

DISCUSSION GUIDE FOR “JAPAN’S EMERGENCE AS AN INNOVATING ECONOMY”

A DISCUSSION WITH PROFESSOR LEE BRANSTETTER

- Organizing Questions
- What is an “innovating economy”?
 - How and when did Japan emerge as an innovating economy?
 - What was the significance of Japan’s high tech industry on a global scale?
 - What was the role (if any) of industrial policy in Japan’s emergence as an innovating economy?

Introduction While growth across the industrial world was slowing down in the 1970s, the Japanese economy shifted its focus from light manufacturing and materials-intensive heavy industries to research and development (R&D)-intensive and skill-intensive manufacturing industries, and as a result, emerged as a serious competitor in high technology industries by the end of the decade. Especially in the semiconductor industry, Japanese firms began to very rapidly displace some of the best Silicon Valley firms of that era, to the point that by the mid-1980s, U.S. firms lived in fear of being out-innovated by the Japanese. This lesson discusses the causes of such rapid industrial growth, and in particular, the role of industrial policy in Japan’s emergence as a high tech manufacturing power.

- Objectives In this lesson, students will:
- gain an understanding of Japan’s move from being a fairly low tech manufacturing power to a very high tech manufacturing power;
 - gain a broad understanding of the role of industrial policy in Japan during the 1970s and 1980s;
 - gain an ability to research and interpret online reading materials and create a presentation based on this information;
 - gain an understanding of the potential causes of Japan’s emergence as a high tech manufacturing power; and
 - practice the ability to absorb and process readings and a scholarly lecture, and draw upon this information to answer and discuss questions.

Materials Video Lecture, “*Japan’s Emergence as an Innovating Economy*,” online at <http://spice.fsi.stanford.edu/multimedia/japans-emergence-innovating-economy>

Handout 1, *Video Lecture Prompts*, 30 copies

Handout 2, *Innovating Economies Activity*, four copies

Answer Key, *Video Lecture Prompts*

Teacher Information 1, *Assessment Criteria for Activity*

Teacher Information 2, *Video Lecture Transcript*

| | |
|---------------------|--|
| Equipment | Computer with Internet access and a Flash-enabled or HTML5-supported web browser Computer projector and screen Computer speakers |
| Teacher Preparation | Instructions and materials are based on a class size of 30 students. Adjust accordingly for different class sizes. <ol style="list-style-type: none">1. Make the appropriate number of copies of handouts.2. View Video Lecture, “<i>Japan’s Emergence as an Innovating Economy</i>,” by Lee Branstetter.3. Become familiar with the content of handouts, answer key, and teacher information.4. Set up and test computer, projector, speakers, and streaming video lecture. Confirm that you are able to play the video lecture and project sound audibly to students. |
| Time | One 50-minute class period |
| Procedures | <ol style="list-style-type: none">1. Explain to students that they will learn about Japan’s emergence as an innovating economy in the 1970s and 1980s, the role of industrial policy during this time, and Japan’s role in the global technology sector. “Innovating economy” is a term used to describe an economic structure that emphasizes entrepreneurship, innovation, and technology, where higher productivity and growth is driven by innovation, rather than capital accumulation. During the 1970s and 1980s, Japanese firms emerged with some of the world’s most innovative technologies and came to dominate global markets, propelling the Japanese economy into a period of high economic growth.2. Inform students that they will view a lecture by Professor Lee Branstetter, whose field is economics and public policy. Distribute Handout 1, <i>Video Lecture Prompts</i>, to each student. Ask students to read through the questions and defined terms in preparation for the video lecture. Play the video lecture.3. Once the lecture has ended, give students some time to write their answers to the questions, and then discuss the answers as a class. Collect the answers for assessment purposes.4. Inform students that they will be participating in an activity that involves researching current innovating economies.5. Divide students into four groups. Distribute one copy of Handout 2, <i>Innovating Economies Activity</i>, to each group. |

