1 Introduction

Most analyses of Japan since the beginning of the twenty-first century portray a scenario of doom and gloom. As the world prepares for the digital transformation (DX), it is often assumed that leadership in future industries such as big data analysis, the cloud, and artificial intelligence will belong to the United States and China.[1] Japanese companies are generally seen as too slow or too weak to compete, and Japan's economic structures are considered too ossified, stagnant, and unproductive.[2] What is more, Japan is the first country in the world to face rapid demographic change, with the population predicted to shrink by 25 percent in the next three decades, from 126 million to fewer than 100 million people by 2050. By 2040, 36 percent of Japan's population will be older than sixty-five years (Cabinet Office 2020a). This has not only made labor shortage a certainty but has also raised grave concerns about the future fabric of Japanese society and economy, as well as its sustainable prosperity and social security.

To many observers, these two trends' co-occurrence means Japan is destined for obsolescence. However, if one looks beyond the macroeconomic indicators and demographic prognostications, the story is not so simple. Together, the digital transformation and demographic change create a window of opportunity for Japan, where the changing needs of labor are creating space for companies to explore and shift to new strategies, which in turn are facilitating a rewriting of the mutual rights and obligations between government, business, and labor that defined Japan's twentieth-century political economy.

The term "digital transformation" refers to the great advances in computing powers and analytical techniques, as well as communication and vision/sensing technologies that combine to create a new world of 5G-enabled constant connectivity, autonomous systems and robotics, blockchain, artificial intelligence and machine learning (AI/ML), data mining, and governance through "the cloud." For industry, these advances coalesce into what has been termed "industry 4.0," that is, the arrival of digital manufacturing, which will upend what we know about operations management. For humans, they bring the next step of our evolution, into "society 5.0," namely, a constantly connected society based on autonomous systems for most service needs.[3] The digital transformation will be borderless,

[1] For example, "Why China can race ahead in digital economy," *CGTN*, September 18, 2019.
[2] For example, Glosserman (2019), McKinsey and ACCJ (2021), and "Too rich, too comfortable: Why Japan is so resistant to change even as disaster looms," *Quartz*, April 2, 2019.
[3] The term "industry 4.0," also called the "fourth industrial revolution," was coined in the early 2010s by German trade associations lobbying for government investments in future technologies. It soon became a rallying cry for increasing competitiveness in Japan, which added the concept of "society 5.0" to refer to the next step in human evolution, following the stages of hunting/gathering and the agricultural, industrial, and information societies; www8.cao.go.jp/cstp/english/society5_0/index.html

ubiquitous, and inescapable, and it has already begun. It is about to affect all industries, societies, and continents in similar ways. The nature of competition, the meaning of production, the demarcation of industrial sectors, and the identity and assignments of workers will all evolve. In many countries, the realization of these impending changes has brought fears of a world taken over by robots, riddled by social displacement and distress, governed by algorithms, and regulated in ways that favor machines over humans (e.g., Brynjolfsson and McAfee 2016; Ford 2016; Acemoglu and Restrepo 2020).

Japan is certainly not the only country to face the digital disruption, nor is it the only country facing demographic change. But what is special about Japan's situation is the timing: Because Japan's society is ageing and shrinking earlier and faster than any other advanced nation, the demographic shock and the digital transformation are arriving at exactly the same time. To visualize this coincidence, Figure 1 shows Japan's working population in the top solid line (see Section 2 for comparative demographics), as well as

