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## Intermediary Functions and the Market for Innovation in Meiji and Taishō Japan

Japan experienced a transformational phase of technological development during the late nineteenth and early twentieth centuries. We argue that an important, but so far neglected, factor was a developing market for innovation and a patent-attorney system that was conducive to rapid technical change. We support our hypothesis using patent data and we also present a detailed case study on Tomogorō Ono, a key developer of salt-production technology who used attorneys in connection with his patenting work at a time when Japan was still in the process of formally institutionalizing its patent-attorney system. In accordance with Lamoreaux and Sokoloff's 1999 influential study of trade in invention in the United States, our quantitative and qualitative evidence highlights how inventors and intermediaries in Japan interacted to create a market for new ideas.

Few episodes in modern business history can match the scale and significance of Japan's economic reversal from relative economic backwardness during the feudal Tokugawa period to Meiji era modernization. At the heart of this transformation was a concerted push by the new Meiji government to nurture industrial development.<sup>1</sup> New institutions, such as legal frameworks permitting limited liability businesses to be established and a banking system to channel finance into industry, created a radically different economic environment for development. Technological innovation was prioritized by the government. Notably,

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<sup>1</sup>For a summary of this literature, see Hiroyuki Odagiri and Akira Goto, *Technology and Industrial Development in Japan: Building Capabilities by Learning, Innovation and Public Policy* (Oxford, 1996).

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the well-known *Gokajō no Goseimon* [Charter Oath of Five Articles] declared by the new Emperor at the start of the Meiji Restoration in 1868 stated that “knowledge shall be sought throughout the world to strengthen the empire.”<sup>2</sup> Why innovation was so crucial to Japanese policy makers at the time is evident from endogenous growth models where innovation is a main determinant of economic development as inventors continuously engage in the search for new ideas.<sup>3</sup>

In this article we take a closer look at the factors that were encouraging technological development during the Meiji (1868–1912) and Taishō (1912–1926) eras. We focus on the Meiji era because the sources of long-run growth can be traced back to these years.<sup>4</sup> Importantly for our purposes, we also cover the period when Japan instituted its first patent system, and our analysis relies extensively on data from patent records. We also cover the Taishō era because during this period Japan began to formalize its patent-attorney system, an institution that we believe (both in its nascent and formally institutionalized stages) played an important role in promoting innovation. We argue that innovation flourished in an economic context where inventors were incentivized to invest in the search for new knowledge.

The development of a market for innovation was not the only factor driving Japanese industrialization, and we do not identify a causal relationship. However, the literature has so far comparatively under studied this factor. The fact that it should be considered is consistent with mechanisms outlined in the literature on the importance of market-based technology exchanges. According to Ashish Arora, Andrea Fosfuri, and Alfonso Gambardella in *Markets for Technology: The Economics of Innovation and Corporate Strategy*, innovation markets play a critical role in economic growth because they “promote the diffusion and efficient use of existing technology and can enhance the rate of technological advance by providing additional incentives for research and development.”<sup>5</sup>

We show that inventors in the Meiji and Taishō eras could expect to receive payoffs through the commercialization of innovation or from

<sup>2</sup> Wilhelm Röhl, “Public Law,” in *History of Law in Japan since 1868*, ed. Wilhelm Röhl (Leiden, 2005), 31.

<sup>3</sup> See in particular, Paul M. Romer, “Endogenous Technological Change,” *Journal of Political Economy* 98 (1990): S71–S102; Gene M. Grossman and Elhanan Helpman, *Innovation and Growth in the Global Economy* (Cambridge, MA, 1991); Philippe Aghion and Peter Howitt, “A Model of Growth through Creative Destruction,” *Econometrica* 60 (1992): 323–51.

<sup>4</sup> See further, Henry Rosovsky, *Capital Formation in Japan, 1868–1940* (Glencoe, 1961); Kazushi Ohkawa and Henry Rosovsky, *Japanese Economic Growth: Trend Acceleration in the Twentieth Century* (Stanford, 1973); Allen C. Kelley and Jeffrey G. Williamson, *Lessons from Japanese Development* (Chicago, 1974).

<sup>5</sup> Ashish Arora, Andrea Fosfuri, and Alfonso Gambardella, *Markets for Technology: The Economics of Innovation and Corporate Strategy* (Cambridge, MA, 2001), 8.

patent sales. Evidence from patent records supports our argument and highlights detailed interactions between inventors and intermediaries; we also examine qualitative archival evidence. Specifically, we present a case study on Tomogorō Ono (1817–1898), an influential salt-industry innovator who extensively used attorneys in connection with his patenting work. Our quantitative and qualitative sources, when taken together, indicate the importance of institutional foundations and intermediation between inventors and attorneys during the process of Japanese modernization.

