-34, and percentage population aged 25-64 having completed tertiary education. The factor of open, excellent and attractive research systems also used two indicators: international scientific co-publications per million population, and scientific publications among the top 10% most cited publications worldwide as a percentage of total scientific publications in the country. The factor of finance and support employed one indicator, which is R&D expenditure in the public sector as a percentage of GDP.

As long as highly educated people can perform in an environment where scientific information exchange is active and the R&D is well funded, the possibility of generating innovation would increase.

The category of firm activities consists of three factors: firm investments, linkages & entrepreneurship and intellectual assets. The factor of firm investments used one indicator, which is R&D expenditure in the business sector as a percentage of GDP. The factor of linkages & entrepreneurship used also one indicator, public-private co-publications per million populations. The factor of intellectual assets used two indicators: PCT patents applications per billion GDP and PCT patents applications in societal challenges per billion GDP (climate change mitigation and; health.)

In the private sector, it is also important to invest in R&D, and one of the provisions to show that companies are pursuing innovation is by securing patents. The linkage between the public sector and private sector is one of the drivers for innovation.

The category of outputs is based on the factor of economic effects, which is consisted of three indicators; medium and high-tech product exports as a percentage of total product exports, knowledge-intensive services exports as a percentage of total service exports, and license and patent revenues from abroad as a percentage of GDP.

These indicators show the effects of innovation more directly, compared to the ones used in the BCG survey. Although different indicators were used for companies and countries, the indicators that show the outputs should be concrete and directly related to innovation.

1.5 Drivers of Innovation

Analyzing both BCG and IUB surveys, four drivers that play a prominent role in innovation were identified:

1) Human resources: how to foster a potential innovator
2) Effective funds for R&D
3) Entrepreneurial environment/ecosystem
4) Commercialization of science and technology

Innovation is a series of human activities that is geared towards solving issues or making the existing society better by providing something new that can make a positive impact. Innovation is not just science and technology; it is an attempt to change the world for the better. Concrete steps need to be investigated, established and executed to achieve innovation, and below is a proposed step for innovation: (Figure12)

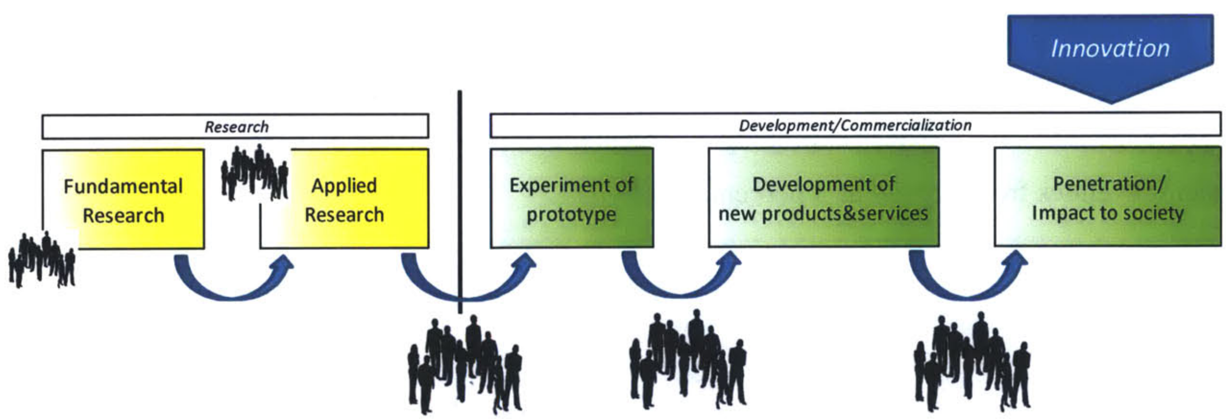


Figure12. Step for Innovation

Source: developed by author

Human resources function as a step to connect each stage and convert the results of a research into outputs. Once data is accumulated through multiple researches, the data can serve as seeds to generate innovation. Thus, sufficient and effective funding to fundamental and applied research is critical to create the foundation of the first step.

However, there is a barrier between the stage of research and the stage of development and commercialization due to the uncertainty and risks. To address these obstacles, entrepreneurs are being flexible to come up with solutions that didn't exist before.

What converts seeds of innovation into products and services is the close linkages between academia (research institutes) and business sectors. This serves as a bridge between the research stage and the development and commercialization stage.

The human resources as innovation driver are consisted of a wide range of work force and students. Work force includes researchers, project managers, administrators and beyond. Students are considering as human resources of innovation, and include both undergraduate and graduate students, professional researchers and elementary and secondary school students. Effective funds in R&D include grants, tax credits and incentive fees. Entrepreneurial environment/ecosystem includes building a better start-up environment for future entrepreneurs. Commercialization of science and technology includes building close linkage between academia (research institutes) and business sectors, organizing the environment where it is easier and faster to commercialize science and technology, and reduce regulations and better protect intellectual property.

Well-organized innovation drivers enable countries to build strong innovation infrastructure. This allows for private sectors, who are the final providers of innovation into society, to produce new products and services that can provide positive impact to existing systems.

The role of government in innovation is to build an innovation infrastructure (or an innovation ecosystem), a total system to achieve the best environment for innovation. The innovation infrastructure should have a plenty of human resources and funds, low barrier to convert the research stage into the development and commercialization stage, and to well execute these plans to overcome uncertainty and risks associated with an innovation.

The BCG presented the role of governments in their report "The Innovation Imperative in Manufacturing" in 2009. The report demonstrated that governments can support companies in three major ways: boost their payback on innovation; support their innovation activities, and; improve their innovation environment. In addition, governments can encourage the development of industry clusters, which can improve the innovation environment, according to the report.

To boost companies' payback on innovation, tax credits could be provided. To support innovation activities, R&D expenditure of public sectors should be increased. Improving the innovation environment could be achieved by three elements; improving work force quality, improving the business climate and lowering structural costs, and promoting industry clusters. Reducing regulations and building well-organized research system should also be recognized. Below is a chart summarizing the roles of governments based on the four categories of innovation drivers: (Figure13)

Drivers of Innovation	*The Roles of Government*
Human resources	*Improving work force quality*
Effective funds into R&D	*Tax credits/R&D expenditures at public sectors*
Entrepreneurial environment/ecosystem	*Improving the business climate and lowering structural costs*
Commercialization of Science and Technology	*Promoting industry clusters* *Reducing regulations* *Building well-organized research system*

Figure13. The Roles of Governments based on the four categories of innovation drivers

Source: BCG report, The Innovation Imperative in Manufacturing 2009, developed by author

All factors in the role of governments belong to one of the four innovation drivers. Since these four innovation drivers are crucial to review the government roles, Japan and the US innovation policy is analyzed based on those drivers.

Chapter2. Japanese Innovation Policy

In this chapter, the structure that could most effectively promote innovation in Japan is investigated. Identify how innovation should be implemented, and who makes decisions on innovation policy in Japan. Take Science and Technology Basic Law as an example; evaluate current implementation of innovation and its systems and Japanese innovation policy. Analyze "Master plan to advance science and technology" and aforementioned four innovation drivers further to assess future needs: 1) human resources: how to foster potential innovators, 2) effective funds in R&D, 3) entrepreneurial environment/ecosystem 4) commercialization of science and technology

2.1 Science and Technology (S&T) Basic Law

Science Basic Law was enacted in1995 to achieve a higher standard of science and technology to contribute to the development of the economy and society in Japan, as well as to improve the welfare of the nation.[2] The S&T law prescribes the basic policy requirements for the promotion of science and technology and also clarifies each responsibility of national government, local government and academic institutions. The establishment of the S&T Basic Law suggests that the country has been struggling to solve economic issues after the burst of the bubble economy in the mid-90's, and by studying this law, the direction Japan is trying to take would be revealed. The law consists of five chapters: Chapter 1, General Provisions; Chapter 2, S&T Basic Plan; Chapter 3, Promotion of R&D; Chapter 4, Promotion of International Exchange, and; Chapter 5, Promotion of Science and Technology Learning.

[2] The Science and Technology Basic Law http://www.mext.go.jp/english/whitepaper/1302752.htm

Chapter 1, General Provisions acknowledges that the role of national government and local government in developing science and technology is to promote research. It also suggests that basic research and applied research should be available as a combined step, and national research institutes, universities and private sector should cooperate to accelerate the development.

Chapter 2, S&T Basic Plan sets government is the party who should build the plan in order to implement S&T policies comprehensively and systematically. It also defines that the government should consult with the Council for Science and Technology Policy on the S&T Basic Plan prior to formulation. Chapter 2 makes it clear that the Japanese S&T policies are implemented based on the S&T Basic Plan, and the Council for Science and Technology Policy plays an important role to ensure that the right path to promote science and technology is taken, which ultimately leads to generate innovation.

Chapter 3, Promotion of R&D explains how the government executes the promotion of R&D. As R&D is one of the important seeds to generate innovation that has a potential to create new industry to further grow the economy, it is important to ensure that the national government implements plans according to the measurements that are set to most effectively promote R&D.

Chapter 4, Promotion of International Exchange encourages the government to promote international exchange on science and technology.

Chapter 5, Promotion of Science and Technology Learning encourages for the government to promote science and technology in school and social education. The chapter aims for all Japanese, young and old, to become more interested in science and technology, and to acquire deep understanding and knowledge in this area.

2.2 Current Innovation Implementation System

The S&T policy is enforced under many ministries in Japan. Below shows the organization of the Cabinet Office of the Japanese Government, and which office enforces the S&T policy. (Figure14)

The Council for Science and Technology Policy (CSTP) was set up in the Cabinet Office as one of the policy councils during the reorganization of government ministries and agencies in January 2001. Under the leadership of the Prime Minister and the Minister of State for the S&T Policy, the Council functions as the centralized office to promote the S&T policy. Below is a chart that shows the CSTP's role in the Cabinet Office of the Japanese Government in more details.(Figure15)

CSTP is consisted of six cabinet members, seven executive members (see the list below) and the President of Science Council of Japan. These members are chosen from both academic and business industries.

[Full-time members]

- Masuo Aizawa: Former President, Tokyo Institute of Technology (academia)
- Naoki Okumura: Former Representative Director and Executive Vice President, Nippon Steel Corporation, Ltd (industry)

[Part-time members]

- Toyoko Imae: Professor Emeritus, Nagoya University (academia)
- Takashi Shiraishi: President, National Graduate Institute for Policy Studies (academia)
- Reiko Aoki: Professor, Institute of Economic Research, Hitotsubashi University (academia)
- Ryoji Chubachi: Vice Chairman, Sony Corporation (industry)
- Toshio Hirano: President, Osaka University (academia)

[Cabinet Office,the Government of Japan]

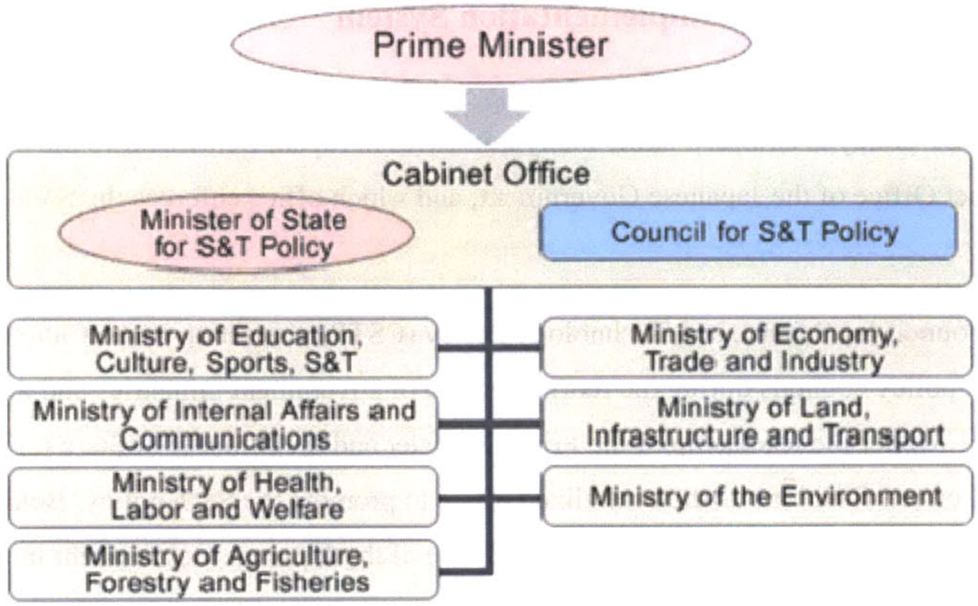


Figure14. Science and Technology Administration in Japan

Source: Cabinet Office, the Government of Japan

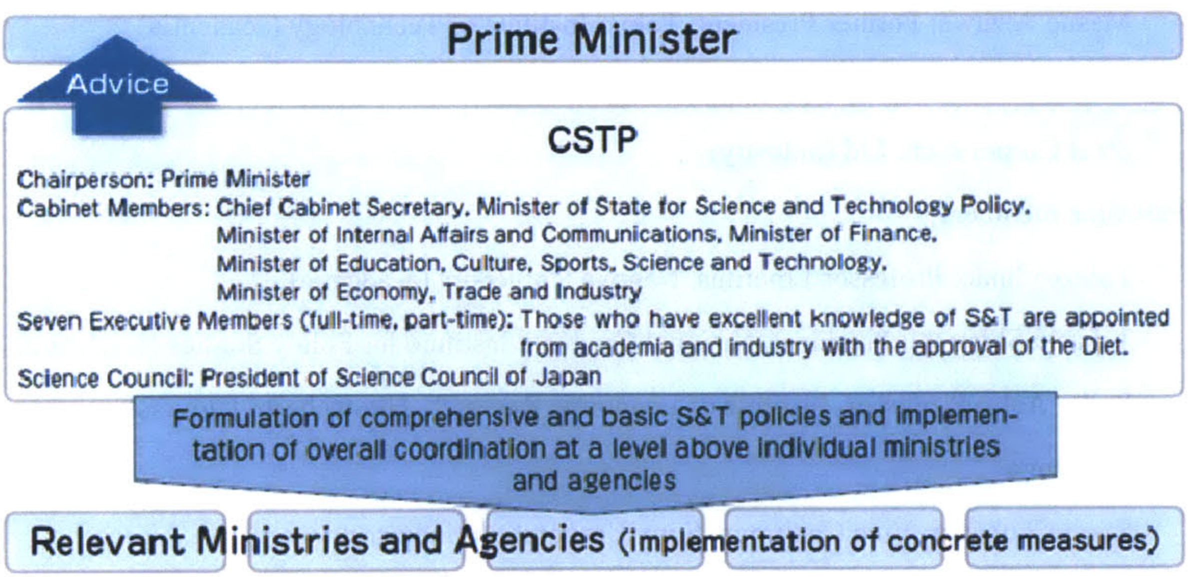


Figure15. The Council for Science and Technology Policy

Source: Brochure about the Council for Science and Technology Policy, modified by author.

CSTP has two members who have experience in business industry, and one of them is a part-time member. The President of Science Council of Japan also belongs to CSTP.

Science Council of Japan was established in January 1949 as a special organization under the jurisdiction of the Prime Minister for the purpose of promoting and enhancing the field of science, and integrating science into administration, industries and people's lives. Two major missions of the Science Council of Japan are to 1) contribute to solve scientific, and 2) coordinate scientific studies to achieve higher efficiency. Four roles support executing these two missions; 1) make recommendations on policies to the government; 2) establish networks among scientists, 3) raise public awareness on science, and; 4) promote international scientific activities.