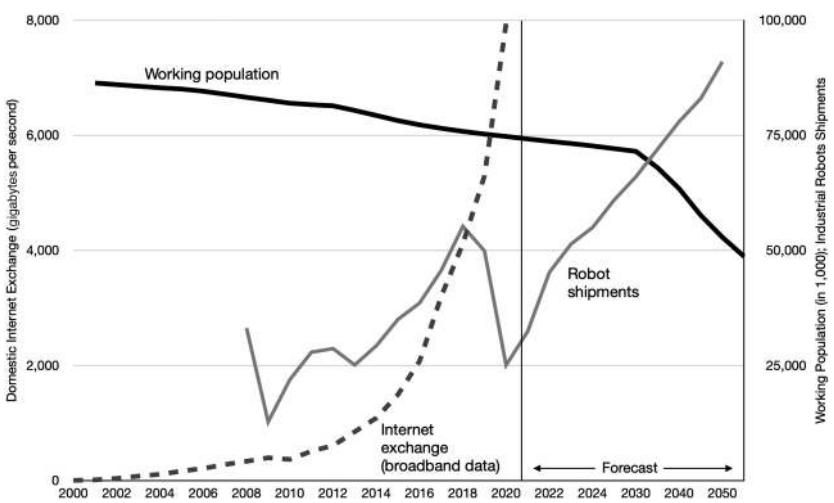

Figure 1 Demographic change and indicators of the digital transformation in Japan

Note: Decline in working population (in 1,000 people, right axis, top line), industrial robot shipments (right axis), and broadband-based data use, peak traffic in December of each year, left axis[4]

[4] Constructed from: Population: NIPSSR, Population Projections for Japan, 2001–2050, www.ipss.go.jp/pp-newest/e/ppfj02/ppfj02.pdf; Robots: IFR 2020 World Robotics Report, https://ifr.org/ifr-press-releases/news/record-2.7-million-robots-work-in-factories-around-the-globe; Japan broadband data use: Ministry of Communication, www.soumu.go.jp/menu_news/s-news/01kiban04_02000160.html

two indicators of technological change. The first is the rapid increase in fixed-line broadband data exchange (dashed line). This began to rise in the 2010s and increased exponentially with the 2019–20 COVID-19 pandemic and the shift to telework. The gray line represents a second indicator, the number of shipments of multiuse industrial robots. While it declined during COVID-19, it is now conservatively estimated to grow at least at 5 percent year-over-year.

This coincidence presents a window of opportunity, a "lucky moment," for Japan. The simultaneous arrival of the two disruptions – ageing society and shrinking workforce *cum* digitization of industry and society – brings not so much a threat, but rather, the solution. Far from throwing Japan into obsolescence, they offer an opportunity to combine two negatives into one positive. Japan may emerge a stronger economy and society for it, as each disruption can solve the problems caused by the other. The arrival of automated systems at a time when many traditional industries are suffering from decline and labor shortage means that workers need not be displaced, and automated production, blockchain logistics, and stores without cashiers can proliferate without the societal upheaval and friction that is so often feared. At the same time, the digital transformation is opening new avenues for Japanese industry to compete. Globally, new technologies create new markets that allow for business growth and productivity gains. Domestically, as companies pivot and reinvent, they have new demand for specific labor skills. This is happening just at a time when the looming labor shortage is increasing the bargaining power of labor, in particular the highest skilled segment. The new power relations are allowing employees to renegotiate the time-honored institutions of Japanese labor relations.

When hearing about the ageing society and the digital disruption, most people conjure up images of a cute-looking robot helping an elderly person with a daily chore. Indeed, Japan is often said to be a leading innovator around robotic applications for nursing and "silver" entertainment.[5] However, in this Element we look at something much broader and deeper. The digital transformation is much more than just an increase in robots, or even the interaction between robots and society. It is about a fundamental shift of economic activity, a deep-seated transformation of what sectors of the economy perform what types of business, how production is governed, how productivity is measured, and how goods and services are presented and consumed.

[5] "Robots take part in Japan's elderly care," *CGTN*, June 30, 2019; "Aging Japan: Robots may have role in future of elder care," *Reuters*, March 27, 2018.

