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Innovation and Entrepreneurship in Japan:
Why Japan (Still) Matters for Global Competition

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Abstract

Through the 1980s, Japan was significant in global competition largely by *shaping global technological trajectories*, *transforming major global industries*, and contributing to fundamental *innovations in industrial production processes,* creating enough wealth along the way to propel Japan to the world's second largest economy. After the economic bubble burst in the early 1990s, however, other places such as Silicon Valley in the United States, moved to the forefront of transforming technology, industries, and production, creating vast wealth along the way. While Japan's role in global competition seemingly became largely irrelevant from the 1990s onward, careful analyses reveal that Japan was in fact transforming quietly and gradually, but significantly. In a pattern of "syncretism," Japan's economic transformation was characterized by the coexistence of new, traditional, and hybrid forms of strategy and organization. This paper examines core areas of the "new" and emerging "hybrid" areas—the startup ecosystem and the efforts of select large firms to harness new forms of innovation from outside their corporate borders. Japan's startup ecosystem, though still small compared to Silicon Valley, as is everywhere else, has dramatically transformed over the past twenty years through a combination of regulatory shifts, corporate transformations, and technological breakthroughs that have opened up vast new opportunities. Some large corporations such as Komatsu, Honda, Toyota, and Yamaha are undertaking innovative efforts of sorts unseen in Japan's recent history to harness Silicon Valley and other startup ecosystems into their core business areas.

Introduction

In the 1980s, Japan's surging economy and industrial competitiveness took the world by storm. However, in 1990, after a massive asset bubble burst, Japan's economic growth faltered, and its industrial competitiveness declined sharply. Japan's takeover of the world's manufacturing and software industries, which many had predicted, never materialized. Narratives of "Japan as Number One," or some government-industrial nexus of "Japan, Inc." posing a new model of successful capitalism, or even "Beyond Capitalism" morphed into tales of failure and stagnation.[1] Titles such as "Japan, the System that Soured," "Japan's Financial Crisis: Institutional Rigidity and Reluctant Change," and books with subtitles such as "…the institutional origins of prosperity and stagnation" probed the causes of Japan's spectacular faltering.[2]

Then, by the 2000s, the world economy seemed to have moved on, and Japan was no longer deemed significant. While some firms remained globally competitive, such as Toyota and a handful of precision equipment firms such as Murata Manufacturing, Japan's economic prowess seemed a far cry from the era when its firms dominated critical cutting-edge high-tech industries such as semiconductors.

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[1] Vogel, E. F. (1979). Japan as number one : lessons for America. Cambridge, Mass., Harvard University Press, Sakakibara, E. (1993). Beyond capitalism : the Japanese model of market economics. Lanham, MD, University Press of America.

[2] Katz, R. (1998). Japan, the system that soured : the rise and fall of the Japanese economic miracle. Armonk, NY, M. E. Sharpe, Gao, B. (2001). Japan's economic dilemma : the institutional origins of prosperity and stagnation. Cambridge ; New York, Cambridge University Press, Amyx, J. (2004). Japan's financial crisis : institutional rigidity and reluctant change. Princeton, N.J., Princeton University Press.

Yet, as this paper reveals, while the world's attention was focused elsewhere, most notably the rapid technological sophistication and breakneck growth of China, Japan has actually been developing in significant ways that matter for global competition.

Large firms are beginning to embrace open innovation, looking outside their own corporate borders to find sources of innovation. With the rise of Silicon Valley as a hub of innovation producing fast growth companies that have disrupted existing industries, reshaped technological trajectories, and created new production paradigms, the frontier of innovation now points to large companies harnessing external resources. Large Japanese companies are increasingly serious about investing in, partnering, and harnessing outside firms to enhance their core business offerings. Some have even successfully harnessed Silicon Valley, partnering with startups to provide essential functionality to their main products and services, as described below. Within Japan, the startup ecosystem has grown significantly, with new levels of partnership and cooperation with large firms to adjust to the realities of information technology intensive competition. Overall, the increasing diversity of Japan's economy, with large firm corporate strategies diverging, a burgeoning startup ecosystem, diversifying elite career paths, and a focus on acquiring new strengths, suggests that Japan will continue to matter. While the focus on social stability led to a long period of slow adjustment at the expense of growth, the increasing diversity in what is still a very large, wealthy, technologically sophisticated and highly educated economy is now Japan's core strength.

Why Japan Mattered

In its essence, Japan's postwar economic growth mattered for global competition not simply because its "miracle" growth from the ashes of devastation was dramatic. It was

because innovations that occurred within the Japanese domestic industrial context *shaped global technological trajectories*, *transformed major global industries*, and contributed to fundamental *innovations in industrial production processes*.

The most critical postwar Japanese innovation was in the automobile industry, pioneered by Toyota, with the "lean production system," analyzed in an MIT study "Machine that Changed the World," and others as a fundamental new paradigm for manufacturing to which the rest of the world had to adjust.[3] Lean production entailed minimizing inventories with "just-in-time" delivery within plants and from suppliers that enabled unprecedented flexibility, and most fundamentally, empowering assembly line workers to suggest improvements and reduce problems, reversing the information flows from top-down only to bottom up. The new information flows in Japanese companies led to studies of organization as lessons for the rest of the world.[4]

Japanese firms surged into global semiconductor markets, taking top shares in a variety of areas, and its consumer electronics firms drove many incumbent US firms such as Zenith or RCA out of the market.

Japan's surge into global markets was supported by innovation in the form of deploying technologies invented elsewhere and bringing them to successful commercialization. While some reverse engineering, accomplished partly through a relatively weak intellectual protection regulatory structure, did occur, many of the innovations were real. For example, Sharp's vision to create a handheld calculator in an era

[3] Womack, J. P., D. T. Jones and D. Roos (1991). The machine that changed the world : the story of lean production. New York, N.Y., HarperPerennial.
[4] Aoki, M. (1988). Information, incentives, and bargaining in the Japanese economy. New York, NY, Cambridge University Press, Nonaka, I. and H. Takeuchi (1995). The knowledge-creating company : how Japanese companies create the dynamics of innovation. New York, Oxford University Press.

when they were large desktop devices that required external power, led to Toshiba becoming the first firm to successfully manufacture C-MOS *complementary metal oxide silicon) chips, which later became a core technology of the entire semiconductor industry. Seiko pioneered the commercialization and mass manufacture of quartz watches, enabled by advanced precision manufacturing and the early adoption of C-MOS chips, and led to Seiko successfully filing hundreds of patents to dominate the quartz watch market. Japanese firms were also at the forefront of commercializing LCD (liquid crystal display) panels for watches, television, and laptop screens. These all followed a pattern of core scientific breakthroughs occurring in American large firm laboratories, such as Bell Labs and RCA, but a lack of ability to follow through and implement them in products or complete successful mass manufacturing processes. The Japanese firms, coming from behind and lacking the scientific basis, succeeded.[5]

Another pattern of Japanese success was to redefine product categories. Sony's portable cassette tape player, the Walkman, for example, took the existing product of large desktop cassette recorder/players, and removed the recording function (against industry wisdom and some within-firm opposition), and adding the extra functionality of portability, which required miniaturization and re-designing parts for low energy consumption.

Japan's competitive capabilities were seen as not only in manufacturing, but also in software. Sophisticated observers viewed Japanese firms and government-orchestrated consortia as a competitive threat for all others with titles such as "Japan's Software

[5] Sony's co-founder liked the idea, but the inventor's direct bosses were against it, saying that people wouldn't buy a tape player that had no recording capability. http://business.nikkeibp.co.jp/atcl/interview/16/031800001/052700007/?P=2&rt=nocnt

Factories" and "Japan's threat to IBM."[6] Top American computer scientists also saw credible competitive potential in Japan's artificial intelligence in the early 1980s, with a book subtitled "…Artificial Intelligence and Japan's Computer Challenge to the World," covering fifth generation supercomputing initiatives that harnessed public-private initiatives.[7]

As Japan burst onto the global competitive scene, a major puzzle became how to understand Japan's competitive strengths. Was it a nexus of government-business collaboration (collusion) of "Japan, Inc?" Was it state-led in some form with smart bureaucrats guiding the economy,[8] dynamic and entrepreneurial businesses succeeding despite government interference, or more about the international system that allowed Japan to access export markets while protecting its own domestic markets under the US Cold War umbrella? Even as the debates continued, Japan's competitiveness seemed to drop precipitously in the 1990s.