6. Handout 2 asks students to find and conduct research on a local community, town or city, state, or country that is currently considered an innovating economy.
7. Inform students that they will have 30 minutes to research and put together a presentation on the region that they have chosen, which they will then be asked to present in front of the class. Their presentations should consider the following questions:
 - What makes your chosen local community, town or city, state, or country an innovating economy?
 - Give a brief historical overview of your chosen local community, town or city, state, or country. When did it become considered as an innovating economy? What are some of the factors that have enabled the transition to an innovation-based economic structure?
 - How are innovation and economic growth related in your chosen local community, town or city, state, or country?
 - What is/was the role of the government (if any) in your chosen local community, town or city, state, or country's emergence as an innovative economy?
 - How does your chosen local community, town or city, state, or country's economy compare to other economies?
8. Allow each group to present for up to two minutes. Allow for a three- to four-minute Q&A session after each presentation. Other students in the class should ask the presenting group to elaborate on particular points or challenge certain claims. Each group presentation should take five to six minutes in total. Use Teacher Information 1, *Assessment Criteria for Activity*, to assess groups as they present.
9. Pose the following questions to the class as a quick debrief of the lesson:
 - What is innovation, and how does it relate to economic growth?
 - Was there anything you found particularly interesting from either Professor Branstetter's lecture or your research?
 - Are there any topics or issues that you want to learn more about?

Assessment The following are suggestions for assessing student work in this lesson:

1. Evaluate student responses to questions on Handout 1, *Video Lecture Prompts*.
2. Evaluate student presentations from Handout 2, *Innovating Economies Activity*, based on Teacher Information 1, *Assessment Criteria for Activity*.
3. Assess student participation in group and class discussions, evaluating students' ability to:
 - clearly state their opinions, questions and/or answers;
 - provide thoughtful answers;
 - exhibit sensitivity toward different cultures and ideas;

- respect and acknowledge other students' comments; and
 - ask relevant and insightful questions.
4. Assess student preparation and performance in the class activity based on:
- ability to work with peers in small groups;
 - ability to use specific information in making a point; and
 - clarity and effectiveness of argument.

VIDEO LECTURE PROMPTS

Title: Japan's Emergence as an Innovating Economy

Professor Branstetter is a professor of economics and public policy at the Heinz School at Carnegie Mellon University. He is also a research associate of the National Bureau of Economic Research and nonresident senior fellow at the Peterson Institute for International Economics. He has held positions at the Columbia Business School; University of California, Davis; and Dartmouth College, and has served as a consultant to the OECD Science and Technology Directorate, the Advanced Technology Program of the U.S. Department of Security Research Institute, and the World Bank. Professor Branstetter's research interests include the economics of technological innovation, international economics, industrial organization, and economic growth in East Asia, with a particular focus on China and Japan.

Please keep the following questions in mind while you watch the lecture. Answer the questions on a separate sheet of paper after watching the lecture.

1. How would you characterize the industrial world in the 1970s?
2. In what ways did Japan emerge as an "innovating economy"?
3. Thomas Rohlen's study of the Japanese educational system in 1983 showed that because of the longer school year, Japanese students were acquiring four more years of education going through their K–12 system than their American peers. He showed that as a result, Japanese students were dramatically outscoring their European and American peers on tests of mathematics and science, and the average Japanese high school graduate in the 1980s probably had the same level of basic knowledge as the American college graduate. What argument does Professor Branstetter make by citing Thomas Rohlen's study?
4. What was the role of industrial policy in Japan's rapid growth and emergence as a high tech competitor, according to Professor Branstetter?
5. Describe the relationship between Silicon Valley and Japan during this time. Then, speculate on how you think this relationship has evolved, and what you think it looks like today.

Defined terms:

Innovating economy—an economic structure that emphasizes entrepreneurship, innovation and technology. Higher productivity and growth is driven by innovation, rather than capital accumulation.