For business, this necessitates a complete "model change," as Toyota CEO Akio Toyoda labelled it.[6] For society, this means a redefinition of self, privacy, and lifestyle, as well as a shift from owning things to consuming subscription services, and to working in fully automated settings and moving in automated systems, with constant connectivity and information updating. For government, the digital disruption requires a redesign of regulation and policymaking in a world governed by ubiquitous connectivity, immediate information sharing, and borderless competition. Japan's social contract – the tacit agreements of the rights and responsibilities of business, people, and the state – is also being rewritten. This means, Japan's entire political economy is in the process of being updated for the "society 5.0" version. The twin disruptions are occurring with certainty; they cannot be avoided. This leaves the government with no choice but to adjust to the shifting industrial and societal architecture.

Japan's rapid economic growth after WWII was characterized by proactive "industrial policies" that consisted of the rank-ordering of industries and anointing of champions to streamline growth through within-industry coordination. The digital transformation is now shifting the global technology frontier to places that the state can no longer organize or coordinate. For companies, the need to compete in the global race for deep-technology advances necessitates new business strategy. For the state, industrial policy needs to be redesigned to support corporate strategies that transcend industries and even economic sectors, as the overall governance of Japan's markets evolves. In 2020, Japan was the first country to appoint a "Minister of Digital Transformation" *(Dijitaru kaikaku tantō daijin)*, to design a Digital Agency (*Dijitaru-chō*) within the government tasked with bringing about a reorganization of ministries, responsibilities, and policymaking processes.

As of 2022, hardly a day goes by where the "digital transformation" is not front-page news in Japan. As this term is unwieldy, especially in Japanese *katakana*, it has been abbreviated as the "DX." We will adopt Japan's term of "DX" here, to refer to this coming technology–society–strategy shift in its entirety. In the United States, even though the "digital transformation" is still spelled out, new vocabulary has emerged to describe the coming industry-specific disruptions, often as a portmanteau ending with "-tech," such as fintech (financial services), insurtech (insurance), agrotech (agriculture), proptech (real estate), matech (marketing), or medtech (health sciences and medical devices).

The goal of this Element is to lay out how the combination of the DX and demographic change are changing the underlying logic of Japan's political

[6] "In search of Akio Toyoda's successor: Toyoda wants a new culture," *Automotive News,* April 15, 2019.

economy, through the upheaval of the country's industrial architecture and employment patterns. We show how industries such as agriculture and the manufacturing sector are evolving, and how the DX is affecting employment, skill formation, and education. Existing assumptions and definitions regarding how to divide economic activity into sectors, or how to assess policy successes, are no longer meaningful as the evolving business models straddle sectors and the technology race is global. The DX reduces corporate resource dependence on the state and empowers businesses with deep technology expertise. The COVID-19 pandemic has only accelerated these shifts, by pushing forward work style changes, shifting career ambitions, and the phasing out of legacy business sectors. In the new political economy, neither business nor people nor the state will work as they used to.

As the first country to face the onset of demographic change, Japan becomes a trailblazer. Its experience may shape how other countries utilize the DX for domestic social policies, and its mistakes may prove relevant for others. As the third-largest economy in the world and a leader in advanced production technologies, materials, mechatronics, and system solutions, Japan has the resources to be a strong global competitor at the technology frontier that is the manifestation of the DX. In what role and with what capacities the Japanese state will emerge, and how Japan's political economy is preparing to compete is likely to be once again an important case study.

We focus on the opportunities that the twin disruptions are opening up for Japan. Of course, the DX will create similar opportunities for Japan's global competitors, and it is unknown who will win in the jockeying for position at the technology frontier, or who will dominate the global supply chains of the future. Within Japan, too, there will be losers. These will include large firms that fail to adapt, and small firms and other parts of society that are left behind in low-productivity parts of the economy. To what extent these are stuck will depend on how the state will be able to compensate them, and how companies will adapt and reskill. The "lucky moment" may create new opportunities for the state to minimize some of these costs, as we allude to in Sections 5 and 6. That said, we will focus on the DX change process and the new constellations that are emerging. A study of the social costs as well as the role of small firms in Japan's DX is beyond the scope of this Element and left for future research.

Our discussion will be structured as follows. We understand "political economy" to mean the interplay between business, people, and the government. We will analyze their relationships in three main sections in this Element.