The remainder of the article is organized as follows. In the next section we outline our main argument using patent data. Then we provide a more detailed account of patent law and the patent-attorney system, which we argue were important factors driving technological change in Japan during the nineteenth and twentieth centuries. We then present our case study on Tomogorō Ono, a salt-industry technologist and entrepreneur, to highlight the significance of interactions between patent agents and attorneys. In a final section we summarize our evidence and conclude with some broader implications of our findings.

### Evidence from Patent Data

Figure 1 presents statistics on the number of patents that were involved in a sale transaction between 1886, the year after the Monopoly Patent Ordinance was passed in 1885, and the final year of the Taishō period in 1926. We derived the data from statistics on ownership transfers held in the archives of the Japanese Patent Office in Tokyo. Although the documents aggregate sales and other types of exchange such as intergenerational transfers, for specific years the official figures provide disaggregated statistics for the share of transfers comprising patent sales alone. We present data on patents sold both in absolute terms and scaled by all patents registered in the same year. Notwithstanding fluctuation year to year, 14.4 percent of all patents were sold, on average, over the period as a whole.

To the best of our knowledge no directly comparable data exists for other countries at this time, but benchmark evidence suggests that the sale of patents in Japan was economically important. Naomi Lamoreaux and Kenneth Sokoloff's pioneering work, "Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries," from 1999, suggests that a market for innovation was widespread in the United States, as revealed by patent assignment contracts. Although assignments are not synonymous with sales (they may, for instance, reflect contracts between employees and firms as opposed to arm's-length transactions between inventors and buyers), they show

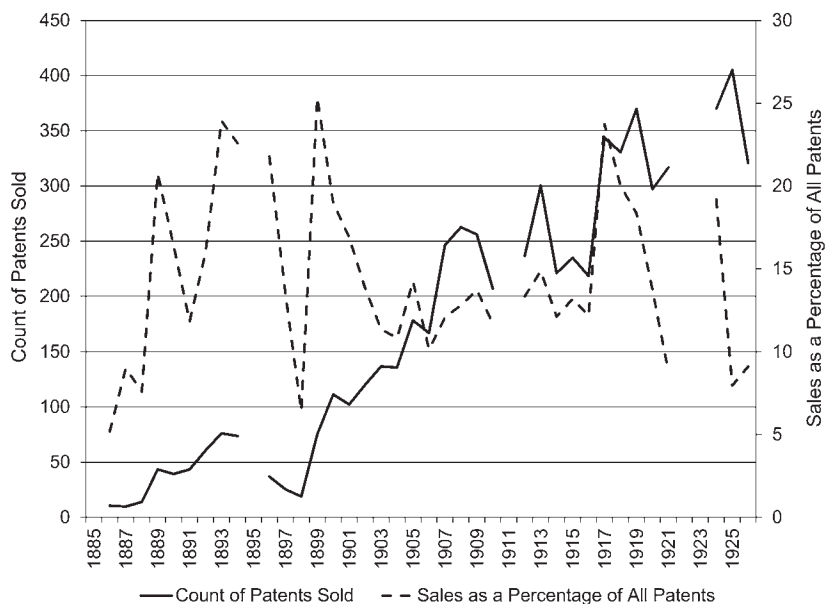


Figure 1. A market for innovation. (Sources: Data compiled from: *Kōgyō Shoyūken Seido Hyakunenshi* [100-Year History of Industrial Property Systems], Additional Volume, 166–69. See also Tom Nicholas, “Independent Invention during the Rise of the Corporate Economy in Britain and Japan,” *Economic History Review* 64 [2011]: 995–1023.)

that an average of 26.3 percent of patents across three cohorts of patents (1870–71, 1890–91, and 1910–11) were subject to an assignment contract, or an average of 13.9 percent when excluding assignments to a group that included the inventor. This latter percentage is most closely comparable with our data for Japan because it excludes potentially non-arm’s-length transactions.<sup>6</sup> Carsten Burhop finds that “about 8 percent of patents were transferred at least once during their existence” in late-nineteenth and early-twentieth-century Germany.<sup>7</sup> Finally, for modern US data Carlos Serrano observes patents that were transferred net of inventor-to-employer assignments, and he finds that 13.5 percent of patents granted between 1983 and 2001 were traded at least once over the lifespan of the patent.<sup>8</sup> Therefore, both historical and modern

<sup>6</sup>Naomi R. Lamoreaux and Kenneth L. Sokoloff, “Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries,” Table 1.2, 28, in *Learning By Doing in Firms, Markets, and Nations*, ed. Naomi R. Lamoreaux, Daniel M. G. Raff, and Peter Temin (Chicago, 1999), 19–57.

<sup>7</sup>See further, Carsten Burhop, “The Transfer of Patents in Imperial Germany,” *Journal of Economic History* 70 (2010): 921–39.

<sup>8</sup>Carlos Serrano, “The Dynamics of the Transfer and Renewal of Patents,” *Rand Journal of Economics* 41 (2010): 686–708.

benchmarks derived from United States patent data imply that the share of Japanese patents sold in Figure 1 corresponds closely to those observed in a well-functioning market for technology.