Science of Council of Japan is consisted of two hundred and twenty council members and some two thousand members. The organization represents eight hundred and forty thousand scientists in the fields of humanities and social sciences, life sciences, physical sciences and engineering. [Science Council of Japan]

2.3 Master Plan for the Advancement of Science and Technology

Based on the S&T Basic law, Japanese government has developed five-year S&T Basic Plan. The first S&T Basic Plan was for the fiscal year 1996 to 2000. The second S&T Basic Plan covered FY 2001 to 2005. The third S&T Basic Plan covered FY 2006 to 2010. The current S&T policy is based on the fourth S&T Basic Plan for FY 2011 to 2015, which was approved by the Cabinet meeting on August 19, 2011.

The current fourth S&T Basic Plan covers the basic principles for the Japanese innovation. To implement science, technology and innovation policies comprehensively and systematically, the Plan requires for specific issues to be defined in advance and implement all steps, from fundamental research, application research to the development stage. The Plan also requires for the government to take strong initiatives to foster human resources with high-level knowledge and to offer adequate infrastructure and environment for these human resources to engage in science and technology, and ultimately generate innovation.

The current S&T Basic Plan for FY 2011 to 2015 is expected to lead all measures launched by several Ministries, including Ministry of Trade, Technology and Industry (METI), Ministry of Education, Culture, Sports, Science and Technology (MEXT), Ministry of Environment, and Ministry of Internal Affairs and Communications. The current S&T Policies can be analyzed by the aforementioned four innovation drivers; 1) human resources: how to foster potential innovators; 2) effective funds for R&D; 3) entrepreneurial environment/ecosystem, and; 4) commercialization of science and technology.

[Cabinet Office, the Government of Japan, 2011]

2.3.1 Human Resources Policy in Japanese Innovation

Japanese government is strengthening policies to improve graduate school education and to secure more researchers post graduate. For example, Ministry of Education, Culture, Sports and Science (MEXT) launched "Program for Leading Graduate Schools" in 2011. 48 million dollars was funded to this Program in 2011, and additional 144 million dollars would be further funded. The Program could produce talents with graduate degrees to become leaders who can take decisive and creative actions based on their deep knowledge and insights. Grants of maximum 3.8 million dollars per year are offered for the Program, and continue for seven years. [Ministry of Education,Culture, Sports, and Science, 2012]

The budget has strict limitations. Although there were six hundred and seventeen students graduated with Master's degrees in 2011 in Japan[3], only thirteen graduate schools were offered to take the grant for this Program (there were sixty three candidates for this program), according to the information retrieved from MEXT.

[3] School Basic Survey 2011, http://www.e-stat.go.jp/SG1/estat/List.do?bid=000001037169&cycode=0

MEXT also provides researchers with grants and an environment where they can continue their research and develop their careers. For example, MEXT developed a project to provide grants to universities that support post doctorial students. With the twenty six million dollars in budget in 2012, MEXT helped universities build career development systems. According to the report by MEXT, they had twelve candidates/universities to be considered to receive the grant. With ninety three million dollars in budget, MEXT also launched a project in 2012 to diffuse the tenure track system so that more opportunities would open up for young researchers. One hundred and sixty five young researchers lined up for this program, which was thirty more candidates from the previous year. In 2011, there were one million researchers working in Japan in the field of private sectors, academia, national research institutes and non-profit organizations, versus three hundred and seventy five thousand researchers belonged to academia. (Figure16) Thus, the tenuere track system just covered 0.04% of researchers belonged to academia. [Ministry of Education,Culture, Sports, and Science, 2012]

	2006	*2007*	*2008*	*2009*	*2010*	*2011*
Graduate students	*261,049*	*262,113*	*262,686*	*263,989*	*272,454*	*272,566*
Researchers	*1,036,155*	*1,052,056*	*1,055,182*	*1,065,037*	*1,063,181*	*1,064,764*
In academia	*349,034*	*355,687*	*358,249*	*364,244*	*369,714*	*375,160*

Figure16. The Number of Graduate Students and Researchers in Japan

Source: Survey of Research and Development by Ministry of Internal Affairs and Communications, modified by author.

According to the report "Japanese Science and Technology Indicators 2011" issued by National Institute of Science and Technology Policy, the number of students who obtain Master's degree per one million population in Japan is five hundred and eighty six; the US is two thousand and seventy two, and; South Korea is over one thousand and five hundred. The number of students who obtain Doctoral degrees per one million populations in Japan is one hundred and thirty five students, and; both the US and South Korea have over two hundred students. [National Institute of Sciecne and Technology Policy, 2011]

Despite the increasing number of graduate students and researchers in Japan, there are less citations by Japanese researchers in top ten percent research papers world-wide. More citations in research papers means high level of contributions were made through high quality research papers, making positive impact on the global research community. Although the number of citation of Japanese research paper is increasing, the impact that the Japanese research papers make on the global community has been weakened. Looking at China, the top ten percent citations made from Chinese research paper from 2008 to 2010 was seven thousand and four hundred eighty one times, which occupies 8.9% of all top ten percent of citations, which increased five times from1998 -2000 average to 2008-2010 average. [National Institute of Sciecne and Technology Policy, 2011](Figure17)

	1988-1990 average	1998-2000 average	2008-2010 average
Citation count of research papers ( ):share to total number			
From Japan	42,568 (7.5%)	62,457(9.2%)	70,576(6.6%)
From the US	195,791(34.5%)	213,229(31.3%)	295,075(27.5%)
Top 10% citation count of research papers ( ):share to total number			
From Japan	*3,548 (6.4%)*	*5,020(7.5%)*	*5,051(6.0%)*
		Percent change from the previous term 100.6%	
From the US	*31,507(56.5%)*	*33,455(49.7%)*	*36,323(43.2%)*
		Percent change from the previous term 108.5%	
From China	*309(0.8%)*	*1,393(2.1%)*	*7,481(8.9%)*
		Percent change from the previous term 537.0%	

Figure17. The Number of Graduate Students and Researchers in Japan

Source: Japanese Science and Technology Indicators 2011 by National Institute of Science and Technology Policy, modified by author.

2.3.2 R&D policy of Japan

The Japanese government launched a "Green Innovation" to secure stable energy source in Japan, and to fight the climate change. The government promotes R&D in renewable energy technologies, such as solar and wind power, biomass utilization, small scale hydropower, geothermal power, and tidal and wave power. The government also promotes R&D for hydrogen supply systems including storage batteries, fuel cells, recharge of infrastructures, superconducting power transmission, manufacturing, transportations and storage. To innovate distributed energy supply systems, the government encourages more R&D in energy management including smart grids. The government aims to achieve higher efficiency and low-carbon generation in basic energy supply sources, including zero-emission thermal power generation system. [Cabinet Office, the Government of Japan, 2011]

In addition, with highly efficient and smart use of energy, the government makes efforts to develop and disseminate the following; i) energy-saving technologies, including high quality insulation systems for houses and buildings, stationary fuel cells, more efficient lighting and power semiconductors, and; ii) power control via storage batteries, fuel cells, and power electronics used for next-generation automobiles. Because consumer sectors (household and commercial) and transportation sectors collectively account for about a half of the final energy consumption in Japan, energy-saving and power control technology would strongly contribute to realize low carbon society. Since information and telecommunication technologies are crucial in supplying and using energy supply as well as in generating less carbon from infrastructures, the government encourages R&D in next-generation information and telecommunication networks, according to the 2010 report by Council for Science and Technology Policy.The government calls for more R&D for highly efficient traffic and transportation systems and promotes mega network systems forming social infrastructures such as electric power, gas, water, and traffic services. The government also drives R&D effort to simulate a comprehensive water resource management system, which would be built with advanced water processing technologies, and to create innovative resource recycling technologies to provide alternate materials for rare metals. The government also promotes improvements on technologies used to obtain earth observation information. [Cabinet Office, the Government of Japan, 2011]

Along with the "Green Innovation", the government also launched the "Life Innovation" to create and revitalize industries such as medical, nursing, and health care services for its aging society, which many countries will face in the near future. For example, the government proposes creating an innovative preventive care, including life style related diseases, infectious diseases, dementia or other diseases, by increasing R&D to improve infrastructures such as computerization of medical data and establishment of database. In addition, the government urges the development of early diagnostic methods, including development of new detection methods and equipment. New diagnostic equipment would be operated with the technologies that can identify trace substances for smaller, less invasive and high performing endoscopes with new imaging technologies such as three-dimensional imaging.

In addition, the government promotes more research in life sciences in order to establish safe and highly effective treatments. To achieve this, more R&D needs to be invested to pursue innovative treatments, such as nucleic acid medicines and drug delivery systems. Also, new medical devices, such as radiotherapy equipment and robotic surgical instruments, need to be accelerated. Drugs and devices that integrate diagnosis and treatments, such as endoscope and medicine combined, telemedicine and image processing technologies, are also in need to be developed at a faster pace. The government also promotes to standardize the regenerative medical techniques, and to develop application and safety assessment techniques.

The government urges the improvement of the quality of life (QOL) for the elderly and the disabled people, and addresses more R&D need to be invested in life support robots, brain machine interface (BMI) equipment, enhancement of personal mobility for the elderly, technologies to support self-sufficient living and livelihoods, technologies for advanced communication and for the care providers. The government also encourages more research to be done in the palliative medicine to relieve mental and physical pains for cancer patients or the elderly, according to the 2010 report published by the Council for Science and Technology Policy.

[Cabinet Office, the Government of Japan, 2011]

The trend of Japan's total expenditure on R&D during the past ten years is included below. Expenditure on R&D as a percentage to the GDP was 3.57 percent in 2010. Total amount of R&D expenditure was $213.87 billion (17,110 billion yen) in 2010. (Figure 18)

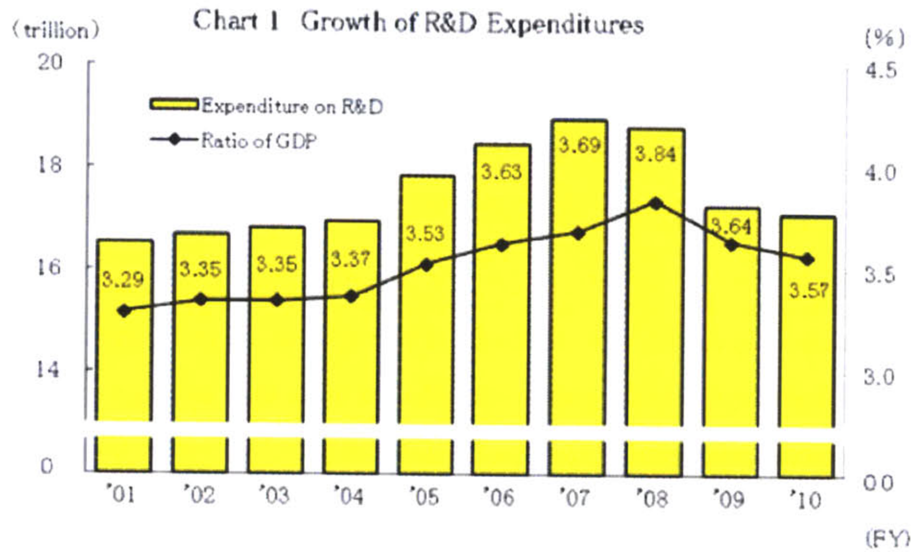


Figure18. Growth of R&D Expenditures in Japan

Source: Survey of Research and Development by Ministry of Internal Affairs and Communications, modified by author.

Japan's R&D expenditure as a percentage to GDP, 3.57%, was bigger than U.S.'s 2.87% The U.S. spent R&D the amount of $400 billion in 2009, and Japan spent $213.87 billion in 2010. 70.2% ($150.12 billion) of R&D expenditure was spent on business sectors, 20.1% ($42.92billion) was spent for the public organizations and non-profit institutions, and 9.7% (20.82billion) was spent for academia in Japan.[4]

---

[4] Japan data in 2010: Survey of Research and Development by Statistics Bureau in Ministry of Internal Affairs and Communications http://www.stat.go.jp/english/data/kagaku/1538.htm $1=¥80

the US data in 2009: Info brief "U.S. R&D Spending Suffered a Rare Decline in 2009 but Outpaced the Overall Economy" on March 2012 by National Center for Science and Engineering Statistics http://www.nsf.gov/statistics/infbrief/nsf12310/nsf12310.pdf

Japan offers four tax credit menus for R&D: 1) tax credit for the total cost of testing and research, 2) special tax deduction for increased amount of test and researching costs, 3) tax credit for special testing and research costs, and 4) tax system to strengthen technical infrastructure for small to med-sized companies (SMEs). See below for more details on these four tax credit menus.

1) Tax credit for the total cost of testing and research is offered for companies to deduct certain percentage of total cost of testing and research from corporate tax. For example, companies can include ten percent of testing and research costs into deductible expenses, but if the amount of deductible expenses excess twenty percent of corporate taxes, then companies can include twenty percent of the total cost of testing and research into the deductible expenses.

2) Special tax deduction on increased amount of test and research costs are offered for companies to choose how to add further tax credits from two options; a) in a certain fiscal year, if a company spent a total amount of testing and research cost more than average of the past three years, and more than the highest amount of the costs during the past two years, they can include five percent of increased amount in testing and research costs into the deductible expenses, and; b) if a company spent the amount of testing and research costs that equal to ten percent of the company's average revenue, they can include the amount calculated in a formula below into the deductible expenses.

Deductible expenses =total testing and researching costs – 10%of average revenues *A
A= (the ratio of testing and researching costs to average revenue -10%)*0.2

3) Tax credit for special testing and research costs means that if special testing and research costs are involved with the corroborated testing and research with national institutes or academic institutions, the outsourcing testing and research to these institutions plus pharmaceutical testing and research could take tax credits. Companies can include the amount calculated in a formula below into the deductible expenses.

Deductible expenses =total costs of special testing and research *(12%- the rate of tax credit on testing and research costs to the total revenue)

Limited deductible expenses = 20% of corporate tax

4) Tax system to strengthen technical infrastructures of the small to mid-sized companies (SMEs) means that the applicable companies that are capitalized at less than one million dollars, except subsidiaries of major companies that are capitalized at over one million dollars or employs over one thousand employees, can include twelve percent of total costs of testing and research into the deductible expenses. Twelve percent is two points more than the deductible rate for non-SMEs. However if the amount of limit on deductible expenses exceed twenty percent of corporate taxes, companies can include the twenty percent of total costs of testing and research into the deductible expenses.

The new tax credit system on testing and research was introduced in 2008. It was the same time as the new accounting regulations for testing and research costs, based on the international rule, were introduced. Prior to 2008, Japanese companies could record the test and researching expenses as their assets.

[National Tax Agency]

2.3.3 Policy for Entrepreneurial Environment/Ecosystem in Japan

To establish new systems for science, technology and innovation, the government sets a measure to improve the environment to strengthen its support for venture start-ups based on advanced S&T, providing consistent support from the initial stage of R&D to the final, commercialization stage. For example, the government provides Small Business Innovation Research (SBIR), a system to provide support for an advanced S&T to transfer into commercialized products or services. The government also strengthens the distributing monetary risks more effectively, and considers a system so that the research findings could contribute to intangible assets, such as human capital and intellectual property. Next, new measures for supporting ventures are examined, including improvement of "angel investment."