For *business,* we are interested in how companies are adjusting corporate strategies for deep-technology innovation and business models that embrace

servitization. The DX will require new skills, new specialization, and new approaches to innovation and measures of profitability. Japan's leading companies are redefining their core businesses and identities to become providers of deep-technology solutions.

We use the label of *people* to refer to demographic change and the labor shortage, as well as changes in Japanese employment practices.[7] The DX will require new designs and processes in education as well as the reskilling of the current workforce. Further, the newly emerging job mobility has begun to alter the rights and responsibilities of employers and employees, just as the DX is removing old jobs and creating new ones.

The role of the *state* is also changing as the government no longer has the answers in a VUCA (volatile, uncertain, complex, ambiguous) world. Power relations between politicians and bureaucrats have changed, old industrial policies no longer apply, and fewer young people are applying to government jobs. But the DX is also bringing new tasks for the state, from geo-economic strategies to protect Japan's global production networks, to education, retraining, and intellectual property protection.

We begin, in Section 2, with an introduction of definitions, examples, and basic data on the DX and demographic change. Section 3 offers context with a succinct summary of Japan's post-WWII political economy, as needed to appreciate the transformations analyzed in this Element. Sections 4, 5, and 6 look into the actual DX that is underway, by presenting detailed case studies on evolving business strategies, employment patterns, and state policies. Each section presents examples of how the DX has already impacted Japan. Section 7 concludes that the "lucky moment" gives each of the three pillars of Japan's political economy a push toward finding a new identity. Whether Japan will be successful is unknown at the time of this writing. Most likely, mistakes will be made, strategies will get thwarted, and losers will suffer. But good or bad, Japan's experience will soon repeat across parts of Asia, followed by Europe. How Japan prepares, and how we can best analyze and assess Japan's progress, will be meaningful for many other countries.

2 Definitions: The Digital Transformation (DX) and Demographic Change

This section introduces the core concepts we will discuss, to set up the case studies of ongoing change and transformation. To illustrate the ground-shifting

[7] The study of people as consumers and the adaption of new technologies is a separate research agenda that requires tools and frameworks from sociology and psychology. We leave this topic to future research.

impact of the DX, we begin with a glimpse into the future of the automobile industry, which is morphing from a manufacturing into a "mobility-as-a-service" (MaaS) business. We then present our argument for why the DX is inescapable, an analysis of what the DX means for Japanese business, and data on demographic change in Japan.

2.1 Vignette: The Automobile Industry of the Future

Imagine it is the year 2030. Like most other people, you no longer own a car. Instead, your transportation needs are filled through a monthly subscription service, similar to how Spotify or Netflix answers your audio-visual entertainment needs today. For a monthly fee, you are assured the provision of just-in-time mobility services. When you need to go somewhere, your phone presents you with a menu of transportation modes. Your choices may include a self-flying automobile for a short hopper, or a car that is parked in your immediate vicinity and will arrive promptly. This could be either electric, solar, or hydrogen-powered. It will be self-driving, and quietly and expeditiously take you to your destination.

If you think that 2030 is too soon for this utopian scenario to materialize, note that some of these options already exist, such as the German corporate car-sharing company *fleetster*, or Zipcar in the United States. In fact, the Toyota Motor Corporation – the world's largest auto maker in 2022 – expects all of this to materialize much sooner. In 2019, Toyota launched "KINTO," a subscription service car company, as well as "Toyota Share," a car-sharing service.[8] In April 2021, Toyota acquired Lyft's self-driving unit, to enhance its existing "e-Palette," a self-driving, battery-powered electric small bus that was launched to transport athletes and visitors to and from venues during the 2020–1 Tokyo Olympics.[9] Earlier, in 2017, Toyota had invested $400 million in a group of Tokyo-based Japanese engineers who were moonlighting on a flying car project. In August 2020, their company, SkyDrive, Inc. made its first safe "test fly" in Aichi Prefecture with a three-wheeled drone that can carry one person. Of over 100 global flying car projects at the time, SkyDrive was one of only a few to take off and land safely.[10] To double down on its bets on the flying car, in 2020 Toyota invested another $400 million in Joby Aviation, a California-based

[8] Toyota Annual Reports of 2018 and 2019, https://global.toyota/en/ir/library/annual/

[9] Toyota website, www.startyourimpossible.com/en-us/mobility; https://global.toyota/en/newsroom/corporate/29933371.html; "Toyota to buy Lyft unit in boost to self-driving plans," *Reuters,* April 27, 2021.