Why Japan Seemed to Fall into Irrelevance

From the 1990s, Japan seemed to slide into relative global competitive irrelevance. This was the result of several factors that hit it all at once. First, a massive asset bubble burst in 1990. Firms flush with cash borrowed on the basis of ever-rising real estate prices were hit with massive write-offs. The exchange rate revaluation after the 1985 Plaza Accord also hit Japan as the yen rapidly appreciated against the dollar, making exports

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[6] Anchordoguy, M. (1989). Computers Inc. : Japan's challenge to IBM. Cambridge, Mass., Published by Council on East Asian Studies Distributed by Harvard University Press, Cusumano, M. A. (1991). Japan's software factories : a challenge to U.S. management. New York, Oxford University Press.
[7] Feigenbaum, E. A. and P. McCorduck (1983). The fifth generation : artificial intelligence and Japan's computer challenge to the world. Reading, Mass., Addison-Wesley.
[8] Johnson, C. (1982). MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975. Stanford, CA, Stanford University Press.

more expensive elsewhere by a factor of X within the span of just a few years. Finally, and significantly for competition, the dynamics of competition in global leading high tech industries transformed—partly as an adjustment to the Japanese competitive threat.

The "IT revolution" of the 1990s introduced new dynamics of competition in the IT industry. The advent of the PCs led to the rise of modular architecture,[9] which enabled a decomposition of vertical integration.[10] Value shifted away from mainframe computers to PCs, and from final assemblers to the operating system and core processor—Wintelism.[11] Both were moves away from Japanese strengths. Many large US firms that had been outcompeted by Japanese competitors transformed themselves significantly—IBM, GE, HP, and others, abandoning the longtime tenets of lifetime employment, in-house R&D, towards an "open innovation" or "New Economy" business model.[12] Platforms became important in competition, with firms that made operating systems or some other software platform on top of which third parties could flourish.[13] The maturation of the Internet into an open global platform enabled Silicon Valley to become the source of not only game-changing competition, but also high value firms including Apple, Cisco Systems, and Google. Services became critical to selling products; the Apple iPod or Amazon Kindle, for example owe their

[9] Baldwin, C. Y. and K. B. Clark (2000). Design rules. Cambridge, Mass., MIT Press.
[10] Langlois, R. N. and P. L. Robertson (2002). Firms, markets and economic change: A dynamic theory of business institutions, Routledge.
[11] Zysman, J. and M. Borrus (1997). "Globalization with Borders: The Rise Of Wintelism As The Future Of Global Competition." Industry and Innovation **4**(2): 141-166.
[12] Chesbrough, H. W. (2003). Open innovation : the new imperative for creating and profiting from technology. Boston, Mass., Harvard Business School Press, Lazonick, W. (2009). "The new economy business model and the crisis of US capitalism." Capitalism and Society **4**(2).
[13] Gawer, A. and M. A. Cusumano (2002). Platform leadership : how Intel, Microsoft, and Cisco drive industry innovation. Boston, Mass., Harvard Business School Press.

success as much to effective integration with online marketplaces and abundant content vis-à-vis attractiveness of the devices themselves.[14]

As Japanese firms faced new dynamics of competition, the rise of other Asian manufacturers, notably Korea, followed by China, rapidly threatened them from the lower end. Korean firms, notably Samsung and LG, moved up the value chain to compete with Japanese firms head on in semiconductors and consumer electronics, eclipsing many of the Japanese firms such as Sony, NEC, and Toshiba by the early 2000s. Chinese suppliers also moved up the value chain with "fast follower" strategies[15] and aggressive harnessing inward foreign direct investment.[16]

Japan also suffered a pattern of innovation in which a number of IT-related industries developed dramatically in the domestic market, but failed to capture global markets. Especially in mobile communications, where a sophisticated ecosystem of mobile Internet platforms, advanced hardware, and a robust content industry flourished, Japan became a "leader without followers," where it clearly led the world along expected trajectories, but without followers—Japan's mobile industry was disrupted by the smartphone revolution by Apple and Google. In other areas such as mobile payments via phones and prepaid cards, Japan also became a leader without followers—referred to domestically as the "Galapagos Phenomenon," after the geographically isolated islands in the South Pacific that led to distinct bio-ecosystems. The problem for these advanced

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[14] Zysman, J., S. Feldman, K. E. Kushida, J. Murray and N. C. Nielsen (2013). Services with Everything: The ICT-Enabled Digital Transformation of Services. The Third Globalization? Can Wealthy Nations Stay Rich in the Twenty-First Century? D. Breznitz and J. Zysman. New York, NY, Oxford University Press**:** 99-129.

[15] Breznitz, D. and M. Murphree (2011). Run of the red queen : government, innovation, globalization, and economic growth in China. New Haven Conn., Yale University Press.

[16] Huang, Y. (2003). Selling China: Foreign direct investment during the reform era, Cambridge University Press.

services was that the value was held by network-owning firms such as cellular carriers and railroad group companies, who failed to internationalize their services, leading to hardware and content ecosystems becoming trapped in the domestic market.[17]

In short, during the 1990s, at the same time that Japan suffered the burst of an asset bubble, the US experienced a resurgence, most notably from Silicon Valley and driven by the computer industry. US firms became the forefront of setting global technological trajectories, global industry transformations, and revolutionizing production processes in a way that brought in other Asian countries.

Japan's Gradual but Significant Adjustment: "Syncretism"

Japan's adjustment occurred gradually and incrementally. While some saw simply stagnation, careful analyses saw processes of change that followed existing patterns of institutional reform, with government and industry reforming themselves rather than through external shocks.[18] Avoiding drastic, sudden change that would lead to social turmoil, reforms were gradual and incremental; rather than mass layoffs, for example, large corporations reduced headcount primarily through attrition and early retirement incentives. Corporate law reforms provided new options for how to organize companies, but were not compulsory. Accounting reform occurred stealthily. And while some previously protected sectors such as finance and telecommunications underwent dramatic influxes of foreign firms, foreign firms were brought in to help soften the end of the

[17] Kushida, K. E. (2011). "Leading Without Followers: How Politics and Market Dynamics Trapped Innovations in Japan's Domestic "Galapagos" Telecommunications Sector." Journal of Industry, Competition and Trade 11(3): 279-307, Kushida, K. E. (2015). "The Politics of Commoditization in Global ICT Industries: A Political Economy Explanation of the Rise of Apple, Google, and Industry Disruptors." Ibid.

[18] Vogel, S. K. (2006). Japan Remodeled: How Government and Industry are Reforming Japanese Capitalism. Ithaca, NY, Cornell University Press.

"convoy system" of implicit government guarantees against bankruptcies in financial sectors.[19] Deregulation enabled new stock exchanges for small market capitalization firms, corporate code revisions enabled stock option compensation, national universities were reformed into independent organizations to increase flexibility, and regulations surrounding mergers and acquisitions made it easier for companies to merge, spin off, and create holding companies to facilitate a variety of organizational forms.

The Japanese economic model that emerged by the early 2000s was more open, more diverse, and less cohesive than the previous model.[20] The system may be best characterized as "syncretism"—the coexistence of traditional, new, and hybrid organizations and practices.[21] The traditional include regional banks and small medium companies (SMEs), for example, remained relatively traditional, with business models and internal organizations largely unchanged for decades. The new segments include foreign firms and the rapidly developed startup ecosystem. Hybrid areas, which represent large swaths of the economy, changed some practices and organizations. Examples include, traditional keiretsu banks merging into three mega-banks, semiconductor divisions of major firms spinning out to create joint ventures to take them off the books for parent companies, and a growing market for mid-career hires, especially in IT-related industries. The point of the concept of syncretism is that not everything hybridized—instead, there was a coexistence of traditional, new, and hybrid areas.