2.3.4 Policy for Commercialization of Science and Technology in Japan

To strengthen the strategically promote innovation system, the government sets three measures. The first measure is establishing "Science, Technology and Innovation Strategy Council" as a platform to support the full process of developing strategies for essential issues, including examination and promotion. This platform aims to establish a collaboration system among industry, university and government. The second measure is strengthening "knowledge" networks for promoting innovation via science and technology by implementing efforts to further advance cooperation among industry, university and government. The third measure is establishing open innovation centers to promote R&D by concentrating various R&D organizations from industry, academia, and government in all the stages including initial research, application, and development. Japanese government has already promoted establishing international R&D centers like Tsukuba Science City in Ibaraki Prefecture and Kansai Science City located in Osaka, Kyoto and Nara Prefectures.

In fact, looking back the history of new laws to enforce the environment for commercializing science and technology, the government launched several new laws one after another. For example, in 1995, the Science Technology Basic Act became effective. In 1998, the Limited Partnership Act for Investment was enacted, which is known as the Venture Fund Act and admits to build an organization like U.S. limited partnership. This law allowed not only private sectors but also public sectors to establish venture funds. The Act on the Promotion of Technology Transfer from Universities to Private Business Operations (TLO Act) was also enacted in 1998. In 1999, The Act on Special Measures for Industrial Revitalization (Japanese version of the Bayh-Dole Act (Patent and Trademark Act Amendments of 1980) is enacted. In 2000, The Industrial Technology Enhancement Act was enacted, which clarifies each role of the national government, the local government, national research institute and academia, and private sectors. In addition, the law also aims to promote transferring the results of research into private sectors, and to identify special measure of patent fees for small-medium sized enterprises. In 2002, The Intellectual Property Basic Act was enacted. [Ministry of Economy, Trade and Industry]

The government also set three major goals; 1) how to establish new regulations and systems, such as sustainability criteria for reducing greenhouse gas emissions by using biofuels, and revision of standards for automotive fuel consumption; 2) reviewing and reforming relevant laws that may interfere with the commercialization and dissemination of next-generation vehicles, supply infrastructure facilities such as hydrogen stations, recyclable energy equipment, and; 3) supporting efforts for an integrated R&D and technical demonstration, dissemination, and development to achieve new social system based on local characteristics, such as smart grids on the basis of the collaboration with local governments, universities, public research institutions, and industrial sectors. [Cabinet Office, the Government of Japan, 2011]

In terms of regulations in Japan, Japan Science and Technology Agency, one of the independent administrative institutions, conducted a meeting to review co-relations between innovation and regulation in Japan. As a result of the meeting, a report was published in March, 2010. The report focused on matters that have been of significant interests from the public, clarifying two types of regulations:

- *Capability regulation (e.g., products should endure a weight of eighty kilograms)*
- *Specification regulation (e.g., product should be made by specific materials and equal size)*

Specification regulations are concerning in Japan. These types of regulation tend to prevent innovation from being created, because the content of regulation does not fit in the social transition or science and technology development. The content of regulation is vague and it is hard to exploit the regulation when people try to invent new product or services. The content of the regulation reflects excessive risk avoidance based on the Japanese conventional wisdom or social climate.

The reform of regulations tend to be hindered by the lack of coherent international regulation, complexity of regulatory and administrative system, and the barrier of vest interests produced by the existing regulations. For example, when promoting "Life Innovation", the government will need to solve an essential issue that the process of applying the results of researches into pharmaceuticals etc. to clinical studies, clinical trials, and commercialization takes too much time in Japan compared with the international standard. [Japan Science and TechnologyAgency, 2010]

According to the aforementioned, the fourth S&T Basic Plan, the government promotes regulatory and institutional reforms related to examinations for approval and development R&D environments. For example, the government improves and strengthens the organization of the examination, fostering and securing human resources who are specific in regulatory science field, by retrieving accurate forecasts, assessments, and decisions based on evidence for the purpose of using the results of science & technology.

In addition, the government promotes the improvement of infrastructure that supports new drug and medical technology development by the joint efforts between the government and the private sector. In particular, the government improves and strengthens research centers that serve as a "bridge" and establish open medical institution networks in universities and businesses. [Cabinet Office, the Government of Japan, 2011]

Chapter3. The US Innovation Policy

How is the US where the most innovative companies in the world like Apple, Google and Microsoft were born, able to achieve sustainable innovative process? Especially, considering after the global economic crises, the US has long been struggling to overcome its economic issues, yet the country is able to produce innovative minds. What does the US do to convert science and technology into innovation? The principles of the US innovation policy is analyzed through reviewing "A Strategy for American Innovation" published by the White House in February 2011. Aforementioned four innovation drivers are also used to examine the US innovation policy.

3.1 A Strategy for American Innovation

As a collaborated effort, National Economic Council, Council of Economic Advisers, and Office of Science and Technology Policy, and the White House published a report "A Strategy for American Innovation - Securing Our Economic Growth and Prosperity" in February 2011. This report is consisted with three outlines; 1) invest in the building blocks of American innovation, 2) promote market-based innovation, and 3) catalyze breakthroughs for national priorities. This report updates "The Innovation Strategy" issued in September 2009.

In the executive summary, the report mentioned that America's future economic growth and its international competitiveness depend on their capacity to innovate. The report used the chart of pyramid, included below. Three categories - invest in the building block of American innovation, promote market-based innovation, and catalyze breakthroughs for national priorities – are connected like a reinforced loop. Innovation blocks (fundamentals) will promote market-based innovation. Market-based innovation will lead breakthroughs for clean energy, biotechnology, healthcare technology and so on. Several breakthroughs will promote market-based innovation. Thus, the American fundamentals for innovation will be strengthened. (Figure19)

Figure19. The Pyramid of Innovation for Sustainable Growth and Quality Jobs

Source: "A Strategy for American Innovation - Securing Our Economic Growth and Prosperity" in February 2011

3.1.1 Human Resources Policy for the US Innovation

"Our innovation strategy begins with critical foundations: education, scientific research, and infrastructure." [The White House, 2011]

The US government clearly launched the education policy for innovation, which builds "the Building Blocks of American Innovation".

American education has slipped behind other countries on many metrics including grade-level proficiency and college graduation systems [The White House, 2011]. The Obama administration focuses on the improvement of America's science, technology, engineering and math (STEM) education, the reform of elementary and secondary education, the creation of a first-class system of early education, which is based on the thought that early childhood education fosters cognitive skills along with attentiveness, motivation, self-control and sociability. The skills can turn knowledge into know-how and people into productive citizens. In addition, in higher education, the Obama administration set four tasks. First, the Health Care and Education Reconciliation Act (HCREA) signed in March 2010, making all federal loans available directly to students, ending wasteful subsidies once paid to third-party administrators. By saving sixty eight billion dollars in subsidies over next eleven years (about six billion per year), the direct loan program allows for both deficit reduction and investments in college affordability for low-income students, including a forty billion dollars expansion of the Pell Grant Program. Second, the president is calling on Congress to make his American Opportunity Tax Credit, worth ten thousand dollars for four-year college, permanent. Third, Trade Adjustment Act invests in nation's community college for advanced training. Lastly, the Task Force on Skills for America's Future will build and improve partnerships between businesses and educational institutions to train American workers for twenty first century jobs. [The White House, 2011]

How does the US government address the reform of the elementary and the secondary education to improve children's STEM education? According to "Strategic Plan: Fiscal years 2011-2014" issued by the U.S. Department of Education, they set national goals; to increase the percentage of fourth and eighth grade students at or above proficient on the National Assessment of Educational Progress (NAEP) in reading, mathematics, and science.

NAEP is the largest nationally represented and continuing assessment of what American students know and can do in various subject areas. Assessments are conducted periodically in mathematics, reading, science, writing, arts, civics, economics, geography, and the U.S. history.

To achieve the national goals, the Department of Education mentions that over the next ten years, increase the number of graduates with STEM degrees by one-third, resulting in an additional one million graduates with degrees in STEM subjects. Improving the quality of STEM education is also required. The Department of Education states that it is important to improve the US STEM education as "Over the long term, the nation's ability to address key challenges, such as launching clean energy and other green industries and spurring advancements in health, medicine, and other areas that can revitalize the American economy, will depend on more students entering—and greater numbers persisting in—STEM fields" [US Department of Education, 2011]

3.1.2 R&D Policy of the US

To strengthen fundamental research, the US government sets two measurements; first, even though the Recovery Act provided eighteen point three billion dollars in research funding, the president's FY 2012 budget provides an additional support for science and basic research. Three key basic research agencies - the National Science Foundation, the Department of Energy's Office of Science, and National Institute of Standards and Technology Laboratories - have double in funding. Second, the president has set a goal to invest more than three percent of GDP in public and private research and development for policies that support basic and applied research, create new incentives for private innovation, promote breakthroughs in national priority areas, and improve STEM education. [The White House, 2011]

Obama administration sets five prioritized areas for innovation by public investments; energy, bio-and nanotechnology, space capabilities, health care, and education. President Obama is committed to the U.S. leadership in energy economy in the future and has goals to put the US at the cutting edge of the renewable energy, advanced battery, alternative fuel, and advanced vehicle industries.

In detailed measures for energy, federal tax credits and financing support have leveraged the manufactures and deployment of gig watts of new renewable energy investments in innovative solar, wind, and geothermal energy technologies. The President has set a national goal of generating eighty percent of the nation's electricity from clean sources by 2035. The proposed Clean Energy Standard will mobilize hundreds of billions of dollars in private investment, spur the deployment of clean energy technologies, and create market demand for new innovations. US Environment Protection Agency (EPA) finalized a rule to implement the Renewable Fuel Standard in February 2010, and the Growing America's Fuels strategy focused on a number of the innovations. In addition, the Obama Administration established three Energy Innovation Hubs in FY 2010 to tackle challenges in nuclear energy modeling, energy efficiency in buildings, and the generation of fuel from sunlight, while bringing together scientists and innovative thinkers from different disciplines to form highly-integrated research teams that can create research breakthroughs on tough problems. They did take an approach not to focus on scientific research but to gather and integrate knowledge from diversities. The Obama administration's FY 2012 budget calls for doubling the number of Energy Innovation Hubs, from three to six. [The White House, 2011]

The Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) has awarded nearly four hundred million dollars to more than hundred research projects that seek fundamental breakthroughs in energy technologies. The President's FY 2012 budget proposes to expand support for ARPA-E. The Obama administration is also spurring private sector innovation through new fuel efficiency and greenhouse gas emissions standards, with new efforts to develop standards over the 2017 - 2025 model years of light vehicles and new standards over medium-and heavy-duty vehicles. The president's FY 2012 budget proposes to make the US the world's leader in manufacturing and deploying next-generation vehicle technologies, expanding funding of vehicle technologies by almost ninety percent to nearly five hundred and ninety million dollars and enhancing existing tax incentives. The 2012 budget will broaden R&D investments in technologies like batteries and electric drives including an over thirty percent increase in support for vehicle technology R&D and a new Energy Innovation Hub devoted to improving batteries and energy storage for vehicles and beyond. In addition, the president is proposing to transform the existing seven thousand and five hundred dollars tax credit for electric vehicles into a rebate that will be available to all consumers immediately at the point of sale. [The White House, 2011]

To accelerate biotechnology, nanotechnology, and advanced manufacturing, first off, the Obama administration is investing in the sequencing over eighteen thousand complete genomes, a more than fifty-fold increase over the thirty four genomes that have been sequenced to date. Through National Institute of Health (NIH), the Obama administration is also leading the Cancer Genome Atlas, the largest and most comprehensive analysis of the molecular basis of cancer, which may unleash new possibilities for cancer treatment, diagnosis, and personalized care. Second, the National Nanotechnology Initiative is investing particularly promising nanotechnology areas, that have examples of potential nanotechnology applications include smart anti-cancer therapeutics that target tumors without the devastating side effects of chemotherapy, solar cells that are cost effective, and the next revolution in computing. Third, FY 2012 budget increases investments at key science agencies, including the National Science Foundation (NSF), National Institute of Standards and Technology (NIST) Laboratories, the Department of Energy Office of Science, and Defense Advanced Research Projects Agency (DARPA), to support the US leadership in developing advanced manufacturing technologies. The FY 2012 budget also proposes to initiate the Advanced Manufacturing Technology Consortia program, a public-private partnership that will improve manufacturing R&D investments and accelerate innovation's time to market [The White House, 2011]

At the field of aerospace technologies, the Obama administration is dedicated to developing the next generation of space vehicles and innovative uses of the International Space Station (ISS) by working with the private sector to expand American industry's roles. The Obama administration is also committed to advancing the US capabilities in other space sectors, including new generation of global positioning satellites and services that allow advanced navigation and timing applications, which can be a platform to further create innovative outcomes in many sectors, including agriculture, communications, air travel, and highway safety. The Obama administration will also continue and improve a broad array of programs of space-based observation, research, and analysis of the earth's land, oceans, and atmosphere. [The White House, 2011]

In the field of health care technology, the Obama administration thinks that information technology has the potential to improve health care systems, creating technological platforms to reduce costs, reduce errors, and increase the quality of care. By breaking down the barriers between health service providers, health IT can integrate health markets to attract scalable, competitively tested private sector innovation [The White House, 2011]

The report shows two cases to expand the use of health IT. The office of the National Coordinator (ONC) for Health Information Technology is promoting health IT adoption by promoting programs to accelerate adoption of Electronic Health Records, to develop standards for health information exchange over the Internet, and to develop mobile health technologies. The Strategic Health IT Advanced Research Projects (SHARP) Program funds potentially advance and address problems for smooth adoption of health IT. The US Food and Drug Administration (FDA) is working to accelerate the development of medical device technologies. In 2010, the FDA announced the creation of the Council on Medical Device Innovation, designed to encourage innovations that will address unmet public health needs. The multi-agency council will facilitate medical technology innovations by identifying the most important unmet public health needs, delineating the barriers to the development of technologies to treat these needs, and addressing obstacles to patient access to information and their healthcare records. [The White House, 2011]

In the field of education, the Obama administration is working to promote educational technology innovations through the Department of Education's National Educational Technology Plan, the National Science-Foundation's "Cyber Learning Transforming Education" initiative, and Defense Advanced Research Projects Agency (DARPA), Department of Energy, National Ocean and Atmosphere Administration (NOAA), and the U.S. Navy programs. The president's 2012 budget proposes to create an Advanced Research Projects Agency for Education (ARPA-ED). ARPA-ED will fund projects run by industry, universities, or other innovative organizations by selecting them based on their potential to transform teaching and learning.

To encourage private sector innovation, the administration has proposed making the Research and Experimentation Tax Credit permanent, while simplifying its use and expanding its incentive payments by twenty percent. The proposal for an expanded credit will invest about one hundred billion dollars over ten years in the form of foregone tax receipts to leverage additional innovation. [The White House, 2011]

This measure is based on the thought that businesses are taxed to encourage innovation and entrepreneurship more broadly and any process or proposal for tax reform should address the market failure that the private incentive for an innovative investment typically falls short of the social interest because many of the innovative benefits accrue to consumers. [The White House, 2011]

In fact, the US provides two methods for computing the incremental credit for 2010: twenty percent credit and the fourteen percent credit.