[10] "Toyota eyes flying car future," *Industry Week,* May 15, 2017; "Japanese flying car startup aces driver test," *Observer,* August 28, 2020. Toyota's main competitors in 2020 included Hyundai, Airbus, a JV between Porsche and Boeing, Uber, Google, and possibly Apple, and startups companies such as eVolo (Germany) and EHang (China).

startup company. Its eVTOL (electric, vertical take-off and landing) machine looks like a small helicopter but with six horizonal rotators.

These efforts are all in pursuit of a new corporate vision for Toyota to become the world's leading MaaS provider. Toyota aims to dominate an industry that will morph automobile manufacturers into transportation operators of electric, self-driving vehicles and drones. This will represent a complete identity change for Toyota as a company. In the 2010s, Toyota earned annual revenues of about $250 billion by selling roughly nine million cars globally. Now, Toyota envisions a future where it no longer sells cars at all.[11] It may still make cars, flying and otherwise, but they will constitute the Toyota rental fleet that offers on-demand transportation and other services.

Traditionally, car companies have been designers and assemblers that oversee a large supply chain of part makers. The assembly process is complicated and characterized by significant economies of scale (Womack et al. 1990). As we will see in more detail in Section 4, "industry 4.0" now brings a shift to digital manufacturing that dramatically alters the logic and economics of production. In addition, in this shift to MaaS the design and product characteristics of a "car" are also turned upside down. Traditionally, car companies have competed with style, design, and engineering, all on a spectrum ranging from high-quality workmanship to low-price affordability. But in a future with no personal ownership, markers such as status, brand, looks, or engine (or motor) size will soon be irrelevant. Instead, going forward, the vehicle itself will become standardized and commoditized. This will be necessary in order to strip it of any idiosyncratic complications and make it as user-friendly and interchangeable as possible for the shared economy.

Add to this "servitization," that is, the creation of business models based on revenue generation from subscriptions and other platform offerings. Until now, car maker services have consisted of leasing and repair services offered through dealerships. These were often seen as a necessary by-product of the core business of manufacturing.[12] Going forward, transportation services will be the new core business, and add-on service offerings will provide differentiation from competitors. Such offerings may include in-vehicle entertainment options, well-being programs, concierge and shopping services, and of course, user data collection.[13]

[11] Toyota Annual Reports of 2018 and 2019, https://global.toyota/en/ir/library/annual/; Toyota investor relations website, https://global.toyota/en/ir/financial-results/

[12] METI (2018b, 2019a), and www.emeraldgrouppublishing.com/topics/blog/what-servitization-manufacturing-a-quick-introduction

[13] Toyota's 2019 "Connected and MaaS strategy" had three components: a mobility service platform for transportation, big data processing for traffic optimization, and additional mobility and daily-life services. "Toyota's connected and MaaS strategy," presentation, February 6, 2019, https://global.toyota/pages/global_toyota/ir/presentation/2019_q3_competitiveness_en.pdf; Ryōsuke Izumida, "Toyota no MaaS senryaku, sekai de no genzaichi wa doko ka" (Where in the world will Toyota's MaaS strategy play out?), *Nikkei BizGate*, October 4, 2018.

Winners in the MaaS business competition will be those that offer the most immediate, reliable, and comfortable mobility solutions, at the best price. They will grow revenues with larger market share, which increases user data collection, which can be used or sold to marketing firms. That is, success will depend on how much traffic – literally and figuratively – the MaaS provider can attract to their platform.