The value of patent capital being transferred was economically significant. For the period 1901 to 1908, records are available showing patents with a value of ¥1,000 or higher where value was determined either by a transfer of the patent or by the patent's collateral value when an inventor secured a loan. We record 130 patents with a transfer or collateral value of almost ¥566,000, which in current prices is equivalent to approximately ¥805,000,000 or \$10,000,000.<sup>9</sup> Between 1906 and 1908, we record separately aggregate figures for patent transfers and patents used as collateral. These show 26 out of 80 patents were transferred with a total value of ¥143,000, equivalent to an average of ¥5,500 per patent, or in current prices ¥7,820,000 or \$102,000 per patent.<sup>10</sup>

More granular data in Table 1 provide an insight into the nature of sales transactions that were taking place. Independent inventors active in the market for technology between 1897 and 1899 sold all patents listed. The types of inventions sold include scientific measuring instruments, armaments, textiles, and food industry inventions. Patents were sold to individuals or to firms such as *Tōkyō Seitan KK*, a metal and engineering firm, *Nippon Nōgyō KK*, an agricultural equipment manufacturer, and *Tokkyo Enpitsu Gōshi Kaisha*, a pencil company. In some cases the patent was sold outright. In others the invention was sold on a restricted geographic basis (see patent number 2,009), a practice that was also common in the United States during the late nineteenth century.<sup>11</sup> Data on the time between the year the patent was registered at the Japanese Patent Office and the year of the sale transaction reveal that patents were traded much earlier in their life cycle as time progressed. Between 1891 and 1894, an average of five years elapsed; between 1895 and 1898, an average of two years elapsed. This finding is particularly important from the standpoint of Lamoreaux and Sokoloff's discovery that as the US market for invention developed, inventors began to "dispose of these rights more and more quickly—often—by the time the patent was officially issued."<sup>12</sup>

Figure 2 (A to C) shows that there is a general relationship between patents per 100,000 of population and gross domestic product (GDP)

<sup>9</sup>These include a method for waterproofing wool (¥16,800 in 1901), a glass tube to cover a lantern (¥10,000 in 1904), and a cigar-manufacturing machine (¥19,000 in 1905).

<sup>10</sup>Current price calculation based on Lawrence H. Officer and Samuel H. Williamson, "Six Ways to Compute the Relative Value of a Japanese Yen Amount, 1879–2009," *Measuring Worth*, 2011, <http://www.measuringworth.com/>.

<sup>11</sup>Lamoreaux and Sokoloff, "Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries," 25.

<sup>12</sup>*Ibid.*, 57.

Table 1  
Patent Sale Transactions

Patent Registration Number	Patent Registration Year	Invention	Date Sale Registered	Years between Registration and Sale	Owner	Buyer
1,187	1891	Method for waterproofing clothes	1897	6	Sōjirō Koike & Eisuke Senda	Kuni Uemura
1,612	1892	Method for making charcoal	1897	5	Sanbei Kihachi	<b>Tōkyo Seitan KK</b>
1,617	1892	Legless chair	1897	5	Kamekichi Ishida	Jihei Katō & Kichijirō Hirano
1,651	1892	Shoe strap	1897	5	Kamekichi Ishida	Jihei Katō & Kichijirō Hirano
2,009	1893	Method to produce soy sauce	1895 <sup>a</sup>	2	Tsunematsu Ishii	Kijōrō Inada
2,009	1893	Method to produce soy sauce	1898 <sup>a</sup>	5	Kiyoharu Tanaka & Shūtārō Inada	Inosuke Hata
2,009	1893	Method to produce soy sauce	1899 <sup>a</sup>	6	Kiyoharu Tanaka & Shūjirō Inada	<b>Sandajiri Shōyu Gōshi Kaisha</b>
2,040	1893	Scientific measuring instrument	1899	6	Matasaburō Kumaki	Rinzō Yōki
2,164	1894	Piston component for a gun	1896	2	Kōshirō Yamaguchi	Katsutaka Asaka
2,491	1895	Weaving machine	1898	3	Tokumatsu Tsutsui	Hatsue Takashi
2,505	1895	Furnace	1898	3	Keizaburō Yanagi	<b>Tōkyo Seitan KK</b>
2,537	1895	Machine to produce umbrellas	1898	3	Isaburō Kuroda & Shōroku Shibata	Shōnokichi Kimura
2,621	1895	Roof tiling	1899 <sup>a</sup>	4	Seisuke Chiba & Teruhisa Chiba	<b>Senbai Tokkyo Seihei KK</b>
2,636	1895	Use of tree fibers to make textiles	1898 <sup>a</sup>	3	Kumakichi Fujii	<b>China Kuwahimen Seizō Gōshi Kaisha</b>
2,643	1895	Farm shears	1899	4	Tōji Oda	<b>Nippon Nōgyō KK</b>
2,682	1896	Mold for making steel	1899 <sup>a</sup>	3	Tetsukichi Munkai	<b>Tōkyo Tekkō Gōshi Kaisha</b>
2,752	1896	Pencil	1896	0	Chōbei Yagi & Torasaburō Okada	<b>Tokkyo Empitsu Gōshi Kaisha</b>
2,837	1897	Fireplace	1897	0	Tsunematsu Yamasawa & Inokichi Akiyama	Senkichi Umeda
3,098	1898	Oil lamp	1898	0	Homikichi Kawai	Genpei Moari
3,217	1898	Sock making machine	1899	1	Kunitarō Hitroki	Hōjirō Iwashiro