Twenty percent credit: The "traditional credits" equal to twenty percent of the amount of the expenditures exceeding a "base amount". The "base amount" means a complicated computation estimating the amount of gross receipts a company would expect to spend on qualified research.

Fourteen percent credit: The alternative simplified credit equal to fourteen percent of the excess of the qualified research expenditures over fifty percent of the average of the prior three years expenditures.

In addition, there are also special credits for basic research (e.g., research conducted in universities), payments to energy research consortium, and research relating to orphan drugs. [Deloitte, 2011]

While qualified R&D expenses are currently deductible, taxpayers must reduce the current deduction by the amount of the tax credit. Alternatively, taxpayers can elect a timely field return to take the credit at a reduced rate of thirteen percent for the regular credit or nine point one percent for the alternative simplified credit.

There is a minimum base amount applicable only to the traditional credit equal to fifty percent of the current qualified R&D expenditures. The cumulative effect of limiting deductions (or electing a reduced credit rate of thirteen percent) and the minimum base amount is that the maximum value of the traditional credit is six point five percent of current qualified R&D spending.

There is no minimum base amount for the alternative simplified credit. If, however, there is no qualified research spending in any one of the prior three years, the credit is equal to six percent of qualified research spending in the current tax period.

The cumulative effect of limiting deductions (or electing a reduced credit rate of nine point one percent) for the alternative simplified credit and the base calculation rules, is that the maximum value of the alternative simplified credit is less than nine point one percent of current qualified R&D spending. [Deloitte, 2011]

The US offers tax credits to offset current, prior, and future income tax liability. Unused research credits can be carried back one year and carried forward twenty years (small businesses with less than fifty million dollars in gross receipts can carry back 2010 credits five years and forward twenty years) Credits are not subject to a cap. In very limited circumstances taxpayers can get a refund for unutilized pre-2006 carry forward credits instead of taking bonus depreciation (2008 to 2009.) In the US, all industries can benefit from research credits. Qualified costs include wages for in-house labor, sixty five percent of contract labor, and supplies used in the research process. Overhead and capital expenditures are excluded. [Deloitte, 2011]

3.1.3 Policy for Entrepreneurial environment/ecosystem in the US

Obama administration sets several measures to increase innovative entrepreneurship.

The first measure is to increase access to capital for new businesses. The Small Business Jobs Act, signed by the president Obama in 2010, provided an additional fourteen billion dollars more in lending support via the Small Business Administration and more than thirty billion dollars in capital support for small business lending via the Treasury, as well as twelve billion dollars in tax relief to small businesses. [The White House, 2011] The government noticed the difficulty to access capital by small and mid-sized business and directly provided the resource of fund.

The second measure is to promote regional innovation clusters. The government thinks that regional clusters can be significant sources of entrepreneurship, innovation, and quality jobs, and the root of new industries. The Small Business Administration's Regional Cluster Initiative, the USDA's Agricultural Technology Innovation Partnership Program, and the Department of Energy's Energy Efficient Building Systems Innovation Cluster are all working to spur regional innovation engines in major technology sectors. And the Economic Development Administration's i6 Challenge series promotes partnership models between lab and marketplace to accelerate technology commercialization. [The White House, 2011]

The system of i6 Challenge is a support program for entrepreneurship initiative by the US Departments of Agriculture, Commerce and Energy, along with the Environmental Protection Agency and the National Science Foundation. The US Commerce Department's Economic Development Administration (EDA) and its Office of Innovation and Entrepreneurship today announced the opening of its twelve million dollars i6 Green Challenge in partnership with the US Departments of Agriculture, Energy, the US Environmental Protection Agency, the National Science Foundation, and Commerce's National Institute of Standards and Technology and the US Patent and Trademark Office. [The White House, 2011]

The i6 Green Challenge aims to not only support start-up firms but also to transfer the great ideas from the lab to the marketplace to spur the development of industries. This competition also focuses on Proof of Concept Centers, which supports all aspects of the entrepreneurship process, from assisting with the technology feasibility and business plan development, to providing access to early-stage capital and mentors to offer critical guidance to innovators. Centers allow emerging technologies to mature and demonstrate their market potential, making them more attractive to investors and helping entrepreneurs turn their idea or technology into a business. [US Department of Commerce, 2012]

The US offers the Office of Innovation and Entrepreneurship. The mission of the Office of Innovation and Entrepreneurship is to unleash and maximize the economic potential of new ideas by removing barriers to entrepreneurship and the development of high-growth and innovation-based businesses. The office focuses specifically on identifying issues and programs most important to entrepreneurs. The office focuses on the following areas:

- Encouraging entrepreneurs through education, training, and mentoring
- Improving access to capital
- Accelerating technology commercialization of federal R&D
- Strengthening interagency collaboration and coordination
- Providing data, research, and technical resources for entrepreneurs
- Exploring policy incentives to support entrepreneurs and investors

There is another institution; National Advisory Council on Innovation and Entrepreneurship. The council will include successful entrepreneurs, innovators, angel investors, venture capitalists, non-profit leaders and other experts who will identify and recommend solutions to issues critical to the creation and development of entrepreneurship ecosystems that will generate new businesses and jobs. It will also serve as a vehicle for ongoing dialogue with the entrepreneurship community and other stakeholders. [US Department of Commerce, 2012]

3.1.4 Policy for Commercialization of Science and Technology in the US

The US Department of Commerce published a concept of "The Research Ecosystem", which means the Federal government, colleges and universities, and the private sector are all interconnected when it comes to research and innovation. [US Department of Commerce, 2012](Figure 20) The research of federal government supports colleges and universities, and private sector. Among colleges, universities and private sector, there is a successful partnership - private sector provides research and colleges with funds and universities provide trained workers and research to accelerate commercialization. Advanced undergraduate and graduate level students' education is assisting faculty in federally sponsored research. Such hands-on experience prepares students to become part of the nation's science and engineering workforce and to help private firms develop and roll out new technologies.

Through strongly connected three sectors (government, universities and private sectors), the sustainable flow to continue researching has a high possibility to connect with innovation to retain and reinforce commercializing innovation.

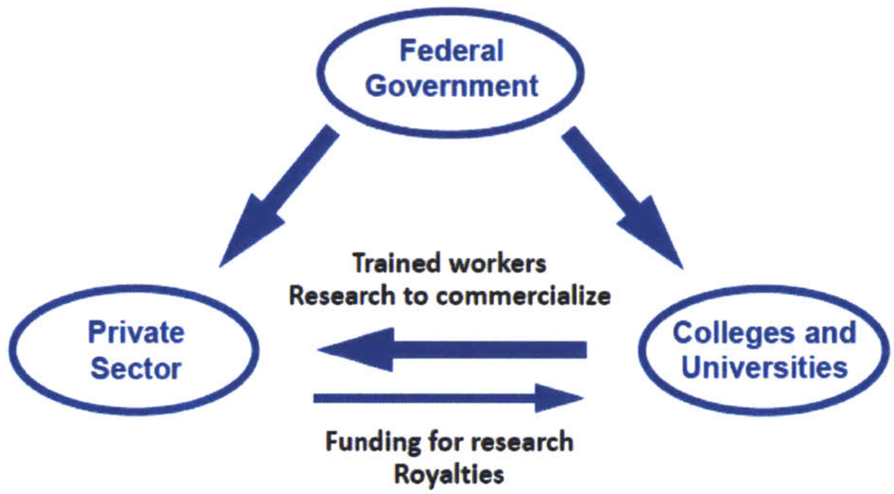


Figure20. The Research Ecosystem

Source: "The Competitiveness and Innovative Capacity of the United States" by US Department of Commerce,2012

President Obama directed federal agencies to establish measures to monitor the number and the pace of effective technology transfer from federal labs to non-federal entities. In details, agencies are required to develop commercialization plans for their labs that will be monitored by Office of Management and Budget (OMB) in consultation with Office of Science and Technology Policy (OSTP) and Department of Commerce (Commerce). In addition, Commerce will maintain technology transfer metrics to help identify new or creative approaches to accelerate the technology transfer from Federal laboratories to industry [US Department of Commerce, 2012]

The US government approaches an issue on how to accelerate innovation by not only funding more to appropriate parties but also by creating practical and certain level of compelling system, which will achieve commercialization of technology. Innovation needs commercialization of technology.

Government initiatives include efforts to streamline licensing procedures that could result in expanding access to federally-owned inventions, and to use best practices to improve programs directed toward small businesses, such as the Small Business innovation Research program, according to the SBIR program.

The SBIR program was originally established in 1982 by the Small Business Innovation Development Act (P.L. 97-219). Subsequent legislation has extended the program until September 30, 2017. Eleven federal agencies set aside a portion of their extramural research and development budget each year to fund research proposals from small science and technology-based firms. This program is organized by the National Institute Standards and Technology (NIST), which is an agency of the U.S. Department of Commerce.

The SBIR program goals are:

1. To increase private sector's commercialization of innovations derived from federal R&D
2. To use small businesses to meet federal R&D needs
3. To stimulate small business innovation in technology
4. To foster and encourage participation by minority and disadvantaged persons in technological innovation.

SBIR supports creative advanced research in important scientific and engineering areas and is designed to encourage the conversion of government-funded R&D into technological innovation and commercial application. SBIR research can lead to important new technology, major breakthroughs, innovative new products, and next-generation products or processes. The program funds the gap from a research-based idea to a prototype that many industrial and venture capital companies find difficult to support.

The SBIR website shares a lot of successful stories provided by the companies which utilizes the SBIR program. For example, Artium Technologies, Inc. was founded in 1998 with the goal of developing and commercializing advanced laser-based diagnostics for environmental and health related applications, received its first SBIR contract from NASA Lewis in 1998 to support the development of the Laser Induced Incandescence (LII) instrument for soot characterization. Over the next several years, they continued to receive SBIR support from NASA, EPA and NIST to further advance this technology and develop it into a commercial product, the LII-200. Artium also partnered with Islet Technology of Minnesota with the goal of developing islet encapsulation for diabetes cure. With the support of SBIR funding, Artium has also successfully developed and commercialized a line of Phase Doppler Interferometry (PDI) products for spray characterization and has also developed the PDI Cloud Probe.

Another example is Proof of Concept Centers, which is managed by The Ewing Marion Kauffman Foundation, which was established in the mid-1960s by the late entrepreneur and philanthropist Ewing Marion Kauffman. (It is different from aforementioned "Proof of Concept Centers" by US Department of Commerce) Even though the activities of the Ewing Marion Kauffman Foundation are not related to the US policy, they are good examples for promoting commercialization of technology. The foundation is based in Kansas City, Missouri and among the thirty largest foundations in the United States with an asset base of approximately two billion dollars. They focus their grant making and operations on two areas: advancing entrepreneurship and improving the education of children and youth. They carry out their mission through four programmatic areas: Entrepreneurship, Advancing Innovation, Education, and Research and Policy. [Ewing Marion Kauffman Foundation]

Proof of Concept Centers aims to commercialize university innovation and fills the seed-stage funding gap for new technologies. They provide seed funding to university-based early stage research as well as a host of advisory services and educational initiatives to assist students and faculty with market research, mentoring, development and testing of innovations, preparation of business plans and connections to the commercial market. They have collectively awarded nearly ten million dollars in seed grants and launched twenty six seed-stage companies that have accumulated more than one hundred and fifty nine million dollars in private capital at two centers: the Deshpande Center at MIT and the von Liebig Center at the University of California San Diego. [Ewing Marion Kauffman Foundation]

Proof of Concept Centers assist with the exchange of ideas between the university innovations and industry by providing mentors with experience in innovation and industry connections that help link faculty and students to external networks. A successful Proof of Concept Center benefits from locating at universities that produce innovative and marketable technology, are located within a strong external network of investors and innovators and have an administrative team and advisors with a depth of commercialization expertise. [Ewing Marion Kauffman Foundation]

A unified approach of providing seed funding, advisory services with industry connections and educational initiatives also is vital to ensure the commercialization of university technology.

In the field of infrastructure, the US government set two directions of measures; one is to build a leading physical infrastructure, and the other is to develop and advanced information technology ecosystem.

To investigate further regarding physical infrastructure, president Obama proposed sustained investments that could build on the Recovery Act and would help create an efficient, high-speed passenger rail network of hundred to six hundred mile intercity corridors that will better connect communities across America. In addition, president Obama's FY 2012 budget increase funding for The Next Generation Air Transportation System (NextGen), which makes ail travel more convenient, dependable, and energy-efficient, while ensuring flights are as safe as possible. The president has also proposed the creation of a National Infrastructure Bank, which will provide a new way to leverage investments in the nation's highest infrastructure projects. [The White House, 2011]

Regarding the information technology ecosystem, the Obama administration is committed to facilitating the development and deployment of the next-generation wireless broadband network that can reach at least ninety eight percent of Americans and enables public safety to have access to a nationwide and interoperable wireless network. For promoting investment and innovation in state-of-the–art wireless technology, the Obama administration is freeing up more spectrum for wireless broadband, from 50 MHz to 550 MHz. The Recovery Act provided six point nine billion dollars to expand broadband access for households, businesses, schools, libraries, public safety providers, and hospitals. By setting standards for smart grid technologies and making information technology investments, the Obama administration is improving the nation's electricity grid to reduce energy waste. The Government is working to secure information infrastructure through new protocols, improved detection capabilities. In addition to the support for wireless innovation, the Networking and Information Technology Research and Development (NITRD) Program funds research in areas such as high-speed networks, next-generation supercomputers, cyber-physical systems, software engineering, and information management. The president's Council of Advisors on Science and Technology has identified research directions that will help foster the next revolution in information technology, and transform health care, energy efficiency, education, and transportation. [The White House, 2011]

To promote market-based innovation, the Obama administration is supporting comprehensive patent reform to slash the processing time for patent applications, enable applicants to fast-track their most important applications, and allows a post-grant review procedure that can improve patent quality. [The White House, 2011]

According to the report of the White House, businesses and entrepreneurs are now waiting an average of thirty five months behind a backlog of over seven hundred thousand patent applications. In addition, the Obama administration thinks that effective enforcement of intellectual property rights is essential to innovation and economic growth. The Obama administration has a plan to fight intellectual property infringement including thirty three specific action items, spanning six broad categories. These measures are grounded in the ideas that intellectual property rights provide critical incentives for commercial innovation, and that intellectual property allows new ideas to be traded between firms, finding their best uses in the marketplace, and is an important determinant of entrepreneurial funding. [The White House, 2011]

To promote innovative, open, and competitive markets, the Obama administration takes four measures. The first measure is to protect and enable competition. The Department of Justice (DOJ) and the Federal Trade Commission (FTC) have developed new Horizontal Merger Guidelines, issued in August 2010. The new Guidelines include, for the first time, a section explaining how the DOJ and FTC assess whether a merger is likely to retard innovation.

In January 2011, president Obama issued an executive order to improve regulation and the regulatory review process. This is the second measure to promote innovative, open, and competitive markets. Under his executive order, the president required federal agencies to design cost-effective, evidence-based regulations that are compatible with economic growth, job creation, and competitiveness. The order also requires review which asks agencies to submit a preliminary plan within hundred and twenty days to determine whether any regulations should be modified, streamlined, expanded, or repealed so as to make the agency's regulatory program more effective or less burdensome.

The third measure is that the Federal Communications Commission (FCC) that has acted to preserve that openness so that users and innovators are able to compete on the merits and not face anticompetitive barriers imposed by incumbent broadband providers.

