RIETI Highlight

2018 SPECIAL EDITION 68

RIETI International Symposium

Information Technology and the New Globalization:

Asia's economy today and tomorrow

BBL Seminar

World's Great Excess of Supply

Energy Markets: What to do when forecasting is useless

RIETI
Research Institute of Economy, Trade & Industry, IAA

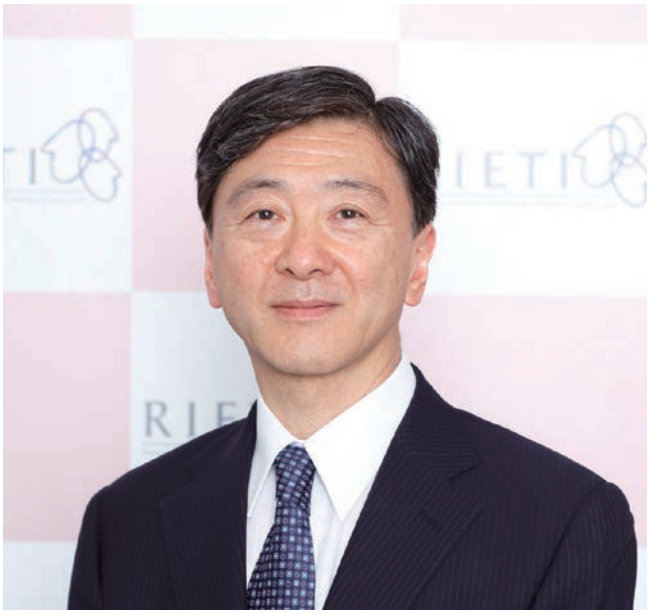
RIETI Highlight 2018 Special Edition 68

Contents

What is *RIETI Highlight*?

RIETI's Japanese-language PR magazine *RIETI Highlight* is published quarterly, featuring RIETI's most recent activities with the objective of disseminating our research outcomes to a wider audience. This *RIETI Highlight 2018 Special Edition* is, as its extra number, edited in English and published annually for our international readers. We hope this special edition will be helpful not only in spreading our activities and research findings but also in deepening international readers' understanding on our mission as a Japanese leading policy think tank.

Message from the Chairman



The world economy continues to recover, thanks to steady economic growth in the United States and China, stable crude oil price, sustained monetary easing policies in major countries, and global momentum in IT product sales. The Japanese economy is also enjoying healthy growth due to favorable conditions including monetary easing, recovery of the world economy, and low energy prices.

Yet, although the economy is sound in and outside Japan, this does not indicate that the Japanese economy's structural issues have been resolved. The pace of productivity increase is slowing down in Japan and many other major countries. Together with the deceleration of population increase, this situation is applying downward pressure on the rate of economic growth. At the same time, income disparity continues to widen. How such disparity could be corrected, e.g., through education, is becoming an issue of increasing gravity.

In FY2017, RIETI engaged in far-reaching research activities, releasing numerous research papers in many fields including the macroeconomy, finance, innovation, human resources, energy, environment, and trade policy. Over the last 12 months, we held or co-organized a number of symposiums, seminars, and workshops covering a wide range of subjects including Brexit, corporate growth, spatial economic issues of large cities, Japan's growth strategy, and the effect of IT and new globalization on the Asian economy.

This edition of *RIETI Highlight* introduces the main contents of our research achievements, symposiums, etc. that occurred in the past 12 months. All of the contents relate to the current conditions and immediate issues of the Japanese and world economy, and therefore should help you deepen your understanding of these matters.

In FY2016, RIETI entered a new four-year Medium-term Plan. Under the plan, we employ the mid- and long-term economic and industrial policy perspectives of "cultivating Japan's strength in the world economy," "making Japan into an innovative nation," and "overcoming population decline" in continuing to engage in theoretical and empirical research that contributes to the formulation of economic and industrial policies and providing evidence-based policy recommendations in the fields of international economy, regional economy, labor economy, productivity, and innovation. At the same time, we are committed to actively sharing the outcome of such research activities in a timely fashion through symposiums and seminars. Your continued support would be sincerely appreciated.

Atsushi Nakajima
Chairman, RIETI

About RIETI

The Research Institute of Economy, Trade and Industry (RIETI) is a policy think tank established in 2001. Our mission is to conduct theoretical and empirical research, to maximize synergies with those engaged in policymaking, and to make policy proposals based on evidence derived from such research activities. For such activities, RIETI has developed an excellent reputation both in Japan and abroad.

Symposium

RIETI International Symposium

Information Technology and the New Globalization: Asia's economy today and tomorrow

Date: August 1, 2017
Venue: Iino Hall and Conference Center, Tokyo

Host: RIETI
Co-hosts: Japan Productivity Center (JPC), Hitotsubashi Institute for Advanced Study (HIAS), Grant-in-Aid for Scientific Research (S) Grant Number 16H06322 Project "Service Sector Productivity in Japan (SSPJ): Determinants and Policies"

As major Asian economies face the issue of an aging and low-birthrate society, for the development of policies that can effectively improve the economic growth rate, it is necessary not only to accurately identify the reality of productivity in an industry or company through the development of a database and its analysis, but also to understand the effects of the use of information technology (IT), innovation, and globalization on productivity. In the first half of this symposium, Professor Dale Jorgenson of Harvard University and Richard Baldwin, president of the Centre for Economic Policy Research (CEPR), delivered a lecture on the second phase of Abenomics and the convergence from the perspective of IT and new globalization, respectively, in a way that leverages the results of the Asia KLEMS Conference. In the latter half of the panel discussion, seven participants analyzed the current status of the Asian economy from the viewpoint of globalization and productivity and held discussion about its future.

Welcoming Remarks

Atsushi Nakajima
Chairman, RIETI

Today's RIETI symposium, "Information Technology and the New Globalization: Asia's economy today and tomorrow" is organized by RIETI and held jointly with the Japan Productivity Center and the Hitotsubashi Institute for Advanced Study, in conjunction with the Fourth Asia KLEMS Conference, which is scheduled to be held in Tokyo.

Asia KLEMS is a framework that has been established to follow up World KLEMS, a project designed to build an international database that allows for conducting international productivity comparison. World KLEMS is participated by economists around the world and led by Professor Dale W. Jorgenson of Harvard University, who is going to give a keynote speech at this symposium. Asia KLEMS is part of the global framework and its key participants from Japan include not only RIETI but also Professor Kyoji Fukao, program director and faculty fellow at RIETI and professor at the Institute of Economic Research, Hitotsubashi University, who will take the podium at today's symposium.

Needless to say, improvement of productivity is a principal source of economic growth. In particular, given the rapid pace of aging and birthrate decline in Japan and major Asian countries such as China and South Korea, productivity improvement is now the top priority issue to be solved for continuous and sustainable growth.

Under these circumstances, in order to develop policies that are effective to stimulate economic growth, it is necessary to accurately identify the reality of productivity in industries and companies through the development and analysis of databases like KLEMS, which I referred to a moment ago, while understanding the effects of the use of IT, innovation, and globalization on productivity.

Under the theme of IT in Asia and new globalization, this symposium will be run by leveraging the results of the Asia KLEMS Conference. While placing the viewpoint of productivity at the core, we will welcome participants from overseas, including Richard E. Baldwin, who is a professor at the Graduate Institute, Geneva and the president of the Centre for Economic Policy Research (CEPR), as well as Professor Lawrence J. Lau of the Chinese University of Hong Kong. Professor Baldwin is the world's top expert on international trade and economy and leads discussions about the changes brought about by IT and new globalization to the world's economy or trades. Professor Lau developed the first econometric model of China and has extensive knowledge and wisdom about Chinese and East Asian economies.

Participants from Japan include Toshitaka Sekine, director-general, Research and Statistics Department, Bank of Japan, and Professor Kozo Kiyota, research associate at RIETI and a professor at the Keio Economic Observatory and Graduate School of Economics, Keio University. These participants will bring a wider scope of view to the panel discussion, which will focus on Asia's economy today and tomorrow.

I strongly believe that the up-to-date reports from these world authorities and their panel discussion will further enhance your knowledge and wisdom.

01 Keynote Speech

The Second Phase of Abenomics

Dale W. Jorgenson
Samuel W. Morris University Professor, Harvard University

We are all familiar with Japan's two lost decades. Since the beginning of the 1990s, there has been little economic growth and no productivity growth. Japan's policy response to the lost decades is the theme of my lecture. Prime Minister Shinzo Abe announced a second phase of Abenomics as an attempt to deal with long-term issues, opportunities of new globalization, and the role of IT. Japan is a laggard in the application of IT and has underinvested in this, the central engine for innovation in the world economy.

The spread of global economic activities and value chains has taken on enormous momentum in the last two decades. With the collapse of Japan's bubble in 1991, a new international order emerged with India and China overtaking Japan on the list of the world's largest economies. In fact, China became the world's largest economy in 2014.

Japan's response to the new world order: Abenomics

This change in the world order provoked a response by Japan by Prime Minister Abe called Abenomics. The first phase of Abenomics is characterized by the three arrows of aggressive monetary policy, flexible fiscal policy, and growth strategy. In early 2016, the prime minister initiated a search for new economic policy built on the perceived successes of the first phase of Abenomics.

I was chosen to provide advice on the new phase of Abenomics. My recommendations were to revitalize the Japanese economy by stimulating productivity growth. I identified non-manufacturing sectors protected from international competition as the primary focus. The reformulation of Abenomics was completed with the economic policy called "Growth Strategy 2017," which I will refer to as the second phase of Abenomics.

Issues facing the Japanese economy

First, Japan's productivity growth has stagnated in a period when technologies have evolved more rapidly than in any period

of economic history. Second, Japan is confronted by a serious demographic crisis with a fall in the labor force and a declining population. The third challenge is that government revenues will rise in relation to the gross domestic product (GDP) to finance needed expenditure and support an aging population.

First phase of Abenomics

The traditional Japanese approach to growth was to subsidize favored industries, which created large companies that stifle competition. Abenomics aims to drill down through policies that sustain cartels, stifle competition, and eliminate incentives to invest in new technologies. The first reform was in agriculture to diminish the influence of agricultural cooperatives and to participate in trade agreements. Second, efforts are being made to increase competition in the highly regulated electric and gas utility sector, but doing so has been complicated by the Fukushima Daiichi nuclear accident. The third would be to stimulate competition by eliminating bedrock regulations in various industries.

The productivity gap between the United States and Japan at the aggregate level for the entire economy was 15%. Japanese industries with striking productivity gaps include the sectors of agriculture, energy, finance/insurance, other services, and wholesale/retail trade. These five sectors account for the entire productivity gap between Japan and the United States. Deregulation of these industries is necessary to stimulate competition and improve innovation and investment in IT. Japanese labor laws need revision to resolve the inefficient allocation of a shrinking labor force. Trade agreements can also play an important role in a growth strategy.

Abenomics 2.0: Growth Strategy 2017

When I met with the prime minister and his cabinet, my recipe was simple: Japan has to end productivity stagnation through a productivity revolution by promoting competition. The new face of Abenomics was then created based on three principles. The first is to boost productivity. The second is to drive innovation and trade. The third is to energize corporate activities.

As for boosting productivity, the first action is to reform the traditional work style, meaning reforming of the labor market. The second is to invest in human resources. The third is to embrace diversity in the labor force, or utilizing the elderly and women. However, where is the aforementioned drilling down to stimulate competition in cartelized industries in order to increase productivity?

As for driving innovation and trade, the first objective is to provide personalized medical care. The second is to have better distribution services for business emulating Amazon or Alibaba. The third is to increase productivity in infrastructure. The fourth is to promote the development of financial technology. However, specific talk about trade, services, and industries identified as lacking in productivity were all omitted.

The third principle is to energize corporate activities through corporate tax reductions, by strengthening investor confidence, and to drive inward foreign investment to facilitate technology transfer.

Conclusion

In order for the Japanese economy to exploit ongoing IT developments, there must be competition to drive investment and innovation. This seems to be a key missing part of Abenomics 2.0. The second arrow of the first phase of Abenomics should be abandoned for energetic reform and restoring fiscal balance through a shift of taxation away from investment toward consumption. A growth strategy should be focused on adapting to the changing world economy and the development of global value chains. We need concrete demonstrations of initiatives to improve productivity in Japan, which was precisely what generated widespread support for the first phase of Abenomics.

02 Keynote Speech

The Great Convergence: Information technology and the new globalization

Richard E. Baldwin
President, Centre for Economic Policy Research (CEPR) / Professor of International Economics, Graduate Institute Geneva

Today, I'd like to broaden the way you think about globalization. Let's begin with a definition: globalization is what happens when goods, ideas, people, services, and capital move from one nation to another. The driving force behind the international flows of these things is arbitrage. Whether it is goods, services, ideas, people, or capital, things tend to flow from where they are abundant and thus cheap to where they are scarce and thus expensive. When thinking about trade in goods, this arbitrage is called "comparative advantage."

In my 2016 book, *The Great Convergence*, I argue that the global nature of globalization has changed in recent decades. In 1990, G7 countries accounted for about 70% of manufacturing output; that percentage has fallen to below 50% as China, Korea, India, Poland, Indonesia, and Thailand increased their share

of manufacturing. The change in G7's share of GDP share was equally dramatic, with G7 countries accounting for 67% in 1993 and 46% in 2014.

Rethinking globalization

The traditional mental model for thinking about globalization is trade theory—in particular variants on David Ricardo's theory of comparative advantage. I think that did a good job of explaining how globalization worked from its earliest start around 1820 right up to 1990. But although comparative advantage still matters, there is a new form of globalization going on.

To understand this, I invite you to suspend your disbelief and ask yourself the question, "What if globalization were driven by knowledge flows, not trade flows?" Suppose that everything is made from know-how and labor, trade costs and barriers have not changed since 1990, and in that same year "pipelines" opened that allowed firms to move know-how across borders. Assume the pattern of pipelines to be the United States connected to Mexico and China, Germany to China and Poland, and Japan to China. In the 20th century, competition was done either with high tech and high wages or low tech and low wages. However, with the pipelines, G7 country companies can take their know-how and combine it with low-wage labor abroad. The manufacturing that used to be competitive in G7 countries because their technological edge outweighed high wages would be moved to high technology and low wages. This would cause a rapid shift of knowledge (and therefore manufacturing) from G7 countries to the factory economies connected by the pipelines. Knowledge pipelines led to an information and communications technology (ICT) revolution.

Three costs that constrain globalization and the great convergence

I would like to combine the idea of globalization as knowledge with the traditional view of globalization to form a broader perspective on globalization. There are three costs that form three constraints on globalization: trade costs, communication costs, and face-to-face costs. The steam revolution and Pax Britannica lowered trade costs without much affecting the other two costs. Low trade costs made high-volume trade feasible and comparative advantage made it profitable. The steam revolution unbundled production and consumption, which is when specialization started. As markets expanded globally, production clustered locally to reduce communication costs, not trade costs. Micro-clustering fostered innovation and ignited the bonfire of innovation and modern growth in G7 countries.

However, high communication costs meant G7 innovations stayed in G7 nations and know-how imbalances appeared. Pre-globalization knowledge between the rich and poor nations were fairly even. Afterwards, most of the knowledge was in the rich countries. That led to the "great divergence" where poor countries stayed poor and formerly rich countries such as China and India became poor. This was because trade costs came down, but communication costs did not. The ICT revolution lowered the cost of moving ideas and made offshoring feasible, while vast wage differences made it profitable. "New globalization" is information crossing borders. This is what led to the "great convergence" where countries such as China and India have started to reclaim their share of GDP as the G7's share of GDP drops.

Explaining the rise of anti-globalization

The first cause of anti-globalization is that the new globalization breaks the monopoly that G7 labor had on G7 know-how. Technology developed in G7 countries was moved offshore. This broke the social contract between companies and workers. Second, new globalization affects economies with a finer resolution. As an example, in old globalization, international competition happened at the level of completed products, such as Japanese cars entering the U.S. market. In new globalization, international competition happens at the level of individual jobs. This is no longer team Japan versus team United States, but rather the United States getting mixed up with Japan. This makes it hard to understand what is going on. These combined two factors led to economic anxiety, fragility, and disenfranchisement in G7 nations. The impacts of new globalization are more sudden, more individual, more unpredictable, and more uncontrollable. Any worker could lose their job next regardless of the skills they possess.

Future of globalization

Although I started with the negatives of globalization, these changes are probably going to allow people to better leverage their know-how. Thinking about the future, I would like to speculate about whether globalization will advance or retreat in the next five years. I think the next step of globalization is going to be more disruptive. Face-to-face costs remain high, and two-thirds of the people in rich countries who work in the service sector have not yet experienced globalization or automation.

However, technological advances in the next five years could make it feel like foreigners are actually working in your office through advanced communications, not travel. Imagine if instantaneous machine translation of spoken communication becomes commonplace and eliminates language barriers. Telepresence systems already exist today where you can feel like everyone is in the same room. Telepresence and instantaneous translation would allow for highly-paid professional jobs to move abroad. Telerobotics would allow for the offshoring of manual jobs or even surgeons. A maid in the Philippines could

work a robot cleaning hotel rooms in London. Telemedicine would allow doctors to work on patients anywhere in the world. Although these technologies are currently expensive and clunky, exponential technological growth will make them affordable and convenient in short order. The future is moving so fast that science fiction is starting to look a lot more like science and a lot less like fiction.

Panel Discussion

Chair
Kyoji Fukao
Program Director and Faculty Fellow, RIETI / Professor, Institute of Economic Research, Hitotsubashi University / Chair of the Fourth Asia KLEMS Conference

01 Presentation

Information Technology and the New Globalization

Lawrence J. Lau
Ralph and Claire Landau Professor of Economics, The Chinese University of Hong Kong

In the long run, whether or not there is economic growth or stagnation is not likely to be constrained by supply but will depend on the growth of aggregate demand. There is no sign of satiation in many economies. The demand for public goods remains very high, but they are not adequately supplied under the current conditions. The enhanced possibility of capital-labor substitution is favorable for the Japanese economy. Therefore, the substitution of labor by capital is the right thing to do. The advances of IT are so powerful that they will bring us closer to the day when it is possible to have "from each according to his ability and to each according to his need."

02 Presentation

Global Value Chain in Asia and Its Implication to Japan

Kozo Kiyota
Research Associate, RIETI / Professor, Keio Economic Observatory and Graduate School of Economics, Keio University

If we look at the global value chain (GVC) income in Asia, we can see that there is a consistent decrease in Japan and Taiwan. On the other hand, a remarkable increase has been observed in the manufacturing industry in China, India, and Indonesia. In the Japanese manufacturing sector, the capital-labor substitution has led to a decrease in the number of jobs. Offshoring has only a marginal influence on domestic employment. However, concern is voiced over the productivity decline in the Japanese manufacturing sector as a whole, which has resulted from the shutdown of highly productive domestic production sites. Attention should also be paid to the fact that the introduction of new technologies will change people's working style.

03 Presentation

Productivity and Price Dynamics: A Bank of Japan economist's point of view

Toshitaka Sekine
Director-General, Research and Statistics Department, Bank of Japan

Against the backdrop of a labor shortage, we do not observe significant increases in wages and the general level of prices. Under these circumstances, Japanese companies are trying to improve productivity through their voluntary initiatives. This has a positive effect on the government's ongoing labor market reform, but at the same time will exert a temporary downward pressure against prices through a decrease in the real wage gaps. However, this will not last forever, and the mechanism designed to achieve the 2% inflation target remains intact. When

making these considerations, it is very important to measure the productivity in an accurate way.

04 Presentation

Globalization, AI and Productivity: From the viewpoint of the service economy

Masayuki Morikawa
Vice President, RIETI

In the past six years, a significant increase was seen in the volume of Japanese service exports while its merchandise exports grew at a very modest pace. This allowed the entire Japanese economy to improve its productivity through the resource reallocation effect. High productivity is often seen in manufacturers without plants, companies with large headquarters functions, and firms making use of IT. The fourth industrial revolution is a cornerstone of the Abenomics' Growth Strategy 2017. However, the service industry is more aggressive than the manufacturing industry in terms of the use of big data, and companies engaged in the global market have a positive view of the impact of artificial intelligence (AI). In addition, it is likely that there is a complementary relationship between AI and high-skilled labor rather than a substitutive one.

Panel Discussion

Fukao: If there is a free flow of knowledge and capital beyond national borders, how Japan can raise the level of the affluence? How should we reform the education systems or what kind of knowledge accumulation is important? Also, there are issues such as cyber security, economic systems including site-seeing assets, and so on. In order to have a more affluent society, what can we do? At the same time, could you please comment on the presentations by the four panel members?

Baldwin: The importance of quality in absolutely everything is done in Japan. This edge of the Japanese way of doing things was limited to the manufacturing sector because only goods could cross borders; however, exporting this excellence through the service sector will expand; that is an opportunity to take account of.

Professor Lau commented on the substitutability of capital and labor. AI does not replace all of the employees because somebody has to supervise people, and the supervisor's productivity does not gone up, thus his wage should not go up. Therefore, I am not really sure that this whole snapback will work, but if you cast the whole thing as either capital or labor, it is a temporary deviation to capital and will snap back. Since AI is infinitely reproducible, whoever can control and use it the best will win everything. I think the nature of this technology will fundamentally encourage inequality.

Fukao: Professor Jorgenson earlier said that the quality of labor is high in Japan, but it is not necessarily utilized effectively. How can wages in Japan be raised in general? Also, what is the concrete direction we should realize in labor reform under Abenomics?

Jorgenson: The manufacturing sector in Japan from the point of view of productivity is very healthy, but the challenge is in the service sectors. It is important to try to limit this drag on productivity that is due to inappropriate government policy that has focused attention on limiting entry into certain key sectors that turn out to be those that are important in international trade.

What is needed is a clear focus, an identification and targeting of the industries where this is a problem and drilling down to the bedrock of regulations that are holding back productivity growth. That will make it possible for Japan to play a leadership role as the way that Apple Inc. has played in smartphones for example. The key to enhancing incomes in Japan and enabling Japan to take advantage of the opportunities are being created through this very rapid globalization process that Professor Baldwin described.

Lau: AI and robotics increase the substitutability between capital and labor. The isoquant will change because it becomes flatter between capital and labor. We focus on substitution and the real wage rate, but we should also look at the cost of computing or AI relative to the wage rate. The wage rate is not going to go up because the cost of computing and AI has come way down. I am very happy to see the rising productivity in the service sector in Japan, but Japan needs to create jobs that cannot move away. As Paul Samuelson predicted, the factor price equalization is actually happening.