Sources: For further details on the construction of these data, see Tom Nicholas, “Independent Invention during the Rise of the Corporate Economy in Britain and Japan,” *Economic History Review* 64 (2011): 995–1023.

Notes: <sup>a</sup> refers to patents for which a partial interest in the invention was sold, so that it could be used in a specific geography. Buyers in bold type are corporations. “KK” is a suffix for *Kabushiki Kaisha*, similar to a joint stock corporation. *Gōshi Kaisha* is similar to a limited partnership.

per capita at the prefecture-level.<sup>13</sup> This does not mean that more patents led to higher levels of GDP because the strength of the relationship may be due to other omitted variables, but it does mean that patents, which represent a commonly used measure of inventive activity, appear to be a significant factor associated with the level of Japanese prefecture development. Since the variables used in the figures are logarithmically transformed, the slope coefficient in each of the figures has an elasticity interpretation. Accordingly, a 10-percent increase in patents per 100,000 of population is associated with a 5.8, 3.7, and 3.0 percent increase in prefecture-level GDP for the years 1890, 1909, and 1925, respectively.

Figure 3 shows that the market for invention developed simultaneously with the growth in the importance of patent attorneys, as would be expected because these were key intermediaries. While our data are not sufficiently detailed to permit a causal examination of the relationship between patent attorneys and the market for invention, it seems clear that a necessary precondition for markets to develop was the rise of individuals specializing in intermediation. In line with Lamoreaux and Sokoloff's evidence for the United States, it is our contention that intermediaries are necessary for markets for technology to become established, and they act as a spur to the growth of market-based exchanges as the division of labor between intermediaries and inventors develops.

The function of Japanese patent attorneys spanned the activities that both patent agents and lawyers undertook in the United States. Their services were performed largely outside the regulatory structure of the patent system until the Patent Attorneys Act of 1922 fully formalized the activity. With joint legal and administrative control over the patenting process, patent attorneys could facilitate the transactions of inventors that we observe in Figure 1. Notably, attorneys were clustered in urban areas where the market for ideas was most vibrant. Statistics indicate that attorneys were spatially concentrated in the major cities of Tokyo and Osaka, with 1,730 and 374 registered in these cities, respectively, in 1930, equivalent to around four-fifths of attorneys active in the country as a whole.<sup>14</sup>

A market for technology existed at a time when Japan was closing the gap with the leading industrial nations. As Diego Comin and Bart

<sup>13</sup>We use prefecture-level GDP estimates for 1890, 1909, and 1925 that were painstakingly collected, and kindly supplied to us, by Jean-Pascal Bassino, Kyoji Fukao, Ralph Paprzycki, Tokihiko Settsu, and Tangjun Yuan, "Regional Inequality and Migration in Prewar Japan, 1890–1940," paper presented at the Asian Historical Economics Conference, Hitotsubashi University, Kunitachi, Tokyo, 2012.

<sup>14</sup>Figures compiled from various volumes of *Tokkyo Kyoku Toukei Nenpyō* [Japanese Patent Office Annual Statistical Report].





Figure 2 (facing page). Prefecture-level GDP and patents. *Panel A*: 1890. *Panel B*: 1909. *Panel C*: 1925. (Sources: Prefecture-level GDP estimates provided courtesy of Jean-Pascal Bassino, Kyoji Fukao, Ralph Paprzycki, Tokihiko Settsu, and Tangjun Yuan, “Regional Inequality and Migration in Prewar Japan, 1890–1940,” paper presented at the Asian Historical Economics Conference, Hitotsubashi University, Kunitachi, Tokyo, 2012.) Patent data scaled per 100,000 of population using figures provided courtesy of Fabian Drixler.