R&D—an abbreviation for "Research and Development," refers to the investigative activities a business conducts to improve existing products and procedures or to lead to the development of new products and procedures

manufacturing industry—the production of merchandise, in which raw materials are transformed into finished goods on a large scale

patent—a government authority or license bestowing the sole right to exclude others from making, using, or selling an invention

semiconductor—a substance that can conduct electricity under certain conditions, making it a good medium for the control of electric current. When we talk about the semiconductor industry, we are usually referring to markets like PCs, mobile phones, and other electronic consumer devices.

market share—the portion of the market controlled by a particular company or product

Ministry of International Trade and Industry—or MITI, was one of the most powerful agencies of the Japanese government at one point, and effectively ran much of Japanese industrial policy, funding research and directing investment. In 2001 its role was taken over by the newly created Ministry of Economy, Trade and Industry (METI).

infant industry—a new industry, which in its early stages experiences relative difficulty or is absolutely incapable in competing with established competitors abroad

import protection—the restriction of imports by means of tariffs, that is intended to insulate domestic producers from competition with imported goods

entrepreneur—a person who starts a business

tariff— a tax that a government collects on goods coming in from another country; also referred to as a duty or custom

import quota—a type of trade restriction that sets a limit on the quantity of a good that can be imported into a country in a given amount of time

protectionism—the theory or practice of shielding a country's domestic industries from foreign competition by taxing imports

subsidy—a sum of money granted by the government or public body to assist an industry or business so that the price of a commodity or service remains low

technology spillover—situation in which firms can acquire information created by others without having to pay for that information, and the creators of the information have no legal right to prohibit other firms utilizing the information

diminishing returns—a point at which the level of profits or benefits gained is less the amount of money or energy invested

consortium—an association

INNOVATING ECONOMIES ACTIVITY

Background

An innovating economy describes an economic structure that emphasizes entrepreneurship, innovation, and technology, where higher productivity and growth is driven by innovation rather than capital accumulation.

In the 1970s, Japanese firms began to succeed in R&D and skill intensive manufacturing industries and started to register a large number of patents. Japanese consumer electronics firms (and automakers) were producing some of the world's most innovative technologies, and their success gave Japan recognition as a major high tech competitor in the global tech sector. Japan's emergence as an innovating economy during this time had the rest of the world scrambling to keep from being out-innovated by the Japanese.

Activity

What are some of the most innovative economies and regions in the world today? In this exercise, you will research and share what you learn about one of these areas. Work as a group to 1) pick a local community, town or city, state, or country that is considered an innovating economy; and 2) create a two-minute presentation based on the given questions below.

Some tips when picking an innovating economy:

- You may choose a local community, town or city, state, or country
- Look for economies with a highly developed high tech sector
- Look for economies with high productivity growth
- Try to pick a region that you do not know well

Please consider the following questions as you research and prepare your presentation:

- What makes your chosen local community, town or city, state, or country an innovating economy?
- Give a brief historical overview of your chosen local community, town or city, state, or country. When did it become considered as an innovating economy? What are some of the factors that have enabled its transition to an innovation-based economic structure?
- How are innovation and economic growth related in your chosen local community, town or city, state, or country?
- What is/was the role of the government (if any) in your chosen local community, town or city, state, or country's emergence as an innovative economy?
- How does your chosen local community, town or city, state, or country's economy compare to other economies?

At the end of your presentation there will be a three- to- four-minute Q&A session in which you should be prepared to clarify and elaborate on any claims that you have made.

VIDEO LECTURE PROMPTS

1. How would you characterize the industrial world in the 1970s?

Following the oil embargo in 1973 against Canada, Japan, the Netherlands, the United Kingdom, and the United States, growth in the entire industrial world slowed down. Oil prices were high, inflation was rising, industrial economies were slowing down, and their industrial structures were changing. The oil embargo affected Japan's economy greatly due to its high reliance on oil. During this time, Japan's economy shifted away from oil-intensive industries to the development of industries like electronics. Japan's automotive industry also benefited from this crisis, as the increase in fuel costs put large, gas-guzzling models out of favor and increased the demand for small, fuel-efficient Japanese models.