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[19] Kushida, K. E. (2010). Inside the Castle Gates: How Foreign Firms Navigate Japan's Policymaking Processes. Ph.D Doctoral Dissertation, University of California Berkeley.
[20] Vogel, S. K. (2006). Japan Remodeled: How Government and Industry are Reforming Japanese Capitalism. Ithaca, NY, Cornell University Press.
[21] Kushida, K. E., K. Shimizu and J. Oi, Eds. (2014). Syncretism: Corporate Restructuring and Political Reform in Japan, Shorenstein APARC.

A significant problem for observing changes in Japan was that if one looked for static, traditional areas, one could find them, leading to conclusions that Japan was stagnant and resistant to change. Yet, when looking somewhere else, one could also find new dynamic change, with new firms, new practices, and altogether new dynamics of competition. The concept of syncretism explains why both were observed; they coexisted.

This paper focuses on the "new" and "hybrid" areas, where Japan is likely to matter more than commonly thought in global competition. The paper first delves into the emerging startup ecosystem, which is more easily observable as a center of dynamism. Then it turns to examine some notable large firm innovations.

II. Japan's New Startup Ecosystem

Japan's economy has, and is likely to remain centered around large firms. However, since an important characteristic of current leading innovation systems is the ability for large firms to make use of new ideas and technologies developed outside their corporate borders—"open" innovation—we first look at Japan's startup ecosystem.

Any startup ecosystem, when compared to that of Silicon Valley, will look small in scale and less dynamic in terms of the speed at which new high-growth startups are created. However, if seen over time, since the mid-2000s, Japan's startup ecosystem has developed considerably. As Japan's overall economic context transformed gradually but significantly, many of the impediments for creating a vibrant startup ecosystem have diminished substantially.

Japan is currently experiencing a wave of exciting science and technology based startups. If the trajectory continues, this is just the beginning, with successive generations

of startups enjoying greater success at rapid growth, partnerships with large firms, and harnessing Silicon Valley.

Rather than delving into analytical framework first, this paper will be more exciting if we jump directly to examples of startups that illustrate various characteristics.

Science and Technology-based Startups

First, Japan has a relatively high degree of investment in research and development from the government and through educational institutions. Japan has been second to the US by far among advanced industrialized countries in government expenditures on R&D, and a higher percentage of GDP than anywhere else. China surpassed Japan between 2005 and 2010 in absolute terms. However, the point is that science and technology based R&D is one of Japan's strengths.

Government Expenditures on R&D

Year	2005		2010		2013	
Country	Amount	% GDP	Amount	% GDP	Amount	% GDP
Japan	128,695	3.31	140,607	3.25	162,347	3.47
United States	328,128	2.51	410,093	2.74	456,977	2.74
China	86,828	1.32	213,460	1.73	333,522	2.01
Germany	64,299	2.42	87,883	2.71	102,573	2.83
United Kingdom	34,081	1.63	38,166	1.69	41,743	1.66
France	39,236	2.04	50,765	2.18	57,987	2.24
South Korea	30,618	2.63	52,173	3.47	68,051	4.15

Source: OECD

Higher Education Expenditures on R&D

Year	2005	2010	2013
Country			
Japan	18,849	18,099	20,807
United States	51,725	60,374	61,227
China	9,449	18,053	22,874
Germany	12,218	15,996	17,157
United Kingdom	9,262	10,322	10,437
France	8,646	10,955	11,225
Korea	3,208	5,646	6,298

Source: OECD

Notable Japanese university spinout starts beginning to appear after regulatory reforms, discussed later. For example, Cyberdyne, which grew out of Tsukuba University, produces robotic suits that assist human movement. Founded in 2004, Cyberdyne was a trailblazer, winning numerous awards in Japan and abroad, including the American Society for Artificial Organs, and the IEEE/IR Invention and Entrepreneurship Award. Cyberdyne worked with large German companies, and received accreditation from the European Commission in 2013, developing the world's first robotic remedial device. The company went public in March 2014 on the Mothers exchange. Founder Yoshiyuki Sankai did note, however, that had the company been founded in Silicon Valley, it would have grown much faster, since the early funding came from personal assets and bank loans during Japan's venture capital downturn in the early 2000s.

Spiber, founded in 2007, successfully created synthetic spider silk by decoding the genetic information of fibroin, a protein that is the main component of spider silk. The technology grew out of a laboratory at Keio University, with then-graduate student Kazuhide Sekiyama, along with then-undergraduate Junichi Sugihara making the discovery in early 2007 and starting the company later that year. Given the unfavorable investment climate immediately following the global financial crisis, it took them two years to make a technological breakthrough to produce artificial spider thread and subsequently secure venture capital funding. In 2012, the company entered into an alliance with an auto parts supplier for Toyota, Kojima Industries, and together they set up a factory for mass production.

A more recent firm is NuProtein, founded in 2015 by three professors and researchers at Nagoya University, who invented a new methodology for synthesizing

proteins. Called Protein Synthesis System 3.0 (PSST), compared to conventional methods that utilize e-coli which take about two weeks, PSST claims about fourteen times faster, fifty times the amount of yield, and a far greater array of proteins that can be synthesized. The researchers first made an academic impact by providing proteins synthesis for particular experiments, becoming co-authors on over ten top academic papers in journals such as Nature. The business is to sell protein synthesis kits and selling difficult to synthesize proteins such as hormones and membrane proteins, which are expected to be useful to discover new pharmaceutical products. The company received early financial support from NEDO, and won startup pitch contests in Japan and Silicon Valley.

Japanese non-university research labs, in particular Riken, Japan's largest publically funded research lab, has also produced new basic research that has enabled venture capital backed startups. The most notable is Healios, which licensed a technology developed by Riken researcher Masayo Takahashi to use iPS cells to develop a regenerative therapy for age-related macular degeneration. While the Riken lab methods would cost an estimated $1 million per treatment, medical doctor and serial entrepreneur Tadahisa Kagimoto set out to develop a far lower cost line of cells using this technology. Founded in 2011, Healios received approximately 3 billion yen in funding from a group of Japanese firms involved in biopharma, including Sumitomo Dainippon Pharman, Nikon, Shin Nippon Biomedical Laboratories, and Tella. The company listed on the Mothers market in June 2015.

Large Firms, Foreign Firms, and Government as a Sources of Talent

Large firms traditionally "locked up" much of Japan's best talent. However, as the survival of many large firms themselves is called into question, and with lifetime career employment paths becoming less attractive, younger employees are increasingly leaving to

form their own companies. This dynamic has driven the creation of some notable startups, which absorb further employees as they grow. Cerevo, for example, a hardware firm that designs products that connect to the Internet to provide functionality, was founded by a former employee of Panasonic, drawing engineers from almost all the major Japanese consumer electronics companies, such as Sony, Sharp, Panasonic, NEC, and others.

UPQ, is a consumer electronics startup founded in 2015 that made headlines by introducing 24 highly aesthetic design products in its first two months, ranging from smartphones to speakers, a glass keyboard, backpack with built-in battery for charging devices, a chair, and other things. The entrepreneur, Yuko Nakazawa, was in her mid to late 20s, and had initially worked for Casio to design their mobile phones, but left when Casio withdrew from the handset industry.

Silicon Valley firms in Japan are a new source of entrepreneurs and Japanese startup ecosystem players. Wantedly, a recruiting service that works by mixing a social networking service with recruiting, was founded by Akiko Naka, a Kyoto University graduate who had worked at Goldman Sachs, followed by Facebook. At the time, Facebook's Japan operations had only six people, so it felt like a startup. Naka realized that the current generation of younger workers were interested in fulfillment from their jobs rather than simply salary, so Wantedly makes a point of not allowing employers to post salaries, but instead appeal to workers' potential passion for the job. As major Japanese firms began to increase mid-career hires, and the IT industry has a highly mobile workforce vis-à-vis other sectors, Wantedly, founded in 2010 was quickly adopted by over a thousand companies and ten million users. Large company personnel recruiting budgets easily covered Wantedly's fees, so the company became profitable early on.