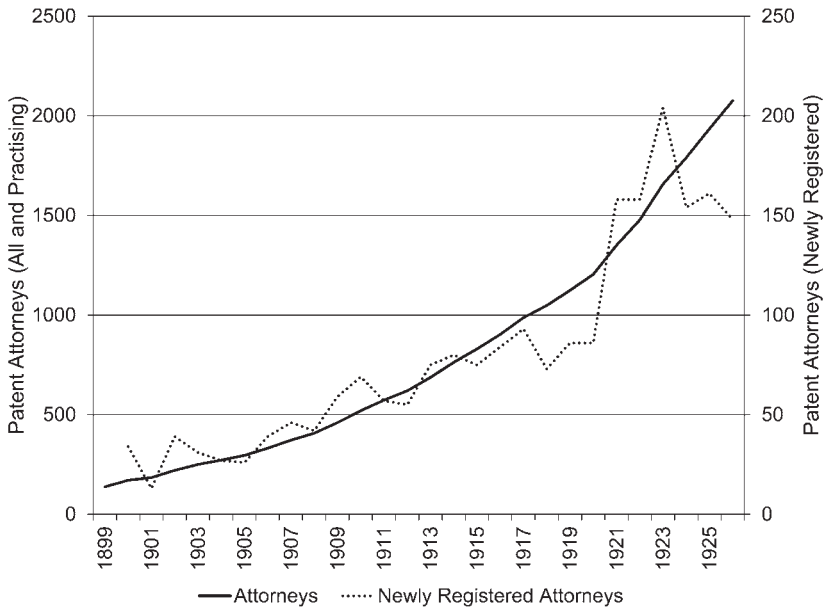


Figure 3. The rise of patent attorneys. (Sources: Data compiled from Christopher Heath, “Intellectual Property and Anti-Trust,” in *History of Law in Japan since 1868*, ed. Wilhelm Röhl [Leiden, 2005], 415–17.)

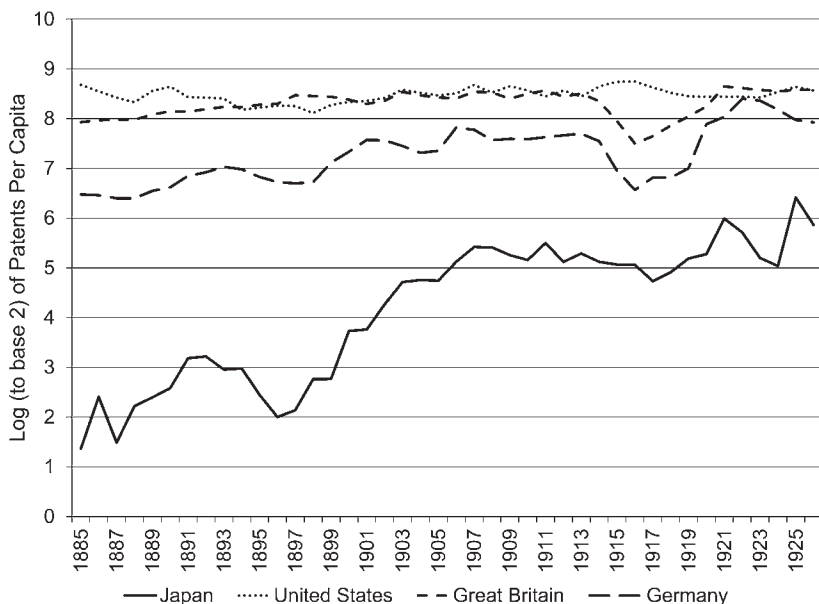


Figure 4. Trends in patents in Japan relative to other countries. (Sources: Population data taken from Angus Maddison, *Statistics on World Population, GDP, and Per Capita GDP, 1–2006 AD* [online at <http://www.ggdc.net/MADDISON/oriindex.htm>] and patents taken from *100 Years of Industrial Property Statistics* compiled by the World Intellectual Property Organization in 1983.)

Hobijn point out, by the 1870s “technological backwardness, surely, was a significant determinant of the development gap between Japan and other (now) industrialized countries.”<sup>15</sup> Figure 4 shows that from the mid-1880s patents per capita in Japan converged on patents per capita in the United States, Britain, and Germany. Notwithstanding that Japan was starting from a low level of development, the data illustrate a striking degree of Japanese technological catch-up to the frontier nations. In 1885, the log difference between the United States and Japan was 7.31, meaning patents per capita in Japan were just  $[1/(2^{7.31})] \times 100 = 0.6$  percent of the United States level. But twenty years later they were 8 percent of the United States level, and by the end of the Taishō era the rate was 15 percent of the United States level, or 15 percent and 24 percent of the British and German levels, respectively.<sup>16</sup>

<sup>15</sup>Diego Comin and Bart Hobijn, “An Exploration of Technology Diffusion,” *American Economic Review* 100 (2010): 2051.

<sup>16</sup>All of the patents per capita series are in logs with a base of 2 so that a unit change in the log is equivalent to a twofold change in the level.