2. In what ways did Japan emerge as an “innovating economy”?

During this time, the Japanese economy shifted away from light manufacturing and materials intensive heavy industries to R&D intensive and skill intensive manufacturing industries. R&D spending and the patenting of Japanese firms began to surge. By the end of the 70s, Japan had emerged as a serious global competitor in R&D-intensive industries, especially in the semiconductors industry. Japanese firms ended the 70s with roughly 25% global market share in memory chips. By the mid-80s, their market share was about 65% and they were rapidly displacing some of the biggest Silicon Valley firms of this era. Japanese companies such as Toshiba, Sony, and Sharp were emerging with some of the most innovative technology in the world, and as a result, experienced very rapid economic growth.

3. Thomas Rohlen's study of the Japanese educational system in 1983 showed that because of the longer school year, Japanese students were acquiring four more years of education going through their K-12 system than their American peers. He showed that as a result, Japanese students were dramatically outscoring their European and American peers on tests of mathematics and science, and the average Japanese high school graduate in the 1980s probably had the same level of basic knowledge as the American college graduate. What argument does Professor Branstetter make by citing Thomas Rohlen's study?

Thomas Rohlen showed that in addition to the longer school year and high test scores, in the 1980s, Japan was graduating more than twice as many engineers per capita as the United States, ordinary workers had high levels of competence in science and math, and four times as many Japanese students were choosing engineering-related subjects as American undergraduates. Professor Branstetter uses Rohlen's study to support the argument that there was phenomenal human capital accumulation in Japan at this time, which laid a strong foundation for the nation's movement into high technology industries and into innovation.

4. What was the role of industrial policy in Japan's rapid growth and emergence as a high tech competitor, according to Professor Branstetter?

Professor Branstetter argues that industrial policy does not explain the rapid growth of Japan's economy in the 1970s and 1980s. He makes this argument by going back to historical records and looking at import tariffs and import quotas. These show that in the early 1960s, Japan's import tariffs on automobiles were particularly high. However, external pressure forced the Japanese government to lower its import tariffs and nontariff barriers to imports of manufactured goods by the early 1970s, long before Japanese cars started to dominate global markets. Japan's real technological advances came after import tariffs were

already low. He also argues that the industries that received the most government funding at this time were uncompetitive industries like mining and agriculture, while the industries that emerged as global competitors like automobiles, and electrical machinery, paid more to the government in taxes than they received in subsidies, low-cost loans, or other forms of funding.

5. Describe the relationship between Silicon Valley and Japan during this time. Then, speculate on how you think this relationship has evolved, and what you think it looks like today.

Japan and Silicon Valley have historically had a competitive relationship. In the early 1980s, the U.S. economy was in a deep recession. At precisely the same time, Japanese firms began to displace several Silicon Valley firms in industries that the United States had long dominated, such as autos and auto parts, electronics and industrial machinery, and especially semiconductors. Many U.S. firms in these industries were forced to close or remake themselves. Silicon Valley firms were seen as being no match for the resources of large Japanese companies. As a result, Silicon Valley shifted its focus to information technology and design, laying the groundwork for the economic resurgence of the region in the 1990s and the 2000s.

As of the mid-2010s, Japan continues to maintain an image of being technologically advanced, but Japanese products and services no longer dominate high tech industries. Japanese consumer electronic products (radios, television, computers, phones, digital cameras, DVD players, etc.) are popular, but are no longer the undisputed leaders in their product line. Most crucially, Japan is not considered a leader in information technology (IT), which increasingly forms the basis of innovation in every industry. Silicon Valley (and the United States more broadly) is considered the world's center of innovation due to its high capabilities in IT. To stay competitive in a world where IT is of increasing salience, Japan is now figuring out ways to work with and learn from Silicon Valley. This spirit of collaboration marks the current relationship between Japan and Silicon Valley.