Morikawa: Graduate students will not be easily substituted by new technologies not because they have high expertise in their work, but rather they have malleable skills. In terms of policy, investment for education is important and, among all, improving the quality of the teachers is imperative. Paying more for newly hired teachers will prevent them from taking up another higher-wage job. Regarding the basic income, it is important to establish

a safety net, and, also, it is necessary to think about negative income tax systems.

Sekine: Japan can maintain the affluence only by increasing productivity. Needless to say, the government has to work on the growth strategy in the labor market. Also, it is important to work on deregulation and introduce more competition. Further, companies' responses to labor shortages are also important. The tighter labor market conditions have induced them to raise productivity. If we continue to have a high-pressure economy, the potential growth of Japan's economy would be boosted through the improvement of productivity, and this could be driven by these corporate responses.

Kiyota: If AI and robots are different from traditional capital, we should be cautious in thinking about this substitution. In order to estimate the elasticity of substitution between AI/robots and labor inputs, however, we need their price data. As for the impact of globalization on employment in Japan, the impact of outward foreign direct investment would be negligible. Some people say both trade and the technology change affect expansion of wage gaps, but others say the effect of technology change is stronger than trade. For now, globalization does not seem to have significantly negative effects on the wage gaps in Japan. However, in the United States, a study found significantly positive effects of globalization on increasing executive compensation. It may be necessary to focus more on a small percentage of people who are benefiting from globalization.

Fukao: Thank you. I would like to shift our attention to companies. What kinds of policies are needed to invigorate Japanese companies, for example, a reduction in corporate taxes?

Jorgenson: As a consequence of the aggressive monetary policy of the Bank of Japan, the devaluation of the yen was finally successful and a very important macroeconomic barrier to Japan's successful access to the world market, including the benefits of globalization and participation in global value chains was removed. That has increased trade in services relative to manufacturing. Also, we need to consider labor market reform. There is a great opportunity for increased efficiency and increased utilization of the highly skilled Japanese labor force. The enormous investments that have been made in human capital in Japan have led to the very high quality of labor force that it currently enjoys.

Morikawa: One regulation we need to focus on is the occupational licensing system in the service industry. It is desirable moving from licensing to certification or to having graded licenses, for example, allowing the hygienist to do some of the dentist's work or the nurse to do some of the doctor's work. Deregulating the occupational licensing system is important in terms of increasing productivity in the service industry.

Sekine: The exchange rate is a sensitive issue, but the Bank of Japan acknowledges that it is one of the important transmission channels, although the Bank does not aim at a specific level. Monetary policy should be conducted in accordance with domestic necessities so as to support economic activity and ensure price stability of each country. Now, I want to hear from Dr. Morikawa about the utilization of big data. Unlike U.S. corporate managers who recognize the importance of big data especially to manage blue-collar workers, Japanese corporate managers seem to be reluctant to utilize big data. I think this is an issue that we need to address.

Morikawa: In the United States, many companies utilized the IT revolution to change their businesses, but Japanese companies tend to worry excessively about compliance infringement. It may inhibit them from taking risks.

Kiyota: According to the data introduced at the RIETI symposium in 2015, Japan was ranked 196th out of 199 countries in terms of the stock of the inward foreign direct investment relative to GDP. The regulation and language barrier do not fully explain this; this is about the uniqueness of Japan. Against the backdrop of labor shortage, we do not observe significant increases in wages. Japanese outward foreign direct investment is increasing, but Japanese companies have 32 trillion yen of internal reserves within foreign affiliates as of the end of 2015. Why are they not coming back to the Japanese workers?

Fukao: I would like to go back to what was mentioned by Dr. Morikawa first. In terms of ICT advancement and new globalization, China is the largest beneficiary which is followed by India. For further advancement of Asia, what kinds of policies are needed?

Baldwin: When the outsourcing started in 1985–1986, the wage difference was 40 to 1 between Japan and China. The success of Asia, especially in manufacturing, was this combination of high tech and low wages. Between 1985 and 2000, there were no free trade agreements in East Asia, but after China approached the Association of Southeast Asian Nations (ASEAN) for a free trade agreement, the domino effect happened in Asia. Unfortunately, the Trans-Pacific Strategic Economic Partnership Agreement (TPP) is stalled currently. Right now, it seems like it might be Japan that is keeping it going. The Regional Comprehensive

Economic Partnership (RCEP) will also be useful. Even keeping the TPP going will continue to be a good thing. Those are the things that we can do to continue Asia's success.

Lau: East Asian industrialization started in Japan, but as the Japanese wage rate went up, labor-intensive industries moved successively to lower-cost locations such as Hong Kong, then Taiwan, then South Korea, then Southeast Asia, and Mainland China when it opened to the world in 1978. All of these economies adopted some form of export promotion policy rather than import substitution. This was facilitated by the favorable exchange rate for Japan. Similarly, Taiwan and China had large devaluations of their currencies. In addition, we need to look at Samuelson's idea of factor-price equalization more carefully. Factor price equalization under globalization is a way of viewing this.

Jorgenson: I agree with Professor Baldwin on the importance of free trade agreements and the proliferation. In East Asia, all of the IT products have been grouped under a free trade agreement. It has had the most important impact in moving IT to the lowest cost producer, by and large, China, but that is now moving on to other parts of East Asia. This is a graphic illustration of a creative response to a particular situation in the fact that information about IT is difficult to contain, and therefore flows across international boundaries, leading to a free trade agreement in the production and trade that facilitates international integration through value chains.

The free trade agreement regarding a commodity is that it is not necessary to think in terms of the TPP, something that is in agreement among countries, that we need to be more creative than that, and it seems that Japan has a very sophisticated approach to this. That is going to be a very important positive force in making use of the developments that we have been discussing here having to do with robotics and AI.

Baldwin: AI should stand for almost intelligent not artificial intelligence because the thing does not think. I read a story about AlphaGo (a computer program that plays the board game Go). The research started by giving it 30 million board positions. It divided itself in half and played itself at computer speed for six months, learning from its mistakes. It went very well and beat the world's best player. However, if the board is changed from 19 to 19 to 20 to 20, it would have lost completely because it did not really know how to play strategically. As for the Japanese uniqueness, if you had a whole series of secret immigrants who came in and took over Japanese service sector jobs, the output was going up, labor productivity did not seem to be going up, and the wages most certainly were not going up. I wonder if the very nature of AI as pattern recognition only is not understanding some of those, but I will leave that as speculation.

Jorgenson: The way that the literature and global value chains have evolved, it has emerged that there are three regional centers of global value chain development: North America, Asia, and Europe. The United States is now reexamining its policy toward integration within North America. Asia is taking advantage of this lack of leadership in North America, but I also think that the same thing is true in Europe. The great German reform that took place before the current government came to power has motivated and powered a lot of the development of global value chains within Europe, which has been a great success. However, when you look at the bottom line, it turns out that Asia has gained the comparative advantage in the development of global value chains.

Fukao: Our session has now concluded. Thank you very much.

Note: Titles and affiliations are as of the day of the event.

RIETI's periodic Brown Bag Lunch (BBL) seminars welcome an array of guest experts to share their research and views. The sessions encourage lively discussions that contributes to dynamic policy-related debate.

World's Great Excess of Supply

Date : May 12, 2017

Speaker:
Atsushi Nakajima
Chairman, RIETI

Moderator:
Satoshi Nohara
Consulting Fellow, RIETI / Director, Economic and Industrial Policy Division, Economic and Industrial Policy Bureau, METI

World economy with intensifying trend against globalization

My recent book, *Era of Large Excess Economy*, examines the world's supply-demand balance as an underlying factor of intensifying sentiments for anti-globalization and curbing migration, as seen in developments since 2016 such as Brexit (Britain's decision to leave the European Union) and the inauguration of Donald Trump as the U.S. president. The sudden drop in crude oil prices in early 2016 and the ongoing negative interest rate trend in Japan and Europe could also be explained from the perspective of excess supply of energy and money.

Since the bursting of the economic bubble in 1990, Japan has had to spend a lot of time processing the excess supply of labor, production capacity and debt. What has been happening to the world economy since the collapse of Lehman Brothers is, indeed, the global version of Japan's post-bubble struggles, characterized by the structural excess of labor, goods, money, and energy.

Changing the world economy

In the 2000s, low- and middle-income economies enjoyed some of the strongest growth in the post-war era until the collapse of the economic bubble. This was largely attributed to the fierce increase in exports from emerging economies, mainly in Asia, in response to the establishment of a global framework facilitating greater industrial production, led by China. Other factors include the subprime lending boom in the United States, the Chinese economy experiencing 10% growth, and the price surge of crude oil and other resources. The emerging and developing economies' share in world trade also rose rapidly up until about 2010.

However, such factors that supported the strong growth of the world economy have gone and left developed nations and emerging economies to compete for a greater share in world trade. While emerging and developing economies have managed to restore a positive supply-demand balance, developed nations continue to suffer excess supply and demand shortfall.

In the post-Lehman world economy, the slower growth and economic disparity between countries have increased discontent among both developed nations and emerging economies, potentially triggering friction in international trade and foreign exchange. This tendency is becoming particularly evident in the United States, which is suffering from a massive international trade deficit.

Arrival of the Era of Large Excess Economy

There is a structural excess in the balance of supply and demand for labor, goods, money and energy, respectively. With regard to goods, developing nations have always taken an export-led approach to boost their growth. Developed nations are prone to losing production opportunities, which undermine their trade balance.

Similar situations are observed with regard to the excess of labor. The increase in the income and education level in emerging economies especially in middle-income countries has made it easier for their citizens to immigrate globally on their own costs, resulting in a dramatic surge in immigration from emerging economies as well as middle-income countries, rather than primarily from low-income countries as was the case in the past. This trend is expected to further accelerate, potentially

provoking negative sentiments against immigrants in some developed nations.

As for the excess of money, the combined money supply of the Organisation for Economic Co-operation and Development (OECD) members and BRICs (Brazil, Russia, India and China) nations now surpasses the global gross domestic product (GDP), following the economic shock caused by the collapse of Lehman Brothers. The situation remains unchanged today, as the world shifts from the age of money shortages to the age of abundant money circulation.

The same applies to the supply of energy. The U.S.-led shale oil revolution since 2008 has boosted shale oil production, and consequently brought down the price of crude oil. According to an announcement by the U.S. Department of Energy, shale oil production might increase further into 2040, diluting concerns about scarcity of energy resources.

Direction of a breakthrough for the world economy

Nothing positive would come about from competing for a larger share of the pie from economic growth between developed nations and developing countries, as it would leave developed nations with higher dissatisfaction and make developing countries unable to fulfill their full growth potential. One possible solution to create a win-win situation would be to generate an economic bubble. Trump's economic policies are expected to have a bubble-inducing effect, but that would only have a temporary benefit. Above all else, a bubble economy would have serious repercussions once it collapses, and therefore cannot be a final solution.

Let us then explore the direction of a breakthrough for the world economy by examining how Japan has dealt with three excesses it faced after the bursting of its economic bubble. The first was to solve the bad debt issues. Japan forcibly realigned banks and other corporations to reduce their excess supply capacity. The other was to take advantage of special demand from China and the digital industry boom to achieve the nation's economic recovery.

Today, even though China is no longer boasting 10% growth, the world economy needs a special structural demand that aids its positive and stable growth. As for the digital industry boom, post-bubble Japan achieved economic recovery thanks to powerful help from worldwide popularity of Japan's DVD recorders and flat-panel television sets. Similar innovation could serve as a perfect driver for another economic recovery.

Having both developed nations and emerging economies compete in the same arena would undoubtedly result in discontent in international trade. At the same time, we are no longer in the age where the supply of goods is the only driver of economic growth. In order to sustain positive long-term growth in the world economy, it is essential for developed nations to create major innovation for a breakthrough, and differentiate themselves from emerging economies in areas other than the supply of goods.

In terms of income balance, developed nations have a competitive edge over emerging economies, gaining surplus from service exports and primary income. President Trump of the United States, a major power in the developed world, does not speak ill of service income and primary income, despite his vocal criticism of trade balance. That means Japan is also almost free to build up surplus in these areas.

As for excess supply of money, the economy has played a main role while finances were in a supporting role. Now that the money supply has increased to an excessive level, finances should be considered more than before as a solid income tool at a standard equivalent to that of the economy. Finances represent a field of strength particularly for developed nations, contributing to a surplus in the balance of primary income. With regard to energy, the sense of energy's scarcity is becoming diluted due to the 21st-century energy revolution, which is expected to reduce energy constraints with respect to energy volume and energy-producing regions.

The Fourth Industrial Revolution also represents a main direction of breakthrough. If technological innovation generates brand-new demand and investment opportunities worth a large sum of money, both developed nations and emerging economies will gain some room for new growth. Past industrial revolutions were all associated with the energy revolution. The same seems to apply to the latest wave of industrial revolution with renewable energies and non-conventional petroleum resources. It is important to take full advantage of it.

In order to put the world economy on a positive growth track as a whole and give greater affluence to the world, rather than letting developed nations continue to earn profits from emerging and developing economies, it is important to build a social system that promotes innovation and turn it into economic growth.

In the case of Sweden, for example, the government offers generous social security, quality education (the world's highest ratio of government spending on education against GDP), and an active labor market policy to strengthen the nation's human resources, thereby boosting its innovation-creating capability and achieving a growth rate of over 4%, on par with emerging economies in 2016. Advancement of human resources leads to the promotion of innovation, and is therefore a mechanism for approaching the Fourth Industrial Revolution.

Singapore has achieved economic growth with powerful government-led initiatives to advance its industries. Today, it is going one step ahead of the Fourth Industrial Revolution by advocating the Smart Nation Vision, in which Singapore strives to become the world's first nation to connect its basic infrastructures and day-to-day infrastructure services with the Internet of Things (IoT). The nation's per-capita income is now more than double that of Japan.

International collaboration is another direction for further developing the world economy. In relation to the latest French presidential election, opinion polls show that public confidence in France's new pro-EU President, Emmanuel Macron, is low when it comes to immigration and other issues that cannot be easily resolved by France alone. This indicates that, in order to resolve various social and economic issues in France, the new president must be able to exert influence not only domestically but also on the EU.

International frameworks are also effective from the perspective of promoting growth with globalization. One such example involving Japan is the Trans-Pacific Partnership (TPP). If it manages to improve or resolve social and economic issues within Japan, it has the potential of making our economy grow and enriching our society.

The biggest comeback strategy for the Japanese economy

What has been discussed about the balance of primary income and the Fourth Industrial Revolution also applies to Japan. During the lost two decades, Japan suffered a low growth rate and a negative balance in supply and demand. However, it should not be overlooked that, even during those days, Japan managed to consistently gain surplus in the balance of primary income.

It is important for Japan to continue achieving this surplus in primary income. To this end, it is essential for Japanese companies to enter into overseas markets to gain overseas earnings and expand investments in foreign securities. While China has the largest reserve of foreign currencies, Japan holds the world's largest net foreign assets in terms of external financial assets and liabilities. If that is the case, Japan should squarely take on achieving greater gains in that area.

Of course, if companies' profits are reserved internally, it would not benefit the economy. It is not good enough if only the wealthy become even wealthier. It is important how the wealth can be repatriated and redistributed within the country.

Another essential task is to further accelerate innovation. Among OECD members, Japan has the second-largest ratio of domestic value-added content in exports. In other words, value-added contents, produced domestically, represent a high weight in Japanese exports. Topping the ranking is Australia, which has a high ratio of domestic value-added content because of its focus on exporting domestically-mined resources. Japan is effectively the world's No.1 among countries that focus on exporting industrial products, and is actually performing well in world trade.

However, by category, the ratio of research and development (R&D) is low within value-added export contents. Japanese small- and medium-sized enterprises, in particular, do not invest in R&D compared to those in other major developed countries. This should be expanded to build up fundamental strength.

As for excess of money, deposits at financial institutions represent a large proportion of Japanese households' financial assets. This may be reflective of the Japanese people's conservative approach to household finance. Yet, in other words, there is room for utilizing such money for the purpose of generating greater wealth and improving their standard of living.

Furthermore, regarding the Japanese companies' capital investments, the ratio of capital investment to GDP is higher than that of major Western countries, but their ratio of IT investments within capital investments is quite low. Since 2000, the IT investment ratio to GDP has remained steady, but the ratio of non-regular employment has increased. What it might mean, in principle, is that Japanese companies have prioritized utilizing cheap and flexible labor over making IT investments since 2000. Fortunately, today's labor shortages have created an ideal opportunity for promoting IT investment. Japanese companies must invest more in IT to boost productivity, so as to achieve a breakthrough in the Fourth Industrial Revolution.

In this sense, the development of an ultra-smart society, one of Japan's growth strategies in Abenomics, could precede the breakthrough of the world economy. Artificial intelligence (AI) and other technologies can deliver advanced social systems. For example, combining the technologies for self-driving cars and solar energy systems could bring about an energy self-sufficient car that self-drives anywhere in Japan. Such a vehicle could resolve transportation inconvenience, for example, in depopulated communities. In recent days, there have been urban residents with no convenient accessibility to supermarkets or other stores nearby. Establishing an ultra-smart society could offer a more convenient way of shopping, thereby resolving their difficulty and potentially generating new demand.

Moderator: In Japan, some argue that the increase in the ratio of aged population could hinder productivity increase using IT due to the issue of IT literacy. In your book, you pointed out that Sweden has achieved a higher rate of productivity increase than Japan, and that a strong productivity increase can still be achieved in an aging society, highlighting the importance of educational investment and active labor market policies.

Some studies suggest that about half of all occupations will disappear in the next 10 to 20 years as a result of the Fourth Industrial Revolution. It is an urgent task to shift our focus to value-added occupations that cannot be replaced by robots.

Japanese companies have made an aggressive shift to non-regular employment, which could be easily replaced by AI and robots. This approach may have had some rationale for Japanese businesses, but it has cast a dark shadow over the nation's future outlook. Our key challenge for the future is to increase productivity and economic growth by making educational and human resources investments and further upgrading human resources.

You have rightfully pointed out that both businesses and households are risk-aversive. Against this background lies the pitfall of preconceived ideas. Since the bursting of Japan's economic bubble, the idea that good companies are those with no debt and no bankruptcy outlook has spread and taken root deep in our society. However, failure to make sufficient investment would turn such companies into losers with no competitive edge.

There also has been a deep-rooted perception in Japan that the population decline would contract domestic demand, making it unwise to invest. There are three directions as a solution.

The first direction is to raise wages. Increasing the standard of income would keep domestic demand strong even if the population declines. The second direction is in regard to foreign trade. Japan has promoted the TPP for this reason. Even the TPP11, minus the United States, has the effect of increasing domestic demand. The third direction is to initiate the Fourth Industrial Revolution to spread new lifestyles for generating greater demand. This is the main theme of the government's growth strategy, amended this year.

Let me ask you one last question. In your book, you said the shift of the world economy from an era of shortage to an era of excess will give price-determining power to consumers. Are you suggesting that there will be downward pressure on prices worldwide, triggering deflation or disinflation? In the era of excess, how long do you think the trend of low inflation and low interest rate will continue?

Nakajima: During the transition of the world economy from an era of shortage to an era of excess, there is always a possibility that even advanced industries of high value added could experience a structural excess in their supply capacity. This would result in the easing of the supply-demand balance, which, in turn, gives extra price-determining power to the demand side.

In addition, while the supply capacity is in excess, consumer prices do not rise in principle. This creates the tendency of excessive competition, which is not good news for industries, businesses, and workers. Accordingly, monetary and fiscal policies alone cannot fully resolve today's disinflation, low interest rates, and slow-growth trends. We need a breakthrough.

Without a breakthrough, the current cycle of slow growth alternating with moderate growth will continue for the foreseeable future, maintaining the structural trend of supply excess. Seven or eight years have passed since the Lehman Brothers collapse. Slightly more stagnant economic conditions in and outside Japan and global disinflation could persist for five more years or so.

A breakthrough provides a major seed of growth for the world economy as it strives to reach the next significant stage of growth. For this reason, even though the bubble economy is not desirable, we must embrace the digital industry boom and the Fourth Industrial Revolution as a major part of it.

Q & A

Q1. Why is it that Japan has the world's second-highest ratio of domestic value-added contents in exports? Does it have anything to do with the "not invented here" attitude?

Nakajima

It has a lot to do with the industrial structure of post-war Japan. There is nothing wrong with the "not invented here" attitude itself. Since neighboring Asian countries lagged behind Japan in terms of the level of industrialization in those days, Japan did not have enough room to attempt an international division of labor in the process of enhancing its industrial structure. In today's economy, the ability to add significant values within the country is a positive property, but it may leave the possibility that Japan does not fully utilize beneficial resources, know-how, and industrial products available in the rest of the world. Remaining tasks include building an international framework that caters to the age of globalization, and embracing the entry of foreign companies into the domestic market as a way of boosting the vitality of Japanese businesses.

Q2. Personally, I believe the biggest problem is the excessive supply of money. Is there any solution?

Nakajima

There is a strong belief in Japan that finance underpins the economy. However, we must pursue the approach of having finance generate value added. Also, in view of the need to distribute wealth, it is necessary to consider, for example, abandoning separate withholding taxation and adopting a comprehensive taxation system instead.

Q3. Would the Fourth Industrial Revolution boost productivity even further to continue expanding the excessive supply of goods? Or would it promote streamlining and appropriate allocation, eliminating inefficiencies to contract the supply of goods?

Nakajima

I don't believe the Fourth Industrial Revolution would eliminate the bubble economy as an economic structure. There is no stopping the excessive supply of goods or trend toward an economic bubble. Yet, at the time of a breakthrough, there is an absolute shortage in supply and demand. When the Industrial Revolution occurred in Britain, the industrial world became capable of achieving what they had not been able to before, thereby triggering an unprecedented level of growth. In post-WWII reconstruction, there were phases of strong growth in world economy, led by developed nations, in the cycle of 15 to 20 years. The greater the scale of breakthrough is, the bigger the scale of bubble-free economic growth we can expect to see, arriving in the cycle of several scores of years.

Note: Titles and affiliations are as of the day of the event.

RIETI's periodic Brown Bag Lunch (BBL) seminars welcome an array of guest experts to share their research and views. The sessions encourage lively discussions that contributes to dynamic policy-related debate.