In addition, president Obama launched the National Export Initiative (NEI), which has a task to help American businesses that sell goods and services abroad, in March 2010. By unlocking foreign markets for the US goods and services, and improving access to credit for the US businesses, the NEI seeks to double the US exports in five years and support millions of additional jobs, according to the White House, 2011. For the US, which has huge current deficits, the efforts of NEI are not only for innovation but also one of the macroeconomic policies.

[The White House, 2011]

Chapter4. Differences in Japan and the US's Innovation Infrastructure

As mentioned in chapter 2 and 3, the governments of Japan and the US try to promote innovation to solve several social issues, including their aging society, climate change and increasing national competitiveness by developing new technologies and industries, and pursuing sustainable economic growth. Many similarities between each objective and policy can be seen. However, the approaches to implementation and the points to prioritize in order to successfully achieve these goals are very different.

4.1 Policy of Human Resources to lead innovation

The policy of human resources to lead innovation can be divided into three categories. The first is fostering the next generation who will lead innovation in the future by strengthening STEM education. The second is improving education at university and graduate school to foster human resources to foster innovation. The third is enhancing the functions of researchers at all stages of basic and applied research.

Through reviewing Japan and the US's basic plan for innovation (Japan: the aforementioned fourth S&T Basic Plan, and the US: "A Strategy for American Innovation"), Japan could strengthen policies to improve education at graduate school and to secure the number of researchers. On the other hand, the US strengthens policies to foster the next generation by reforming the elementary and the secondary education to improve children's abilities in STEM related classes and to develop students' cognitive abilities.

In Japan, the government does not intend to introduce a fair and competitive environment to generate the seeds of innovation in the Japanese academia institutes, but strives instead to support and secure the number of researchers. However, the number of researchers whom the government can support is limited due to its budget. Simply providing them with grants will not lead to planting the seeds of innovation and to fostering competitive researchers who are always one step ahead of their international counterparts.

Also, Japan needs a reform graduate school education to increase the productivity of academic institutes as intellectual capital to provide solutions to social issues or to lead economic growth. MEXT should set concrete goals to achieve this within a specific time limit. The fourth S&T Basic Plan for FY 2011-2015 mentioned the need to foster ideal leaders who have the ability to take decisive and creative actions by using advanced knowledge and insight, and also who have a specific academia background and will achieve high performance not only in academia but also in the private sector. The government seems to foster ideal students at school, yet does not seem to be able to create the same environment at the graduate level. By employing the principle of competition in academic institutes, the government should provide cash awards to practical achievements like the citation count of research papers and the global competition in science and technology research, rather than grants for plans for which it will be difficult to evaluate achievement levels.

In addition, there is an important and non-negligible result of the survey, "Program for International Student Assessment (PISA)," which is conducted by OECD (Organization for Economic Co-operation and Development) every three years. PISA is an international study which began in the year 2000. It aims to evaluate educational systems worldwide by testing the skills and knowledge of 15-year-old students in participating countries. Sixty-five countries/economies implemented the PISA 2009 assessment in 2009. The results from 2009 show that the rank of the U.S. is lower compared to other developed countries and Asian countries, including Singapore, China, and South Korea, who acquired higher rankings. This may be attributed to the US Human Resources Policy, which focuses on improvements to America's STEM education. (Figure 21)

PISA 2009 Results

		On the science scale
	OECD Average	501
1	Shanghai-China	575
2	Finland	554
3	Hong Kong-China	549
4	Singapore	542
5	Japan	539
6	Korea	538
7	New Zealand	532
8	Canada	529
9	Estonia	528
10	Australia	527
11	Netherlands	522
12	Chinese Taipei	520
13	Germany	520
14	Liechtenstein	520
15	Switzerland	517
16	United Kingdom	514
17	Slovenia	512
18	Macao-China	511
19	Poland	508
20	Ireland	508
21	Belgium	507
22	Hungary	503
23	United States	502
24	Czech Republic	500
25	Norway	500
26	Denmark	499
27	France	498
28	Iceland	496
29	Sweden	495
30	Austria	494
31	Latvia	494
32	Portugal	493
33	Lithuania	491
34	Slovak Republic	490
35	Italy	489
36	Spain	488
37	Croatia	486
38	Luxembourg	484
39	Russian Federation	478
40	Greece	470
41	Dubai (UAE)	466
42	Israel	455
43	Turkey	454
44	Chile	447
45	Serbia	443
46	Bulgaria	439
47	Romania	428
48	Uruguay	427
49	Thailand	425
50	Mexico	416
51	Jordan	415
52	Trinidad and Tobago	410
53	Brazil	405
54	Colombia	402
55	Montenegro	401
56	Argentina	401
57	Tunisia	401
58	Kazakhstan	400
59	Albania	391
60	Indonesia	383
61	Qatar	379
62	Panama	376
63	Azerbaijan	373
64	Peru	369
65	Kyrgyzstan	330

		On the mathematics scale
	OECD Average	496
1	Shanghai-China	600
2	Singapore	562
3	Hong Kong-China	555
4	Korea	546
5	Chinese Taipei	543
6	Finland	541
7	Liechtenstein	536
8	Switzerland	534
9	Japan	529
10	Canada	527
11	Netherlands	526
12	Macao-China	525
13	New Zealand	519
14	Belgium	515
15	Australia	514
16	Germany	513
17	Estonia	512
18	Iceland	507
19	Denmark	503
20	Slovenia	501
21	Norway	498
22	France	497
23	Slovak Republic	497
24	Austria	496
25	Poland	495
26	Sweden	494
27	Czech Republic	493
28	United Kingdom	492
29	Hungary	490
30	Luxembourg	489
31	United States	487
32	Ireland	487
33	Portugal	487
34	Spain	483
35	Italy	483
36	Latvia	482
37	Lithuania	477
38	Russian Federation	468
39	Greece	466
40	Croatia	460
41	Dubai (UAE)	453
42	Israel	447
43	Turkey	445
44	Serbia	442
45	Azerbaijan	431
46	Bulgaria	428
47	Romania	427
48	Uruguay	427
49	Chile	421
50	Thailand	419
51	Mexico	419
52	Trinidad and Tobago	414
53	Kazakhstan	405
54	Montenegro	403
55	Argentina	388
56	Jordan	387
57	Brazil	386
58	Colombia	381
59	Albania	377
60	Tunisia	371
61	Indonesia	371
62	Qatar	368
63	Peru	365
64	Panama	360
65	Kyrgyzstan	331

		On the overall reading scale
	OECD Average	493
1	Shanghai-China	556
2	Korea	539
3	Finland	536
4	Hong Kong-China	533
5	Singapore	526
6	Canada	524
7	New Zealand	521
8	Japan	520
9	Australia	515
10	Netherlands	508
11	Belgium	506
12	Norway	503
13	Estonia	501
14	Switzerland	501
15	Poland	500
16	Iceland	500
17	United States	500
18	Liechtenstein	499
19	Sweden	497
20	Germany	497
21	Ireland	496
22	France	496
23	Chinese Taipei	495
24	Denmark	495
25	United Kingdom	494
26	Hungary	494
27	Portugal	489
28	Macao-China	487
29	Italy	486
30	Latvia	484
31	Slovenia	483
32	Greece	483
33	Spain	481
34	Czech Republic	478
35	Slovak Republic	477
36	Croatia	476
37	Israel	474
38	Luxembourg	472
39	Austria	470
40	Lithuania	468
41	Turkey	464
42	Dubai (UAE)	459
43	Russian Federation	459
44	Chile	449
45	Serbia	442
46	Bulgaria	429
47	Uruguay	426
48	Mexico	425
49	Romania	424
50	Thailand	421
51	Trinidad and Tobago	416
52	Colombia	413
53	Brazil	412
54	Montenegro	408
55	Jordan	405
56	Tunisia	404
57	Indonesia	402
58	Argentina	398
59	Kazakhstan	390
60	Albania	385
61	Qatar	372
62	Panama	371
63	Peru	370
64	Azerbaijan	362
65	Kyrgyzstan	314

Statistically significantly above the OECD average
Not statistically significantly different from the OECD average
Statistically significantly below the OECD average

Source: OECD PISA 2009 database.

Figure21. PISA 2009 Results

Source: OECD PISA 2009 database

On the other hand, Japan's rankings for science and mathematics declined when compared to the results from 2000. (Figure 22)

	2000	2003	2006	2009
Science	2	2	6	5
Mathematics	1	6	10	9
Reading	8	14	15	8

Figure22. Japan's Rankings of PISA 2000-2009

Source: OECD PISA 2000,2003,2006,2009 databases, modified by author

The Japanese government should directly tackle two issues: one is the declining trend in the Science and Mathematics ranking; and the other is the momentum of other Asian countries who are improving their Science and Mathematics abilities. The government should take strong initiatives in the long term to foster the next generation of high potential students. In addition, the enhancement of cognitive skills at early education stage, for accelerating to foster people with high attentiveness, motivation, self-control sociability and creativity.

To analyze the performance of university students, graduate students and adults in the work-force, the Program for International Assessment of Adult Competencies (PIAAC) is used. This aims to provide effective tools to assess where participating countries rank and also to provide insights into the skills related to the social and economic well-being of individuals and nations. It also provides benchmarks for how effectively educational and training systems meet emerging skill demands. The US and Japan both participated in this survey and the report will be issued in 2013; however, a gap between the achievement levels of elementary and secondary education and those of high education has been noted in Japan in PIAAC's report.

The "Times Higher Education's list of the world's top universities for 2011-2012", which is conducted by Thomson Reuters, ranks the top universities across the globe by employing thirteen separate performance indicators designed to capture the full range of university activities, from teaching to research to knowledge transfer. These 13 elements are brought together into five headline categories, which are: 1) Teaching - the learning environment (worth 30 per cent of the overall ranking score; 2) Research - volume, income and reputation (worth 30 per cent); 3)

Citations - research influence (worth 30 per cent); 4) Industry income - innovation (worth 2.5 per cent); and 5) International outlook - staff, students and research (worth 7.5 per cent). [Times Higher Education's list of the world's top universities for 2011-2012]

Results show the US universities occupied over 60% at the top 50 ranking. (31universities among top 50). The result of the world university rankings clearly shows the low competitive advantage of Japanese universities. As this ranking is based on diverse and appropriate criteria to assess the level of education qualities around the globe, it is therefore important to consider the reasons behind so few Japanese universities appearing in this list. (Figure23)

For Japan to increase its competitiveness, the government should immediately address two issues. One is to critically assess the current education levels using accurate data from around the globe. The important thing is to recognize the current status by not only comparing chronologically arranged internal data, but also considering the comparative status against other countries. It is also important to set clear goals, including numerical approaches. Moreover, the role of government is to establish strategies to improve next generation's ability of Science and Technology and cognitive skills, and to build competitive systems to reinvigorate high education, such as incentive schemes for high performance research report and projects.

World Rank	Institution	Country/Region
1	California Institute of Technology	United States
2	Harvard University	United States
2	Stanford University	United States
4	University of Oxford	United Kingdom
5	Princeton University	United States
6	University of Cambridge	United Kingdom
7	Massachusetts Institute of Technology	United States
8	Imperial College London	United Kingdom
9	University of Chicago	United States
10	University of California Berkeley	United States
11	Yale University	United States
12	Columbia University	United States
13	University of California Los Angeles	United States
14	Johns Hopkins University	United States
15	ETH Zürich - Swiss Federal Institute of Technology Zürich	Switzerland
16	University of Pennsylvania	United States
17	University College London	United Kingdom
18	University of Michigan	United States
19	University of Toronto	Canada
20	Cornell University	United States
21	Carnegie Mellon University	United States
22	University of British Columbia	Canada
22	Duke University	United States
24	Georgia Institute of Technology	United States
25	University of Washington	United States
26	Northwestern University	United States
27	University of Wisconsin-Madison	United States
28	McGill University	Canada
29	University of Texas at Austin	United States
30	University of Tokyo	Japan
31	University of Illinois at Urbana Champaign	United States
32	Karolinska Institute	Sweden
33	University of California San Diego	United States
34	University of Hong Kong	Hong Kong
35	University of California Santa Barbara	United States
36	University of Edinburgh	United Kingdom
37	University of Melbourne	Australia
38	Australian National University	Australia
38	University of California Davis	United States
40	National University of Singapore	Singapore
41	Washington University in St Louis	United States
42	University of Minnesota	United States
43	University of North Carolina at Chapel Hill	United States
44	New York University	United States
45	Ludwig-Maximilians-Universität München	Germany
46	Ecole Polytechnique Fédérale de Lausanne	Switzerland
47	London School of Economics and Political Science	United Kingdom
48	University of Manchester	United Kingdom
49	Brown University	United States
49	Peking University	China

Figure23. The World University Ranking Top 50 by Thomson Reuters

Source: Thomson Reuters: Times Higher Education's list of the world's top universities for 2011-2012, modified by author

4.2 Effective funds funneled into R&D

Focusing on the rate of tax incentives, the Japanese system is more beneficial to companies because of the calculating base used to total the amount of research expenses. In contrast, the US system provides tax credits on the basis of the rate for expenditure amounts.

In terms of correlations between R&D tax credits and innovation performance, an interesting report mentions that there is a positive relationship between R&D tax credits and innovation performance, but the size of the tax credit has minimal impact on performance. [James P. Andrew, 2009] (Figure 24)

It is clear that R&D tax credits provide positive effects into innovation performances. However, the amount of tax credits would not directly affect Innovation performance. R&D tax credits can play a role, not as an initiative for innovation but as a supporter to those who generate innovation by providing an environment where it would be easier for them to continue their research activities and develop new businesses.

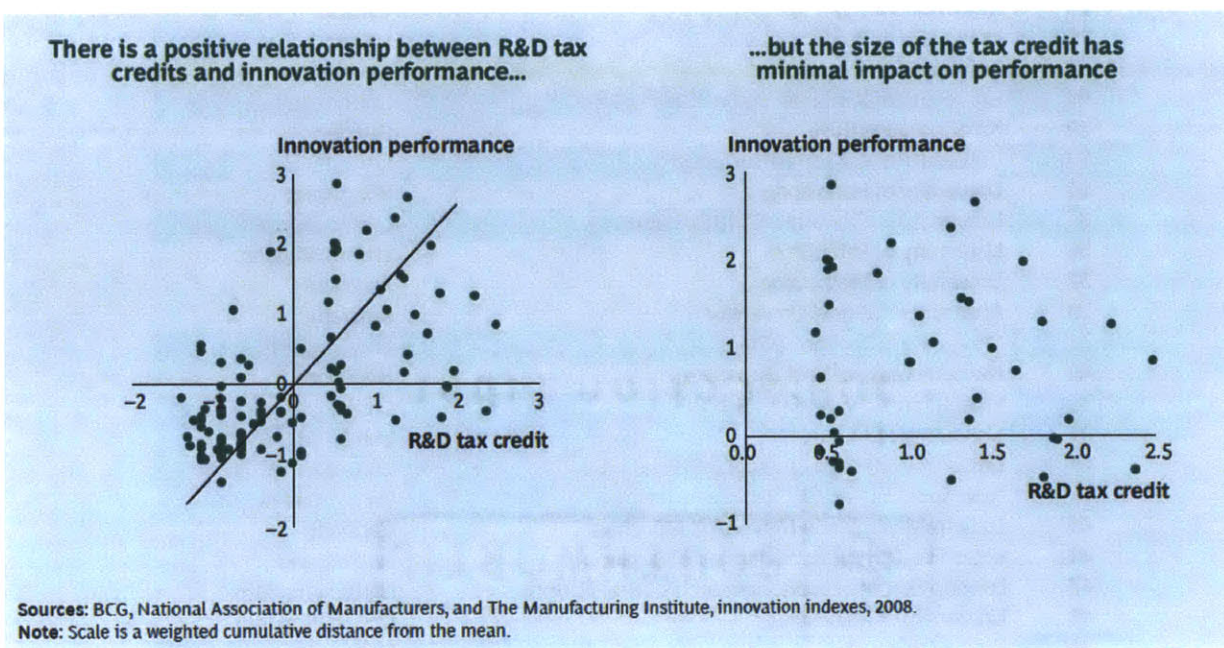


Figure24. Correlation between Tax Credit Size and Innovation Performance

Source: BCG, National Association of Manufacturers, and The Manufacturing Institute, innovation indexes, 2008.