ASSESSMENT CRITERIA FOR ACTIVITY

| Scoring Criteria | Score and Notes | Score Descriptions |
|--|-----------------|--|
| <p>Organization and Clarity: The presentation is clearly outlined and responses directly address all questions.</p> | | <p>1—Unclear in most parts, missing most of the required components 2—Clear in some parts but not overall, missing some of the required components 3—Mostly clear and orderly in all parts 4—Completely clear and orderly presentation, covers all required components</p> |
| <p>Presentation Style: Tone of voice, use of gestures, and level of enthusiasm are convincing to audience.</p> | | <p>1—Few style features were used, and none were convincing 2—Few style features were used convincingly 3—All style features were used, most convincingly 4—All style features were used convincingly</p> |
| <p>Use of Facts: Facts are given to support claims.</p> | | <p>1—Few or no relevant supporting facts 2—Some relevant facts given 3—Many facts given, most relevant 4—Many relevant supporting facts given</p> |
| <p>Group Cohesiveness: All members of the group contribute during discussion, and the presentation represents the work of the entire group.</p> | | <p>1—Few members contribute to group discussion and presentation 2—Some members contribute to group discussion and presentation 3—Most members contribute to group discussion and presentation 4—All members contribute to group discussion and presentation</p> |

VIDEO LECTURE TRANSCRIPT

Lee Branstetter

Professor of Economics and Public Policy, Carnegie Mellon University

The Japanese economy slowed down in terms of its growth rate in the 1970s. The entire industrial world slowed down. These were turbulent times. Oil prices were shooting up through the roof, inflation was rising more generally, industrial economies were slowing down, their industrial structures were changing, but the Japanese economy continued to grow faster than all of the other advanced industrial economies. Everybody was growing more slowly, but Japan continued to outperform.

And the other thing that was happening inside the Japanese economy was that the sources of that growth were changing. Light manufacturing and materials intensive heavy industries were growing much more slowly. R&D intensive and skill intensive manufacturing industries were growing much more rapidly. And the research and development spending and the patenting of Japanese firms began to surge and by the end of the 70s, Japanese firms had very quickly emerged as serious competitors in high technology industries U.S. firms had long dominated, including autos and auto parts, electronics and in industrial machinery.

In semiconductors, Japanese firms emerged as particularly important competitors. Japanese firms ended the 70s with a roughly 25% global market share in memory chips. By the mid-1980s their market share was about 65%, so very rapidly over the course of the 1980s they were displacing some of the best and brightest Silicon Valley firms of that era. They were starting to dominate an industry that had literally been invented in the United States, mostly here in Silicon Valley.

By the mid-1980s the titans of Silicon Valley, many of them anyway, were living in mortal fear of being out-innovated by the Japanese. Now as this emerged there was a group of scholars that sought to explain the seemingly rapid and seemingly surprising emergence of Japanese firms as high technology competitors by pointing to the role of government policy, and in particular they were pointing to the industrial policies that had been implemented by what was then known as the Ministry of International Trade and Industry. These policy interventions, it was suggested, were really the things that caused Japan to move from being a fairly low tech manufacturing power to a fairly high tech or a very high tech manufacturing power. And a number of these books—*Japan As Number One* by Ezra Vogel, *MITI and the Japanese Miracle* by Chalmers Johnson, *Trading Places* by Clyde Prestowitz—became bestsellers and catapulted their authors to academic celebrity.

Now in many cases what these experts were advocating was an old idea: infant industry policies. Alexander Hamilton, the most famous founding father today thanks to the Broadway musical, actually suggested that the United States engage in a policy of deliberately protecting its infant manufacturing firms from foreign competition in order to develop an indigenous manufacturing industry in the United States. And the great classical political economist John Stuart Mill gave this idea his blessing in his very important economic writing in the early 19th century.