Energy Markets: What to do when forecasting is useless

Date : May 17, 2017

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Introduction

This talk is about energy in general, but mainly about oil prices. I will discuss oil and how other energy sources are connected to oil and its pricing. I will also talk about the past and what might happen in the future with energy in general and the price of oil. Then I will discuss the linkages of other forms of energy. I want to focus on sharp price changes and why they occur. This comes down to supply and demand elasticities: what happens when supply and demand shocks occur. Why don't we know what will happen to the price of oil? The key is what might happen and the extent of the uncertainty. Finally, I want to talk about what we can do in a world like this, in which no one can predict. The key is assessing the uncertainty and thinking about option value, because oil and coal reserves can be viewed as real options.

Recent oil price volatility

Over the last five years, the price per barrel of oil went from around $100 to close to $30 and has rebounded to about $48 today. These fluctuations surprised many people, but in 2005 and 2006, the price of oil increased over a period of a year or two from $70 to over $140, dropped to about $45, and rebounded to $80. Sharp changes have begun to appear normal. All the way back to about 1985, very sharp fluctuations have occurred. Why do we see these very sharp fluctuations? Does demand for oil change that quickly? Does the supply? Why is the price so volatile? Is it possible to forecast prices?

I am the co-author of a textbook on microeconomics which contains an example about the world oil market. The purpose of the example is to compare short-run and long-run supply and demand elasticities. The competitive oil supply, added to the amount the Organization of the Petroleum Exporting Countries (OPEC) produces (less than one-third of all world oil production today), gives the total supply. In the short-run—meaning about one year to 1.5 or two years—the demand curve is very steep, very inelastic, and the supply curve is also very steep and very inelastic. In the textbook example, suppose something happens in Saudi Arabia and there's a drop in its production of three billion barrels per year. This would cause the supply curve to shift, creating a new intersection at a very high price. Any shift in the supply curve or the demand curve in the short-run can cause a very big change in the price.

The long run (from 5–10 years) looks totally different. Supply and demand are much more elastic. In the long run, people drive smaller cars, put new insulation in their homes, etc. More sources of supply will be coming online over the long term; new facilities are developed and new sources of oil are discovered. The same shift in the curve over the long term causes a much smaller change in the price. The problem is that things change in the short run.

Recent oil production and consumption trends

What has happened in the oil market over the last three or four years? In 2016, world oil consumption was about 97 million barrels per day. From 2013 to 2016, production increased by

about three million barrels per day, mostly from the United States. Oil production in the United States has increased dramatically, mostly due to shale oil. Russian production increased by about a half million barrels per day and Brazilian production increased as well. Iraq increased by about one million barrels per day. Smaller changes have taken place in other countries as well. Libyan production decreased by about two million barrels per day because of the ongoing civil war. If the fighting ends, Libya can produce about 2.5 million barrels per day. It has large oil and productive capacity. However, no one can predict what will happen in Libya, so the price of oil can't be predicted. If Libyan oil comes on the market, the price will drop dramatically.

Consumption, by contrast, has increased by about one million barrels per day. It hasn't increased more partly because world gasoline consumption has not risen very much due to improved automobile and airplane fuel efficiency. The result is that either inventories increase greatly or the price drops. Inventories around the world are at their highest levels ever, but it's not enough to prevent the price from dropping. The price dropped during this period simply because production increased greatly amid a modest increase in consumption. This is simple but hard to predict.

U.S. production increased by quite a bit over the past few years. Oil prices will continue to fluctuate over the next few years. Attempting to forecast the price of oil is fruitless. The right question to ask is what might happen to the price of oil. What's the extent and nature of the uncertainty? Why this is the right question comes down to option value. In the end, we want to know the value of our options.

Problems with forecasts

The International Energy Agency produced an approximately 20-year oil price forecast in 2012 or 2013 assuming various policy differences. For example, strong carbon dioxide emission policies would cause a price drop. It claimed these forecasts were useful, but it was wrong. Large oil companies predicted three cases, but they, too, were wrong. Natural gas price forecasts out to 2030 by an energy agency were all wrong. Yen-U.S. dollar exchange rate forecasts are wrong. Forecasts are produced because people are paid to produce them. This is called "technical analysis." This is done for the stock market as well. We look at tendencies and draw lines, but the result is essentially trying to forecast a random walk with gibberish explanations. They sell this and people buy it.

The futures market uses information from the Energy Information Administration (EIA) of the U.S. government. It produces a short-term outlook every month. It looks at the futures price and makes a forecast. The forecasted price is above the futures price because people mistakenly believe the futures price to be equal to the expected future oil spot price. In other words, the futures price a year from now would be the same as the expected spot price a year from now. This is incorrect; it's only correct if the commodity has no systemic risk. Under the capital asset pricing model, the beta for oil, which measures the systemic risk, is about one. This is because oil, like copper, is an industrial commodity, and when the economy is booming, demand goes up and the price goes up accordingly. That means that these commodities have systematic risks, i.e., risks correlated with the overall market or economy. Because of these systematic risks, the futures price is biased downwards as an estimator of the expected future spot price. A positive beta causes the expected future spot price to be above the futures price. At the 95% confidence interval—which means we can be 95% sure we are within a specific range—we can find useful information because this is a range of possibilities. The EIA looked at options prices. Futures contracts involve the trading of call options and put options. From the options prices, the implicit volatility of the spot price can be determined using the Black-Scholes formula, and from that, we can determine the confidence interval. This is what the EIA did. I focus on this because the confidence interval is very large. According to the options prices in the options market, an enormous amount of uncertainty exists. Even going out only one year, we are looking at a range of about $30 to $90. That's only the 90% confidence interval. We know that from the options market. This is useful. What you might ask is not so much what the price will be, but what is the confidence interval for the price of oil next year. This can be learned from the options market and the options on futures. The answer is that the interval is very large.

Effect of uncertainty on undeveloped oil reserve pricing

How is oil produced? The first thing to do is to find oil. We take a guess and drill and if we're lucky, we discover oil. That is called an undeveloped oil reserve. We can't produce the oil, but we know it's there. Next, we have to develop the reserve to produce the oil. That's very expensive. Maybe $1 billion, at least. Developing offshore oil reserves can cost from $3 billion-$5 billion. After the reserve is developed, oil can be produced for the next 10 years, maybe longer. The revenue earned every year depends on the price of oil, but the price fluctuates. What is that undeveloped oil reserve worth? And when should it be developed?

Does greater uncertainty raise or lower the value of the undeveloped oil reserve? There is world A, with very little uncertainty, in which the oil price doesn't change much, and world B, which has a lot of volatility. In which world is that undeveloped oil reserve more valuable? It's worth more in world B, even though it doesn't appear so, because of the addition of a risk premium. Uncertainty raises the value because the reserve is exactly like a call option. The more uncertainty the greater the option value. If the price goes down, the option is worthless. If it goes down by a lot, it's still worthless. If it goes up, it becomes worth something. There is a limit on the downside: it can only be worth zero, but on the upside, there is no limit, it can be worth anything. That's why it's important to know what the level of uncertainty is. Because companies that deal with oil need to determine the value of their undeveloped reserves, the key is understanding the nature of the uncertainty.

Coal and natural gas

Natural gas and coal prices are linked—but only loosely—to the price of oil. Oil is easy to transport, so there is a world market for it. Natural gas is not as easy to transport. That's why today, natural gas in the central United States is only $3 per 1,000 cubic feet (Mcf). In Boston, it's $12. We don't have pipelines because people don't want them in their backyards. There's a capacity problem. In Europe, it's about $10. In Japan, it was about $15, but it has fallen to about $7. The issue here is transportation. Liquefied natural gas is becoming more prevalent. That might be why the price in Japan has gone down. Coal is easier to transport, but it's dirty and regulated. Its use is declining because natural gas is cheaper and cleaner. It doesn't have a strong connection to the price of oil. Nuclear is simply not economical. To build a nuclear power plant is very expensive. The capital costs are huge. The regulatory environment is difficult and uncertain. That's true in Japan, the United States, and Europe. Nobody predicted that Germany would turn around completely on nuclear. The result is that there has been very little or no construction of nuclear plants.

Q & A

Q1. Two things are important in forecasting the future. One is trends. The other is game-changing events, like Libya. I agree with you on uncertainty, but if you look at trends, it's very important for forecasting the future. However, we cannot forecast the game-changing events. What do you think about that?

Robert S. Pindyck

I agree that you can't forecast what will happen with game changers. There are many other places besides Libya. Brazil potentially has enormous offshore oil reserves, but Petrobras has a lot of problems, as does the Brazilian government. Maybe it will produce much more in the future. We don't know. Nigeria is another case. There is theft and disruption there. However, even the trends are unpredictable. Five or six years ago, no one predicted that the United States would produce so much shale oil and natural gas. Nobody predicted fracking. Over three years, production went from six to nine million barrels per day. That's the difficulty. The trends are often not there.

Q2. In a related question, from a policy perspective, given the great uncertainty, what should the government do? In research and development (R&D), for example, in the field of energy conservation technology or alternative energy development, it takes time to produce outcomes. Under great uncertainty, what should the government policy be?

Pindyck

Many people would say that the government should subsidize R&D. I disagree with that. I don't think the government has been very good at picking winners and losers. If there is belief that an externality exists, which there is in the case of oil (because of climate, security, impact on the economy of sharp fluctuations, etc.), then a tax is imposed. The market then should be allowed to operate and companies decide if they should develop new technology, invest in R&D, etc. The pharmaceutical industry is a good example. There's a lot of uncertainty over disease. Drug companies develop new drugs to fight disease. The uncertainty does not mean the government should subsidize drug companies to develop new drugs. It's the same thing.

Q3. Oil prices were controlled by OPEC for a long time, but it now provides only one-third of the supply. Should an international organization be established to stabilize oil prices?

Pindyck

There are two parts to your question. The first is the role of OPEC: did it affect oil prices? The second is whether the government should stabilize prices by stockpiling, etc. OPEC had very little influence on oil prices. Since its inception in 1962, OPEC has many members, but they really never agree. They have meetings and then all go and do what they want. OPEC has not had that great an impact since it started. Given this volatility, should the governments do anything? No, I don't think the governments should do anything. These are world markets. Similarly, the copper cartel has no effect on the price of copper. First of all, there needs to be some sort of world

stabilization fund. Stockpiling is necessary, and knowing how much and when to release it is also necessary. It's impossible. If there is worry about fluctuations, then hedging should be done on the futures market. We have futures markets for this purpose. Governments should not come in and try to stabilize prices.

Q4. Aside from using options prices, how can we measure the degree of uncertainty?

Pindyck

Options prices are one good way of doing this, by looking at actual market transactions. The other way is to conduct simulations—"what-if" experiments. What if Libya does this or that, what if Brazil does this or that, etc. There are so many such experiments that can be done. Which are the important ones? Which are more likely? That's very hard to decide. Options are the best choice. If there are no options to look at to get price data, then scenarios have to be considered. Using oil as an example, by making a list of things that could happen to increase supply, a price of $20 or $140 can be imagined with all of the possible factors for the scenarios. The key is understanding how many different things can happen and how much uncertainty exists.

Q5. You mentioned copper. Currently, an enormous steel and aluminum oversupply exists globally. The government is trying to control this. U.S. President Donald Trump is introducing an investigation. What would your recommendation be to the U.S. administration regarding the oversupply issues?

Pindyck

With regard to the word "oversupply," a buyer of steel does not think an oversupply exists; it would think there's exactly the right amount. Whether there is a feeling that an oversupply or undersupply exists depends on whether the party is a buyer or a seller. I think there's an oversupply of economists. I am a big believer in free trade. We have the World Trade Organization (WTO) so we can have a playing field where we can trade freely and have rules. Dumping and other things can be a problem. If a problem exists, it might be appropriate to go to the International Trade Commission. That has to do with the rules for free trade and how to enforce them to continue trading freely.

Q6. If the options price is unavailable, is the data on past volatility important for predicting the confidence interval?

Pindyck

Good point. Yes, definitely. That's a very common way of looking at volatility and uncertainty. Over the last 30 years, the price has fluctuated enormously. Looking at the past and treating it as some type of stochastic process, volatility can be estimated.

Q7. If we consider a rare disaster-type shock that occurs only once every hundred years, does this estimation change?

Pindyck

Rare disasters are my favorite. This is a world in which people produce, buy, and trade oil. Life goes on. What would happen in the event of some huge catastrophe? Who knows?

Q8. Price is influenced by market expectations. How can we understand the role of market participants' expectations?

Pindyck

Are you asking whether expectation influences price? The answer is no. Many people have argued—and they only argue this when the price goes up—that, for example, heating oil price increases occur because speculators speculate on the futures market and push the price up. The futures market does not push the price up. The futures market is like a bet on a football game. I bet on one team and you bet on the other. If my team wins, you give me money, and if your team wins, I give you money. It has no effect on the game. Expectations don't affect price. Chinese demand increased because they were locking up supply at a much more rapid rate than what they needed. Some other countries were doing the same thing. Then, China said it didn't need so much oil and its consumption, etc. dropped. How could this be predicted?

Q9. My question is about the EIA forecast. This forecast is based on a variety of scenarios which take many variables and conditions into account. I assume it has simplified the variables. Does it have specific principles for the variables? Also, in scenario making, the key is how to use them. Could you discuss the extreme left and right of the scenarios, the range of possibilities? We could then decide what measures to take.

Pindyck

The forecast was useless. If a line is drawn, what does it imply? Nothing. I don't know what the EIA did and what it assumed, but it made a projection. The projection is useless, based on information it doesn't have. What it comes to scenarios, the key is that there are possibilities, and the EIA can't deal with this. It would be useful to say there are possibilities that could affect the price. If a party is thinking about getting into the energy industry and producing oil, and spend money, sure, it should look at scenarios and possibilities. It should know that the price could drop to $20 or go up to $140. The same is true for an oil consumer. It would want to know the possibilities so that it can take actions. It might hedge its risk on the futures market to reduce exposure.

Note: Titles and affiliations are as of the day of the event.

Overcoming Silos and *Kakines*

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The silo effect

Recently, I often notice the phrase "silo effect" and calls to "break down silos" when talking with European and American researchers and business people. Because the word "silo" may not be familiar to people in Japan and other Asian countries, many readers may wonder what it means. However, "breaking down silos" is extremely important for the Japanese society, a nation beset by long-term economic stagnation, and, at the same time, "building up silos" is what the emerging economies in our region must avoid at all costs. While awareness of the need to cope with the silo effect has been growing in Europe and America, I find the issue to be even more important for us living in this region.[*1]

Until recently, whenever I heard the word silo, an image of a large farmland came to my mind, with many cows eating grass. A silo is a building used to store animal feed and grain, such as wheat and corn. Silos are frequently seen in Europe and North America. They can be found in Hokkaido as well. This is what I learned in my grade school days.

What do silos have to do with economic stagnation and healthy economic growth and development? The reason relates to the silo's shape and structure. As you can see from the picture, silos are cylindrical, have no windows, and are

designed to isolate their contents from external factors, in order to prevent harvests from deteriorating. Looking at the picture, perhaps, you may have already understood why people talk about the importance of "breaking down silos."

Silo can also be a metaphor for compartmentalization, describing the tendency for people to become entangled solely in their own specialist areas as the degree of specialization advances. In a business setting, silos may refer to the growing isolation of individual departments, deterioration in coordination between departments, and even competition between different departments of the same company for the same customers. In an academic setting, silos may result in researchers becoming cut off from other fields, unable to explain the significance of their own research in a broader context.

One of the hardest tasks of a researcher is to avoid straying into, and becoming captured within, the cylindrical isolation of a silo. This is difficult because good research comes only from the deep understanding of a field; a good researcher must dig into the very core of a subject, which is like stepping into a silo to look for a hidden treasure. At the same time, good economic research must always be closely tied to the ever changing real world; an economist must not become captive within a silo. As a professional economist, I have struggled to find the right balance by trying to maintain simultaneously two opposing perspectives, one from inside, and the other from outside, the research "silo."

Silos

Photo via Good Free Photos

Kakine (or Fence)

Kakine is a Japanese word for fence. It can be used to refer to an artificial divide that separates "this side" from "the other." Japanese society faces many issues caused by the presence of *kakine*, without which different groups might more easily be integrated. A *kakine* divides the affluent from the impoverished, regular employees from temporary employees, economists from lawyers, government agents from others, and humanities from sciences. These *kakines* prevent greater fluidity in society and hamper economic growth and development.

Recently, new *kakines* have been emerged in various parts of the world and are creating serious concerns for our society. Brexit, for example, seems about to begin the rebuilding of a troublesome *kakine* between the UK and Europe. U.S. politics seem currently to be driven by the divide between the traditional white establishment and other groups who are emerging as the new mainstream in American society. *Kakines* between different nations and between different ethnic groups are an increasing cause for concern even in our region. It is no exaggeration to say that the issue of how to break down these *kakines* is one of the largest issues now facing modern society.

Kakines

Wikimedia Commons

RIETI's initiatives

At RIETI, we regard the silo and *kakine* problems as a high priority research theme. Our recent research covers the flexibility of employment and corporate performances, gender differences and career building, open innovation and creative destruction, and many more issues.

In addition to academic research, our public service activities also place emphasis on the issues of silos and *kakine*. As a part of this initiative, in November 2016, we invited renowned economists including Professor Richard Baldwin, President of the Centre for Economic Policy Research (CEPR), one of the leading economic research institutions in Europe, Barbara Petrongolo, Professor of Economics at the Queen Mary University of London, and Tarun Ramadorai, Professor of Financial Economics at the Imperial College London, to hold a symposium for general audience and research workshops on the theme of Brexit, an issue that has its roots in various fences found in British society, including the fences between the UK itself and Europe, between the UK's regions and London, between migrant workers from overseas and workers born in the UK, and between young people and middle-aged or older people.

Market quality theory

The frequent references to the issues of silos and *kakines* made by our external advisers reflect the renewed focus on silos and *kakines* as obstacles to the development of society throughout the world. In Western countries, as the concept of "silo effect" has become more widely understood, there is now frequent debate in wider society on the importance of coordination between different fields.

Currently in Japan, a formidable *kakine* exists that divides natural sciences from humanities. Even within humanities, social sciences are separated almost completely from literature.

In Japan, silos and *kakines* are underpinned by the design of systems, making the problem more intractable than in Western countries. As was pointed out in my 2015 book with Masahiko Nakazawa, the *kakine* in Japanese society between humanities and sciences dates back to governmental orders on secondary and tertiary education issued in the early 20th century (Japan's Taisho Era)[*2]. This tradition has become an obstacle, and Japanese universities still maintain an extremely rigid compartmentalized structure (in the U.S., on the other hand, many universities have a School of Arts and Sciences that encompasses the faculties of literature, economics, mathematics and physics, among others).

The silos and *kakines* dividing academic research are huge obstacles to innovation. An economy can be divided into two basic sectors: making goods (production) and using goods (consumption). On the one hand, if you grow rice, eventually, someone will eat it. On the other hand, if you want to eat rice, you need someone to grow it. Similarly, innovation is useless unless it is responsive to people's needs. Natural scientists are expected to develop a method to produce goods whereas social scientists are expected to come up with the best way to use those products. Natural and social scientists must, therefore, always put their utmost efforts into looking beyond their respective silos.

The *kakine* between natural and social sciences might be one of the fundamental factors hampering the growth of the Japanese economy. Motivated by this observation, I proposed market quality theory and have continued to study the relationship between market quality and healthy economic growth and development. The existence of *kakine* between various groups and of silos within a group is one of the largest obstacles standing in the path of building high quality markets. If market quality falls, gains from market transactions will be distributed unfairly between market participants. This may in turn result in an unfair wealth distribution, transferring economic wealth into the hands of people favorably treated by silos and *kakines*.

Open society

In order to avoid such an unhealthy scenario, it is important to raise the quality of markets. Recently, the EU and U.S. governments have started advocating open science, an effort to lower the *kakine* existing between the science community and the rest, and an initiative that the Japanese government follows. I believe that in order to keep our economy on a healthy path of growth and development, it is even more important to build an "open society," in which ideas and goods flow freely without impedance by such artificial structures as silos and *kakines*.

Footnotes:

[*1] See Gillian Tett, *The Silo Effect: The Peril of Expertise and the Promise of Breaking Down Barriers*, Simon and Schuster, 2015.

[*2] See Makoto Yano and Masahiko Nakazawa, *Why Science does not Lead to Affluence?* (In Japanese, *Naze kagaku ga yutakasa ni tsunagaranainoka*), Keio University Press, 2015.

Assessing the Impact of AI and Robotics on Job Expectations Using Japanese Survey Data

Masayuki Morikawa

Vice President, RIETI

Given the early stages of diffusion of many artificial intelligence (AI) and robotic technologies, it is too early to measure the impact of these innovations on jobs. This column uses comprehensive survey data from Japan to measure the extent to which workers across different industries, levels of education, and occupations perceive their jobs to be at risk. Workers with adaptable skills acquired through higher education (particularly in science and engineering) or occupation-specific skills (particularly those in human-intensive personal services) are less worried about their jobs being replaced by AI and robotics.

Amid the stagnant productivity and potential growth rates in major advanced economies, policymakers expect the Fourth Industrial Revolution and its technologies, including AI and robotics, to drive future economic growth. In Japan, Investments for the Future Strategy 2017, the latest growth strategy of the Shinzo Abe Cabinet, places the Fourth Industrial Revolution as the top priority for growth promotion policies. On the other hand, the negative impacts of AI and robotics, especially loss of human jobs, have been actively discussed around the world.

Impact of AI and robots on human jobs

According to an influential study by Frey and Osborne (2017), about 47% of total US employment faces the risk of being computerized. Their study attracted attention not only from researchers, but also policymakers around the world. David (2017) applies a similar methodology to Japan to estimate that 55% of employment is susceptible to being replaced by computers. On the other hand, Arntz *et al*. (2016), taking a task-based approach, estimate that the share of automatable jobs in the 21 OECD countries is only 9%, which is far smaller than the figure derived from the occupation-based approach employed by Frey and Osborne (2017). The point of their task-based study is that some of the tasks contained in high-risk occupations cannot be easily computerized. In addition, computers and robots may create new products and services, and these product innovations will result in currently unimaginable new occupations (Mokyr *et al*. 2015). Furthermore, new automation technologies and some types of labor are highly complementary (Autor 2015).

In spite of widespread interest in the impact of AI and robotics on the labor market, studies in economics are still in the initial stages and quantitative empirical studies have been limited. A major reason for this delay is the lack of statistical data on AI and robotics, as the technologies are in the phase of development and early diffusion. A possible approach to overcoming the lack of statistical data is to conduct surveys on firms or individuals to collect subjective assessment of the impacts of these new technologies. A recent example of this line of study is Morikawa (2017a), in which I conducted a survey of a large number of Japanese firms to analyze the possible impact of AI and robotics on employment. The study detects technology-skill complementarity at the firm level. In particular, the complementarity with AI-related technologies is more prominent for employees with postgraduate education. However, the individual characteristics used in the analysis are limited and aggregated at the firm level.