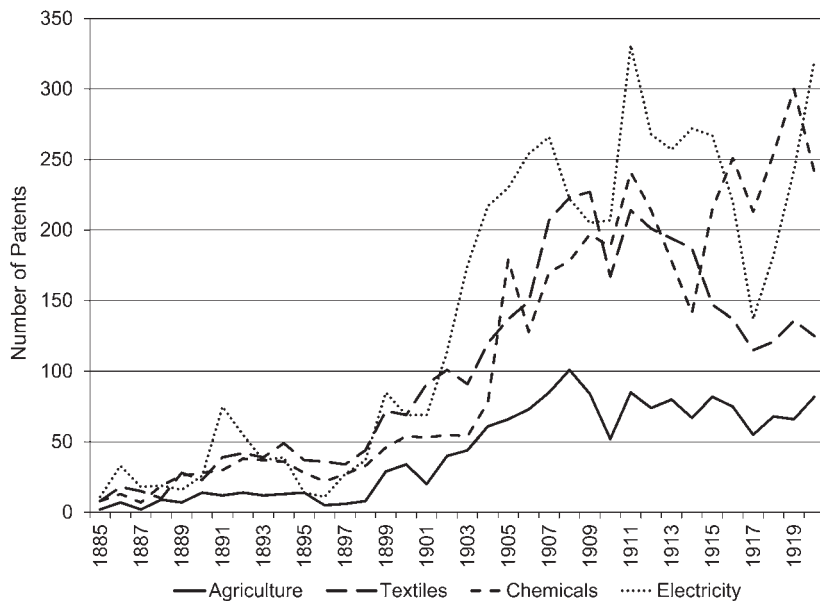


Figure 5. Sectoral changes in the distribution of patents. (Sources: Data on patent classes compiled from *Tokkyo Bunrui Mokuroku* [Japanese Patent Office Patent Classes] with categories set using the concordance of Akira Goto and Kazuyuki Motohashi, “Construction of a Japanese Patent Database and a First Look at Japanese Patenting Activities,” *Research Policy* 36 [2007]: 1431–42.)

Not only did the number of patents increase in the process of technological convergence, but the sectoral distribution also shifted. Figure 5 shows the importance of the textile industry in the patent statistics, a major sector in Japan, and a distinct trend towards the progressive sectors of chemicals and electricity from around 1900. Chemicals and electricity became focal areas of technological development and productivity growth in the United States.<sup>17</sup> Ryoshin Minami claims that the electrification of Japanese manufacturing establishments was wholly a function of borrowed technology, which is to be expected given that firms such as Tokyo Electric and Shibaura Engineering Works, Ltd., which General Electric partially owned, made a number of key investments.<sup>18</sup> In fact, the market for technology involved not only patent sales by inventors but also arms-length transactions between firms through

<sup>17</sup>Petra Moser and Tom Nicholas, “Was Electricity a General Purpose Technology? Evidence from Historical Patent Citations,” *American Economic Review Papers and Proceedings* 94 (2004): 388–94.

<sup>18</sup>Ryoshin Minami, *Power Revolution in the Industrialization of Japan, 1885–1940* (New York, 1987).

joint ventures or licensing in technology-based industries. Shigehiro Nishimura shows that approximately 25 percent of General Electric's US-patented inventions were transferred to Japan through subsidiary ownership and international contracting.<sup>19</sup> Technology transfer across national borders clearly mattered for Japan during the Meiji and Taishō eras in the push towards modernization. David Jeremy's extensive investigation of technology transfer reveals that foreign experts facilitated learning within Japan in a range of industries such as textiles, machine tools, and railways, and Japanese engineers also travelled abroad to learn about innovation.<sup>20</sup>

Yet, the changes that took place were not being driven purely by transfers of technology from the West spilling over from Japan's ability to select and modify Western organizations and institutions.<sup>21</sup> Nishimura is careful to point out that General Electric benefitted extensively from Japanese engineers' knowledge under the same system of licensing and contracts that allowed Japanese engineers to benefit from technical knowledge being developed in the United States. Despite the literature's emphasis on Western influence, it is important to note that Japan simultaneously nurtured its own technological capabilities. And in line with Nishimura's evidence in the electricity industry, the flow of ideas often ran the other way.<sup>22</sup> In an important case, the Toyoda family developed the G-type automatic loom with a continuous automatic shuttle that vastly increased productivity. They then licensed it, most notably, to the English firm Platt Brothers for a sum of ¥250,000.<sup>23</sup> Beyond the textile industry, Japanese militarism led to large industrial investments that promoted domestic invention. At the Mitsubishi Nagasaki Shipyard, which received government subsidies, in-house research and development (R&D) in electric welding and metallurgy technology led to major advances in shipbuilding techniques.<sup>24</sup>

<sup>19</sup> Shigehiro Nishimura, "International Patent Control and Transfer of Knowledge: The United States and Japan before World War II," *Business and Economic History* 9 (2011): 5.

<sup>20</sup> David Jeremy, *The Transfer of International Technology* (London, 1991).