The basic idea is that a government offers temporary import protection to local entrepreneurs in an industry the government wants to develop because it believes that this industry is well-suited

to the characteristics of the country – it's just that there are other producers elsewhere in the world that have gotten a head start and make it very difficult for local firms to get into the game without a little bit of help from the local government. So protect the domestic market, at least a little bit, from foreign goods and perhaps offer some low-cost financing for a period of time to help these local producers get off the ground. And if this experiment is successful then within a few years this infant industry will have grown up, it will be competitive, you can remove the subsidies, you can remove the tariffs or import quotas that are protecting these local firms from foreign competition, and they will thrive and they will compete and they will be an economic asset for the nation.

In the 1980s, mainstream trade theorists begin to construct trade models with what are now called technological externalities, basically features of the model that can make industrial policy actually quite effective in theory, and in fact the creators of these models—people like Paul Krugman who eventually won the Nobel Prize for this work, Jean Grossman of Princeton, Elhanan Helpman now of Harvard, Jim Brander and Barbara Spencer of the University of British Columbia—they were all responding to what seemed to be happening in Japan. They might not admit this today, but they were actually reacting to the stories that people like Ezra Vogel and Chalmers Johnson and Clyde Prestowitz were telling. And these new models that were created seemed to offer quite sophisticated arguments in favor of Japan-style industrial policy.

Now the models were quite technically sophisticated, mathematically dense, but the basic idea can be illustrated in this series of figures. In these models there were firms, they were very stylized firms but they were firms, and they were creating economically useful new technology and as they did so they were drawing on two different inputs. The firms were drawing on their own R&D spending, of course, but they were also drawing on a general stock of knowledge, the state-of-the-art, the technological knowledge that would be common to engineers and technologists in that industry. Now if they were successful in creating economically useful new technology, then they would be generating two kinds of outputs. Now one would be the new product or service in which the new technology was embodied, and they can make a profit selling that new product or service, but over time the new technology embodied in that new product or service would eventually be reverse engineered by other engineers working for other firms in that industry, would eventually become an addition to the general stock of knowledge upon which this firm and other firms could build.

That was a technology spillover, and that technology spillover was very important in these models. What it meant was that over time the stock of general knowledge upon which inventors built got higher and broader. So at the firm level, firms could combine a steady level of own R&D expenditure with a steadily expanding stock of general knowledge that made their own R&D investment more valuable because it could be combined with this ever larger pool of general knowledge. Because of that, diminishing returns to R&D never sets in at the firm level, the stock of general knowledge grows over time with outbound, and innovation driven growth can continue in the economy forever.

But maybe not at the same rate for all countries. It's logical to think that within a country firms can easily meet, they can observe what they're doing, they can interact at conferences, and this knowledge flows pretty easily across firms within a country. But if you've got two groups of firms and they are separated by the Pacific Ocean and they exist in different countries and they speak different languages and there's not a lot of employee transfer across that ocean, then it's possible to imagine that there's not one but two or many different stocks of general knowledge and firms have very good access to the stock of general knowledge that exists in their own

country and it's actually pretty hard for them to access the stock of general knowledge that exists abroad.

Now if you've got this fragmentation of the global knowledge stock into different national bits, then that actually creates the possibility for industrial policy to be very powerful. What if you've got a temporary subsidy, let's say, that encourages firms in your country to invent and therefore add to the general stock of knowledge that they can draw upon? Well if they invent more quickly for a period of time, then that builds the stock of general knowledge such that it becomes larger, perhaps permanently larger, than the stock of knowledge that this firm's rivals abroad can build upon. So a temporary policy intervention can produce a permanent source of technological advantage. All right, that was the argument that people like Chalmers Johnson and Ezra Vogel were trying to make in words. The great trade economists of the 1980s made this argument very eloquently and with the kinds of mathematical models that economists find convincing.

So if you read the books that are written by Chalmers Johnson and Clyde Prestowitz, you'll see a lot of frustration in those books directed towards economists. Economists are portrayed as this group of religious zealots that had such an abiding faith in the perfection of the market that they simply can't imagine that government intervention could lead to a better outcome than the market would select, but that's just not right. The most brilliant economists in the country in the 1980s were developing exactly the kinds of economic models in which, in theory, industrial policy intervention of a certain kind could have a permanent impact on comparative advantage. So the question is not can economists conceive of this working in theory, the question is does the economic data support the idea that it worked in practice in Japan. And the answer to that question appears to be no.