A new survey on individuals

Against this backdrop, I conducted an original survey on Japanese individuals to present new evidence on the possible impacts of AI and robotics on employment (Morikawa 2017b). The major interests of this study are the type of individuals concerned about

losing their jobs, and what type of jobs are likely to be replaced by the development and diffusion of AI and robotics. To be more specific, I analyzed the relationship between various individual characteristics (e.g. age, educational attainment, and occupation) and their perception of the impact of AI and robotics on their own employment prospects. The main hypothesis of this study is that highly skilled individuals tend to perceive the impact of AI and robotics positively, and vice versa. I distinguished malleable/adaptable general skills formed through higher education and occupation-specific skills acquired from vocational schooling or embodied as possessing occupational licenses.

The data used in the study originate from the 'Survey of Life and Consumption Under the Changing Economic Structure and Policies', which I designed and was conducted by RIETI in 2016 with exactly 10,000 respondents. The specific questionnaire regarding the impact of AI and robotics is: "What do you think about the impact of AI and robotics on the future of your job?" The choices to answer this question are: 1) "I might lose my job", 2) "I don't think I will lose my job", and 3) "I don't know". The methods of analysis are simple cross-tabulations by individual characteristics and ordered-probit estimations. The individual characteristics include gender, age, education, industry, type of employment, and occupation.

Who is afraid of losing their job?

According to the analysis, about 30% of people believe there is a risk of their job being replaced by AI and robotics. By age classes, younger generations (those in their 20s and 30s) tend to perceive a risk of losing their jobs (Figure 1). This is a natural result, as the development and diffusion of AI and robotics will be advancing gradually. By education, workers with postgraduate education are least pessimistic about the prospect of their job, followed by university graduates and those who graduated from vocational school (Figure 2).

The ordered-probit estimation to explain risk perception by a wide range of individual characteristics confirms the cross-tabulation result that those who have postgraduate education are less likely to perceive their jobs to be at risk. Although the coefficient for university education is statistically insignificant, the coefficient for natural science majors is positive and significant. A natural interpretation is that those who studied natural sciences in higher education have better analytical skills, which are less likely to be replaced by the new technologies. Interestingly, the coefficient for vocational schooling is positive and significant. These people perceive that their occupation-specific skills, which are not necessarily numerical or analytical, cannot be easily substituted by AI and robotics.

Further, those who possess and use occupational licenses in their current job perceive the risk of losing their job to be lower. One interpretation is that the holding of occupational licenses reflects high-level, occupation-specific skills. Since consumers' preference for services provided by human workers is strong in currently human-intensive services such as childcare, healthcare, and education, those who are working in these occupations may recognize the importance of human contact and perceive the risk of substitution to be small. Another possibility is that the

Figure 1:
Impact of AI and Robotics on Employment by Age

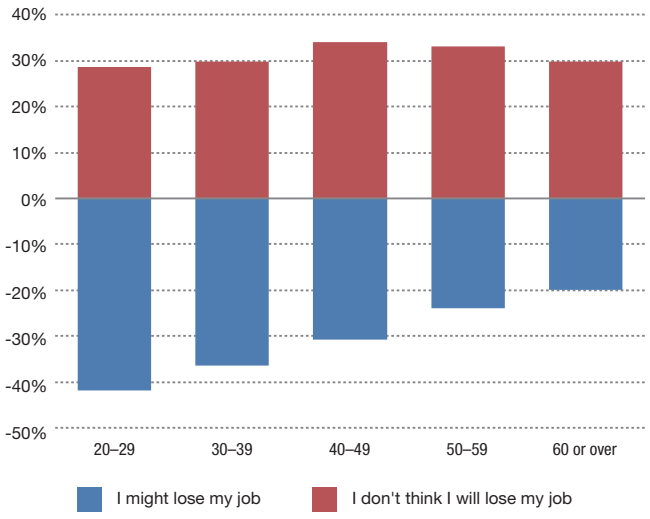
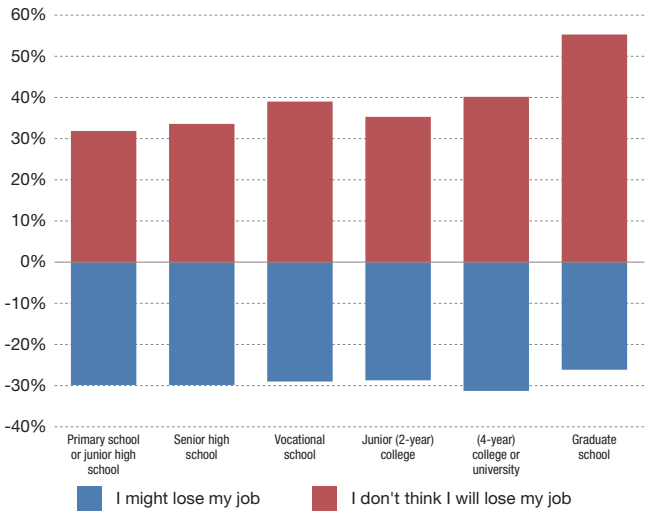


Figure 2:
Impact of AI and Robotics on Employment by Education



Note: Calculated from the "Survey of Life and Consumption Under the Changing Economic Structure and Policies." Sample comprises those who are currently working (N=6,579).

labor markets of licensed occupations are protected by laws and regulations and the restrictions on new entry leads to monopolistic powers for the incumbents.

By type of employment, the coefficients for part-time employees, temporary agency workers, and entrusted employees are negative and statistically significant. On the other hand, the subjective risk of company executives and the self-employed is statistically indistinguishable from that of regular employees. The result of the non-regular employees' higher subjective risk perception is consistent with the results of the study by David (2017), which assesses the risk of job destructions induced by computer technology in Japan from a technical viewpoint.

Concluding remarks

The results suggest that malleable/adaptable skills acquired through higher education, particularly in science and engineering, are complementary with new technologies such as AI and robotics. At the same time, occupation-specific skills acquired by attending professional schools or holding occupational licenses, particularly those related to human-intensive personal services, are not easily replaced by AI and robotics. From a policy perspective, investments in developing malleable high-level skills through postgraduate education and personal skills specific to human-intensive services are both important.

Editors' note: This article first appeared on www.VoxEU.org on July 6, 2017. Reproduced with permission.

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COLUMN

"Power of Data Analysis" Essential to Evidence-based Policymaking

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Lately, people have begun to point to the importance of evidence-based policymaking. The idea is that evidence-based discussion, supported by scientifically rigorous data analysis, should inform governments in their decisions in formulating and changing policies. The concept of evidence-based policy (EBP), initiated in the United States and the United Kingdom, has spread to other countries. In recent years, Japanese government ministries and agencies have been increasingly showing interest.

In order to accelerate the move toward evidence-based policymaking, government policymakers, as the users of

evidence, need to have the ability to understand data analysis results accurately as well as detecting false results so as not to be deceived. However, a recent survey has found that such understanding is far from being widespread.

In this article, I would like to consider what is the "power of data analysis" that is essential to evidence-based policymaking, partly drawing on my recent book (Ito 2017).

Lack of ability to understand data analysis posing an obstacle to evidence-based policymaking

RIETI conducted a set of surveys to find out the actual state of evidence-based policymaking in Japan (Morikawa, 2017). One particularly interesting finding is how policymakers and policy researchers responded to the question asking what factors they think are posing an obstacle to evidence-based policymaking.

Approximately two-thirds of the respondents in both groups cited "Government officials are not skilled enough to analyze statistical data and understand relevant research findings," pointing to the need to enhance the analytical skills of government officials as essential infrastructure for evidence-based policymaking.

Importance of distinguishing causality from correlation

Although various skills are required to analyze statistical data and understand the resulting research findings, particularly important is the ability to determine whether a relationship identified by data analysis is a mere correlation or causality between policy interventions and outcomes.

Let's consider a specific example. Suppose that your boss asked you to find evidence relevant to the policy question of whether subsidies for energy conservation measures are effective in encouraging businesses to conserve energy. Thus, you gather relevant historical data.

By examining the data, you find the following. In 2011, Company A applied for and received a five million yen subsidy for energy conservation. Data aggregated for Company A show that its energy consumption per unit of production decreased from 100 in 2010 to 80 in 2012.

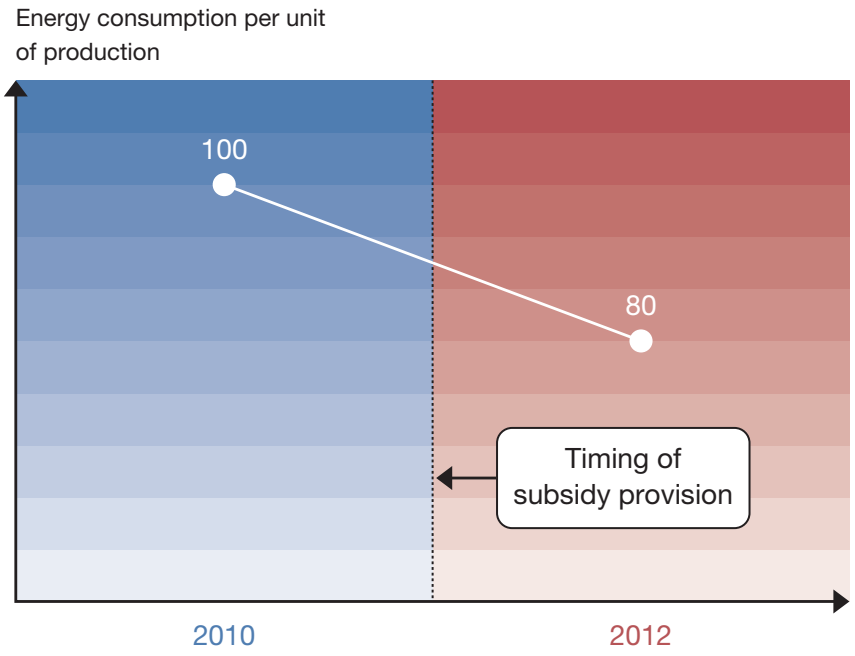
Based on this evidence, you make the following report to your boss: "As shown in the figure on the right, Company A's energy consumption per unit of production decreased by 20% because of the effects of the subsidy provision. Therefore, the provision of energy conservation subsidies is expected to have significant energy-saving effects."

Now, let's consider why this conclusion may be false. You want to show the effects of energy conservation subsidies on energy consumption based on the results of data analysis. However, apart from the provision of subsidies, various other factors may have affected energy consumption in 2010 and 2012.

For instance, energy consumption for air conditioning at factories might have decreased because of a cooler summer in 2012 than in 2010. Employees of Company A might have become more conscious of the need to conserve energy in the wake of the Great East Japan Earthquake in 2011. Or, perhaps Company A introduced new, energy-efficient equipment in 2011 as had been planned regardless of the availability of the subsidy. Thus, from this data analysis, we cannot conclude that the provision of the subsidy caused Company A to improve its energy efficiency by 20%.

In other words, while the figure below shows a correlation between the provision of energy conservation subsidies and energy consumption, we cannot tell whether there is causality between the two factors. We can exclude the influence of some factors, such as differences in weather conditions, for which data are available. However, data on changes in employees' awareness of the need for energy conservation and those pointing to the fact that a certain company was to make capital investment in 2011 regardless are usually not available. Unless we exclude the influence of these factors, we cannot say that the provision of subsidies is effective as a measure to promote energy conservation by citing the correlation.

Figure: Greater Energy Conservations Because of Subsidies?



Why do we need to distinguish causality from correlation?

Mistaking mere correlation for causality in policymaking could result in a waste of taxes by deriving the conclusion that an ineffective policy measure has been effective. Such misinterpretation could also work in the opposite direction with a highly effective policy measure pronounced to have been ineffective, leading to a conclusion that calls for the abolishment of the policy measure.

When thus explained, it is relatively easy to understand that we should not take the presence of correlation as evidence in policymaking. In reality, however, the results of data analysis provided by those referred to as "specialists in data analysis" at the forefront of policymaking are mostly cases of mere correlation, and many of them are presented as "evidence" showing causality. This makes it all the more important for policymakers as users of such evidence to understand the difference between mere correlation and causality.

What sorts of data analysis can identify the causal effects of policy interventions?

The U.S. Commission on Evidence-Based Policymaking, launched under the Barack Obama administration, has been promoting the utilization of a data analysis approach that can provide scientific evidence of causality between policy interventions and outcomes.

The "randomized controlled trial (RCT)" method provides the most reliable scientific testing. One case example of the use of RCTs in Japan is the Agency for the Natural Resources and Energy's Next-Generation Energy and Social Systems Demonstration Project in which I was involved. Meanwhile, the "natural experiment" method, which takes advantage of a real world setting similar to an unnatural setting prepared specifically for a social experiment and can be implemented even in cases where RCTs are unfeasible, has continued to evolve.

Those readers interested in natural experiments may refer to Ito (2017) for more details. Here, I would like to draw attention to an important international trend. That is, U.S. and UK policymakers practicing evidence-based policymaking are increasingly demanding that evidence providers conduct scientific analysis to support evidence. In extreme cases, policymakers (such as the U.S. Department of Energy) have gone so far as to issue an order that no analytical findings be admitted as evidence unless supported by scientific analysis. By imposing stringent demands on those providing analysis results, policymakers are creating trends toward policy discussion based on highly reliable evidence.

Attempts to utilize evidence derived from scientific research in actual policymaking have been made in various countries. For instance, the California Public Utilities Commission (CPUC) used research findings from a researcher at the University of California, Berkeley as well as mine in its policymaking meeting (Borenstein, 2012; Ito, 2014). At the meeting, the commission pointed to the need to simplify and clarify the electricity rate structure by citing the analytical findings showing that a complex rate structure would cause confusion on the part of consumers and fail to deliver the intended policy effects, and this led to the simplification and clarification of electricity rate structure in California (CPUC, 2015). In another similar example, the Inter-American Development Bank (IDB) terminated its One Laptop per Child program and moved on to try out new development assistance programs after scientific analysis showed that the provision of free laptops did not have its intended effects on children in developing countries (Cristia *et al*., 2012). Meanwhile, the University of Chicago Crime Lab and the city of Chicago have been making continuous efforts to jointly analyze the effects of various policy interventions designed to prevent youths from developing criminal behavior in a bid to promote cost-effective measures by having cost-ineffective ones curtailed or eliminated (Heller *et al*., 2015).

Following these examples, Japan should work to produce reliable evidence and start discussing how we can make effective use of such evidence in actual policymaking.

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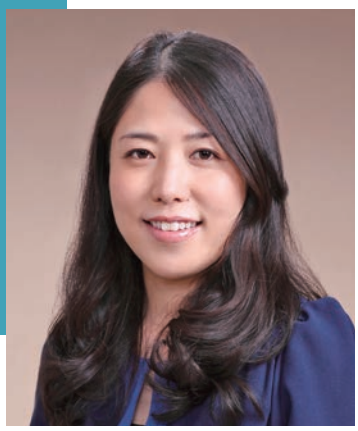
Toward Artificial Intelligence Technologies as an Integral Part of Service Business Operations

COLUMN



Yoko Konishi

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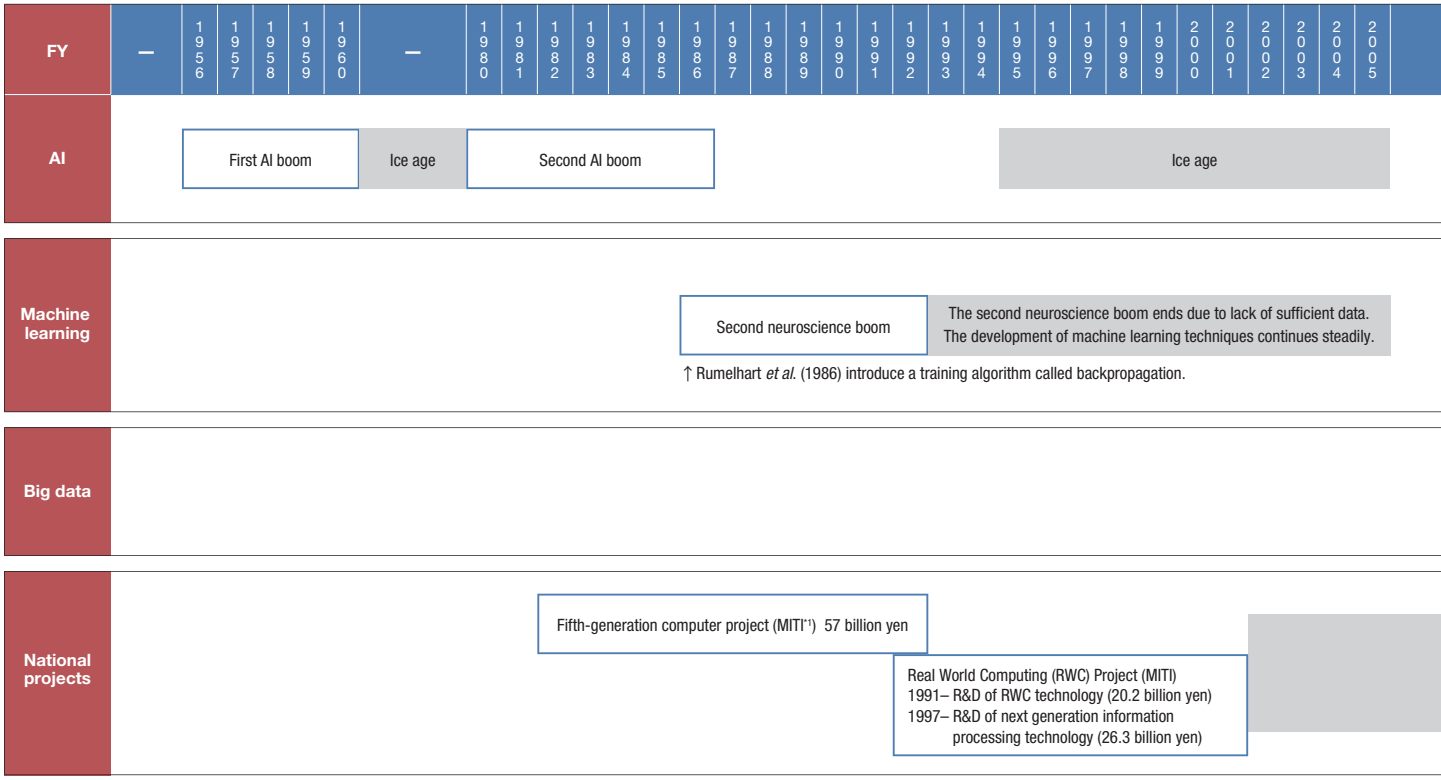
Unprecedented opportunity

Recently, we have frequently encountered such terms as big data, artificial intelligence (AI), and the Internet of Things (IoT) revolution in daily media reports or on social networking sites (SNS). The importance of such emerging technologies is widely recognized even among those with an aversion to numbers and statistics (and data science). In my previous article for the RIETI Column (Konishi 2014), I provided an overview of a boom in big data. At the time, I strongly hoped that another emerging boom in statistics (and data science) would be a lasting one. As it turns out, statistics (and data science) found a role for itself in today's world as a tool for machine learning, a data analysis method attracting much attention amid the ongoing AI boom, and that for evidence-based policymaking (EBPM). What started as vague interest in data science is now focused on this particular aspect as a tool indispensable for AI

Figure: AI Booms and Related Developments



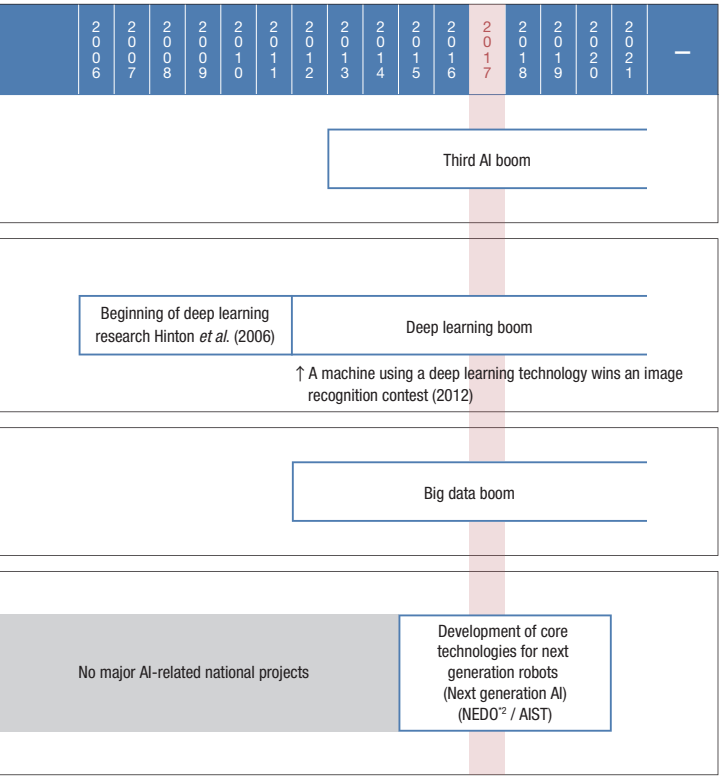
*1 Ministry of International Trade and Industry
*2 New Energy and Industrial Technology Development Organization

and EBPM.

Meanwhile, the AI boom that started in 2012 shows no signs of fading, as AI continues to evolve and find its way into our everyday lives. Why is the AI boom this time around—the third one—lasting so long?

The timeline in the Figure, taken from Konishi and Motomura (2017), shows the development of AI, machine learning, big data, and relevant large-scale national projects over the years. In the first half of the second AI boom, machine learning—in which computers learn from data without being explicitly programmed—was not linked with AI technologies, and thus, the construction of information systems involved an enormous amount of human work, i.e., writing programs for computers to perform specific tasks and processes. The latter half of the second AI boom overlapped with the second boom in neuroscience, a period in which numerous theoretical and applied studies on neural networks were carried out. However, as the processing capacity of computers was rather limited and large-volume data—such as those referred to as big data—were not available, neuroscience at this stage failed to achieve a sufficiently high level of precision, ushering in the ice age of neuroscience in the first half of the 1990s.