Daisuke Sasaki, the co-founder of Freee, a Fintech firm that provides financial tools, especially for SMEs, was previously employed at Google. The company was founded in 2012, and aimed to fill un-served demand for an easy to use accounting system for companies that did not require, or found too cumbersome the enterprise-grade accounting software that dominated the Japanese market. Co-founder Ryu Yokoji had worked at Sony, and between the two of them Freee was able to enlist 1600 banks to integrate into their service, making it easy for users to integrate their accounting with banks. It was Sasaki's interpersonal networks from being at Google, which involved business trips to the Silicon Valley headquarters, that led to an introduction to top tier venture capital firm DCM, which became a lead investor into Freee.

Soracom, founded in 2015, provides IoT solutions through a SIM chip with cellular connectivity, allowing devices to connect to leading telecommunications carrier NTT DoCoMo's cellular network, and Soracom provides the platform with access to storage and analytics for connected devices. The founder, Kenta Yasukawa and Ken Tamagawa, both previously worked at Amazon and had worked to facilitate diffusion of Amazon's cloud computing resources, Amazon Web Services.

Even a pattern of government employees leaving to create their own startups is gaining momentum. For example, Agri Info Design, which provides an Android smartphone application that uses GPS to enable farmers to move their tractors in straight lines in the field for seeding and fertilizer, was founded in 2014 by Yasuyuki Hamada, who had been a senior researcher at the National Agriculture and Bio-oriented Research Organization. He started originally as a researcher in the Ministry of Agriculture, Forestry and Fisheries. The app, which provides an extremely low cost solution for developing countries and other

farming users who cannot pay the high fees for existing automated tractor services, won several startup pitch contests, including the Tech in Asia conference, Infinity Ventures Summit 2015, and the New Economy Summit 2016.

As Japanese companies increasingly embrace working with startups and even buying them, new career paths are becoming possible, providing examples for others. For example, Yusuke Asakura, a University of Tokyo graduate, worked for McKinsey, then started his own company making pre-smart phone cellular Internet service middleware. That company was purchased by social networking service provider Mixi, and Asakura eventually rose to CEO of Mixi when the latter was facing a downward spiral. Asakura successfully turned around the company, then left to start his next venture—still in his early 30s.

Large Firms and Startups: Greater Symbiosis

Startup ecosystems do not function unless startups can partner with, sell to, and often sell themselves to larger companies. Japan's large firms were historically hesitant to do so, but the landscape has transformed considerably. The overall number of mergers and acquisitions in Japan increased from 1707 in 2010 to 2285 in 2014, although the proportion of startup acquisition is a small proportion of the total.[22]

In terms of partnering with large companies, the aforementioned firms such as recruiting service Wantedly, and online business accounting service Freee found favorable environments. For Wantedly, the need for large firms to recruit new talent, combined with large firms' significant recruiting budgets made Wantedly's subscription prices quite

[22] Kariyazono, S. (2015). Japan as a Startup Nation. US-Japan Venture Capital Conference, Stanford University.

affordable for them, and enabling Wantedly to become profitable early on. Freee was able to enlist 1600 banks to integrate with their services in order to offer accounting services that integrated with banks.

Preferred Networks, founded in 2014 by a Tokyo University computer scientist, provides machine learning algorithms and tools. Japan's top manufacturers including Toyota and factory robot producer Fanuc have partnered with Preferred Networks to jointly develop systems for factory robotics that enable the robots to learn new movements and tasks by themselves without operators programming them.

Even Silicon Valley firms such as Google are beginning to buy Japanese startups. While still a rare case, Japanese robotics startup Schaft was purchased by Google in 2013. Schaft was founded by University of Tokyo researchers focused on producing walking robots. Schaft entered the US DARPA Robotics Challenge, making headlines by dominating the trial round. However, once purchased by Google, the latter's philosophical opposition to receiving funding from DARPA, part of the US military, given to the competition's winner, pulled Schaft out of the final competition.[23] This purchase represents a new pathway for Japanese startups, since top tier Silicon Valley firms such as Google have rarely purchased Japanese startups.

The Deepening Venture Capital Industry and Broad Sectoral Variety of Startups

Japan's *venture capital* industry has developed significantly. While the size remains far smaller than that of Silicon Valley, or the US in general, the amounts are actually greater than other notable advanced industrialized countries such as France, Germany, and the UK.

[23] Guizzo, E. and E. Ackerman. (2014). "Who is Schaft, the robot company bought by Google and winner of the DRC?" Retrieved June 1, 2016, from http://spectrum.ieee.org/automaton/robotics/humanoids/schaft-robot-company-bought-by-google-darpa-robotics-challenge-winner.

Figure 1. Venture Capital Investment Amounts (billions USD)

FY	2010	2015
Japan	1.29	1.11
EU	4.26	5.91
Germany	0.97	0.87
France	0.80	0.84
UK	0.79	0.62
Israel	0.41	0.65
South Korea	0.96	1.78
US Total	23.52	59.70
Silicon Valley	9.39	27.76

Source: Venture Enterprise Center, GVCA, BVCA, AFIC, IVC Research Center, KVCA
*Note that UK's data is as of 2014.

The most important qualitative shift in Japan's venture capital industry has been the rise of independent VCs. The historical dominance of financial institution funds was criticized for not incentivizing investors to pursue high returns. By 2015 and 2014, however, the largest amounts of capital invested in new funds were for independent funds. In 2015, it was 35%, followed by corporate venture capital (CVC) at 28% and financial institution VCs at 18%. For the previous year, independent VCs received 42%, with CVCs receiving 43%. Some examples of independent VCs include World Innovation Lab, Globis Capital Partners, B Dash Ventures, and others.

An important driver of Japan's VC growth was the creation of small capitalization markets in the late 1990s. Two competing small cap markets were created in 1999, providing a stable source of exits in which VCs could realize returns from their investments. The relative cost of listing in Japan's small cap markets, Mothers and JASDAQ, is far lower than other Asian markets, and the scale is far smaller than the US NASDAQ.[24] On the one

[24] Riney, J. (2016). "7 Things Investors & Founders Need to Know about the Japan Startup Ecosystem." Retrieved 2016, June 1, from http://500.co/japan-startup-ecosystem-founders-investors/.

hand, this hinders truly large high-growth firms from emerging, since once firms are listed at a smaller scale, they tend to become more risk averse and pursue stable rather than exponential growth. On the other hand, since it is easier to IPO in Japan than in the US, Japanese VCs may actually face a more predictable exit strategy environment.[25]

Figure 2. Amounts Raised in IPO, Small-cap Markets in Japan, US

	Average (million $)		Median (million $)	
	Japan (Mothers/JQ)	US NASDAQ	Japan (Mothers/JQ)	US NASDAQ
2015	7.6	116.0	3.5	75.0
2014	8.7	121.6	5.7	65.0

Source: Tokyo Stock Exchange, NASDAQ

The Innovation Network Corporation of Japan (INCJ) is a noteworthy government-spearheaded attempt to spark investments in Japan's startup ecosystem. Established in 2009, it was a 300 billion yen fund with 286 billion from the government and 14 billion from 26 corporations which include Japan's major corporations including Toyota, Canon, and many from the Sumitomo and Mitsubishi groups. Additional government guarantees of 1800 billion yen in loans enabled the INCJ to invest approximately 2000 billion yen total. The lifespan of INCJ is fixed at 15 years, and it is run by a mix of government officials and private sector participants. While some analyses may view this government-spearheaded fund as simply crowding out potential private investments, it may also be viewed as having a legitimizing effect for startups and other venture capital firms such as WiL that have received INCJ investments.

[25] Ibid.

Figure 6 shows the Japanese startups that raised the most VC funding (according to publically available news and data sources), as well as founders' backgrounds. This is a useful figure because we can see where VCs were placing large bets.

A key observation is that the sectoral variety of Japan's high growth startups receiving the most VC investment is broad. For example, Spiber develops synthetic spider web material, with a vast array of potential industrial application, as it is an extremely strong, lightweight material. Freee provides web-based accounting software, particularly to small-medium businesses, at a fraction of the cost of traditional accounting software systems. Raksul took a traditional industry with excess capacity—printing—and reorganized the supply chain through a customer-facing online interface and efficiency-optimizing IT back-end that connects customers with capable factories around the country at low prices. Quantum Biosystems is a commercial DNA sequencer, Origami is a mobile payment service, and SmartNews delivers news feeds curated to peoples' preferences as revealed through social networking services and other preference stipulations. There are even firms delivering 3D tissue engineering technology, regenerative medicine iPS cell analysis and measuring tools, commercial satellite microimaging, and a fresh fish distribution platform.