So the great thing about trying to assess empirically whether industrial policy worked in Japan or not is in Japan's democracy. Its government keeps good data records, and so you can actually go back to the historical record and you can look at import tariffs and import quotas and how high they were and how they differed across industries. Now the industrial policy argument would tell us that Japan's bureaucrats were very strategic, that they skillfully protected the sectors that later emerged as technological world beaters. But the sequence of events is that you protect first, and the technological capability emerges, and then you lower the barriers as these firms are storming global markets and sweeping all before them.

Well, you know, in the early 1960s Japan was a fairly protectionist country and the evidence indicates that its import tariffs were particularly high in transportation equipment, so cars. But even by the late 1960s, pressure outside Japan had forced the Japanese government to substantially lower its import tariffs and nontariff barriers to imports of manufactured goods. And by the early 1970s, long before Japanese cars were storming global markets and threatening Detroit with bankruptcy, import tariffs in Japan were already very, very low, generally below 10%, and they were quite uniform across sectors. So the historical evidence just really doesn't support the view that import tariffs were what generated this technological advance. The real technological advance emerged after the import tariffs were already low and pretty uniform.

But what about subsidies? So it's true that in the 1950s government affiliated financial institutions in Japan financed a pretty large fraction of the corporate investment, the industrial investment of Japanese firms. But even by the mid-60s, early 70s that fraction had fallen very substantially. As the Japanese economy grew, the importance of government-directed finance shrank very substantially. So government finance was almost completely unimportant as a source of industrial equipment investment long before Japanese firms emerged as technology

leaders in their industries. Again, the data doesn't really support the argument. And finally Kent Calder, who is actually a political scientist, went back to the records on taxes and subsidies and he actually tried to calculate how much financial largesse Japanese industries received from the government versus how much they paid to the government in taxes. And so he sort of calculated the net financial benefit showered on different Japanese industries and he looked at this in the 1950s and he looked at it again in the mid-1980s.

Now the industrial policy argument would tell us that net financial largesse was concentrated in the industries that later became Japan's world beaters – but what the actual data suggest is that the industries that got the financial largesse in Japan were industries like mining and agriculture, industries in which Japan was fundamentally uncompetitive. The industries that emerged as world beaters, like motor vehicles and electrical machinery, consistently and significantly paid more to the government in taxes than they got in subsidies or low-cost loans or other forms of financial largesse.

So again when you actually look at the data, the industrial policy argument—which could work in theory—just doesn't find a lot of empirical support. And the best paper on this is the 1983 article by Gary Saxonhouse. It wasn't actually published until many years later, but in 1983 Gary Saxonhouse, an economist at the University of Michigan, painstakingly deconstructed the argument that industrial targeting was driving Japan's technical advance. I mean he just cites fact after fact and numerical comparison after numerical comparison and when you read that article you just can't help but come to the conclusion that Japanese R&D subsidies were quite modest, especially in comparison to U.S. subsidies of R&D and of high tech industry more generally. You see the significant government aid that Japan provided went to the less competitive, less technologically dynamic industries, and you see that official trade barriers were low and increasingly uniform across products and industries.

If we want to explain Japan's technological surge, we just can't point to industrial policy as the driving factor. Now there was later research that extended this scholarship. Richard Beeson and David Weinstein in the 90s statistically tested the relationship between productivity growth at the industry level and government's industrial policy tools and they found no relationship.