As shown in the Figure, AI technologies and neural networks had no major boom from the 1990s through the first half of the 2000s, and so did relevant large-scale national projects from the first half of the 2000s through 2015. A key turning point along the way came in 2006 when a group of researchers introduced a new learning algorithm that allows a neural network to have multiple hidden layers connecting the input and output layers. This activated research on deep learning. Then, in 2012, a machine using a deep learning technology won an image recognition contest, attracting attention from all over the world, hence creating a deep learning boom. In parallel with this, Japan's third AI boom began in 2013. Notably, these booms overlap with a big data boom that began in 2012. Furthermore, in May 2015, the Artificial Intelligence Research Center (AIRC), the largest AI research and development (R&D) hub in Japan, was established within the National Institute of Advanced Industrial Science and Technology (AIST). It is undertaking R&D on next-generation AI through March 2020, and industry-government-academia collaboration in AI research once again has been set in motion.



Source: Konishi and Motomura (2017)

Today, we have everything needed for AI development, ranging from machine learning-based AI technologies, high performance computing, and big data to relevant large-scale projects and industrial application needs. They together offer the greatest ever opportunity and explain the reason why the ongoing boom is so extensive and having an impact on the entire society.

AI literacy and service business operations

AI technologies introduced for use in service business operations are mostly purpose-specific—rather than multipurpose as seen in humanoid robots—and designed to perform and automate specific tasks previously carried out by humans just as well as, or even better than, humans. In my previous article (Konishi 2015), I defined AI literacy as being conscious about whether excessive labor, money, or time is spent carrying out tasks that machine learning and other AI technologies are highly capable of performing, i.e., categorization, repetition, exploration, organization, and optimization. AI is most efficient when used to perform the kind of tasks in which repeating, increasing the number of combinations, and/or spending more time will lead to greater accuracy and/or value.

For instance, suppose there is a project that involves finding and approaching potential customers in order to earn revenue. In classifying the existing customers for this purpose, coming up with several distinctive features or properties per customer would be the maximum that a human worker is capable of doing. However, AI would make it possible to identify several

dozen features or properties per customer by segmenting customers based on their purchasing behavior. Meanwhile, an AI system programmed to access information on economic trends or information about certain rival companies would be able to produce a strategy that reflects such information. This is very elementary, but information must be on the network to be accessible to AI, or conversely, everything on the network is accessible as information to AI. Unlike those that have been introduced for use in manufacturing operations, AI and information and communications technologies (ICT) currently available for use in service operations are devices, rather than machines. Those devices—whether wearables or personal computers—can be introduced on a piece-by-piece basis and make a difference, thanks to the accumulation of massive data as well as to the reduced size, refinement, and prevalence of information technology equipment. Against this backdrop, an increasing number of companies—both big and small—are showing willingness to collect big data and utilize AI technologies. However, no matter how convenient they are, it remains our task to determine what technologies to employ for our business processes. It is not easy to gain insights into what it takes under what environment to make a project successful and sustainable.

Perspectives needed to make AI sustainably useful

Konishi and Motomura (2017) reviewed 28 AI projects undertaken by AIST regarding their respective purposes and outcome. Many of them are practical, intended for application in real world service operations, for instance, to improve work processes for providing medical and nursing care services, make service recommendations to clients in the entertainment industry, and optimize commodities logistics. Through this review, we found some answers to our simple question: What kinds of AI projects develop sustainably?

1. The purpose of the project and the uses of technology are clear, and benchmark targets can be translated into data.
2. Workers on the frontline are highly motivated and have strong needs for AI.
3. It is possible to accumulate and integrate data at a relatively low cost via sensors, networks, and the Internet.
4. It is possible to collect data continuously by integrating the process into the regular flow of work.
5. Knowledge obtained by analyzing data and/or the results of calculation can be used as additional data.

We can see that data play crucial roles in AI projects. Meanwhile, researchers are working to develop various techniques and algorithms collectively referred to as AI technologies. Put into practical applications as soon as made available, these technologies are quick to penetrate. Given the programming techniques and computing environment as they stand today, it is quite easy to improve and utilize existing systems in accordance with the needs of workers. In other words, since data are the key determinant of the performance of machine learning-based AI, the sustainable availability of high quality data is crucial to competitiveness. The quality of data is dependent on frontline workers' ability to collect data, whether at a retail shop or inside a company office. Collecting as much information as possible on the behavior of as many people as possible will enhance the precision of analysis and the value of data.

The initial stage of decision making over whether or not to introduce an AI system is quite important. In selecting a specific AI system out of many available options, it is important to have the perspective of looking at what outcome or value added we intend to generate with this task and asking why we want machines to take this task away from human workers. Just look around your own room. You will see quite a few home appliances that were purchased to improve efficiency or for pure satisfaction but which have been left unused for long time. The same holds true for business and AI investments. We often seek to introduce AI as if doing so were a goal. In order not to fall into this pitfall, we must make sure we know the reason and the purposes for introducing AI.

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Agglomeration Benefits versus Firm Selection

Keisuke Kondo

Fellow, RIETI

The large literature on agglomeration economies attests to the higher average productivity of firms in larger cities. However, this literature focuses on positive externalities, and a second potential mechanism—selection against less productive firms—has received little empirical attention. This column explores how these two mechanisms contribute to higher productivity in Japanese cities. Consistent with earlier work considering the case of France, no evidence for a selection effect is found.

It is well known that firms, on average, are more productive in larger cities. Agglomeration economies are considered to generate benefits as positive externalities (e.g. Combes and Gobillon 2015). However, recent theoretical studies have proposed another hypothesis of selection. As introduced by Melitz (2003) in the international trade literature, selection is defined as less-productive firms being unable to survive in the market. Further introducing the endogenous markup, Melitz and Ottaviano (2008) showed that larger markets bring about tougher selection, and, consequently, aggregate productivity in larger cities is higher than that in smaller cities, since only more-productive firms survive in larger markets.

A crucial empirical concern is to examine whether higher productivity in larger cities derives from agglomeration economies or firm selection. The standard regression approach cannot distinguish productivity advantages of agglomeration economies from firm selection. Although urban economists have understood the productivity advantages of large cities as deriving from agglomeration economies, there may be different implications if stronger selection plays the key role. Thus, there is an increasing need to develop a new empirical methodology that can distinguish agglomeration from selection.

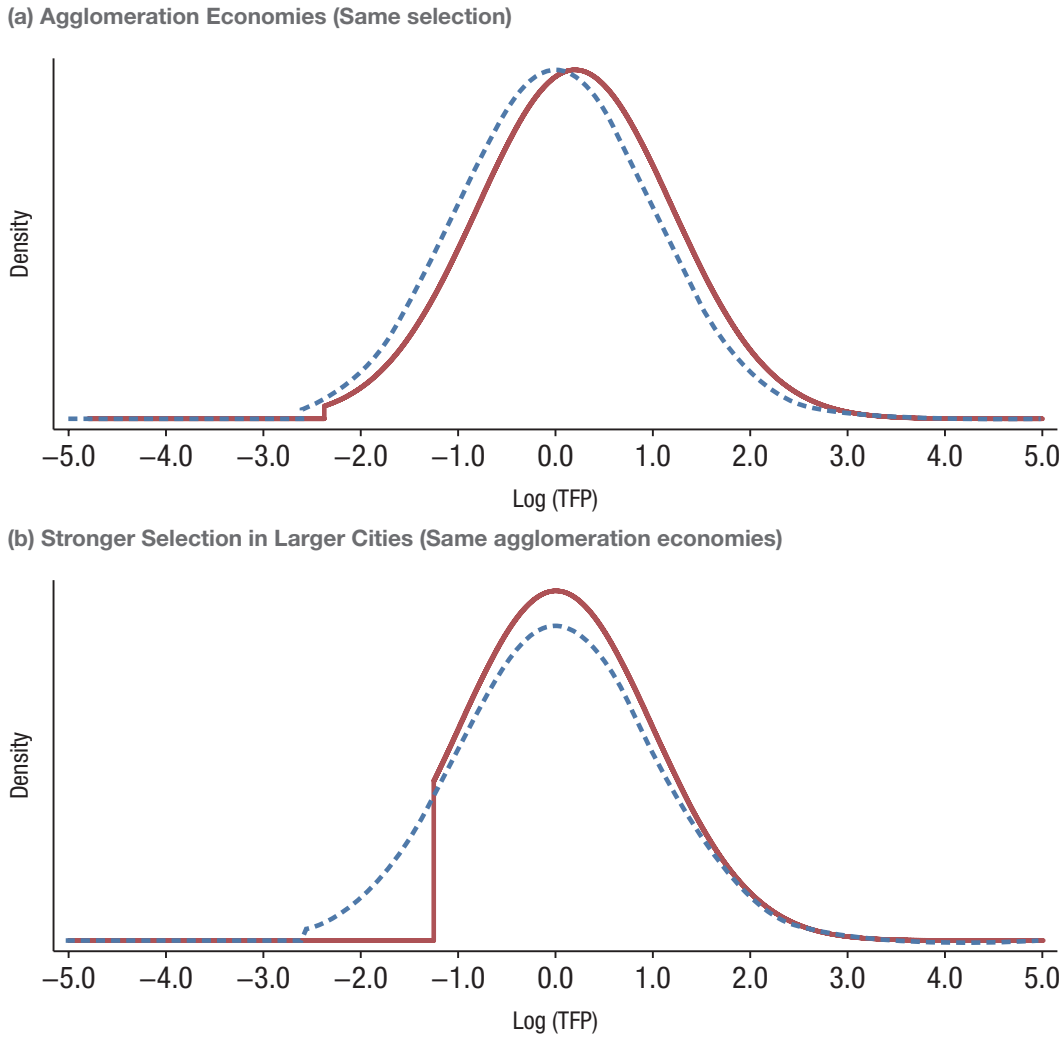
Quantile approach to distinguish agglomeration from selection

To simultaneously test for agglomeration economies and firm selection in spatial productivity differences, Combes *et al*. (2012) developed a new quantile approach that focuses on entire productivity distributions through three key parameters (shift, dilation, and truncation), whereas the standard statistical approach only captures the shift and dilation through the mean and variance of distributions. Agglomeration economies are captured by the right-shift of productivity distributions between larger and smaller cities (i.e. the right-shift captures the difference in average productivity between larger and smaller cities). Furthermore, Combes *et al*. (2012) considered the dilation effect of agglomeration economies, which indicates that more-productive firms can enjoy greater benefits from agglomeration (i.e. the dilation examines whether productivity distributions in larger cities are more dispersed than those in smaller cities). Finally, the selection is detected as a left-truncation of the productivity distribution (i.e. the left-truncation captures how less-productive firms can't survive in larger cities).

An empirical issue is that when stronger selection exists in the productivity distribution for larger cities, the omitted truncation parameter causes overestimation of the right-shift effects, and underestimation of the dilation effects of agglomeration economies. Figure 1 (see next page) offers an intuitive explanation regarding this bias. Panel (a) exhibits agglomeration economies

via a right-shift of the productivity distribution (same selection in both cities). By contrast, Panel (b) exhibits stronger selection in larger cities, but no agglomeration economies (i.e. no right-shift of the productivity distribution). In other words, both panels show that average productivity is higher in larger cities, but the background mechanism in cities is entirely different. The quantile approach suggested by Combes *et al*. (2012) compares the entire productivity distributions between larger and smaller cities to simultaneously examine whether agglomeration or selection plays the more important role.

Figure 1:
Comparing Entire Productivity Distributions Between Large and Small Cities



Note: Created by author. The solid and dashed lines denote productivity distributions for larger and smaller cities, respectively. Panel (a) shows agglomeration economies (right-shift only) and the same selection. Panel (b) shows stronger selection in larger cities and the same level of agglomeration economies.

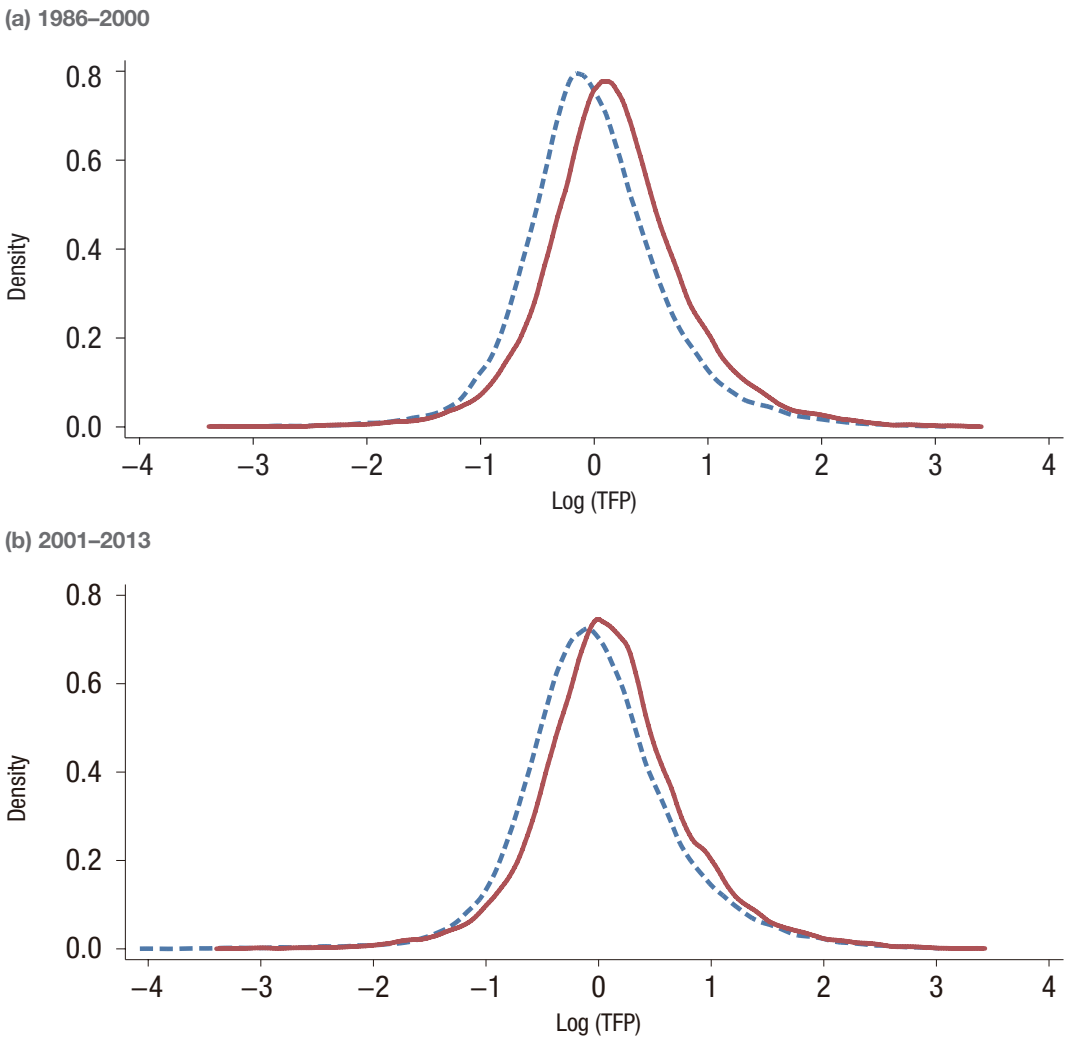
Empirical findings

My study applies this new quantile approach to the Japanese manufacturing sector from 1986 to 2013 (Kondo 2016). I hardly find any stronger selection effects in larger cities (i.e. no stronger left-truncation of productivity distribution in larger than smaller cities). Conversely, as shown in Figure 2, higher average productivity in larger cities is mostly explained in terms of the right-shift of the productivity distribution, suggesting that agglomeration economies do better explain spatial productivity differences in the Japanese manufacturing sector. In addition, the dilation effect of agglomeration economies shows greater variations across sectors. On the one hand, more-productive firms enjoy greater benefits from agglomeration in some sectors, while, on the other hand, less-productive firms enjoy greater benefits

from agglomeration in other sectors.

Another key testable prediction of Combes *et al*. (2012) is whether benefits from agglomeration economies decrease as interregional accessibility increases. For example, information and communications technology facilitates the exchange of ideas between geographically distant cities, decreasing the potential benefits of agglomeration economies. I find that benefits from agglomeration economies in the Japanese manufacturing sector have decreased in the recent decade. This suggests that when regional economies are integrated more tightly as communication and transportation costs decrease, the productivity advantages of agglomeration also decrease.

Figure 2:
TFP Distributions Between Above- and Below-Median Employment Density for All Sectors



Note: Kondo (2016). The solid (dashed) line is the productivity distribution of cities with above-median (below-median) employment density. Estimation results by sector are available in Kondo (2016).

Toward further empirical studies

The main findings in the Japanese manufacturing sector are similar to those of Combes *et al*. (2012), which concluded that firm selection does not play a crucial role in determining spatial productivity differences in the French manufacturing sector. By contrast, focusing on the pre-war Japanese silk reeling industry, Arimoto *et al*. (2014) concluded that selection played a key role in explaining why aggregate productivity in silk industrial clusters was higher than that in non-clusters. They also found that relatively less-productive firms enjoyed greater benefits from agglomeration economies, which indicates that the productivity distribution for the silk industrial cluster was less dispersed than that in non-clusters. These findings are in contrast to Combes *et al*. (2012) and those presented here.

Limited evidence in this literature is not enough to conclude that selection does not matter in spatial productivity differences. This literature requires further empirical studies worldwide, since there may be more counterexamples in other countries and time periods. Considering why differences arise across countries and time periods will deepen our understanding of agglomeration economies and help us draw better implications for urban and regional policies.

Finally, in Kondo (2017), I developed a new Stata command, estquant, which implements the quantile approach suggested by Combes *et al*. (2012) on Stata. I hope that the estquant command helps researchers apply this new approach and extend the empirical evidence in this literature.

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The "Scientification" of Industry: New indicators of science intensity

COLUMN

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There is growing interest in measuring the scientific aspects of industrial innovation and performance to understand the economic impact of publicly funded research and development (R&D). This column presents new indicators for science-industry linkages in Japan based on a novel dataset combining academic research paper data, patent data, and economic census data. It finds that the academic sector is getting more involved in patenting activities, and that scientific knowledge generated in the sector is being utilized not only in science-based industries, but also in many others.

A scientific foundation has become increasingly integral to the industrial innovation process. For example, genome science has substantially changed the R&D process of the pharmaceutical industry. Miniaturization of the large-scale integrated circuit fabrication process requires an understanding of the nano-level physicality of its materials. Furthermore, advancements in information technology have a significant impact on society and the economy. In particular, 'big data' analysis contributes to the scientific understanding of business and management activities (Redding and Weinstein 2016). Since science sectors, such as universities and public research institutes, are heavily subsidized by public money, there is a growing interest in measuring the scientific aspects of industrial innovation and performance to understand the economic impact of public R&D, despite severe constraints on public spending in general. Against this background, in a recent paper, we propose new indicators of science-industry linkages that reflect the interaction between science and industry via academic patenting activities (Ikeuchi *et al*. 2017).

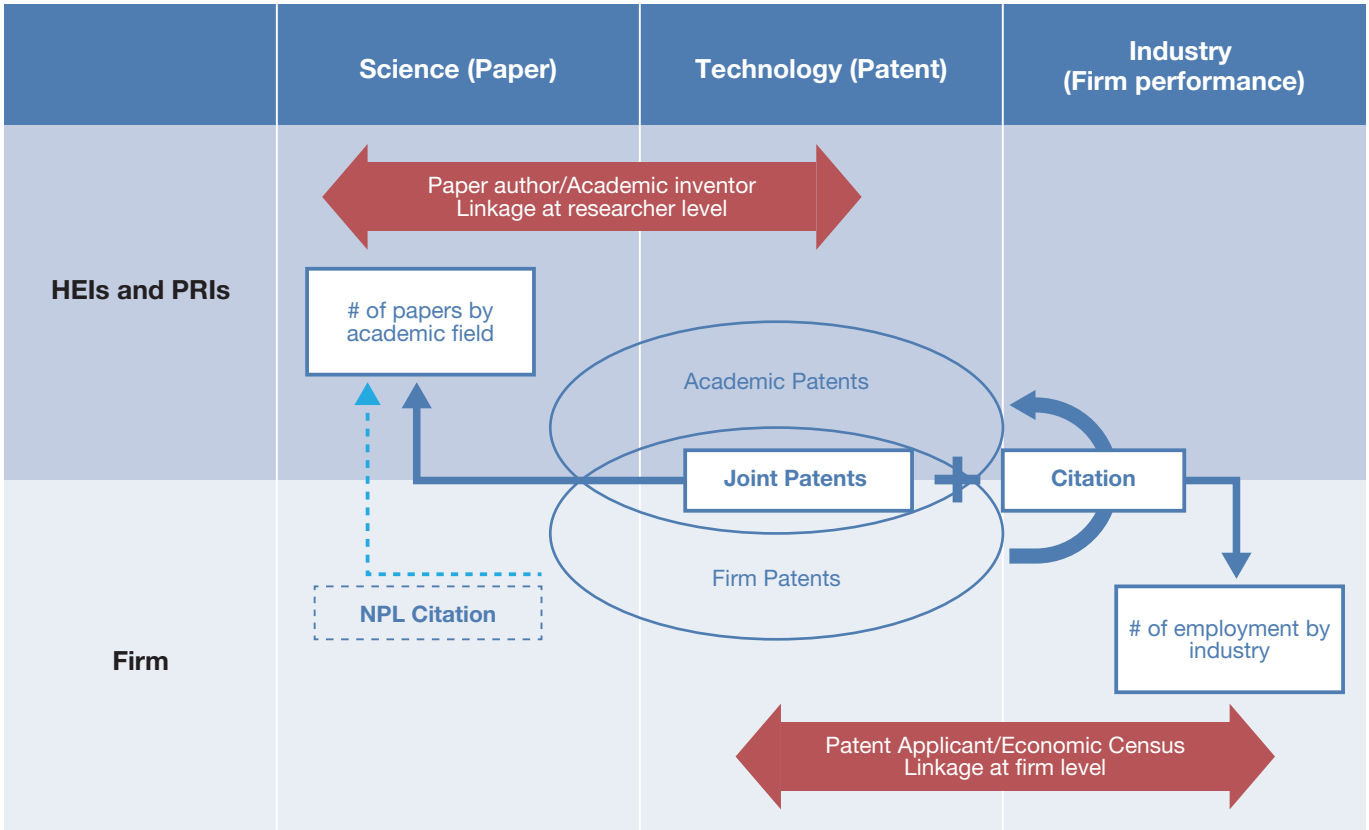
Traditionally, the degree of scientific basis, or 'science intensity' of industry has been measured using non-patent literature citations made by patents (Narin and Noma 1985, Schmoch 1997). This indicator captures the extent to which patents (technology for industrial use) are based on the scientific content of research papers. Alternatively, the science-technology linkage can be captured using patent-publication pairs, i.e. overlapping content regarding the research output/invention between patents and research papers (Lissoni *et al*. 2013, Magerman *et al*. 2015).