While many of the firms on this list may not exist five years from now, this would likely indicate a churning of high growth startups as expected for a healthy high-growth startup system. The point, however, is that there is significant variety across sectors, and the firms are both Business-to-Business (B to B) and Business-to-Consumer (B to C) firms.

Figure 3. Major Venture Capital Fundraising by Japanese Startups, 2015

Company	Amount Raised (billion yen)	Description	Founder	Education	Previous Employment
Spiber	10.54	New-generation biomaterial development	Kazuhide Sekiyama	Keio University	Founded company while still a doctoral student
Metaps	4.89	Marketing tools and consulting service in mobile business	Katsuaki Sato	Waseda University	Dropped out of university to start company
Freee	4.49	Cloud-based accounting software	Daisuke Sasaki	Hitotshbashi University	Google
Raksul	3.99	Commercial printing service	Yasukane Matsumoto	Keio University	A.T. Kearney
Megakaryon	2.54	Producing platelet products from iPS cells	Genjiro Miwa	University of Tokyo, Harvard University	St. Thomas Investments
Quantum Biosystems	2.4	Commercial DNA sequencer	Toshihiko Honkura	University of Tokyo, Columbia University	McKinsey & Company
Plus One Marketing	2.13	Mobility hardware products made by Japan	Kaoru Masuda	Waseda University	Dell Japan
Preferred Networks	1.9	Industrial IoT applications with AI	Toru Nishikawa	University of Tokyo	Software intern at a bio venture firm
			Daisuke Okanohara	University of Tokyo	Google
AXELSPACE	1.89	Commercial microsatellite imaging and data service	Yuya Nakamura	University of Tokyo	University of Tokyo (Post-doc)
Treasure Data, Inc.	1.77	Cloud data management platform	Hiro Yoshikawa	Waseda University	Mitsui Ventures
GLM	1.69	EV Development / providing EV platform	Hiroyasu Koma	Kyoto University	Koma Enterprise
Origami	1.59	Mobile payment service	Yoshiki Yasui	Waseda University, University of Sydney	Doll Capital Management
iPS PORTAL	1.53	Instruments to analyze and measure iPS cells	Syosaku Murayama	Doshisya University	Teikoku Seiyaku Co., Ltd.
seven dreamers	1.52	R&D of carbon tool and medical equipment	Shin Sakane	University of Delaware	Super Resin, Inc.

Money Design	1.5	Financial portfolio design with AI	Mamoru Taniya	University of Tokyo	Asuka Corporate Advisory Co., Ltd.
			Tomoyoshi Hirose	Yokohama National University	Criteria Japan
CYFUSE	1.41	3D tissue-engineering technology	Koji Kuchiishi	Keio University	Mckinsey & Company
from scratch	1.29	Next-generation marketing platform	Yasuhiro Abe	Nihon University	Link and Motivation Inc.
SmartNews	1.19	News discovery app	Ken Suzuki	Keio University, University of Tokyo	University of Tokyo
Ptmind	1.1	Data analysis and monitoring	Yuan Zheng	Nihon University	Founded Ptmind while still an undergrad at Nihon University
			Takashi Ando	Rikkyo University	OKWave Inc.
Money Forward	1.03	Online application for personal accounting	Yosuke Tsuji	Kyoto University, University of Pennsylvania	Monex, Inc.
AnyPerk	1.02	Integrated perks and rewards platform	Taro Fukuyama	Keio University	Was developing an online social community service when picked up by Y combinator
FOODiSON	1.01	Fresh fish distribution platform	Tohru Yamamoto	Hokkaido University	SMS Co., Ltd.
JOMDD	1.01	Medical device incubator	Takahiro Uchida	Fukushima Medical University, Harvard University	Necess Medical, LLC
Retty	1.0	Social gourmet site	Kazuya Takeda	Aoyama Gakuin Univeristy	NGI Group
LOCONDO	1.0	Shoes and fashion e-commerce service, buy first and then choose	Yusuke Tanaka	Hitotsubashi University, UC Berkeley	McKinsey & Company

Sources: Japan Venture Research Co., LTD

Social Norm Changes Driven by Economic Environment, Maturation of Support Ecosystem

The *attractiveness of entrepreneurship* and working at high growth startup firms has increased significantly over the past two decades. For elite university graduates, the possibility of lifetime careers at large firms are less likely when the longevity of the firms themselves are in question. In the late 1990s, staid financial institutions such as the Long Term Credit Bank and Yamaichi Securities went bankrupt, most large electronics firms such as NEC, Fujitsu, Sony, and others lost in global competition for semiconductors, telecommunications, and consumer electronics, selling off or shuttering their operations in those areas. Consumer electronics firm Sanyo was sold to Panasonic, with many of its divisions sold to Chinese firm Haier, a massive accounting fraud was uncovered in Toshiba in 2015, and in early 2016, Sharp, once a front-runner in flat panel displays and consumer electronics such as mobile handsets, was sold to Taiwanese firm Foxconn. While stable jobs at large firms continue to be attractive, they are far less so than two decades ago. A list of the universities attended by founders of startups with top fundraising in 2015 reveals that almost all were from elite universities.

Numerous startup pitch contests and major events celebrating high growth startups have been taking place in recent years. Audiences number in the thousands, some are focused on having policy recommendation arms, and the often receive national news coverage. These organizations and events help legitimize and popularize a culture of high growth startups. Some include the annual New Economy Summit, launched in 2013, organized by the Japan Association of New Economy, set up by Japan's largest, listed online commerce company, Rakuten. The New Economy Summit invited prominent Silicon Valley

entrepreneurs such as Larry Ellison, founder of Oracle, and the founders of startups such as Dropbox, Lyft, Box.com, and Andy Rubin whose company was bought by Google and became the Android platform. The Infinity Ventures summit, which began in 2009, brings hundreds of companies to Kyoto annually, and is a hub for investors, entrepreneurs, and large firms to meet. Less business focused and inspiration community building events such as Slush Asia, orchestrated by Finish firm Slush, took place in Tokyo in 2016. From the government, the New Energy and Industrial Development Organization (NEDO), which subsidized the R&D of science and technology-based startups, pitch contest, the NEDO Technology Commercialization Program, featuring startups that entered several rounds of pitch competitions around the country. The first program took place in 2015.

Finally, Japan's *startup support ecosystem* is maturing, with an increasing number of support actors such as accounting firms and law firms not only providing services, but also actively orchestrating startup-focused events and services. For example, Tohmatsu Venture Support, a subsidiary of accounting firm Deloitte Tohmatsu, has been supporting weekly "morning pitch" events at 7am in Tokyo since 2011, expanding to other major cities as well. They provide many services to early stage startups free of charge, with the aim of fostering a vibrant startup ecosystem from which they can benefit. The company has also set up a Silicon Valley branch to help Japanese startups enter Silicon Valley.

While there is no comprehensive database of Japanese startups in Silicon Valley, ties between the Japanese startup ecosystem and Silicon Valley are strengthening.[26] Several Japanese were part of the programs at top accelerators such as Y Combinator and 500 Startups.

[26] The Stanford Silicon Valley – New Japan Project is compiling a database of Japanese startups in Silicon Valley. http://www.stanford-svnj.org

As seen from mid-2016, Japan's startup ecosystem has developed considerably, as many of the characteristics of the overall economy have transformed to create a new environment.