<sup>21</sup> See further, Eleanor Westney, *Imitation and Innovation: The Transfer of Western Organizational Patterns to Meiji Japan* (Cambridge, MA, 1987); and Janet Hunter, "Institutional Change in Meiji Japan: Image and Reality," in *Institutional Change in Japan*, ed. Magnus Blomstrom and Sumner La Croix (London, 2006).

<sup>22</sup> It is often argued that as part of the catch-up process Japanese inventors observed and adapted imported intermediate goods. And a notable case is the textile machinery industry where ideas spread rapidly across manufacturing establishments. The upshot of learning was the rise of Japanese preeminence and "the astonishing ascendancy of Osaka over Lancashire." See further Gary Saxonhouse, "A Tale of Japanese Technological Diffusion in the Meiji Period," *Journal of Economic History* 34 (1974): 149–65.

<sup>23</sup> Kazuo Wada, "The Fable of the Birth of the Japanese Automobile Industry: A Reconsideration of the Toyoda-Platt Agreement of 1929," *Business History* 48 (2006): 90–118. In current prices ¥250,000 is equivalent to ¥165,000,000 (around \$2.1 million or £1.4 million).

<sup>24</sup> Yukiko Fukasaku, "Origins of Japanese Industrial Research: Pre-war Government Policy and In-House Research at Mitsubishi Nagasaki Shipyard," *Research Policy* 21 (1992): 197–213.

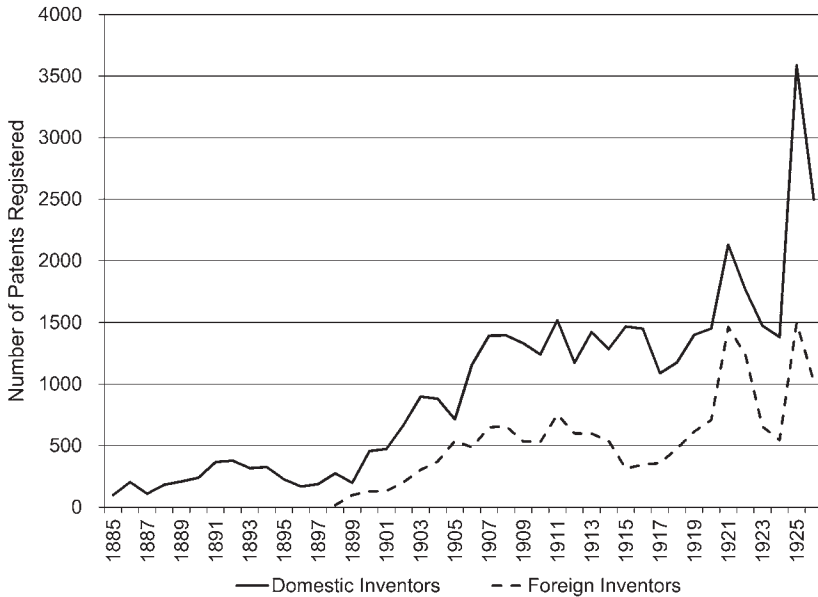


Figure 6. Patents by domestic and foreign inventors patenting in Japan. (Sources: Data compiled from records of the Japanese Patent Office. See also Tom Nicholas, “The Origins of Japanese Technological Modernization,” *Explorations in Economic History* 48 [2011]: 272–91.)

Figure 6 illustrates the significance of domestic versus foreign inventors. Between 1900 and 1926, Japanese inventors accounted for 69 percent of all patents registered in the country. And notwithstanding important contributions to the literature that emphasize the role of government and especially large family-owned conglomerates, or *zaibatsu*, in the process of technological development, innovation progressed not only within firms, but also outside of firm boundaries.<sup>25</sup> Independent inventors, such as those listed in Table 1 as selling their patents, accounted for approximately 70 percent of all patents in Japan by 1920 and still half of all patents in Japan in 1930, over four times as many as the largest 200 firms by asset size.<sup>26</sup>

Some of the most significant advances occurred as a result of breakthroughs by independents.<sup>27</sup> Kōkichi Mikimoto (1858–1954) was able

<sup>25</sup> See further, Randall Morck and Masao Nakamura, “Business Groups and the Big Push: Meiji Japan’s Mass Privatization and Subsequent Growth,” *Enterprise and Society* 8 (2007): 543–601; and John P. Tang, “Technological Leadership and Late Development: Evidence from Meiji Japan, 1868–1912,” *Economic History Review* 64 (2011): 99–116.

<sup>26</sup> Tom Nicholas, “Independent Invention during the Rise of the Corporate Economy in Britain and Japan,” *Economic History Review* 64 (2011): 995–1023.