Both of these indicators reflect only one aspect of science linkages—non-patent literature citations show the degree of disembodied scientific knowledge that flows into patents, while the patent-publication pair indicates co-occurrence of scientific and invention activities within the same research. Our proposed new indicators of science-industry linkages can capture the linkage between science and technology embodied in human capital (academic inventors) via patenting, and the indicators are based on a novel dataset combining science (academic research paper data), technology (patent data), and industry (economic census data) at the author/inventor and firm levels to see how academic discipline, technology, and economic activities are interlinked.

Figure 1 illustrates the relationship between the dataset and the indicators. While the non-patent literature citations of patents are based on a firm's patent citations of scientific publications in the academic sector, our new indicators for science-industry linkage capture the interactions between the industry and the academia in patenting activities, i.e. joint inventive activities (captured by joint patent inventions) and firms' patent citations to academic patents.

Both industry citations to the academic inventors' patents and the joint patent inventions between firms and such academics reflect

Figure 1: Framework of Indicators



different channels of scientific knowledge flow from academia to industry compared to those measured by conventional indicators such as non-patent literature citations in patents. Furthermore, unlike past studies regarding paper-patent linkage at the researcher level for particular technologies, such as biotechnology (Murray 2002) and nanotechnology (Meyer 2006), our dataset covers all technological fields by constructing a large-scale database.

Our new indicators are intended to capture the mechanism of involving scientific knowledge in industrial innovation via patenting activity of academia. Although universities and public research institutes principally provide scientific publications as their research outputs, there is a growing global trend of patent applications from these institutes (OECD 2013). In Japan, national universities, which used to be government organizations, became independent agencies in 2004. This institutional reform allows them to claim patent rights, and university patent applications have increased significantly (Motohashi and Muramatsu 2012). Therefore, a patent-based science linkage indicator has become increasingly important.

Academia-industry interactions via patenting in Japan

According to our dataset, as shown in Table 1, the proportion of academia among inventors increased in Japan from 3.2% in the period 2000–2003 to 5.4% in the period 2008–2011. The proportion of academic authors with patent inventions also increased from 3.0% in 2000–2003 to 4.1% in 2008–2011. Furthermore, the proportion of academic authors to total inventors doubled from 1.4% to 2.8% during the 12-year period.

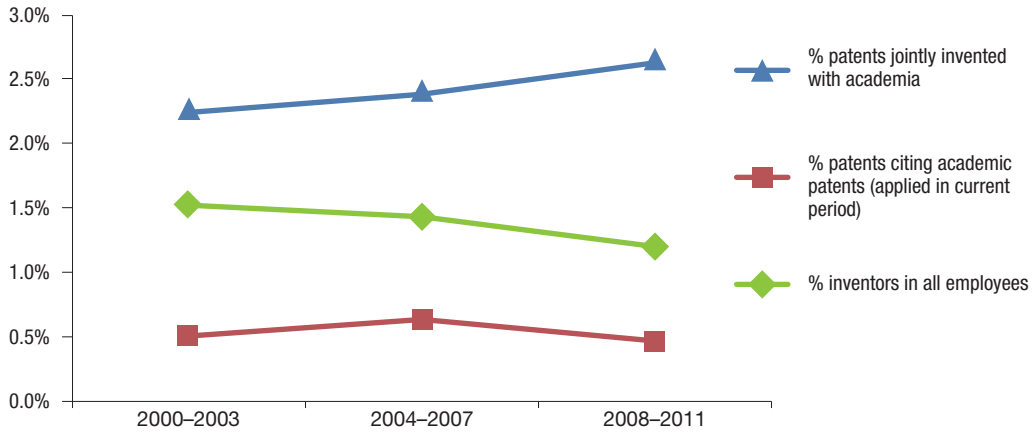
Figure 2 shows the aggregated trend of academic involvement in industry innovation. It shows that both the shares of academia-industry joint applications and patents citing academic patents increased from 2000–2003 to 2004–2007. In subsequent periods (2008–2011), the share of joint applications increased further, while the share of patents citing academic patents decreased. Additionally, the number of inventors per employee (reflecting R&D intensity) decreased over time in the industry sector.

Table 1:
Patent Inventors and Academic Authors Active in 2000–2011 in Japan

		2000–2003	2004–2007	2008–2011	Total
[A]	Number of authors	316,031	355,936	381,660	739,372
[B]	Number of all inventors	673,927	623,849	562,822	1,229,027
[C]	Number of academic inventors	21,437	31,421	30,505	53,446
[C/B]	Proportion of academia in inventors	3.2%	5.0%	5.4%	4.3%
[D]	Number of patenting authors	9,532	15,726	15,598	26,333
[D/A]	Proportion of inventors in authors	3.0%	4.4%	4.1%	3.6%
[D/B]	Proportion of authors in inventors	1.4%	2.5%	2.8%	2.1%

Source: Authors' calculations based on Scopus and the IIP patent database.

Figure 2: Science-Industry Relations in Patents



New indicators of science intensity of firms

We define science intensity as the amount of new scientific knowledge (the number of academic papers) utilized by inventors in firms through joint inventions with academia and/or academic patent citations per employee in industry. Figure 3 shows the science intensity in the total economy in Japan, which increased from 2000–2003 to 2004–2007 by increasing both joint inventions and academic patent citations. After the incorporation of Japan's national universities in 2004, academic patent applications increased substantially. Moreover, industry-university collaboration activities have been promoted for over ten years, which has contributed to the increase in science intensity indicators after 2004.

However, the total science intensity decreased from the second to the last period. Along with the incorporation of the national universities in 2004, the research outputs of the universities sufficiently valuable for patent applications were intensively patented, and, accordingly, patent citations to academic patents temporarily increased sharply in 2004–2007. For that reason, in the last period, research outputs suitable for patenting at university might have been exhausted. The decline in joint research may be influenced by the fact that firms saved R&D investment due to the

Figure 3:
Employee-Based Science Intensity in the Total Economy
(Average number of linked academic publications per 100 employees)

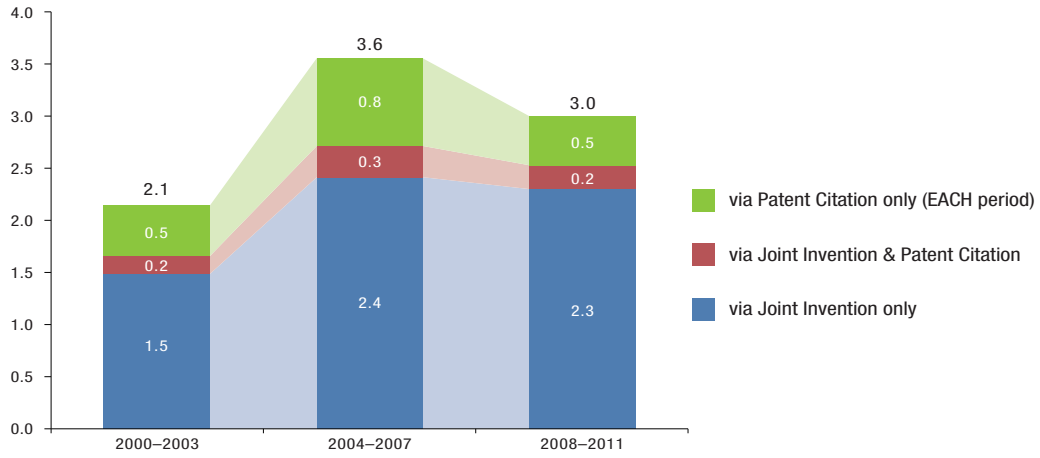
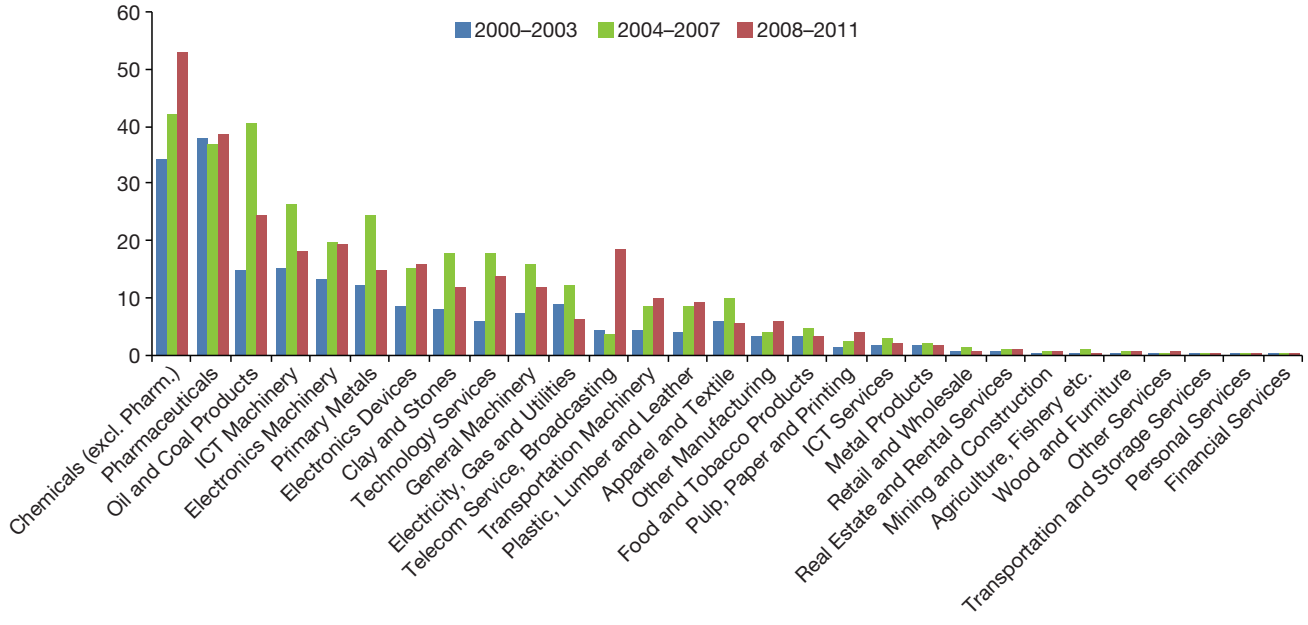


Figure 4: Employee-Based Science Intensity by Industry
(Average number of linked academic publications per 100 employees)



recession after the collapse of Lehman Brothers in 2008.

Figure 4 (see previous page) shows the industry breakdown of employee-based science intensity. It shows that the chemical and pharmaceutical industries substantially lead other industries. However, the science intensity indicator has generally increased in other industries, which means that 'scientification' of industrial innovation can be observed across industries. In general, the cross-industry distribution of science intensity becomes equal.

Utilization rate of science knowledge

We also defined an indicator from the viewpoint of science as a utilization rate of science-knowledge of academic research by industrial inventors, via joint invention with industrial inventors and/or citations by industrial patents to academic patents. Figure 5 shows the aggregated trend of this indicator. A similar trend is observed in the employee-based science intensity, which increased from 2000–2003 to 2004–2007 and decreased in the subsequent period. The changes in the utilization rate of science-knowledge are caused not only by the demand side factors of scientific knowledge in industry, but also by the supply side factors of scientific activities. The up-and-down trend of the utilization rate of science-knowledge is similar to that of employee-based science intensity, but it should be noted that any changes in supply-side factors such as new scientific advancements may affect the trend.

Viewing this trend from an academic perspective, the situation is more complicated. In general, as shown in Figure 6, the industry utilization rate increased over time, while a sharp decline from 2004–2007 to 2008–2011 is found in some fields (e.g. chemistry, physics, and astronomy). In contrast, some academic fields, such as mathematics and social science, show a strong increasing trend. Thus, the overall inequality in URSK in the academic field decreases from 2000–2003 to 2008–2011.

Discussion and conclusion

In this column, we have presented new indicators to measure scientification of industry in Japan, by linking a scientific paper database (science), patent information (technology), and economic census data (industry). The new indicators reflect a mechanism of science linkage between science and industrial activities, which cannot be measured by the existing indicators based on non-patent literature citations.

These new indicators of science linkage in Japan show an increasing trend over the past ten years. One reason behind these trends is the institutional reform of the academic sector in Japan, i.e. incorporation of national universities in 2004 and various polices stimulating university-industry collaborations from the late 1990s onwards (Motohashi and Muramatsu 2012). These policy actions induced academic sectors to work with industry, which involved patenting activities.

Moreover, the growing importance of scientific inputs in industrial innovation has an impact as well. In our analysis, science linkage with industry is found not only in science-based industries, such as pharmaceuticals and electronics, but also in many other industries. Our study has shown that scientific knowledge becomes general inputs in almost all industries, and this trend can be referred to as the 'science-based economy', for non-science based industries as well.

Figure 5:
Utilization Rate of Science Knowledge
(Share of academic publications linked to industry in total academic publications)

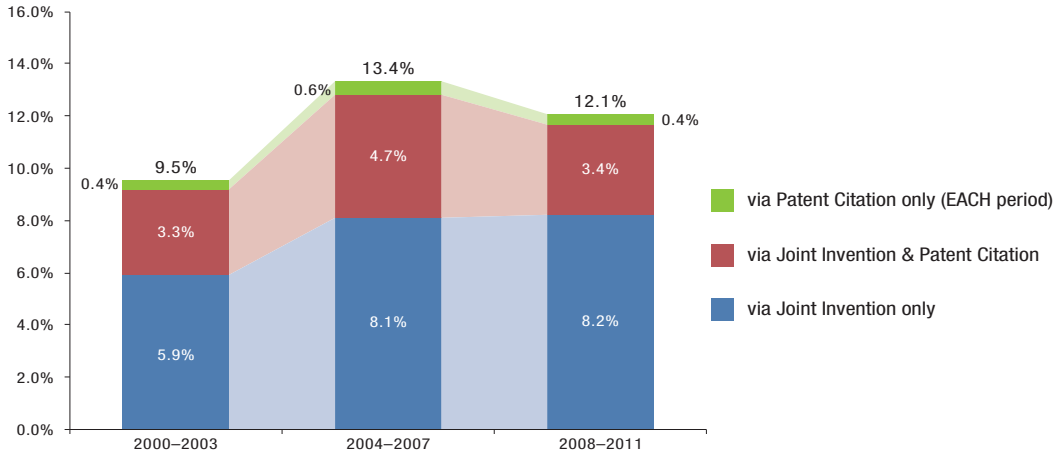
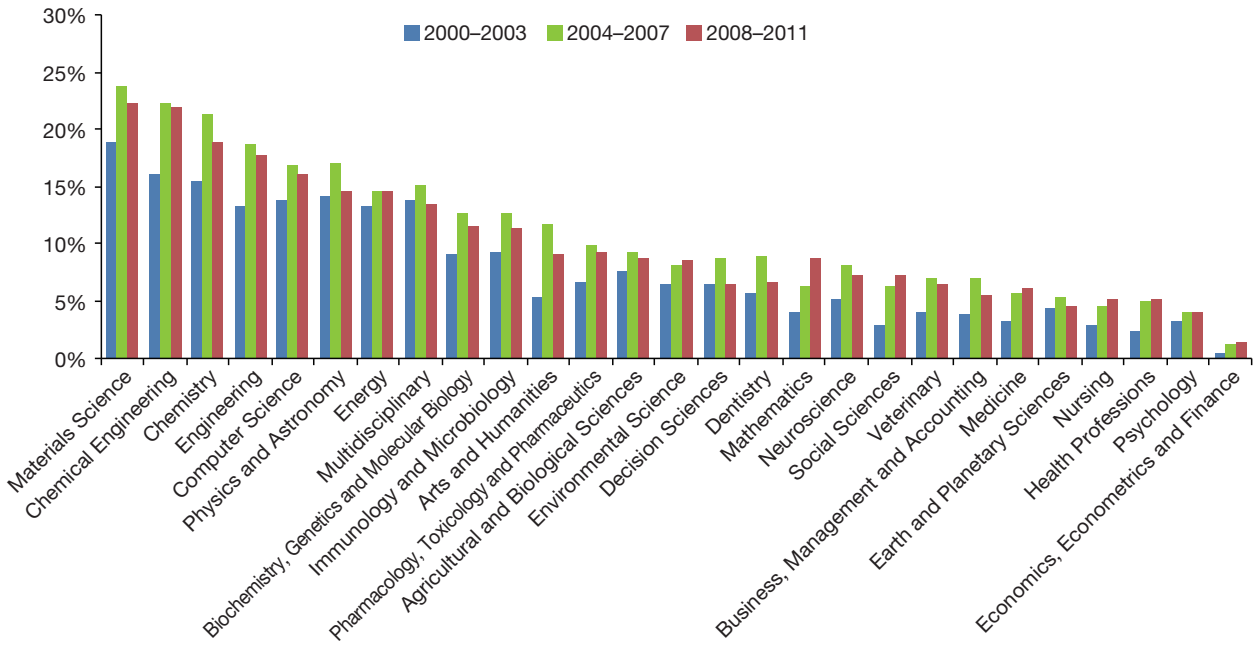


Figure 6: Utilization Rate of Science Knowledge by the Science Field
(Share of academic publications linked to industry in total academic publications)



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Research Digest

In Research Digest, we interview authors of Discussion Papers (DP) to provide a simple introduction to their understanding of problems addressed in their papers, along with the major points and policy implications.

Policy Uncertainty in Japan

Arata Ito Fellow, RIETI

Arata Ito has been a fellow at RIETI since 2013. After receiving his M.A. from Hitotsubashi University, he became a research associate at the Institute of Economic Research, Hitotsubashi University in 2009. In 2012 he joined the Graduate School of Economics, University of Tokyo as a project academic support specialist. His recent works include: "Fiscal policy switching in Japan, the U.S., and the U.K.," *Journal of The Japanese and International Economics*, 25 (4), 2011 (with Tsutomu Watanabe and Tomoyoshi Yabu) and "Policy Uncertainty in Japan," NBER Working Paper No. 23411, 2017 (with Elif C. Arbatli, Steven J. Davis, Naoko Miake, Ikuo Saito)

There is "a lack of clarity" and "uncertainty" over various government policies, e.g., re-postponement of the consumption tax rate increase, negotiations for the Trans Pacific Partnership (TPP), and monetary policy. How would this affect consumption activities and investment activities? RIETI Fellow Arata Ito prepared the News-based Economic Policy Uncertainty Index for Japan based on newspaper articles to quantify the uncertainty of policy steering, so as to analyze the relationship between policy uncertainty and the economy. The study has found that the increase in policy uncertainty is the pre-stage of decline in economic activities. The finding suggests that clarifying future policy steering to reduce policy uncertainty could prevent deterioration of economic performance. Ito hopes that the index will prove to be useful for conducting economic research at both the government and private levels, and implemented in academic studies for accumulating insight into policy uncertainty.

Research background and methodology

- Tell us about your motivation behind conducting this study.

The world financial crisis from 2007 to 2008 caused the economy to recede in many countries. The economy has since recovered, but the pace of recovery has been quite slow. Why is it that the economic recovery has not gained momentum? Overseas academics and media have presented several theories. One of them is with regard to policy uncertainty. For example, Stanford University Professor John Taylor cited policy uncertainty as one of the main inhibitors of economic recovery. He notes that— amidst the poor outlook of the medical system reform, financial system reform, as well as the monetary policy of the Federal Reserve Board (FRB)—reduced policy uncertainty would encourage companies to utilize their surplus fund, thereby stimulating the economy.

Researchers keenly observed whether actual data would support this theory. A team of researchers including University of Chicago Professor Steven Davis and Stanford University Professor Nick Bloom developed a new indicator called the Economic Policy Uncertainty Index, focusing on newspaper coverage, as I will explain later. Today, substantial knowledge has been accumulated based on this index. Yet, Japan's level of knowledge on policy uncertainty is quite poor compared to that of European and North American countries. As the first step for narrowing the gap, I thought it was necessary to ask three basic questions, i.e., how Japan's policy uncertainty has changed with time, which policy areas are the source of increasing uncertainty, and how does policy uncertainty relate to economic activities.

- Tell us about actual results provided in your paper, particularly about policy implications.

This policy discussion paper provides policy practitioners with the results of joint research by Professor Davis, economists at the International Monetary Fund's (IMF) Regional Office for Asia and the Pacific, and myself. It gives three main findings, corresponding to the three questions mentioned earlier. First of all, the policy uncertainty index rose when a new prime minister was inaugurated or at the time of fiercely-contested national elections. The index also rose at the Asian currency crisis from 1997 to 1998, collapse of Lehman Brothers in 2008, U.S. debt ceiling crisis and U.S. credit rating downgrade in 2011, and, more recently, the

re-postponement of the consumption tax rate increase in 2016. As you can see, Japan's policy uncertainty rises in response to not only domestic factors but also overseas factors.

Next, the study also found that the rise in policy uncertainty is attributable primarily to factors associated with fiscal policies. More specifically, about 60% of all factors are related to fiscal policies, while about 30% are associated with monetary policies. Finally, simple quantitative analysis shows that the increase of policy uncertainty is a precursor of decline in economic performance.

Third, the study has indicated that the economy benefits from having policy uncertainty kept low by way of stabilizing the government's policy steering and clarifying policy outlook.

- Can you explain the method for measuring policy uncertainty?

There are several approaches to measuring policy uncertainty. The first approach is to conduct a survey. The advantage of this approach is that it directly captures uncertainty faced by households and companies of varying characteristics. Its disadvantage is the amount of work involved in conducting a large-scale survey at high frequency, e.g., weekly or monthly. It is also difficult to obtain retrospective data, making this approach unsuitable for time series analysis.

There is also an approach of using newspaper coverage. The research group led by Professor Bloom and Professor Davis developed an indicator of policy uncertainty by focusing on the frequency of newspaper coverage related to uncertainty. Against the backdrop of this approach lies an assumption that households and companies must be facing a state of high uncertainty when newspapers carry a large number of such articles. The advantage of this approach is the retrospective availability of high coverage data. Databases of articles, held by major newspapers, can be used to search relevant articles published over a long period of time. Its disadvantage is the difficulty in capturing uncertainty faced by households and companies of varying characteristics. This study adopted the latter approach as it caters to the purpose of the study.