On the other hand, the BCG report shows the effects of government funding of R&D on innovation performance. (Figure25)

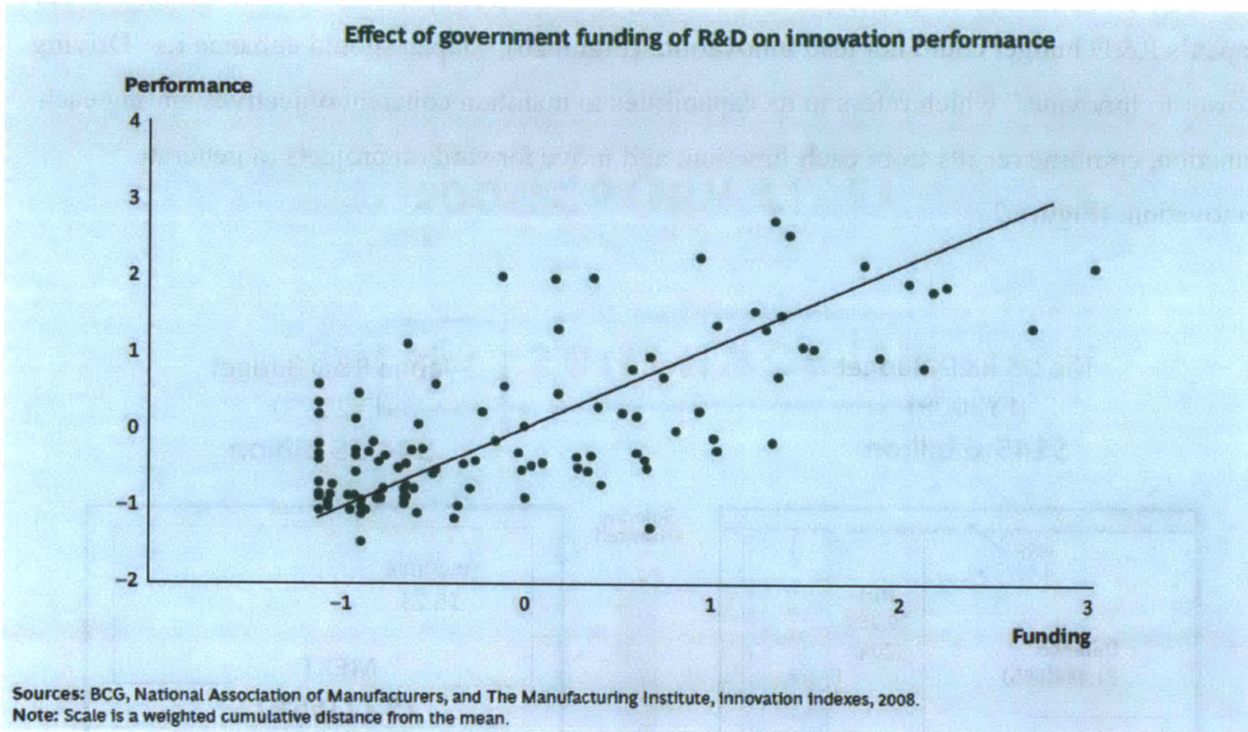


Figure25. Correlation between R&D funding and Innovation Performance

Source: BCG, National Association of Manufacturers, and The Manufacturing Institute, innovation indexes, 2008.

Expenditure on R&D as a percentage to the GDP shows that Japan invests in R&D with more highly rate than the US. (Japan: 3.57%, the US: 2.87%) However, despite of the percentage to the GDP, Japan does not have the concrete output of innovation compared to the US in terms of business performance in the private sector and the degree of contribution by Japanese research papers in academia.

It seems that the issue for Japan is that the nation cannot convert inputs (R&D expenditure) into effective outputs (innovation). This leads to the more concrete issue of converting the result of research into new products and services. Japanese innovation policy tends to focus on research fields and to take efforts to strengthen each functions in a series to generate innovation. For R&D funds, the government provides funding to enhance research functions. The Comparison of R&D budget structure in Japan and the U.S. shows that Japanese budget structure is developed on the basis of focusing on the funds for research. If MEXT with 66% of Japan's R&D budget would not accelerate commercialization of science and technology, Japan's R&D budget could not lead innovation. (Figure26) Japan should enhance its "Driving Power to Innovate," which refers to its capabilities to maintain coherent objectives among each function, combine results from each function, and move forward on projects to generate innovation. (Figure 27)

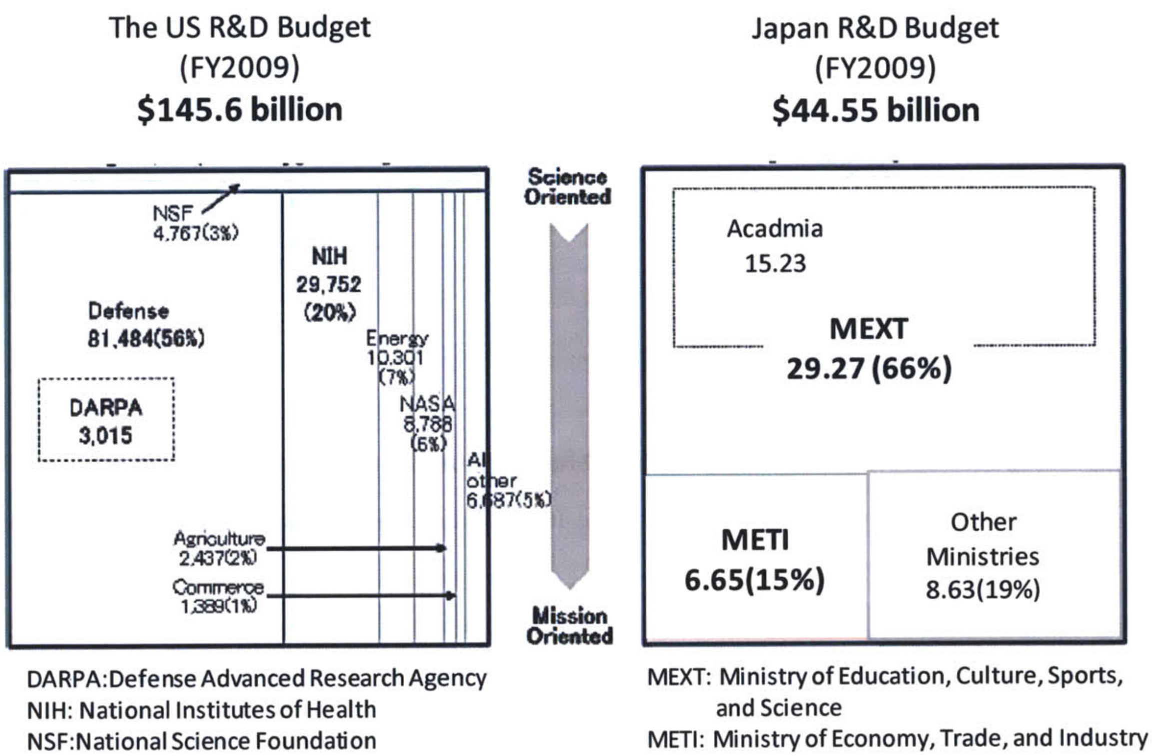


Figure26. The Comparison of R&D budget structure between the US and Japan

Source: The Report of Industrial Structure Council, Ministry of Economy, Trade, and Industry, May 2010, modified by author (currency conversion $1=¥80)

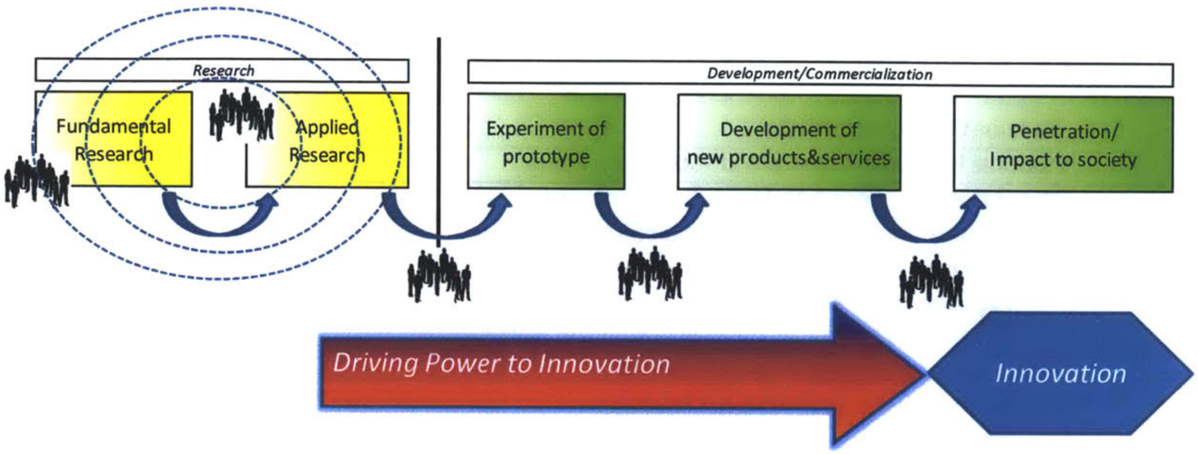


Figure27. Step for Innovation - Driving Power to Innovation

Source: developed by author

Japan and the US government have common specific research fields, including green energy and health care. To set targets to promote research is beneficial; however, there is a difference between both nations' policies. The US policy, "A Strategy for American innovation," is more focused on the time frame to readily achieve results that generate innovation for economic growth. The role of national research institutes is also clearer than those in Japan in terms of basic policy. For example, the Science and Technology Basic Plan for Japan mentioned many concrete measures about Green Innovation; however, there is no information on the approached needed to achieve the goals, timelines and numerical resources, including the amount of R&D budget, current business market status or the penetration rate of renewable energy in Japanese households. In addition, through reviewing the Life Innovation in the Science and Technology Basic Plan, there is no information on how to achieve the goals, timelines and numerical resources, including the amount of R&D budget and current business market status. For the approach to improve application system of drugs, there is no information related to reducing regulations, just adding and strengthening the organization by increasing specific staff members. The budget to maintain these larger independent administrative agencies will increase, yet there is little concrete information on how to utilize these staff to achieve the goals put forth in the Basic Plan. Additionally, the way in which R&D budgets are implemented should be looked at in more detail, due to Japan's complicated budget distribution system. A prime example is MEXT, the ministry that receives a high ratio of the government's total R&D and distributes part of the budget to a total of 31 other institutions and agencies. (Figure28)

Tsukuba Center for Institute	1
National Institue of Science and Technology Policy	1
Inter University Research Institute Corporation	19
National Institutes for the Humanities	6
National Institutes for Natural Sciences	5
High Energy Accerelator Organization	4
Research Organization for information and Systems	4
Independent Administrative Institutions	10
National Institute of Material Sciences	1
National Institute of Radioragical Sciences	1
National Research Institute for Earth Science and Disaster Prevention	1
Japan Aerospace Exprolation Agency	1
Japan Society for Promotion of the Science	1
Japan Science and Technology Agency	1
National Institute of Natural Sciences (RIKEN)	1
The World Largest Synchrotron Radiation Facility	1
Japan Agency for Marine-Earth Science and Technology	1
Japan Atomic Energy Agency	1
Total number of institutions and agencies	31

Ministry of Education, Culture, Sports, and Science Website

Figure28. A list of Institutions controlled by MEXT

Source: MEXT homepage, developed by author

Consequently, the budget of MEXT is distributed into other institutions and agencies listed above. It seems like an impossible task for MEXT to control and manage all the organizations. Overlapping projects or organizations definitely produce duplicate functions and higher cost systems. In addition, the grant budgets for universities are distributed to one of the independent administrative institutions, either Japan Society for the Promotion of Science or the Japan Science and Technology Agency. Those agencies have two functions, a research function and examination function. Do organizations that include opposite functions and may present conflicts of interest work well? Since each agency tries to enhance its examination function, the guidelines and large amount of paperwork needed for applications obscure the critical focus and the essential objectives of the projects. CSTP discussed how to appropriately manage these complicated systems in which many stakeholders are involved, and came to the conclusion that they will establish another committee to manage projects by themes, without considering how to integrate similar work and projects across institutions and agencies.

The other issue in terms of implementing the system of R&D budgets is the obligation to implement R&D grants by year. According to a research report that looked at Science and Technology Policy issued by the Japanese Cabinet office in 2006, the government noticed differences between the Japanese and the US R&D budget implementation system. The US government distributes R&D grants three times a year and allows researchers to implement R&D budgets over several years. The US government takes efforts to decrease the necessity to build precise research plans that include all expenses and to implement R&D budgets according to plan. On the other hand, the US government strictly examines the contents of each research plan and checks the results of research reports. [Cabinet Office of Japanese Government]

The most critical action that the Japanese government should take is to immediately integrate research and projects across independent administrative agencies and national research institutes. Taking into account Japanese national debts and an accelerated competitive environment to pursue innovation, there is no time to discuss matters in more detail and to postpone solving the issue of funds ineffectively funneled into R&D.

4.3 Policy for Entrepreneurial environment/ecosystem

Through reviewing "A Strategy for American Innovation", it is evident that the US innovation policy centers on the roles of the private sector and entrepreneurship in generating innovation. Compared to Japanese innovation policy, the US government can provide big-picture solutions to promote innovation. There has also been a shift in the Japanese government now that it has announced in the Science and Technology Basic Plan that promoting PDCA cycles is important.

The US policy tries to accelerate conversion from technology in the lab to business in the market place through entrepreneurship. To achieve this goal, the government tries to play a role in supporting all processes of entrepreneurship, from assisting in the development of business plans to providing access to capital and mentors. The results have contributed to the establishment of "Startup America Partnership", with technology feasibility and business plan development, to providing access to early-stage capital and mentors to offer critical guidance to innovators.

Since the Japanese government intends to strengthen the research stage, there is a lack of awareness that innovation needs driving power to convert the results of science and technology research into prototypes, products and services. This critical stage, from research to experiment with prototypes and introducing products into markets, contains high uncertainty and risks.

Yokichi Koga, the Director of Business Development at Globespan Capital Partners noted that innovation requires prevailing over high levels of uncertainty. In an environment where there is no precedent, innovation requires taking risks. It is actually impossible to invest in uncertainty and risk by exploiting taxes in Japan. The most important role of the government is not to intervene in markets. To foster start-ups companies, Japan needs real venture capitalists and labor liquidity. To that end, is it fair to say that the Japanese government intervenes in markets and does not take efforts to build entrepreneurial environment?