In a series of papers with Mariko Sakakibara, who is now a professor at UCLA, I looked at the industrial policy instrument that is perhaps the one that economists would be most enthusiastic about, the Japanese government bringing Japanese firms together into research consortia, allowing them to collaborate on pre-commercial research and providing financial incentive to do this. If there was any industrial policy instrument that might be precisely targeted in a way that would build technological capability, it would be this. But we did the numbers, we did the math, and at the end of the day we were forced to conclude that while this tool probably did raise innovation in the targeted areas, the effects were very modest. Again if you want to explain the emergence of Japan as an innovating economy, you just can't point to government intervention as the deciding factor.

Stanford researcher Thomas Rohlen made an enormous contribution to our understanding of this question when he published a landmark study of the Japanese educational system in 1983. The book was called *Japan's High Schools*, and it was based in part on field research that Professor Rohlen had done in the 1970s. And he came to a number of conclusions about the economic impact of Japan's educational system that are quite important for answering the question [you] just posed.

Rohlen concluded that because of its longer school year, in the 1980s Japanese students effectively acquired four more years of education going through their K–12 system than their

American counterparts did. And even by the mid-1960s, Japanese students were dramatically outscoring their European and American peers on tests of mathematics and science. And this outperformance existed at all grade levels and in all quantiles of the ability distribution. So their top 10% outscored our top 10%, their next 10% outscored our next 10%, all the way down to the bottom. And this outperformance wasn't trivial. In the mid-60s Japanese students were performing at twice the level on some of these tests as their American counterparts. Rohlen concluded that the average Japanese high school graduate in the 1980s probably had the same level of basic knowledge as the American college graduate. Now let's just pause a minute and let the implications of that sink in.

If you are moving into higher tech industries, if you want to become an innovating nation, there's nothing more important than the basic human capital of your workforce. And what seems evident from Thomas Rohlen's work is that the human capital accumulation in Japan was phenomenal, and by the early 1970s they had laid a very strong foundation for the nation's subsequent movement into high technology industries and into innovation. And Japanese universities were generally not regarded as being as good as American universities—certainly there was no Japanese university that had the cachet and global scientific impact of, say, Stanford—but in the 1980s, Japan was graduating more than twice as many engineers per capita as the United States and its ordinary workers had dramatically higher levels of competence in science and math. And in undergraduate curricula, four times as many Japanese students were choosing engineering-related subjects as American undergraduates were. And you know what's true for Japan is actually true of industrial East Asia more generally. If you compare the skills that students in Taiwan and South Korea acquire in school with the skills of German or American or Indian or Mexican or Brazilian students, the differences are very, very striking.

So in this graph that you can see, Eric Hanushek, who is an economist who works on education and has had an affiliation with Stanford in the past, it shows that in terms of average cognitive ability (that's measured by these blue bars) the Asian economies are real standouts. They just consistently score much higher in terms of average student achievement. The red line tracks the fraction of students that score one standard deviation above the OECD average—so this is looking at how many students are performing at a really outstanding level—and in that regard the Asian countries are even more spectacular in terms of their outperformance. And the performance of Taiwan and South Korea in terms of educating their people relative to the performance of India or Mexico or Brazil or Ghana is really quite breathtaking. I mean if you want to understand why Taiwan and South Korea have become successful high tech economies and Mexico and Brazil have not, surely a very important part of the explanation can be found in the basic human capital foundation that exists in these countries.

Comparisons of test scores suggest that other East Asian countries have done an even better job of educating their students than the Japanese schools did, and Professor Hanushek has actually tested the statistical relationship between human capital formation as measured by these tests and the rate at which different regions or countries around the world converge to the income and output levels per capita of the rich countries. And what he finds is that educational performance explains a lot.

And he's not the only one: there's an Australian economist named John Romalis. In the mid 2000s, he published a study in which he tried to explain the evolution of the export structure of countries around the world by measuring among other things their human capital. And very interestingly, he finds that once you control for the expansion of human capital in industrial East Asia—and other things like the investments they were making in physical capital—you can basically explain the change in their export structure. You can explain their rise as exporters of

teacher information 2

high tech products. To put it another way, there's really nothing left over for industrial policy to explain. I think that's a pretty powerful set of results.