Methodology of the News-based Economic Policy Uncertainty Index for Japan

- Can you provide details of the methodology for compiling the News-based Economic Policy Uncertainty Index for Japan?

Of all of the articles published in the Nikkei, Yomiuri, Asahi, and Mainichi newspapers, I searched for those that contain at least one term relating to the three categories listed below for each month. The article search covered the period from January 1987 to today.

Economy: "*keizai* (economy)," "*keiki* (economic condition)"

Uncertainty: "*futomei* (unclear)," "*fukakujitsu* (uncertain)," "*fukakutei* (unconfirmed)," "*fuan* (concern)"

Policy: "*zeisei* (taxation system)," "*saishutsu* (expenditures)" and other policy-related terms

Japanese terms corresponding to "economy" and "uncertainty" have been chosen through careful comparison of Japanese articles and their English translations provided by the respective newspaper publishers. Let's take the case of "uncertainty" for example. First, I randomly selected a specific number of articles from the searched articles containing the words "uncertainty" or "uncertain." Then, the selected articles were compared against their Japanese equivalent articles to identify Japanese terms corresponding to "uncertainty" or "uncertain." This found that "*futomei*," "*fuan*," "*bimyo*," "*fukakujitsu*," "*fuantei*," and "*fukakutei*" were used as corresponding terms at a relatively high frequency.

Then, I randomly selected a specific number of articles from articles containing both "*keizai*" or "*futomei*." The selected articles were compared against their English equivalent articles to identify English terms corresponding to "*futomei*." The same comparison was made for the other five Japanese terms mentioned above as well. Of the six terms, those that corresponded to "uncertainty" or "uncertain" at a high frequency were "*futomei*," "*fuan*," "*fukakujitsu*" and "*fukakutei*." This study therefore adopted these four terms as Japanese equivalents of "uncertainty." The same process was applied to the term "economy," and the study consequently adopted "*keizai*" and "*keiki*" as its Japanese equivalents.

As for the "Policy" category, I used many of the terms that Professor Davis *et al*. listed as candidate terms when they compiled the U.S. version of the index. The aforementioned method was used to determine corresponding Japanese terms. In the end, I adopted a total of 32 terms including "*zeisei* (taxation system)," "*seifu saimu* (government debt)," "*kisei* (regulations)," "*hoan* (legislative bill)," and "*Nihon Ginko* (Bank of Japan)."

Data of newspaper coverage, collected this way, were applied with seasonal adjustment and other treatments, before calculating an index with the average for January 1987–December 2015 set at 100. Indices were also prepared for individual policies, in addition to the index for all policies. More specifically, indices were compiled for fiscal policy, monetary policy, foreign exchange policy, and trade policy. Of all of the articles collected in compiling the index for all policies, those containing each of the individual policies were selected to calculate the respective indices. Index data are compiled monthly, starting from January 1987.

Index characteristics

- Tell us more about the characteristics of the pre-2000 index.

The figure on next page shows the transition of the News-based Economic Policy Uncertainty Index for Japan. The higher the index is, the greater is the level of uncertainty. Until the mid 1990s, the index hovered around just below 100 in general. However, there were times when the index showed a sharp spike, e.g., in October 1987. This was when Japan's political landscape became

Interviewer **Yoshiyuki Arata** Fellow, RIETI

destabilized over the choice of successor to Prime Minister Yasuhiro Nakasone. Meanwhile, overseas, U.S. President Ronald Reagan was in fierce confrontation with the U.S. Congress over the reduction of fiscal deficits.

One of the periods when the index reached a very high level over the last 30 years was the late 1990s. At the time, the Cabinet led by Prime Minister Ryutaro Hashimoto adopted austere fiscal management to rebuild fiscal health. However, the 1997 Asian currency crisis caused the economy to rapidly deteriorate. In response, Japan's political opposition and even some forces within the ruling party began calling for shelving the fiscal reconstruction initiative and shifting into a more aggressive fiscal policy. The standoff between those promoting fiscal reconstruction and those seeking an aggressive fiscal approach heightened uncertainty over fiscal policy.

The index rose again in 1998. In July, the Liberal Democratic Party (LDP) lost its majority in the Upper House election, allowing the opposition camp to claim majority in the chamber. The sense of concerns rose over the possible difficulty in policy implementation under this so-called "Twisted Diet." The LDP then forged a coalition with the Liberal Party, etc. to regain Upper House majority, resolving the "twisted" state of the Diet. This caused the index to drop sharply.

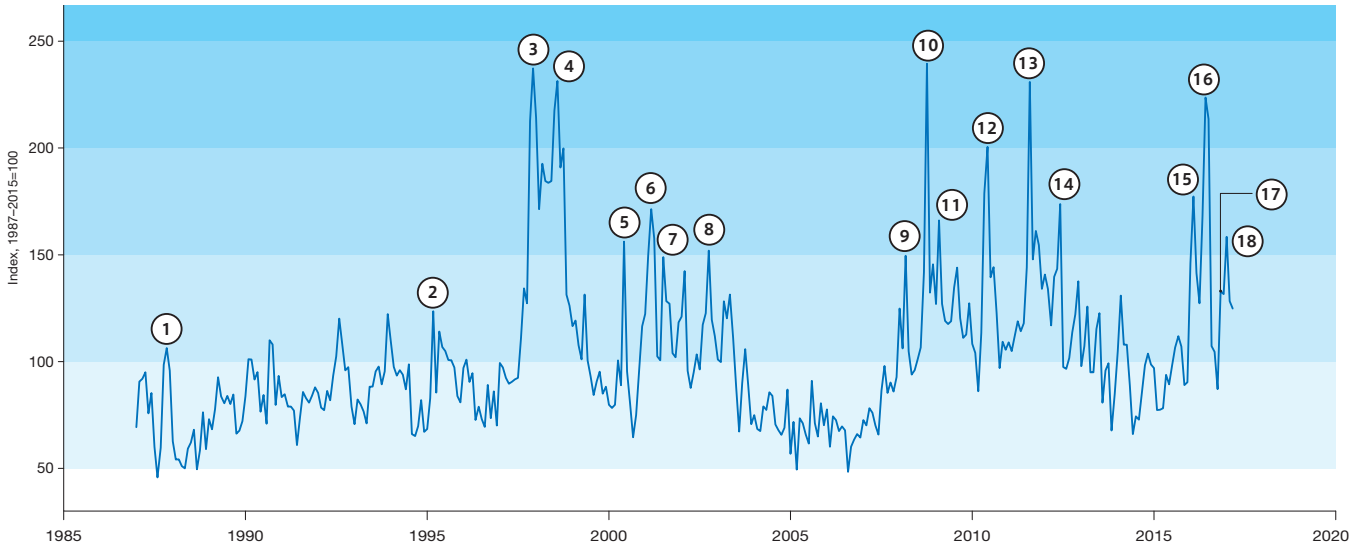
- Can you explain details about post-2000 periods when the index rose?

As you can see in the figure, the index has spiked frequently since 2000, e.g., in 2001. Then, the resignation of Prime Minister Yoshiro Mori triggered infighting within the ruling party, driving up political uncertainties. With no further room to lower the policy rate, there were discussions about the Bank of Japan (BoJ) introducing new monetary easing measures. Fast forward to 2008, the index reached the highest level over the last 30 years. Discussions were made on what policy approach the government should take, especially in terms of fiscal policy, to address economic recession triggered by the world financial crisis. In the current decade, the index spiked at major events such as the European sovereign crisis, the U.S. increase of federal debt ceiling, the BoJ's decision to adopt a negative interest rate policy, and the re-postponement of consumption tax increase. Most recently, the index rose sharply at the time of the U.S. presidential election in November 2016.

- The Shinzo Abe administration's decision to re-postpone the consumption tax rate increase has significantly heightened uncertainty. How does the consumption tax rate increase relate to uncertainty?

First, it is a good idea to examine how the fiscal policy's uncertainty index reacted when it was decided to postpone the increase in consumption tax rate. At the time of first postponement, i.e., in November 2014, the index rose by about 20 points. At the time of the second postponement, i.e., in May 2016, the index rose by about 80 points. This indicates that the postponement of consumption tax rate increase does not necessarily heighten uncertainty. Why was it that the second postponement raised uncertainty to that extent? I believe it was attributable to the prime minister's failure to present convincing and specific preparation for clearing the fiscal consolidation goals to which he had committed. In a news conference announcing the re-postponement, the prime

News-based Economic Policy Uncertainty Index for Japan



minister indicated that the increase in tax revenues, resulting from economic growth, would be partially used to meet the rising fiscal demand. However, he fell short of clearly stating how he planned to secure the tax rate increase in 2019, and generate fiscal surplus until then.

Uncertainty of monetary and trade policies

- Tell us about the uncertainty of monetary and trade policies, and how the recent TPP development and U.S. presidential election relates to uncertainty.

Let me talk about the monetary policy's uncertainty index first, and then about trade policy's uncertainty index. The monetary policy uncertainty index has three characteristics. First, the index rises just before and after any changes to the framework of monetary policy, e.g., in early 2001. At the time, with little room left for lowering the policy rate, there were debates on the introduction of new monetary easing measures. In March, the BoJ adopted the quantitative easing policy, in which the outstanding balance of current accounts held by Japanese banks at the BoJ was used as the main target for monetary operations in the financial market. The index also spiked at the start of 2016, when the BoJ adopted the negative interest rate policy. The index's second characteristic is its sharp increase when the Japanese yen's exchange rate reaches around 80 to the U.S. dollar. It rose in 1995 amidst debate on the official discount rate cut, and in 2010–2011 during the debate on expanding the qualitative easing policy. The third characteristic of the index was seen in early 2008, when it rose due to fear that the position of BoJ governor could become vacant. This was because the Twisted Diet made it difficult for the ruling party to pass BoJ governor nominations the government had submitted.

As for the trade policy's uncertainty index, it showed significant increases twice in the past. The first surge came in the period from the late 1980s to the early 1990s. This includes 1988, when the U.S. Congress deliberated on the bill for the Omnibus Foreign Trade and Competitiveness Act, and 1993, when final trade negotiations for an agreement were held in the General Agreement on Tariffs and Trade (GATT)'s Uruguay Round. The other increase came in the period from 2011 to present. The index's fluctuations are closely associated with developments surrounding the TPP Agreement. For example, the index spiked in November 2011, when the ruling Democratic Party of Japan was suffering from severe infighting over whether Japan should participate in TPP negotiations. The index also rose from 2014 into 2015, when the level of concerns built up over the final agreement on TPP negotiations and its parliamentary ratification procedure. The index reached its highest level over the last 30 years in November 2016 at the time of the U.S. presidential election, and in January 2017 at the inauguration of the new U.S. President Donald Trump. This was because of the significant uncertainty created by the U.S. decision to leave the TPP Agreement.

Further development and future tasks

- How do you plan to further expand this study, which includes this paper as well as your previous papers?

The index I prepared this time has several issues, including the selection of terms in the "Policy" category. It is necessary to more carefully examine terms that appear frequently in articles that refer to policy uncertainty, as the U.S. index does. This paper could not accomplish it.

This study compiled a new index based on newspaper coverage in order to answer three basic questions about Japan's policy uncertainty. I hope this index will have proved to be useful for conducting economic research at both the government and private levels, and be utilized in academic studies for accumulating knowledge about policy uncertainty.

① October 1987: Black Monday; Prime Minister Yasuhiro Nakasone picking Noboru Takeshita as the next LDP President; Conflict between U.S. President Ronald Reagan and U.S. Congress over the reduction of U.S. fiscal deficits; Coordinated dollar-buying market intervention by the central banks of Japan, United States, and Europe
② March 1995: The Tokyo Metropolitan Assembly rejecting a proposed supplementary budget containing expenditures for bailing out collapsed credit unions suffering from non-performing loans; Coordinated dollar-buying market intervention by the central banks of Japan, United States, and Europe; Debate on lowering the official discount rate
③ November–December 1997: Asian currency crisis; A series of collapses of banks and securities brokerages; Debate on a shift away from the fiscal reconstruction policy
④ July–August 1998: The defeat of the ruling LDP in the Upper House election creating the Twisted Diet; Russian crisis
⑤ June 2000: The ruling coalition's loss of Lower House seats in general elections, causing concerns about the government's policy executing ability
⑥ February–March 2001: Fierce confrontation within the ruling party concerning the resignation of Prime Minister Yoshiro Mori; Debate on the introduction of quantitative easing policy as the policy rate approaching zero; Introduction of the said policy
⑦ July 2001: Upper House election; Debate over Prime Minister Junichiro Koizumi's structural reforms
⑧ October 2002: Fierce confrontation in the government and ruling party over the measure to accelerate the handling of non-performing loans and the pump-priming measure involving significant fiscal outlay; Debate on additional monetary easing; Expansion of quantitative easing
⑨ March 2008: A series of Upper House rejections on BoJ governor nominations
⑩ September–October 2008: Collapse of Lehman Brothers; BoJ cutting of the policy rate; Debate on economy-stimulus measures
⑪ February 2009: U.S. Congress deliberations on the stimulus package containing the "Buy American" provisions
⑫ May–June 2010: Greek debt crisis; Resignation of Prime Minister Yukio Hatoyama
⑬ August 2011: U.S. government credit rating downgrade; Concerns over European debt crisis; Resignation of Prime Minister Naoto Kan; Enhancement of monetary easing amidst sharp appreciation of the yen; Yen-selling market intervention by the BoJ
⑭ June 2012: Concerns over debt crisis in Greece and Spain; Tri-party agreement on the amendment of integrated reform bill concerning social security and taxes
⑮ January–February 2016: Introduction of the negative interest rate policy
⑯ May–June 2016: Re-postponement of consumption tax increase, UK referendum on its departure from the EU
⑰ November 2016: U.S. presidential election
⑱ January 2017: Inauguration of Donald Trump as the new U.S. president

Research Digest

In Research Digest, we interview authors of Discussion Papers (DP) to provide a simple introduction to their understanding of problems addressed in their papers, along with the major points and policy implications.

The Dynamics of Inter-firm Networks and Firm Growth

Yukiko Saito Senior Fellow, RIETI

Yukiko Umeno Saito has been a senior fellow at RIETI since 2014, and was a fellow from 2012–2014. Prior to that, she was a researcher at the Fujitsu Research Institute, Japan from 2002 to 2012. She received a Ph.D. in Physics from the University of Tokyo in 2002. She was a research fellow of the Japan Society for the Promotion of Science from 1999 to 2002. Her research field is industrial organization and spatial economics. She is interested in how firms construct inter-firm relationships and how it affects a firm's performance.

Her works include: "Production Networks, Geography and Firm Performance," (with A.B. Bernard and A. Moxnes), *Journal of Political Economy*, forthcoming (NBER Working Paper, No.21082 (2015.4)); "Geographical Spread of Interfirm Transaction Networks and the Great East Japan Earthquake," in *The Economics of Interfirm Networks*, Springer Publishing, 2015.

RIETI Senior Fellow Yukiko Saito has analyzed how inter-firm relationships (networks) evolve according to a firm lifecycle, and how such networks affect firm growth. The analysis has presented a new perspective based on inter-firm networks, as opposed to recent empirical studies' finding that firm age has a strong association with the size of subsequent growth. Saito's analysis has found that a younger firm tends to build, revise and discontinue transaction relationships more frequently than older firms do, that such inter-firm relationship stabilizes as their transaction relationships continue for an extended period of time, and that a firm age affects the association between networks and growth, with younger firms achieving growth more readily by building new transaction relationships. The findings suggest that the approach of policy support for inter-firm networks varies depending on firms' lifecycle stages.

Research motivation

- What motivated you to take on this research?

At RIETI, I am currently researching the dynamics of inter-organizational networks, examining how inter-firm relationships affect firm performance. As part of this research, I have conducted this analysis, incorporating firm age as a new factor.

I began considering firm lifecycle in the research I was involved in about 10 years ago. At the time, I was studying the historical effect of firm growth (effect of the past history of firm growth on the firm's subsequent growth), firm metabolism, and the effect of firm networks on firms exit. Then, Queen Mary University of London Assistant Professor Tatsuro Senga took an interest in these studies. About 10 years ago, the correlation between networks and firm growth history was predicted but not studied in depth. Compared to then, data concerning firm networks have been accumulated, allowing the examination of firm lifecycles in an approach incorporating the perspective of firm age. I decided to undertake this collaboration study to re-examine the association between networks and firm growth, adding the factor of firm age. Research collaboration is currently ongoing. My research partners, the abovementioned Dr. Senga and University of California, Los Angeles Lecturer Daisuke Fujii, are both theoretical research specialists. Combining theoretical research allows for even greater understanding. They are also specially appointed RIETI fellows, and I exchange ideas with them frequently.

Another motivation is the fact that I have gained access to Tokyo Shoko Research's (TSR) 10-year panel data because of my involvement in a project by the Small and Medium Enterprise Agency. TSR is a credit research company that collects detailed data from a very large number of firms. RIETI only holds intermittent TSR data for 2006, 2011, 2012, and 2014, making it unsuitable for panel analysis. However, TSR provided transaction data from 2007 to 2016 for the project of the Small and Medium Enterprise Agency, giving me an opportunity to take on this

research. These data form the basis of the dataset, compiled in this research.

- Why did you focus on inter-firm networks and network dynamics?

Our RIETI research project has confirmed that inter-firm transaction networks drive firm growth from the perspective of causality. At the same time, as the government policy highlights the use of the "power of connections," it is considered important to provide policy support that encourages firm growth, using inter-firm networks. Presenting a more detailed mechanism is important in order to explore evidence-based policies. Firms grow through efforts to connect with better transaction partners and build better relationships with existing transaction partners. I believe examining the perspectives of network dynamics and firm growth will help promote greater understanding.

Inter-firm networks are an important factor not only to examine the microeconomic mechanism of firm growth, but also to consider macroeconomic implications. More recently, Acemoglu *et al*. found that macroeconomic fluctuations are caused through inter-firm networks. We also analyzed ripple effects following the Great East Japan Earthquake to verify them empirically. Right now, my research is based on understanding that inter-firm networks play an important role not only for macroeconomic fluctuations but also for macroeconomic growth. Existing research on Japan's "lost two decades," when the national economy stagnated, highlights the absence of correct firm metabolism, in which low-productivity firms should exit the market. Such studies did not consider the effect of mutual interactions between firms, and instead examined individual firms as completely separate operations. However, as confirmed in research on shock propagation, macroeconomic fluctuations do not represent the sum of microeconomic fluctuations. Furthermore, with confirmation that inter-firm networks promote firm growth, I have come to the conclusion that macroeconomic growth should be examined from the networks perspective, rather than by merely adding up the growth of standalone firms.

This study first examined how inter-firm networks evolve along with firm lifecycle to identify network dynamics, and how networks would affect growth in relation to factors including firm age.

Network evolutions along with firm lifecycle and its relationship with firm growth

- What kind of research have you conducted about how an inter-firm network evolves?

With regard to the dynamics of inter-firm networks, I have focused on network stability. The perspective of how firms choose their partners in developing such networks is important, but is also very difficult as it makes it necessary to examine the mechanism of inter-firm matching. This is why I decided first to examine the relationship between firm age and network stability. More specifically, I studied how a network becomes stable as a firm becomes older. To verify this, I used data to see how a firm forms, updates, and discontinues connections (link) with suppliers and customers.

The analysis found that younger firms change such links frequently compared to older firms. More precisely, compared to older firms, younger firms tend to establish more ties with a new transaction partners, and discontinue transactions more frequently. Transaction stability that firms attain as they age could indicate that such ties accumulated between firms turn into something similar to assets for firms involved. At the same time, ceasing to build connections with new partners means the firms could be missing out on growth opportunities. From these perspectives, it is necessary to examine how inter-firm networks are built and their effect on firm growth.

As for transaction continuity, it is possible to carry out detailed analysis on how it changes according to the nature of suppliers and customers. More specifically, the ratio of transaction relationships (link) continuing into next year (survival rate) was put to regression analysis based on the characteristics of suppliers and customers. The analysis found that, as shown in Table 1, the probability of transaction relationship continuation has a positive correlation with age of suppliers as well as customers. Interestingly, the sales of suppliers and customers have a different correlation with transaction continuity. The greater the sales size of suppliers is, the higher the probability is for transaction continuation. On the other hand, the greater the sales size of customers is, the lower the probability is for transaction continuation. Customers with a larger size of sales are suspected to be rebuilding transaction relationships with new partners, rather than maintaining transactions with existing partners. Indications are that, as a firm grows in its size, it gains a greater benefit in

Table 1:
Stability of Inter-firm Linkages

	Continuation of business partnerships	
Age of clients	+	Not significant
Age of suppliers	+	+
Net sales of clients	–	–
Net sales of suppliers	+	+
Distance to transaction partners	–	–
Continuation for 2 years		+
Continuation for 4 years		+
Continuation for 6 years		+
Number of samples	3,211,750	3,211,750

1% significance level

Interviewer **Kenta Ikeuchi** Fellow, RIETI

finding better suppliers, and could therefore start spending more in searching for better suppliers.

Table 1 also shows that the more that transaction relationships continue, the more they stabilize.

- Next, can you explain about your analysis on the relationship between inter-firm networks and firm growth?

In order to examine the relationship between inter-firm networks and firm growth through firm lifecycle, firm samples were divided into five groups based on firm age, i.e. 0–4 years old, 5–9 years old, 10–19 years old, 20–39 years old, and 40+ years old. I studied how the relationship between inter-firm networks and firm growth varies between these groups, and identified differences in this relationship according to firm age (Table 2). The groups of higher firm age showed a smaller relationship between firm age and growth. The groups of lower firm age showed greater age-based differences. Such natural results were controlled before observing the relationship between inter-firm networks and firm growth. As a result, age-based differences were greater for changes in transaction partners (network dynamics) than for the number of transaction partners (network size). My observation was that for younger firms, those that aggressively build new transaction partners have a greater rate of sales growth, and that a stable transaction relationship becomes more important for older firms. These findings suggest that seeking new transaction partners is important for younger firms, and that they require policy support in this area. Note that this analysis examined only correlation, and has not discussed in-depth causality. Further analysis is required to compile more solid and specific policy suggestions. In addition to causality, the analysis must adopt additional perspectives, e.g., whether effect of relationship development differs between suppliers and customers, and what kind of transaction partners firms should seek to connect with.

- What are the new perspectives adopted in this study?