In reconsidering Japanese policy for the commercialization of science and technology in the late 1990's, it is important to note that the government developed an environment conducive for entrepreneurs and the commercialization of science and technology. For example, as mentioned in Chapter 2, in 1998, the Limited Partnership Act for Investment was enacted, which is called the Venture Fund Act and functions to build an organization like US Limited Partnerships. The Act for the Promotion of Technology Transfer from Universities to Private Business Operations (TLO Act) was also enacted in 1998. In 1999, The Act on Special Measures for Industrial Revitalization (Japanese version of the Bayh-Dole Act (Patent and Trademark Act Amendments of 1980) was enacted. In 2000, The Industrial Technology Enhancement Act was enacted, which clarifies the respective roles of the National government, the Local government, National research institutes and academia, and private sectors. In addition, the law also aims to promote the transfer of the results from research into the private sector, and to identify special measures for patent fees for small-medium sized enterprises. In 2002, The Intellectual Property Basic Act was enacted, which was a set of new laws aimed to develop favorable conditions to generate spin-off companies from academia. These new regulations were drafted specifically to build a favorable entrepreneurial environment.

The laws above were created by the Ministry of Economy, Trade, and Industry (METI). An interview with a young government official from METI, who is currently pursuing a Master's degree in Boston, touched on several topics. The official spoke about METI, by passing laws related to innovation, played a role in developing an environment conducive to innovation. In another interview, a different METI official noted that even though the government has built a platform to collaborate between the government, academia, and private sector, each sector does not intermingle. The official also mentioned that national research projects in which METI took strong initiatives tended to never last long. In addition, he believes that it is doubtful that the government needs to clear any risks from markets for start-ups companies or other private companies. A project implementation body should take risks, and that innovation finally requires personal will and tenacity.

Compared to the US policy for building an entrepreneurial environment/ecosystem, the Japanese policy seems to be very formal. The U.S. government steps in to encourage entrepreneurs through education, training, and mentoring. Effective mentoring will be provided by experienced entrepreneurs. The US environment that has already developed many entrepreneurs can create an effective mentoring system. Socially accepted ideas like the promotion of diversity, the acceptance of failure and the rewards of meeting new challenges also may reinforce the building of an entrepreneurial environment/ecosystem.

While it is not possible to exhaustively cover the issue of cultural differences and their effects on an entrepreneurial environment, it can be said that cultural differences between Japan and the US are present. Also, it is true that there are large differences between the two countries in terms of socially accepted ideas for entrepreneurs. This may be a "chicken or the egg" in terms of the following idea: if the presence of entrepreneurs in Japan will increase, the number of people who create start-ups companies will increase. If the numbers of start-ups increase, the entrepreneurs will increase. If the experienced entrepreneurs increase, the presence of entrepreneurs as a whole increases.

For building these positively reinforced loops, the role of government may actually be minor. While continuing to enhance tax systems to increase the inflow of capital into entrepreneurial markets, the government should focus on promoting the streamlining of independent administrative agencies and national research institutes, and promote the sharing of research results from national research institutes with the aim to increasing spin-offs.

4.4 Policy for the Commercialization of Science and Technology

At the beginning of a chapter, in the section on "Promoting Market-Based Innovation" in "A Strategy for American Innovation", there are the following sentences:

> *The private sector is an engine of innovation. Great ideas can come from many corners, and the capacity of decentralized, competitive markets to see innovative opportunities, prove their value, and enable their diffusion drives our economic growth and the creation of new, better jobs for the American People. The Obama Administration is committed to providing the best possible environment for private-sector innovation, whether by established firms or entrepreneurs.* [The White House, 2011]

These sentences highlight that fact that decentralized, competitive markets can recognize innovative opportunities, prove their value and be converted into drivers of economic growth, which in turn creates innovation. Thus, the government aims to create the best possible environment for established firms or entrepreneurs. This idea includes some different and clear concepts which have never been seen in Japanese Policy statements: 1) decentralized, and competitive market; and 2) the best possible environment for established firms or entrepreneurs. For creating a favorable environment for innovation, the Obama administration has already recognized that there should not be any presence of ineffective regulations to restrain innovation, and on the basis of this thought, the President ordered all government agencies to pick up the regulations and build measures to improve them within a limited timeframe.

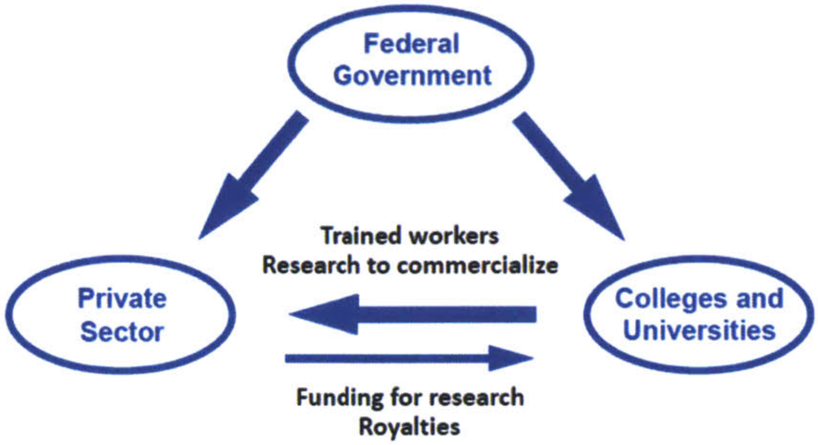
The important difference between Japan and U.S. policy is minor but clear. The Obama administration addresses deregulation with a limited timeframe. In contrast, the Japanese government believes that creating new regulations for zero emission standards for bio fuels or revising the regulation of gas mileage standards would promote innovation.

Unlike the business environment of the 1970's-80's, when Japanese cars succeeded in overcoming high emission regulations thereby allowing penetration into international markets, Japanese business sectors constantly built global strategies to exploit the economic growth of emerging countries, and also to solve global issues such us climate change, energy and food securities, and aging societies, all of which had no precedent. The private sector needs dynamism or momentum in order to address many issues, including recovery from the Great East Japan Earthquakes. The Japanese government believes not in the power of the competitive advantage of the private sectors, but in the power of regulations.

In addition, there is a difference between Japan and the US in terms of the exchange of R&D. The Japanese government promotes exchanging among researchers who belong to different universities and research institutes. This thought reflects the government's focus on the limited field of Research in Science and Technology. There is little consideration for the total process of innovation, which starts from basic research, and then transition to applied research, development, and commercialization. In pursuing innovation, it is necessary to promote more horizontal exchanges among different organizations, for example between academia and the private sector.

The proof that the government does not think about the total process of generating innovation lies in the fact that the government implements measures to diffuse the results of R&D, such as the publication of the results of R&D and the provision of the information related to R&D to promote appropriate practical applications. The publication of R&D information such a tactical actions, is not the government's responsibility. The government's essential responsibility is how to establish a sustainable innovation ecosystem, which means sustainably generating innovation by strengthening the fundamentals for building innovation and invigorating the exchange of knowledge relating to innovation in Japanese society.

In Contrast, as mentioned above at Chapter 3, the US Department of Commerce mentioned a concept in its "Research Ecosystem", which interconnects the Federal government, colleges and universities, and the private sector for the purpose of research and innovation.



(Repeat) Figure20. The Research Ecosystem

Source: "The Competitiveness and Innovative Capacity of the United States" by US Department of Commerce,2012

The exchange of intellectual knowledge may be just one component of activities to enhance innovation. However, through assessing both Japan and the US policies, it is clear that the establishment of an ecosystem to combine research activities and commercialization of technology will achieve a sustainable system to generate innovation.

In addition to four innovation drivers, two examples of effective systems combining academia and business sectors in the US and Japan will be highlighted.

4.4.1 MIT Entrepreneurial Ecosystem

In 1930's, MIT created a Technology Plan to link industry with MIT in what became the first and still the largest university-industry collaborative, the MIT Industrial Liaison Program. In 2010, the program had close to 200 of the world's leading research- and technology-based companies as its members. [Roberts, 2011]

MIT, established by William Barton Rogers in1861, has as its credo "to respect the dignity of useful work." MIT's slogan, "Mens et Manus" (Latin for "mind and hand"), and its logo show both the scholar and the craftsman in parallel positions. It is possible to say that MIT had already maintained the position of promoting its liaison function between academia and industry.

According to the report "Entrepreneurial Impact" written by Edward B. Roberts, David Sarnoff (Professor of Management of Technology, MIT Sloan Scholl of Management, and the Founder and Chair of the MIT Entrepreneurship Center, and Assistant Professor, Stanford University Department of Management Science and Engineering), MIT continually acted as a platform of entrepreneurship, which created a positive feedback loop for entrepreneurship, in turn creating new technology clusters, like The Biotechnology Cluster and The Energy Cluster.

Historically, MIT created many development and research laboratories, which were elite research and development centers for specific practical devices for winning the World War II. MIT existed in an environment conducive to research, where national research resources gathered along the Route 128 highway. However, MIT made efforts to promote spin-offs from the science and technologies which MIT possessed. Karl Taylor Compton, who was MIT's president during wartime, pioneered efforts towards commercial use of military developments, among other innovations helping to create the first institutionalized venture capital fund, American Research and Development (AR&D). [Roberts, 2011]

AR&D was organized in 1946 to supply new enterprise capital to New England entrepreneurs by Merrill Grisword, Chairman of Massachusetts Investors Trust, and Ralph Flanders, the President of the Federal Reserve Bank of Boston. MIT President Karl Taylor Compton became a board member and MIT became an initial investor, and a scientific advisory board was established which included three MIT department heads. AR&D's first several investments were in MIT developments, and some of the emerging companies were housed initially in MIT facilities. MIT provided the space and utilities, and AR&D paid for the staff and out-of-pocket R&D expenses. [Roberts, 2011] The report provided one of the examples, Ionics Inc., which was housed initially in the basement of the MIT Chemical Engineering building, became the United States' pre-eminent water purification company and was purchased by General Electric in 2004 for $1.3 billion.

MIT involvement's with industry was legitimatized in its official "Rules and Regulations of the Faculty." It encouraged not only active consulting by faculty members of one day per week, but also approved faculty's part-time efforts in forming and building their own companies. The report showed some companies' names which were founded by MIT Faculties as consulting firms, including Arthur D. Little, Inc. (ADL), Edgerton Germeshausen and Grier (EG&G, Inc) and Bolt Beranek & Newman (BBN, Inc.). Faculty entrepreneurship gradually transformed from part-time into full-time, and into MIT labs and departments. The result was that a large fraction of all MIT spin-off enterprises, including essentially all faculty-initiated companies and many staff-founded firms, were started on a part-time basis, smoothing the way for many entrepreneurs to "test the waters" of high-tech entrepreneurship before making a full plunge. These companies are obvious candidates for the most direct movement of laboratory technology into the broader markets not otherwise served by MIT. [Roberts, 2011]

To utilize technology originally created for wartime purposes for a postwar society, MIT, from the start-line, organized an infrastructure to transform technology created by academia into commercially viable technology. These objectives were achieved through entrepreneurial capital funds and accelerating spin-offs from academia. Through increasing the number of faculty founders at MIT, their activities became the clear evidence for others who wanted to tackle entrepreneurship. The report said that this process created a positive feedback loop -- the more entrepreneurial that MIT appeared to be, the more potential entrepreneurs wanted to be there. The more entrepreneurs MIT produces, the stronger the entrepreneurial environment and reputation. The growing number of early entrepreneurial developments at MIT and domestically also encouraged brave investors and brought other wealthy individuals forward to participate, which created another positive feedback loop according to Edward B. Roberts. Also, the benefits carried over into providing the infrastructure to support entrepreneurs, including the technical. legal, accounting, banking and the real estate industries, which were able to provide more in-depth understanding of how to serve the needs of young technological firms. [Roberts, 2011]

What does a positive feedback loop generate? Edward B. Roberts said that this positive feedback process certainly played an important role in the 1980's, the beginning of the still-continuing proliferation of biotechnology spin-offs from MIT and Harvard academic departments and medical centers. [Roberts, 2011]

According to the report, a total of 95 biotech companies, all located close to MIT in Kendall Square, Cambridge, MA, had been documented by early 2008. Twenty-one of the Kendall Square companies either were founded by MIT alumni or faculty, or had MIT-licensed technology. 66 of the 493 MIT life scientists have founded or served on the Board of Directors of at least one venture founded company, totaling 134 companies in all. [Roberts, 2011]

The positive feedback loop impacting MIT's entrepreneurial output is the product of the earliest faculty founders who were senior faculty of high academic esteem at the time they started their firms. Their initiatives as entrepreneurs were evidence for others at MIT that technical entrepreneurship was a legitimate activity to be undertaken by strong technologists and leaders. [Roberts, 2011]

4.4.2 Division of University Corporate Relations in The University of Tokyo

The University of Tokyo, the most prestigious higher education institution in Japan, established the "Division of University Corporate Relations (DUCR)" since 2004. The purpose of the establishment of the DUCR is to capitalize on the gains made in research at the University to society and to serve as a contact point for requests from industry as well as a university-wide support unit to facilitate cooperation between the University's researchers or offices and industrial circles. [Division of University Corporate Relations The University of Tokyo, 2010]

The University of Tokyo has created action plans to achieve its vision by 2015. One of these is enhancing collaboration with society and taking on new challenges from "Technology Transfer" to "Knowledge Co-creation". To achieve this, the University has three goals. First, the University will enhance interactive communication between the University and society by providing a "platform" that is open to the public, and ensuring that people with diverse backgrounds identify and share issues to be addressed and act creatively to solve such issues. The University calls this activity "Knowledge Co-creation". Second, the University will step up efforts to provide returns on the results of research to society through industry-academia partnerships, developing "Knowledge Co-creation" to link the University's knowledge to industry's knowledge, and connecting the results of such collaboration to innovations. Third, the

University will provide information on the diverse activities of the University and the result of its research through different levels of outreach activities to promote society's understanding of the university's many functions. [Division of University Corporate Relations The University of Tokyo, 2010]

The DUCR is organized into three offices: the "Office of Collaborative Research Development" implements new forms of collaborative research; the "Office of Intellectual Property" manages intellectual property and supports its practical application; and the "Office of Science Entrepreneurship and Enterprise Development" supports businesses, helps promote start-up companies for university spin-offs, and assists in the practical application of research results. The administrative group of the University Corporate Relations Department plays a role to promote and implement administrative work. In addition, the DUCR works closely with TODAI TLO, Ltd. (CASTI), and the University of Tokyo Edge Capital Co., Ltd. (UTEC). [Division of University Corporate Relations The University of Tokyo, 2010] (Figure29)

While reviewing the history of University Corporate Relations in the University of Tokyo, and the establishment of the DUSP, a knowledge based ecosystem for innovation, it is clear that a transition in terms of Japanese policy has taken place.

The University of Tokyo established the Office for the Promotion of University Corporate Relations in 2002, after enacting the Industrial Technology Enhancement Law, and the National University Corporation Act to promote the establishment of DUCR was enacted in 2004.