Figure 4. Silicon Valley Startup Ecosystem Characteristics Compared to Japan in mid-100s, Japan in 2016

Silicon Valley Startup Ecosystem Characteristic	**Japan in the mid-1990s: impediments**	**Japan in 2016: changes that facilitate startup ecosystem**
Financial System: Venture capital	Bank-centered, traditional financial markets	New small cap financial markets, growing VC industry, rise of independent VCs
Labor Market: fluid, diverse, highly skilled	Long term employment with seniority ties creating illiquid labor markets. Best and brightest locked into large firms for entire career	Increasing labor mobility, especially in IT sector and with foreign firms. Lower prestige and opportunity with large firms
Industry-University-Government Ties	Numerous formal regulatory constraints	Active efforts by universities, private venture capital, and government to spin out successful startups with university technology
"Open" innovation with large firms and small firm symbiosis	Closed innovation with large firms in-house R&D and uninterested in business with startups	Firms more interested in open innovation, participation in VC funds, business with startups.
Social system encouraging entrepreneurship	Entrepreneurship seen as low prestige vis-à-vis large firms and government	Rising attractiveness of entrepreneurship as large firms enter competitive crises, increases cases of successful startups
Professional services ecosystem	Small size of professional ecosystem	Law firms and accounting firms setting up startup-focused practice areas to foster and benefit from growing startup ecosystem

University-related VC funds UTEC (University of Tokyo Edge Capital), and Miyako Capital, affiliated with Kyoto University, have also been actively working to spin out

technologies from these Japanese top universities into high growth startups. UTEC was established in 2004, with approximately $300 million in its funds, with 9 IPOs and 8 M&A exits by the end of 2015 among its 65 portfolio companies. Although still at an early stages of development, Miyako Capital was given $60 million from Kyoto University in 2015.

III. Large Firms: The Core of Japanese Industry

It is often more challenging to observe large companies undertaking breakthrough innovation of the sort that startup firms aim for. By their very nature, large companies are slower, and carry far higher costs to undertake new activities. And compared to startup firms, large firms require massive revenues to justify new lines of business. There are a variety of forces at work that constrain large firms from moving quickly, including the "innovator's dilemma," in which listening to current customers and optimizing current suppliers can lead to missed opportunities that require jettisoning these actor in favor of something new that is not yet profitable; hence, large companies can get disrupted.[27]

Japanese large firms are particularly slow, since enacting measures such as reducing personnel tend to be accomplished through attrition, which takes time. Moreover, unprofitable subsidiaries such as semiconductors have been spun out into joint ventures across previous rivals, letting parent companies move the divisions and personnel off the books.

There are, however, firms whose innovative activities have the potential to change technological trajectories, affect competitive dynamics, and influence the logic of production. While not all the following examples may be realized, they are serious

[27] Christensen, C. M. (2000). The innovator's dilemma. New York, HarperBusiness.

developments worthy of attention, and they tend to be underappreciated both inside and outside Japan.

Komatsu: IT Frontier in Massive Equipment Deployment

Komatsu, one of the world's leading heavy machinery producers, has been at the forefront of IT, and is boldly developing into a platform player and lead user of Artificial Intelligence in a way that has rarely been seen in a Japanese firm.

Within Japan, Komatsu has been well known for its pioneering use of IT tools to connect its heavy machinery. Using its system called Comtrax, Komatsu gathers detailed information about all its machinery operating around the world. It can alert customers if wear and tear on parts require maintenance or replacement. It can also use usage data for demand forecasting, especially in parts of the world where official government economic statistics may be unreliable. Komatsu can even stop the operation of its leased machinery if the installment payments are late, or alert customers if fuel levels decrease despite non-usage of the machinery, indicating illegal fuel siphoning. This was all news from the early 2000s.

More recently, even as the world's automobile manufacturers have rushed after Google, Tesla, and Apple to develop autonomously driven vehicles after around 2012, Komatsu has actually been commercially deploying fully automated mining dump trucks since 2008. This has not been well publicized outside Japan or the construction and mining equipment sectors.

Even more significantly, however, and not obvious even within Japan, is that Komatsu has progressed surprisingly far in another, contrasting area of Artificial Intelligent (AI)—that of Intelligence Augmentation (IA). While AI tends to focus on replacing human

activity, such as with self-driving automobiles, the aim of IA is to enhance and augment rather than replace humans. AI and IA are derived from contrasting intellectual and development paradigms.[28]

Komatsu's IA solution in its heavy equipment allows operations that previously required highly skilled workers with close to a decade of experience to be performed by relative novices. Put simply, it is a solution allowing low-skilled workers to perform high-skill jobs, with intelligence built into the construction equipment to assist the operators.

In both Komatsu's AI and IA solutions, it deploys technologies acquired from outside the company. The sensor technologies and AI systems for its automated dump trucks were procured externally, then improved and integrated internally. For the IA, the construction equipment used to use GPS sensors, procured from outside the company, to map the terrain and determine the position of equipment parts, but now it uses drones—also procured externally. Moreover, the company has partnered with drone companies that provide wireless drones for large open air operations, and with those that can provide wired drones for construction sites, enabling the latter to hover without running out of battery power, straying outside the construction site, and enabling higher data throughput. Komatsu is therefore engaging in open innovation.

In pursuing open innovation Komatsu is harnessing Silicon Valley and its US operations. It invests in both large and small boutique Silicon Valley venture capital funds, and sends researchers to both Stanford University and UC Berkeley. It is using a drone data analysis platform provided by San Francisco firm Skycatch.

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[28] Markoff, J. (2015). Marchines of Loving Grace: The Quest for Common Ground Between Humans and Robots. New York, Ecco Books.

Finally, and most interestingly, Komatsu is attempting to make an open platform that will connect any device that is part of a construction site. As low cost sensors usher in an era of "Internet of Things (IoT)" in which various devices connect to networks, Komatsu foresees a near future where all sorts of devices will communicate with each other. Significantly, Komatsu intends to make the platform open, without taking ownership of data or control of third party equipment that connects to the platform. By ushering in an era of smart construction, Komatsu intends to remain competitive with its own equipment despite allowing any other equipment to access the platform. For projects that cross national borders, they are looking into building a bitcoin solution.

The Japanese government is supporting Komatsu's technological capabilities as an industry standard for bidding. Known as iConstruction, variables such as time to completion and cost can be calculated as variables with various machinery usage rates and site characteristics as optimizable parameters rather than fixed values.

Yamaha: Harnessing Silicon Valley with a Humanoid Motorcycle Robot

In 2015, as research and development into self-driving automobiles rapidly gained momentum, Yamaha Motors developed an autonomous motorcycle riding humanoid robot that sits on and rides a conventional motorcycle. This was done by harnessing Silicon Valley.

Source: Yamaha Motors

In 2015, Yamaha created the Yamaha Motor Ventures & Laboratory Silicon Valley (YMVSV). The story of how it was established, and the thought behind it provides important clues for other companies. Saijo Hiroshi had been a robotics engineer in Yamaha Motors. When Yamaha Motors decided to figure out how to harness Silicon Valley, it borrowed space in a local Silicon Valley incubator, Plug and Play, where Saijo spent time in 2014. There, he realized how difficult it would be for a simple branch office of a large Japanese firm to operate in, and make use of, the resources available in Silicon Valley.

When Saijo discussed creating a new entity in Silicon Valley with the company's top management, he made sure that several conditions were met. First, the Silicon Valley entity would be free to develop and pursue business opportunities even if they were potentially disruptive to existing Yamaha businesses. The fear of disruption is one of the reasons that large firms tend to have difficulty pursuing new business lines—the "innovator's dilemma."[29]

Saijo also recognized the need for fast speed in decision-making, which can only occur if enough resources are controlled locally. Therefore, Yamaha's entity was a combination of a Corporate Venture Capital firm and a business unit. Through this autonomy, YMVSV was able to make some investments in as little as ten days (to a mobile wifi grid startup from Vietnam), and engage in projects that might have encountered severe pressures for compromise in-house. For example, putting sensors on moving vehicles to obtain active and more detailed data about air quality might have been limited to Yamaha motorcycles if developed solely in-house.

[29] Christensen, C. M. (2000). The innovator's dilemma. New York, HarperBusiness.

Motobot, the humanoid motorcycle-riding robot, was an important demonstration project to the company's home R&D labs as well. YMVSV partnered with SRI International, the research institute that began as Stanford Research Institute that later developed and sold the Siri voice recognition software to Apple. They co-developed the Motobot in 10 months, at a far lower budget than YMVSV had initially expected. SRI provided the robotics expertise, but in the later stages of development, Yamaha engineers were able to cut the robot's weight in half. Despite the lack of an immediate, short-term market profitability projection, the fact that Yamaha was willing to do this will also be a major morale booster for the company.