We presented new perspectives to existing studies on firm growth. With regard to decisive factors for firm growth, Gibrat examined how firm growth depends on a firm's size. There are numerous papers that examined the relationship between firm growth and firm size. Despites those, Haltiwanger *et al*. referred to firm age in their analysis. Haltiwanger *et al*. highlighted the importance of firm age, and pointed to the need to direct attention to the effect of firm age, rather than firm size, on firm growth. The study added that a government policy, aimed at creating employment, should provide assistance to younger firms instead of small- and medium-sized enterprises (SMEs). However, their study fell short of explaining the mechanism on why firm age is so important for firm growth. Our study is unique in that it incorporates the perspective of network dynamics in examining the relationship between firm growth and firm age, in order to uncover the underlying mechanism. Another uniqueness is found in the presentation of a firm age perspective in examining network dynamics.

Policy implications

- What policy implications have you obtained?

The Small and Medium Enterprise Agency project aims to identify long-term changes that will have occurred to SMEs by 2030. This

Table 2:
Inter-firm Transaction Relationships and Firm Growth

Firm age	Rate of net sales growth					
	All ages	0–4	5–9	10–19	20–39	40–
Firm age	–	–	–	–	–	–
Number of employees	+	Not significant	+	+	+	+
Number of transaction partners	+	Not significant	+	+	+	+
Ratio of transaction continuation	+	Not significant	Not significant	+	+	+
Ratio of new transaction partnerships	+	+	+	+	+	+
Number of samples	682,391	19,358	46,468	115,032	288,006	213,527

1% significance level

Coefficient ratio relative to all-age figure: 2– | 1.5–2 | 1–1.5 | –1

study examined changes that have occurred to them over the last 10 years, and found rapid progression of aging among firms. As shown in the figure, the firm population pyramid, showing the distribution of firms according to their age, has a peak similar to the Baby Boomer peak in the normal population pyramid, shifting toward the high age category in the next 10 years. This study has confirmed that the relationship between inter-firm networks and firm growth varies according to firm age. That means that, when firm aging progresses, policy intervention must be adjusted accordingly. It is naturally important to implement policies that encourage firm metabolism to halt firm aging, but it is even more important to accept the current trend of firm aging and adopt policies that encourage firm growth in the given context.

When research advances in the future to identify what kind of partnership building will lead to firm growth, we might be able to say that firms should adopt a different type of partnership building according to their age. Then, the Small and Medium Enterprise Agency, for example, could launch a website as part of its policy to offer business matching, referring suitable potential transaction partners to firms. Yet, there has not been much research progress in this area due to the difficulty in verifying connections between individual firms from a business matching perspective. It is difficult to examine their compatibility as transaction partners for both sides of business matching. This is a research task for the future.

Figure: Firm Age Distribution

Future initiatives

- Finally, can you tell us about your future research?

This research was a fact-finding study on how inter-firm networks develop through the firm lifecycle, and how such networks relate to firm growth. However, no consideration was given to firms' market entry and exit in their firm lifecycle. In the future, I would like to encompass firms entering and exiting business in my study. Yet, there is still room for further deepening research on the relationship between firm age and firm growth. In addition to the perspective of what kind of business partnerships firms should be connected to, as explained earlier, we must examine, in greater detail, the perspective of building new business partnerships and deepening closer ties with existing business partners. In fact, there is data from Belgium that is actually for calculating value-added taxes, but encompasses transaction volumes of all firms broken down by business partners. This allows us to identify how firms deepen their ties with existing business partners. I wish there was such data for Japan, but that is unfortunately not the case. While it may be difficult to identify the depth of individual transactions, data such as sales value, number of customers, purchase value, and number of suppliers can be used to estimate the average depth of such transactions. I would like to examine the advantages and disadvantages of finding new business partners and continuing (deepening) transactions with existing business partners.

Furthermore, the results of this fact-finding study will be used to draw up a logical framework to deepen the understanding over individual facts. With the relationship between firm growth, inter-firm networks and firm age are beginning to be clarified, I am currently working with my joint researchers, Dr. Senga and Dr. Fujii, who specialize in theoretical research, to build a theoretical model on this matter. In considering networks, I wish to build a model that allows us to examine network stability, as studied in this research, as well as desirable business partners to network with, development of new transaction partnerships and deepening of relations with existing business partners.

The structure for building the theoretical model is already prepared. Dr. Senga studies firm dynamic model theory and simulation analysis. Incorporating the network variables, observed in this study, enables the simulation of firm growth. This not only enables gauging macroeconomic effects, but also facilitates policy simulation. Having already worked with Dr. Senga in the K supercomputer project, I have high expectations for the collaboration, which will enable various policy assessments.

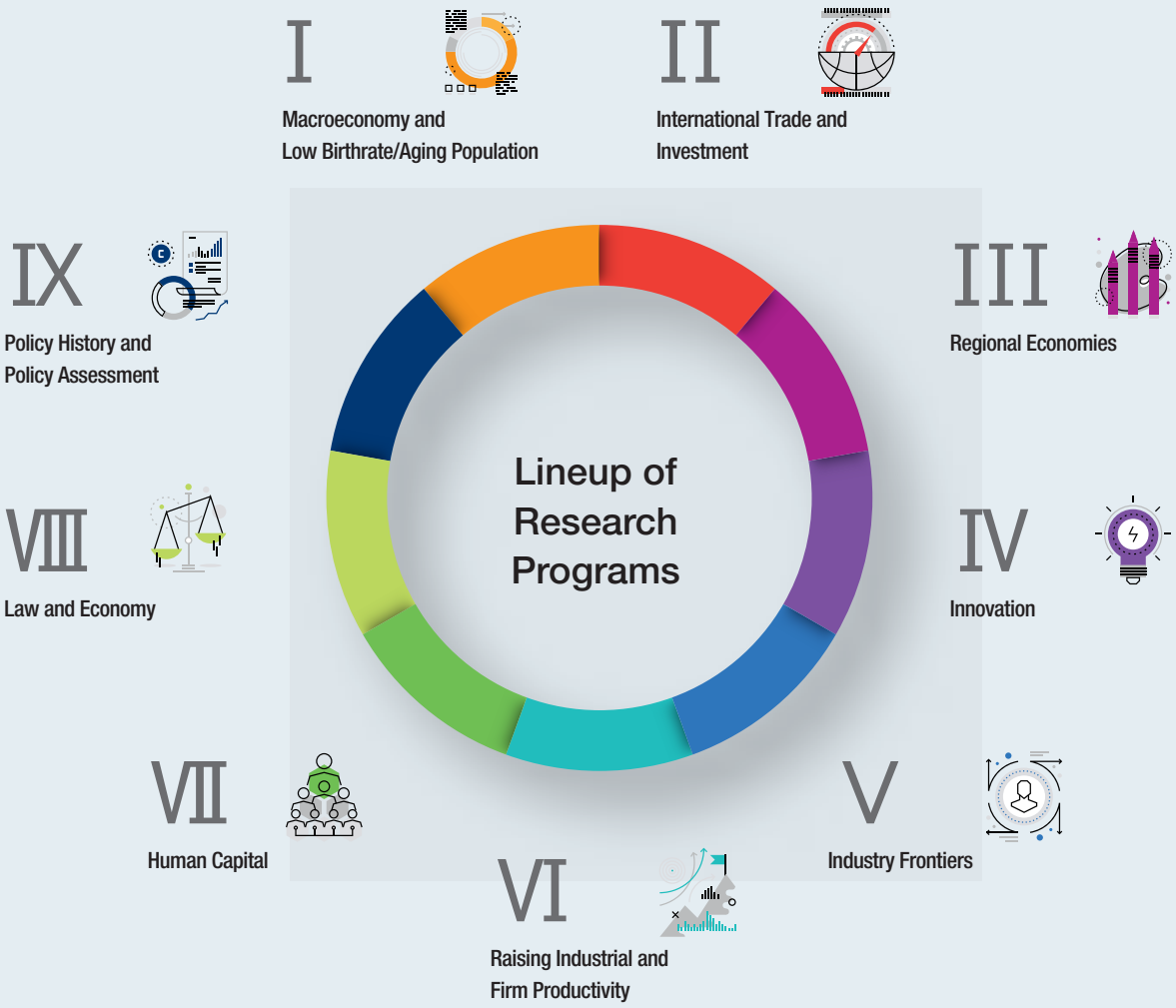
Dr. Fujii studies theories that explicitly incorporate networks within the framework of economic models. Many network analyses in the economics field only deal with local networks (around individual firms). However, our project on seismic disaster propagation and Dr. Fujii's research can encompass far-reaching networks as a whole rather than local networks. For example, when examining a firm's growth factors, we can consider the impact of the indirect business partners, such as business partners of the firm's business partners. I would like to use facts obtained in our research in a way that is acceptable in terms of economic theories, so as to build a theoretical model that examines entire networks. By combining empirical research and theoretical research, I hope to achieve research of high added value both in terms of academic value and policy applications.

RIETI's Fourth M

Fiscal 2016 to Fiscal 2019

In the Fourth Medium-term Plan, RIETI has been promoting research activities under three new medium- to long-term perspectives on economic and industrial policies with consideration for related government policies such as the Japan Revitalization Strategy and the Medium- to Long-Term and Structural Points and the Future Direction of Economic and Industrial Policies (April 2015, Industrial Structure Council).

Research themes under the Fourth Medium-term Plan invariably set these perspectives as basic principles, and we have put in place nine programs covering policy research areas consisting of similar individual research topics. Leading experts in respective fields serve as program directors and supervise multiple projects conducted by fellows under the program. If necessary, these programs will be changed or added to respond to needs for new research depending on the progress and the changes in economic situations.



edium-term Plan

Three Medium- to Long-term Perspectives on Economic and Industrial Policies

1 Cultivating Japan's strength in the world economy

2 Making Japan into an innovative nation

3 Overcoming population decline

Research Process

To further improve the quality of research, RIETI ensures that discussions are organized for each research project through brainstorming workshops and discussion paper (DP)/policy discussion paper (PDP) seminars, in which Japanese and foreign experts and policymakers participate to deepen the research.

Brainstorming Workshops
Launching of a new research project

Discussion Paper and Policy Discussion Paper Seminars
Deepening the analysis of individual papers

Symposiums, Workshops, Seminars, Publication of DPs and PDPs, Book Publication
Dissemination of research findings

Introduction of the Nine Research Programs

Program I Macroeconomy and Low Birthrate/Aging Population

Program Director: Keiichiro Kobayashi
Faculty Fellow, RIETI
Professor, Faculty of Economics, Keio University
Research Director, Canon Institute for Global Studies

Maintaining long-term growth has been a challenge for economies around the world, and Japan is facing a rapidly aging population ahead of that of other nations. We will conduct research that contributes to policies to maintain Japan's economic vitality as well as to the development of the global economy. Specifically, we will consider system infrastructure, such as the role of Asian currency baskets, and analyze trends in international finance and the global economy, and long-term deflation mechanisms, etc. Furthermore, we will conduct multifaceted and integrated research on the analysis of comprehensive panel data on the elderly, direction of the comprehensive reform of the social security and taxation systems, policy proposals for economic recovery, fiscal consolidation, etc.

Program II International Trade and Investment

Program Director: Eiichi Tomiura
Faculty Fellow, RIETI
Professor, Faculty of Economics, Hitotsubashi University

When considering Japan's economic policies in the midst of globalization, an understanding of international trade and foreign direct investment is even more important now than in the past. This program, focusing on the globalization of firm activities (i.e., exports and overseas production), will study the international trading networks of firms from theoretical and empirical perspectives, while also studying trade policies and international trade and investment rules from empirical and legal perspectives.

Program III Regional Economies

Program Director: Nobuaki Hamaguchi
Faculty Fellow, RIETI
Professor, Research Institute for Economics and Business Administration (RIEB), Kobe University

This program will study the effect of international trade, movement of capital and labor, and changes in technology on urban and rural areas and industries, while viewing the regions of Japan in the context of the global economy and using this to develop proposals, etc. on such important policy issues as the aging population and regional revitalization. Specifically, we will consider policies to promote the features of export industries in regional areas and regional economic circulation, strengthen functions of regional financial institutions, create social institutions that utilize cutting-edge information technology and transport infrastructure, and utilize and strengthen international production networks (value chains), as well as create statistical indicators that conform with the structure of economic spaces, form policymaking frameworks, etc.

Active Projects

Fiscal and Social Security Policy under a Low Birth Rate and Aging Demographics
Project Leader: Sagiri Kitao (Faculty Fellow)

Monetary and Fiscal Policy in the Low Growth Era
Project Leader: Ippei Fujiwara (Faculty Fellow)

Exchange Rates and International Currency
Project Leader: Eiji Ogawa (Faculty Fellow)

Economic Analysis of the Development of the Nursing Care Industry in China and Japan
Project Leader: Ting Yin (Fellow)

Exploring Inhibition of Medical Expenditure Expansion and Health-oriented Business Management Based on Evidence-based Medicine
Project Leader: Kazumitsu Nawata (Faculty Fellow)

Microeconomics, Macroeconomics, and Political Philosophy toward Economic Growth
Project Leader: Keiichiro Kobayashi (Faculty Fellow)

Active Projects

Studies on Firm Management and Internationalization under the Growing Fluidity of the Japanese Economy
Project Leader: Hongyong Zhang (Fellow)

Empirical Analysis of Corporate Global Activities in the Digital Economy
Project Leader: Eiichi Tomiura (Faculty Fellow)

Research on Global Inter-firm Networks and Related Policies
Project Leader: Yasuyuki Todo (Faculty Fellow)

A Study of the Effects of Trade Policy: A microdata analysis of Japan from the 1990s to 2010s
Project Leader: Shujiro Urata (Faculty Fellow)

Analyses of Offshoring
Project Leader: Jota Ishikawa (Faculty Fellow)

Comprehensive Research on the Current International Trade/Investment System (pt. IV)
Project Leader: Tsuyoshi Kawase (Faculty Fellow)

Active Projects

Dynamics of Inter-organizational Network and Geography
Project Leader: Yukiko Saito (Senior Fellow)

An Empirical Framework for Studying Spatial Patterns and Causal Relationships of Economic Agglomeration
Project Leader: Tomoya Mori (Faculty Fellow)

Economic Analysis of Property and Reform Proposal
Project Leader: Motohiro Sato (Faculty Fellow)

An Empirical Study on Compact City: Evaluating place-based policies in Japan
Project Leader: Keisuke Kondo (Fellow)

Spatial Economic Analysis on Intracity Economic Activities and Interregional Economic Activities
Project Leader: Takatoshi Tabuchi (Faculty Fellow)

Innovation Enhancing Regional Economic Structure and Evolution of Cities
Project Leader: Ryohei Nakamura (Faculty Fellow)

Stable Development of Regional Economies under a Declining Population
Project Leader: Nobuaki Hamaguchi (Faculty Fellow)

The Role of Regional Financial Institutions as the Core of the Local Economy and Regional Cooperation
Project Leader: Nobuyoshi Yamori (Faculty Fellow)

Program IV Innovation

Program Director: Sadao Nagaoka
Faculty Fellow, RIETI
Professor, Tokyo Keizai University

The creation of new knowledge and its exploitation to resolve problems which we face is the main source of innovation. This program will develop original data to understand the innovation processes, and will conduct research from an international perspective, so as to contribute to evidence-based policy formation. Specifically, the program will analyze the innovation capabilities of industries, the economic impact of artificial intelligence, intellectual property systems, open innovation, knowledge transfer and the mobility of human resources across organizations, university-industry cooperation, technical standards, and business and industrial organizations that promote innovation.

Program V Industry Frontiers

Program Director: Hiroshi Ohashi
Faculty Fellow, RIETI
Professor, Faculty of Economics, The University of Tokyo

Through innovation in the key technological areas of sophistication of data processing and evolution of telecommunication networks, signs of changes in the industrial structure have begun to be seen in Japan as well as in other leading nations. Via the Internet of Things (IoT) using sensor technology, large quantities of unstructured data have now become accessible, and artificial intelligence (AI) technology is being gradually put into practical use. In Japan, new industrial frontiers are opening. As such, this program will venture on research as to how policies should be instituted to overcome the challenges facing the Japanese economy, taking cross-industry policies into perspective, in addition to conventional policies intended for individual industries.

Program VI Raising Industrial and Firm Productivity

Program Director: Kyoji Fukao
Faculty Fellow, RIETI
Professor, Institute of Economic Research, Hitotsubashi University

The aim of this program is to measure industry- and firm-level productivity and its determinants for Japan and other East Asian countries and to conduct research on policies aimed at raising productivity. At the industry level, in addition to updating and expanding the Japan Industrial Productivity (JIP) and China Industrial Productivity (CIP) databases in collaboration with Hitotsubashi University, we will construct an industrial productivity database by prefecture for Japan and examine the total factor productivity (TFP) disparity between regions and the factors behind it, etc. At the firm or establishment level, employing micro-data from government statistics and corporate financial data in Japan and abroad, we will research the following: determinants of productivity gaps among firms; the impact of globalization and changes in demand affect corporate performance; policies for raising productivity in the service sector; productivity gaps between firms in Japan, China, and Korea; and international comparison of productivity dynamics. We will also measure investment in intangible assets such as research and development, software, in-house training, and organizational structure, all of which are important sources of innovation and productivity growth at both industry and firm levels, and examine the economic effects of such investments.

Active Projects

Productivity Revolution through IoT
Project Leader: Koichi Iwamoto (Senior Fellow)

Empirical Study on the Management and Utilization of Data Generated from Industry
Project Leader: Toshiya Watanabe (Faculty Fellow)

Empirical Analysis of Innovation Ecosystems in Advancement of the Internet of Things (IoT)
Project Leader: Kazuyuki Motohashi (Faculty Fellow)

Frontiers of Innovation Policy: Evidence from micro data
Project Leader: Sadao Nagaoka (Faculty Fellow)

Creation and Development of High-tech Startups
Project Leader: Yuji Honjo (Faculty Fellow)

Active Projects

Large-scale Simulation and Analysis of Economic Network for Macro Prudential Policy
Project Leader: Hideaki Aoyama (Faculty Fellow)

Economic and Financial Analysis of Commodity Markets
Project Leader: Kazuhiko Ohashi (Faculty Fellow)

Heterogeneity across Agents and Economic Growth
Project Leader: Hiroshi Yoshikawa (Faculty Fellow)

Study Group on Corporate Finance and Firm Dynamics
Project Leader: Iichiro Uesugi (Faculty Fellow)

Development of New Indicators for Service Sector Analysis and EBPM
Project Leader: Yoko Konishi (Senior Fellow)

Globalization, Innovation, and Competition Policy
Project Leader: Noboru Kawahama (Faculty Fellow)

Policy Analyses on Industrial Organization
Project Leader: Hiroshi Ohashi (Faculty Fellow)

Productivity Gaps and Industrial Competitiveness
Project Leader: Koji Nomura (Faculty Fellow)

Active Projects

East Asian Industrial Productivity
Project Leader: Kyoji Fukao (Faculty Fellow)

Microeconometric Analysis of Firm and Industry Growth
Project Leader: Kaoru Hosono (Faculty Fellow)

Analysis of the Regional-Level Industrial Productivity and Regional Production Networks
Project Leader: Joji Tokui (Faculty Fellow)

Research on the Improvement in Resource Allocation and Productivity among the Healthcare and Education Service Industries
Project Leader: Tomohiko Inui (Faculty Fellow)

Research on Productivity-improving Capital Investment
Project Leader: Tsutomu Miyagawa (Faculty Fellow)

Program VII Human Capital

Program Director: Kotaro Tsuru
Faculty Fellow, RIETI
Professor, Graduate School of Business & Commerce, Keio University

For Japan, a nation with scarce resources, to maintain and strengthen economic vitality and innovation and increase its growth potential by using its advantages amid a declining population resulting from a rapidly aging society and intensifying global competition among other factors, a significant key is how to utilize its human resources. We will conduct multifaceted, comprehensive research on ideal labor market systems to increase worker incentive and capability; reconstruction of employment institutions and systems from a full life-cycle perspective from early childhood education through higher education; human resources development in employment years; and utilization of elderly as human resources as well as from the perspective of promoting diversity including increased women's participation.

Program VIII Law and Economy

Acting Program Director: Makoto Yano
President and Chief Research Officer, RIETI
Professor, Institute of Economic Research, Kyoto University

Technological innovation is expected to accelerate in many fields such as financial services, information/communications, and life sciences. In such an environment, what can a nation do to build an economy that leads the world in innovation? Many cases have been observed that important innovation is born in a market in which free entry and free enterprise are guaranteed. In order to foster such a market, various rules and institutional arrangements need to be built into the economy. From this viewpoint, in the present program, the design of new types of economic and industrial policies is investigated.

Program IX Policy History and Policy Assessment

Program Director: Haruhito Takeda
Faculty Fellow, RIETI
Professor Emeritus, The University of Tokyo

This program aims to review and assess policy shifts, chiefly during the period 1980–2000, as we look at the roles played by Japan's economy and society as well as its trade and economic industrial policies at the end of the 20th century. While the final two decades of the 20th century were a time of significant changes in Japan's economy and society, they also represent an important point of comparison when considering the development of policy after the creation of the Ministry of Economy, Trade and Industry from a historical perspective. We will attempt to clarify how changes in trade and industrial policy at the turn of the century were affected, based on the recognition of policy issues over the preceding quarter-century, choice of policy responses, and evaluation on their results.

Active Projects

Reform of Labor Market Institutions
Project Leader: Kotaro Tsuru (Faculty Fellow)

Change in the Utilization of and Investment in Human Resources
Project Leader: Yoshio Higuchi (Faculty Fellow)

Research on Working Style Reform and Health Management
Project Leader: Isamu Yamamoto (Faculty Fellow)

Employment System Reform to Use Human Resources More Efficiently
Project Leader: Hideo Owan (Faculty Fellow)

Fundamental Research for Economic Growth and Productivity Improvement in Japan
Project Leader: Kazuo Nishimura (Faculty Fellow)

Active Projects

Intellectual Property and Standardization—Strategy and Policy
Project Leader: Masabumi Suzuki (Faculty Fellow)

Frontiers in Corporate Governance Analysis
Project Leader: Hideaki Miyajima (Faculty Fellow)

Active Projects

Historical Evaluation of Industrial Policy (H28FY)
Project Leader: Tetsuji Okazaki (Faculty Fellow)

Historical Study on Industrial Policy
Project Leader: Haruhito Takeda (Faculty Fellow)

Promoting Evidence-based Policy in Japan
Project Leader: Kazuo Yamaguchi (Visiting Fellow)

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