At the functionality of the DUCR could overlap with the Council for Science and Technology Policy (CSTP), the National Council should set a total vision for the progress in science and technology and a path to sustainable economic growth in Japan. In order for Japan to promote innovation more effectively, it is essential to apply the results of research to industrial circles more effectively. The DUCR noted that they aim to play the role of facilitator for collaborative research between industry and the University, effective utilization of the University's intellectual property, and the development of university startups with the aim of bringing about innovations through collaborative creation of knowledge between industry and the University.

The DUCR implements concrete measures, including managing the proposal website to connect 4,000 researchers in the University of Tokyo and private sector. Also, it provides a one year educational program for local government officers to learn how to build collaborations between local universities and local companies. In addition, the office oversees the University of Tokyo Entrepreneur Plaza to provide working spaces for entrepreneurs. It partners with the University of Tokyo Edge Capital, which has ability to do "proof of concept" for start-up companies and also plays a role as a venture capitalist. It is an encouraging sign that the DUCR system has been expanding to other national universities, which are looking for effective methods to promote partnerships between the government, academia and private sector.

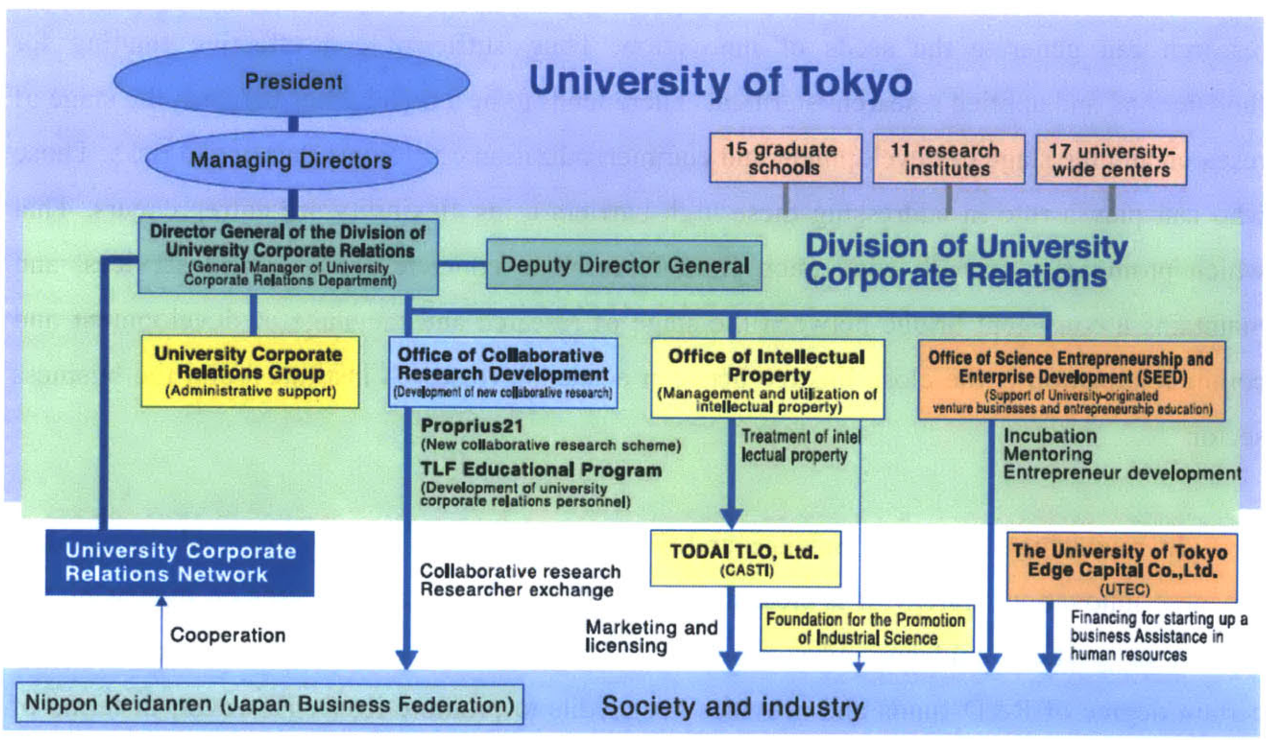


Figure29. Overview of the University of Tokyo's Industry-Academia Partnership System

Source: Division of University Corporate Relations, the University of Tokyo, Annual Report 2010

Chapter5. Conclusion

By comparing the differing approaches to foster innovation, it is clear that there are four innovation drivers: 1) human resources and mentoring future innovators, 2) effective funds funneled into R&D, 3) entrepreneurial environment/ecosystem, and 4) commercialization of science and technology. In addition, in formalizing the process to create innovation, it is also clear that the process has two main stages -- research and development/commercialization -- and five functions: 1) fundamental Research, 2) applied Research, 3) prototype experiments, 4) development of new products and services, and 5) penetration into markets and impact on society.

Those who can successfully connect each stage and can convert the results of research into outputs/outcomes are the innovators, i.e. human resources. The accumulated results from research can generate the seeds of innovation. Thus, sufficient and effective funding for fundamental and applied research is critical. There tends to be a high barrier between the stage of research and the stage of development and commercialization due to uncertainty and risks. Those who can play a role in addressing these high barriers using flexibility are entrepreneurs. That which promotes a smooth conversion from research to concrete products and services, and maintains a consistent bridge between the stage of research and the stage of development and commercialization is the close linkage between academia (research institutes) and the business sector.

In reviewing the fourth Science and Technology Plan (FY2011-2015), which clarifies Japanese innovation strategy, it is clear that the Japanese government focuses on increasing the number of graduate students and securing a sufficient number of researchers. It maintains a certain degree of R&D funds and provides tax credits to promote R&D. However, in terms of building an entrepreneurial environment/ecosystem and commercializing technology, there has been less progress despite the creation of new laws to promote the conversion of research results into business models. The government faces several issues, such as rebuilding appropriate regulation systems to promote innovation or strengthening support for venture start-ups based on science and technology.

In reviewing "A Strategy for American Innovation", which spells out the US innovation strategy, it is clear that the US government has a clear vision for and focus on building a sustainable innovation reinforcement loop. Innovation blocks (fundamentals) will promote market-based innovation, which will lead to breakthroughs in clean energy, biotechnology, healthcare technology and other critical industries, and ultimately produce greater market-based innovation. Thus, the American fundamentals for innovation will be strengthened.

One of the noteworthy US policies, in contrast to Japan, is the i6 Challenge series, a support program for entrepreneurship initiatives, which awards up to $1 million to each of the six teams around the country with the most innovative ideas to drive technology commercialization and entrepreneurship in support of a green innovation economy. The other is the Small Business Innovation Research program (SBIR program), which is designed to encourage the conversion of government-funded R&D into technological innovation. Another prominent policy is the establishment of proof of concept centers, which assist with the exchange of ideas between university-based innovation and industry by providing mentors with experience in innovation and industry connections helping to link faculty and students to external networks. Overall, the US government places more emphasis on the commercialization of technology while encouraging an entrepreneurial environment.

When comparing the innovation policies for Japan and the US using four innovation drivers as benchmarks, the differences between the two innovation infrastructures are clear.

Japan's government emphasizes education for graduate schools and securing the number of researchers when compared with U.S. human resource policy on innovation. However, on the basis of the results of PISA (Program for International Study Assessment conducted by OECD) and the world university ranking top 50 by Thomson Reuters, which use multiple viewpoints for assessment, it is evident the Japanese government should establish a strategy to improve the next generation's abilities in Science and Technology, to improve students' cognitive skills along with attentiveness, motivation, self-control and sociability. This will foster human resources that can address and manage uncertainty, and not simply comply with existing rules, and also to build competitive systems to reinvigorate higher education.

Regarding R&D policy, the implementation system for R&D budgets is fundamentally different between the two countries. Japan has two issues: a complicated budget distribution system and the overlapping of similar organizations. This translates into 31 organizations under the control of the Ministry of Education, Culture, Sports, and Science (MEXT), for which several have duplicated tasks in terms of innovation. The most critical action that the Japanese government should take is to integrate activities and projects across independent administrative agencies and national research institutes immediately. In addition, the obligation to implement R&D grants for one year at a time at research institutes in Japan should be removed.

In terms of the policy to develop an entrepreneurial environment/ecosystem, the US government steps in to encourage entrepreneurs through education, training, and mentoring, and tries to accelerate the conversion from technology in the lab to businesses in the marketplace, from assisting in business plan development, to providing access to capital and mentors. On the other hand, the Japanese government is inclined to strengthen the research stage. There is a lack of awareness that innovation needs driving power to convert the results of science and technology research into prototypes, products and services, which tends to have high uncertainty and risk. The private sector, rather than the government, may play more important roles in promoting an entrepreneurial environment/ecosystem. While continuing to enhance the tax system to increase capital inflow into entrepreneurial markets, the government should focus on promoting the streamlining of independent administrative agencies and national research institutes, and promoting the sharing of research results from those institutes with the aim of increasing spin-offs.

The establishment of ecosystems to combine research activities and the commercialization of technology will allow for achievement of a sustainable system to generate innovation. The US government aims to establish a "Research Ecosystem", meaning that the federal government, colleges and universities, and the private sector all are interconnected in terms of research and innovation. Colleges and universities contribute by developing a trained workforce for innovation and conducting research for commercialization. The private sector provides research royalties to colleges and universities and the federal government promotes the interaction between colleges, universities and the private sector. In addition, the US government aims to create a decentralized and competitive market, which is the ideal environment for either established firms or entrepreneurs, believing that the private sector is the engine of innovation.

The Japanese government simply focuses on diffusing the results of R&D, such as the publication of the results of R&D and the provision of the information on R&D to promote appropriate practical applications. This work seems lack the necessary teeth to allow for the conversion of research into the commercialization of technology.

From the standpoint of academia, MIT and the University of Tokyo are two examples of leading institutions promoting the interactions between academia and the private sector by acting as a bridge or connector. While the time frame to build an entrepreneurial ecosystem and foster the commercialization of technology has differed between the two organizations, both have the same goal, which is to promote interactions between academia and the private sector.

The Japanese ability to convert science and technology developments in the lab to businesses in the marketplace is weak compared to the U.S. The weakness of coherency and strong bonds among the private sector, academia and the public sector is one of the reasons for the diminishing capability to create innovation. In addition, the Japanese government and the private sectors did not recognize that the will power vital to tackle the uncertainties had diminished after the period of extended economic prosperity, and that the inclination to simply focus on improving existing products and services had increased.

The Japanese government has not played an important role in introducing the principle of market mechanisms into academia and into their own implementing bodies, the independent administrative institutions. This omission is an obstructive factor to strengthening the Japanese innovation infrastructure. Even though the government has tackled the creation of a platform with the aim to develop strong bonds among the private sector, academia, and public sector, the platform has been underutilized.

The Japanese government should take three actions: 1) integrate activities and projects across independent administrative institutions and national research institutes immediately; 2) stop excessive grants for academia and national institutes in order to introduce the principle of market mechanism; 3) focus on improving regulations and the regulatory review process in order to immediately eliminate factors hindering the conversion from technology in the lab to businesses in the market place; 4) develop a new education strategy with the aim to improve students' cognitive skills along with attentiveness, motivation, self-control and sociability. This will foster human resources that can address and manage uncertainty, and not simply comply with existing rules. This will be long-term policy, but will certainly contribute to an increase in the number of entrepreneurs who are willing to take risks.

The government should focus on developing an innovation infrastructure / ecosystem and the private sector and academia should be more conscious of diversity and flexibility and should continue to work towards solving issues while taking risks.

Innovation is one of the results of a process created by a series of human activities based on intellectual knowledge and will power. Human activities can be managed by appropriate assessments of well-functioning and underperforming activities, in addition to targeting consistent improvement. In order to pursue a higher level of performance for human activities that focus on developing or enhancing innovation, it is critical to facilitate interactions between academia, and the private and public sectors. Only then will the seeds of innovation truly be converted into products and services that revitalize the market and benefit society.

Bibliography

(2011). *Innovtion Union Scoreboard.*

Cabinet Office, the Government of Japan. (2011). *Strategy for Rebirth of Japan.*

Cabinet Office, the Government of Japan. (2011). *the Fourth Science and Technology Basic Plan for FY2011 to 2015.* Tokyo: Cabinet decision dated August 19,2011.

Cabinet Office,the Government of Japan. (2011). *Strategy for Rebirth of Japan -Overcoming crises and embarking on new frontiers-.* Tokyo: Cabinet decision dated December24,2011.

Cabinet Office,the Government of Japan. (n.d.). *Science and Technology administration in Japan.* Retrieved from Science Technology Policy/Council for Science Technology Policy: http://www8.cao.go.jp/cstp/english/about/administration.html

Clayton Christensen, T. C. (2001, March/April). The Great Disruption. *FOREIGN AFFAIRS*, pp. 85-88.

Clayton M.Christensen, S. L. (n.d.). *The Great Disruption.*

Council for Science and Technology Policy. (2010). *Japan's Science and Technology Basic Policy Report.*

D.Anthony, S. (2011). *The Little Black Book of Innovation-How It Works, How To Do It-.* Boston, Massachusetts, US: Harvard Business Review Press.

Deloitte. (2011). *Global Survey of R&D Tax Incentives.*

Division of University Corporate Relations The University of Tokyo. (2010). *Annual Report.*

Ewing Marion Kauffman Foundation. (n.d.). *Proof of Cocepts Center.* Retrieved from Ewing Marion Kauffman Foundation: http://www.kauffman.org/advancing-innovation/proof-of-concept-centers.aspx

James P. Andrew, E. S. (2009). *The Innovation Imperative in Manufacturing* . The Boston Consulting Group.

Japan Society fo the program of science. (n.d.). *Business report 2011-2012.*

Japan Science and TechnologyAgency. (2010). *Report to review co-relations between innovation and regulation in Japan.* japan Science and Technology Agency.

MEXT (Ministryof Education, Culture, Sports and Science). (2011). *School Basic Survey.*

MIC (Ministry of Internal Affairs and Communications). (2011). *Survey of Research and Development.*

Ministry of Economy, Trade and Industry. (n.d.). *History of Japanese Industrial Policy.* Retrieved from Ministry of Economy, Trade and Industry: http://www.meti.go.jp/policy/economy/gijutsu_kakushin/innovation_policy/pdf/nenpyou.pdf

Ministry of Education,Culture, Sports, and Science. (2012). *Plan for fostering young researchers 2012.* Ministry of Education, Culture, Sports, and Science.

Minitstry of Education, Culture, Sports, Science and Technology. (n.d.).

National Institute of Sciecne and Technology Policy. (2011). *Japanese Science and Technology Indicators 2011.*

National Tax Agency. (n.d.). *Corporate Tax Guide (R&D tax credits).* Retrieved from National Tax Agency: http://www.nta.go.jp/taxanswer/hojin/5441.htm

PIAAC (Programme for the International Assessment of Adult Competencies). (n.d.). Retrieved from OECD.

Roberts, E. B. (2011). *Entrepreneurial Impact.* Foundationa and Trends in Entrepreneurship.

Science Council of Japan. (n.d.). *Science Council of Japan top page.* Retrieved from Science Council of Japan: http://www.scj.go.jp/en/scj/index.html

The White House. (2011). *A Strrategy for American Innovation.*

Times Higher Education's list of the world's top universities for 2011-2012. (n.d.). Retrieved from Thomson Reuters.

US Department of Commerce. (2012). *The Competitiveness and Innovative Capacity of the United States.*

US Department of Education. (2011). *U.S.Departmnet of Education Strategic Plan :Fiscal Years 2011-2014.*