Servitization will also bring a new meaning to the profession of the "car worker," which is shifting from a factory to a desk job. Employees of MaaS companies will have assignments ranging from IT and advanced operations management to logistics, mapping and data solutions, and designing and managing third-party offerings and alliances. Japan's shrinking workforce helps in this transition, as the labor shortage is already causing factory work problems. We will see in Section 5 how large companies are rolling out programs to "reskill" their existing office and shopfloor workforce. For younger workers, the government has launched an education reform, including the redesign of high school curricula as well as university course offerings to prepare the next generation of car workers for platform services jobs. For companies, the shrinking workforce leaves no choice but to retrain existing workers, and this affords Japan as a nation a chance to upgrade the skill level of its entire labor force. It also presents an opportunity to funnel the top talent into new and innovative assignments with fast-track promotions in ways that do not necessarily undermine the existing lifetime employment system.

The tectonic shifts in business models in Japan's car industry are but one example. They repeat across industries, as we will see in Sections 4 and 5. Automobiles have long been one of Japan's largest and most successful industries. Their pivot into a completely new business realm with different profit and employment logics is a harbinger of the changes that are to arrive for Japan's entire industrial architecture, which is being disrupted at the core.

2.2 What Is the DX?

The DX is much more than a replacement of people with machines. It brings tectonic shifts in economic activity, industrial organization, revenue generation, connectivity, and access to information. This shift is coming about thanks to recent rapid advances in technology, especially in data collection through connectivity, storage capacity, and computing powers. DX technologies are divided into hardware and software. The hardware infrastructure consists of advanced communication (5G), sensors and vision technologies, embedded communication tools in all buildings, systems, parts, and machines (the IoT, "internet-of-things"), edge computing devices (on-site data governance), and

"the cloud" (data center governance). These new hardware capabilities in turn have triggered great advances on the software side, namely in the collection and analysis of data, including unstructured data such as video. The tools developed for "mining" (deciphering, sorting, analyzing) these scrambled data are labelled artificial intelligence and machine learning (AI/ML). In combination, these technologies disrupt how economies are structured, industries organized, companies compete, governments rule, and people work and communicate (METI 2017, 2018b, 2020b; Kimura and Numata 2018).

Despite the constant news coverage on these developments, as of 2022, many still wondered how soon the DX would truly arrive, and to what extent people would resist the intrusions into privacy that these shifts will mandate. Indeed, there were still few use cases to prove the superiority, or even basic utility, of some of these advances, such as bitcoin, blockchain, or flying cars. Some even claimed that AI did not yet exist beyond some basic levels of visual pattern recognition, or that as a matter of personal daily-life experience, infrastructure was not nearly advanced enough to even allow ubiquitous access to the internet. Inadequate cybersecurity was also becoming a major concern.

Yet, from the perspective of policymakers and strategy planners, in the public and private sectors, the DX is already a force to be reckoned with. It will arrive with certainty, sooner rather than later. Nearly all policymakers, around the world, have realized that they cannot afford to postpone preparations for a future that is sure to arrive and needs to be shaped to serve the national, societal, economic, and human interest. The DX has three salient features that make it a critical juncture for all countries, and will touch all actors and institutions of a political economy:

1) *Speed and volume* of information exchange. Whereas it used to take several weeks, days, hours, or minutes to transfer a few words across the world, information is now shared instantaneously. The volume of information transmittals is growing rapidly. Inventions spread faster and are adopted more rapidly. This can be exploited for good and sinister purposes, with potential for huge advances or conflict. For any domestic political economy, the arrival of the DX means that policy decisions can no longer rely on using "time" either as a competitive advantage or a regulatory delay to allow slow adjustments.
2) *Ubiquity.* The "internet-of-things" (IoT) means that every single thing, every machine, every input part, every household item, and every person – and even every pet – is constantly connected to everything else, generating volumes of data along the way. What seemed to be a science fiction movie just a few years ago is now reality; in this new world, a smart watch can talk to a refrigerator to