Toyota: The Challenge to Avoid Disruption as Largest Incumbent

Toyota, by far the largest market capitalized firm in Japan, the original creator of the world's new production paradigm with "lean production" has been undertaking various activities to stay ahead of the competition. Their gasoline electric hybrid engine first introduced in the 1997, Prius, shifted the technological trajectory of the automobile industry. Just as "lean production" became the standard paradigm for how to organize automobile manufacturing among US and European countries, gasoline electric hybrid engines are now offered by manufacturers around the world.

Toyota's more recent innovations have been multipronged, as the automobile industry faces possibly unprecedented challenges from artificial intelligence that can create automated self-driving cars as spearheaded by Google, ride-sharing companies such as Uber, and electric vehicle companies such as Tesla at the high end, BYD in China and elsewhere, and the possibility of low cost producers enabled by the fact that electric motors

are much easier to manage than gasoline engines in production—even the Chinese smartphone manufacturer Xiaomi rolled out an electric vehicle model in mid-2016.

Toyota has successfully developed a hydrogen fuel cell vehicle. Using hydrogen rather than gasoline, it is a clean but difficult technology, and so far Toyota has been the only automobile manufacturer to introduce a full model Mirai sedan, first introduced in Japan in 2014, and in limited locations in the US in 2015 and 2016. The question for hydrogen fuel cell vehicles, of course, is who will be providing the infrastructure needed for the new energy system—the collection, processing, and distribution of hydrogen and network of fueling stations. Within Japan, the government is actively subsidizing the creation of hydrogen fueling stations, as well as subsidizing the purchase price of fuel cell vehicles. Will this be another "Galapagos," in which the Japanese domestic industry diverges from global markets, even if it is advanced? The lesson from Japan's IT industry is that without a business logic for network creation worldwide, any hardware that relies on that network will be trapped in the domestic market. So far, neither the US nor Europe, nor most industrializing countries, seem poised to assist or orchestrate the creation of hydrogen fuel cell networks. However, an important hypothesis that emerges, especially when taking into account Toyota's significant R&D presence in mainland China, is the possibility that the Chinese government, for the purposes of lowering air pollution and gaining further energy independence, may orchestrate the creation of hydrogen fuel cell charging stations. If this occurs, and the Chinese market can significantly shift towards hydrogen, then Toyota's fuel cell will not be trapped in Japan's "Galapagos," as China is far bigger than Japan's Galapagos. However, since Toyota will not directly divulge their core strategy, this remains a hypothesis as seen from the outside.

Toyota is not, however, putting all its eggs in the fuel cell vehicle. They are deploying plug-in hybrids, which can be charged from electricity off the grid, as well as gasoline.

Toyota is also investing in artificial intelligence with an aim to create self-driving vehicles. They are doing so through substantial industry-university research, the creation of a new research lab in Silicon Valley, and investments into venture capital initiatives. In 2015, Toyota announced $25 million research initiatives with Stanford University and MIT, creating new research centers with AI related projects. At the end of 2015, Toyota also announced that it would spend $1 billion over five years in creating the Toyota Research Institute (TRI) in Silicon Valley, hiring a team including Gill Pratt, who ran the US DARPA's robotics challenge.

Also in 2015, Toyota jointly created a venture capital fund of approximately $110 million, contributing around $80, with the rest from Sumitomo Mitsui Banking Corporation and a Japanese asset management firm Sparx. The fund intends to target startups related to AI, robotics, and hydrogen fuel.

In 2016, Toyota made a strategic investment into ride-sharing service Uber of an undisclosed amount. It may involve leasing arrangements for Uber drivers. Uber's competitor Lyft, had announced leasing plans with GM, with reduced leasing prices according to the amount that drivers used the cars to work for Lyft.

Fanuc: Towards Intelligent Automation

Fanuc is one of Japan's most competitive firms whose name is fairly unknown to most people around the world not involved in manufacturing. It is one of the world's leading factory robotics firms, and has held an estimated 60% of the world's computer numerical control systems for machine tools, and 18% of the world's factory robotics share

in 2013 according to Goldmans Sachs.[30] Fanuc high precision factory robots can be found in factories serving Apple, Samsung, Toyota, GM, and a wide array of manufacturing. It is one of the "big four" global factory robotics firms, which includes ABB Group of Switzerland, Kuka of Germany, and Yasukawa Electric, also of Japan.

Fanuc has been a secretive and closed company, located away from Tokyo, building its own factories only in Japan, and even restricting external email exchanges of its employees. However, its financial success was extreme to the point that a New York hedge fund that purchased a stake of its shares in the hope of convincing it to disperse some of its more than $8 billion in cash holdings to the shareholders, noted that the company spends $1 billion annually, and gets returns of $2 billion, which it holds onto rather than gives back to shareholders.[31]

Fanuc's recent strategies that it announced include creating an open platform for within factories that can be used by any other entity to communicate and share information across machines and equipment. In creating this system, Fanuc co-developed technology platforms with Cisco Systems, the leading networking company from Silicon Valley.

In the next generation of factory robotics, Fanuc is moving aggressively to harness artificial intelligence, in particular machine learning. They have a substantive tie-up with Japanese startup Preferred Networks, founded in 2014 and focused on deep learning, a particular class of algorithms within the field of machine learning. The goal of Fanuc is to pursue self-learning factory robots, and in a demonstration in late 2015, they showed how

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[30] http://blogs.wsj.com/japanrealtime/2015/06/11/fanuc-aims-to-enhance-factory-robots-with-deep-learning/

[31] http://www.japantimes.co.jp/news/2015/02/19/business/corporate-business/secretive-robot-maker-fanuc-targeted-by-activist-investor-loeb/#.WOvXrFPyuUk. (Full letter available at: http://www.marketfolly.com/2015/02/third-point-q4-letter-fanuc-new-position.html)

a robot could self-learn a task of stacking cylindrical objects, which would have taken approximately 8 hours to program by technicians, in approximately two hours by itself with no prior ability to handle those objects.

In 2016, GM awarded Fanuc its innovation award for suppliers, for Fanuc's "Zero Down Time" system that gathers real-time data from machines and orders parts, or alerts the company before malfunctions occur.

Fanuc is therefore a highly profitable company focused on future investment in the areas of artificial intelligence and so-called "Internet of Things (IoT)" connected devices, and is an integral part of global production networks and supply chains.

Honda: Surprisingly Open Innovation in Silicon Valley

Honda is harnessing Silicon Valley in a surprisingly open manner. It opened basic computer science research offices in Silicon Valley in 2000, and in 2005 it established corporate venture capital entity. In 2011, it decided that rather than an investment operation, it could better harness Silicon Valley by creating an open innovation lab to partner directly with startups. It created the Honda Silicon Valley Lab (HSVL) that year, with two major initiatives, the Honda Xcelerator (established 2015) and Honda Developer Studio (2014).

The Honda Xcelerator is unique by providing funding for prototyping, access to test vehicles to test, take data, and refine prototypes, collaboration workspace, and mentors from within Honda itself. In effect, Honda is offering startups the resources to develop, test, and refine their products and services in a joint development-type arrangement. Significantly, however, Honda is not interested in monopolizing the outcomes. Startups are free to sell their products or services developed in the Honda Xcelerator to any other

automobile firm or anybody else. The view is that, having co-developed the offering, Honda will be first to market in the slow-moving automobile development cycle, giving it an advantage. Without allowing startups open access to partner with whomever they want as an end result, Honda realized that it would be unable to attract potentially valuable startups.

The Honda Developer Studio follows a similar paradigm, focused on creating an ecosystem of developers for a platform to access automobile info-tainment systems. Since smartphones far outpace automobile hardware for development cycles, having a platform that can allow app developers to access and control portions of automotive info-tainment systems was seen as critical. Offering access to test vehicles and Honda engineering teams allows developers to accelerate their development. Numerous developers are partnering with Honda in this way, with an early notable partner including Silicon Valley startup Drivemode, which provides a driver-friendly interface and functionality for Android phones.

The head of Honda's Silicon Valley labs is Naoki Sugimoto, who started his career with Recruit, and was in charge of developing their corporate web services. Sugimoto then attended the UC Berkeley Haas School of Business to get an MBA, founding his own successful IT company that was purchased by Recruit in 2001. After spending several years as a consultant and venture capital investor, he joined Honda in 2005. Taking an outsider's perspective, and bringing insider know-how and interpersonal networks from Silicon Valley, he was able to orient HSVL into an open innovation orientation.

In a public event at Stanford University, when in conversation with the founder of Drivemode, Yo Koga, Sugimoto and Koga outlined the various challenges they overcame to

work with headquarters, such as reworking the standard corporate non-disclosure agreements that were entirely inappropriate for Silicon Valley and not at all optimized for working with startups (such as requiring the bootstrapped startup to carry multimillion dollars worth of insurance to work with Honda.)[32] As part of the ecosystem, experiences and experiments undertaken by those such as Sugimoto provide learning opportunities for other Japanese firms attempting to learn specific techniques to incorporate outside firms in their innovation processes.

Conclusion: Why Japan Still Matters

This paper ends with the question: does Japan still matter in the world's political economy, and if so, why? This paper began with a historical vantage of when and why Japan mattered most. Japan altered technological trajectories, transformed industries, and created a new production paradigm in the 1970s and 80s. Since then, its impact has decreased as primarily US startups from Silicon Valley took the lead in these areas, and it is not clear whether it will exert this level of influence on the global economy in the future. The advent of Information Technology (IT) has radically increased the speed of industrial change and disruption, and shifted the focus of value-added activity away from Japan's high growth strengths in manufacturing. Moreover, the world's political economic configuration has changed dramatically, with the end of the bipolar Cold War structure and the rise of various countries, notably from Asia, entering global competition.

However, it is also clear that Japan has been written off prematurely and too often. Visitors are often surprised, after reading about Japan's crisis, stagnation, and decline, that

[32] Silicon Valley – New Japan Summit 2016. Stanford University. Oct 4, 2016.

the Tokyo area is vastly more modern, clean, efficient, and transportation networks are incredible in the precision and scope.

Japan's transformation has taken the form of syncretism, in which traditional, hybrid, and new organizational forms and practices coexist. A focus on the new and hybrid areas reveal significant change. The context surrounding large firms has shifted significantly, although gradually, leading to a greater openness and collaboration with newer firms. Most of the explicit and implicit domestic market protections no longer exist, and firms are freer to fail than ever before, leading to greater pressure to innovate and adapt to survive.

Large firms are inherently the targets for disruption by new firms. In the current paradigms of innovation, enabled by the rapid deployment of IT tools, "open" innovation in the form of partnering with startup firms is more important than ever.

Japan's startup ecosystem, both in terms of producing high-growth startup firms, and as a source of ideas and potential new collaborations for the large firms to avoid getting disrupted, is developing rapidly. While any startup ecosystem compared to Silicon Valley looks small, Japan's startup ecosystem is actually sizable vis-a-vis other advanced industrialized countries, and has been developing along a promising trajectory. In particular, science and technology research and development intensive startups have begun to appear, highlighting some of the changed aspects of Japan's startup ecosystem. While some of the notable startups are trailblazers, they provide examples for others to follow.

It is harder to observe disruptive innovation in large firms, since their primary focus tends to be on avoiding disruption, and adjusting to potential disruptions. However, as

shown by the examples of Toyota, Komatsu, Yamaha Motors, and Fanuc in this paper, they are embracing potentially disruptive technological change. While new technological trajectories such as automated driving were spearheaded by Silicon Valley firms, there are merits to being rapid adopters. As large firms, they do have the potential to transform their respective industries. Komatsu, in particular, embracing both artificial intelligence and intelligence augmentation, making full use of new drone technology, and considering the orchestration of an open global platform, is seeing other firms rush to follow its trajectory. Fanuc may be able to take the lead incorporating machine learning into factory automation robots, leveraging its existing expertise and deep integration into various manufacturers' operations. While it might not be these specific companies that take the lead, their underappreciated potential representing Japan's underlying industrial strength is what this paper aims to highlight.

New sets of firms bridging Japanese large firms' existing strength and Silicon Valley-style new firm creation are also assisting the transformation. World Innovation Lab (WiL), for example, a 400 million yen venture capital fund with investors from large Japanese firms and the government-spearheaded Innovation Networks Corporation of Japan with offices in both Tokyo and Silicon Valley, aims to add value by taking the underutilized intellectual property within large firms and spins them out into companies with Silicon Valley management.

Demographic Change as Opportunities from Resource Scarcity

Beyond the observations that it is the world's third largest economy and has a very large pool of technologically savvy, a deep pocketed middle class also provides a market for

various IT services. Japan's rapidly aging population and shrinking workforce are actually opportunities, from both the policy and technology standpoints.

Japan's demographic challenge is actually an opportunity for deploying artificial intelligence and human activity-replacing algorithmic automation. Political debates that are likely to occur elsewhere about replacing human labor by automation, AI and robotics in Japan can be seen as a necessary augmentation of a shrinking labor force. In an era when searching for high quality data is critical to improving algorithms, the abundance of data that can be gathered from Japan's aging society in terms of health, lifestyle, and machine-human interfaces through eldercare robots or companions, for example, can be highly valuable. The question, of course, is who best gathers and uses this data, but Japan is unmistakably a leader in the global advanced industrial country trend of demographic change.

Government Policy: Potentially to Foster Deployment, Experimentation, Market Access

Government policies in terms of direct subsidies or industry promotion are less likely to work in the current era of rapid IT-enabled transformations. The era of "Japan, Inc." if it ever existed, no longer applies.

However, unknown to most observers both inside and outside Japan that are not part of the biopharma industry, Japanese government regulations have actually led to potential industry leadership in an important niche area. A revision of the Pharmaceutical Law that came into effect in 2014 enabled regenerative medicine, which utilizes growing new cells from the iPS cell (a stem cell alternative that does not need to be harvested from

a human embryo), to bring products to market during clinical testing in two years. Shrinking the time needed from around ten to two years made Japan's timeframe the shortest among advanced industrialized countries. This led to a wave of regenerative startups from around the world to open branches in Japan and conduct trials in Japan as well. Some Japanese startups such as San Bio, for example, were founded in Silicon Valley but moved to Japan when the regulatory changes enabled a potentially faster time to market. While it is still early to tell whether these regulatory changes actually enabled Japan to be a leader in regenerative medicine, the fact that one of the areas where Japan was long criticized for being slow—clinical trials and pharmaceuticals—has moved to be a fast mover, even if a small market segment, is significant. If this paradigm can be applied to pharmaceuticals, there may be the potential to do so elsewhere as well.

An area where progressive policymaking can be beneficial is in the usage of individual data. Since the availability and usage of behavioral and biometric data will be critical in all areas, ranging from biotech to financial technologies (Fintech), the array of Internet-connected devices and sensors (known as the "Internet of Things (IoT)") and artificial intelligence, government policy that encourages the use of such data may be beneficial. For example, standards of privacy that stipulate sufficiency levels of anonymization and protection that enable companies to use or sell data collected from individuals can be useful, has potential. Rather than fear open-ended liability or the potential for public criticism leading to companies hoarding data out of caution, government standards that enable them to safely use and contribute anonymized data could spur their collection and use.

Government measures to facilitate increased efficiency, such as digital signature regulations that can reduce transaction costs for the vast amount of paper forms currently being mailed and stored in file cabinets and handled by human work hours, are also beneficial.

Historically, since it has been large lead firms deploying IT tools that have led to leaps forward, Japan, with its concentration of large firms, spurred by competition and cooperation with the newly burgeoning startup ecosystem, has the potential to take such leaps.

Thus, while there is no cohesive model of the emerging "new Japan," this paper has shown that there are clearly areas in which Japan matters, both in building upon its existing large firms strengths, and from an underappreciated but significantly transformed new high growth startup ecosystem. The demographic change as a source of data and acute need for a variety of healthcare related services should also be seen as a not simply a series of constraints, but significant opportunity for why Japan matters.

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