<sup>27</sup> *Ibid.*, 1000.

to cultivate and produce cultured pearls effectively from oysters. He raised loans, started a successful enterprise in 1888, and obtained his first patent for pearl culturing in 1896.<sup>28</sup> Jōkichi Takamine (1854–1922) discovered a method for manufacturing pure adrenaline and patented his idea in 1901. Hidetsugu Yagi (1886–1976) constructed an antenna for wireless communications for which he was awarded a patent in 1926. Yasujirō Niwa (1893–1975) developed and patented a method for the telegraphic transmission of images, demonstrating the feasibility of television broadcasting at least a decade before it became a commercial reality. Inventors without capital for expansion or the entrepreneurial spirit to commercialize could transact their patents in the market for ideas.<sup>29</sup>

An important aspect of technological development at this time was that independents could sell or commercialize their technological discoveries in an environment that fostered innovation. While we concentrate in this article on the role of intermediaries in the market for ideas as a driving factor, this was just one factor in a convergence of influences that facilitated Japanese industrialization. Carl Mosk emphasizes urbanization, human capital accumulation, transportation infrastructure, and institutions, especially in the industrial area between Tokyo and Nagasaki, which created positive externality-inducing investments.<sup>30</sup> Tomoko Hashino argues that efforts by trade associations to promote technical education in traditional industries like weaving facilitated technology transfer from frontier nations in areas such as synthetic dyestuffs, which contributed to product differentiation and the expansion of markets.<sup>31</sup> Kris Mitchener and Mari Ohnuki focus on the role of banking innovations and improved communications that led to capital-market integration across prefectures during the Meiji era, which may have provided the necessary financial impetus for entrepreneurs to facilitate economic development.<sup>32</sup> Randall Morck and Masao Nakamura view the early coordinating role of the cross-industry *zaibatsu* as being crucial because market failures and hold-up in transactions between entities in diverse industrial sectors would have otherwise held back economic development.<sup>33</sup> Kazushi Ohkawa and Henry Rosovsky

<sup>28</sup> Japanese Patent Office, *Kōgyō Shoyūken Seido Hyakunenshi Jōkan* [100-year History of Industrial Property Systems], vol. 1 (Tokyo, 1984), 342.

<sup>29</sup> Nicholas, “Independent Invention during the Rise of the Corporate Economy in Britain and Japan,” 3.

<sup>30</sup> Carl Mosk, *Japanese Industrial History: Technology, Urbanization, and Economic Growth* (Armonk, 2001).

<sup>31</sup> Tomoko Hashino, “Institutionalising Technical Education: The Case of Weaving Districts in Meiji Japan,” *Australian Economic History Review* 52 (2012): 25–42.

<sup>32</sup> Kris Mitchener and Mari Ohnuki, “Institutions, Competition, and Capital Market Integration in Japan,” *Journal of Economic History* 69 (2009): 138–71.

<sup>33</sup> Morck and Nakamura, “Business Groups and the Big Push,” 543–601.

suggest that the social and economic structure established at the start of the Meiji Restoration created the necessary “initial conditions” for growth and convergence with advanced industrial nations.<sup>34</sup>

We do not intend to discount these multifaceted factors in the process of economic growth, but we emphasize an additional factor that has been comparatively neglected in Japanese business history. Some of Japan’s most influential writers on historical technology and patenting such as Hoshimi Uchida and Tadashi Ishii do not discuss the emergence of a market for innovation.<sup>35</sup> Our evidence from patent records and complementary sources indicates that Japan experienced a fundamental phase of technological transformation during the Meiji and Taishō eras. We believe that an environment where a market for innovation and a broad set of institutions incentivized inventors, including a patent-attorney system, was an important inducement mechanism. We now elaborate on some key aspects of our hypothesis by discussing the history of the Japanese patents and the attorney system.

### Patent Law and the Patent-Attorney System

*Establishing the Patent System.* For a market for ideas to function, inventors must have intellectual property rights to sell. Early on in the Meiji era, the idea of allowing inventors to have a temporary monopoly to exploit their inventions became popular among policy makers although it took some time to fully institute complex legal systems with regards to patents. Unlike in the United States or in Europe where patent laws were instituted to guarantee the rights of inventors, in Japan the rationale extended to the idea that the protection of invention would encourage further innovation.<sup>36</sup> In a country where technological backwardness was so apparent at the beginning of the Meiji era, the patent system was seen as a mechanism to incentivize inventors, facilitate the diffusion of technological knowledge, and speed up the process of catch-up industrialization.

Given that Japan was so technologically backward, an important question is why the decision was made to have patent laws at all? Alexander Gerschenkron famously argued in *Economic Backwardness in Historical Perspective* (1962) that countries could benefit from being

<sup>34</sup> Ohkawa and Rosovsky, *Japanese Economic Growth*.

<sup>35</sup> See further Hoshimi Uchida, *Nihon Bōseki Gijyutsu No Rekishi* [History of Japanese Cotton Spinning Industry] (Tokyo, 1960); Hoshimi Uchida, *Sangyō Gijyutsu Nyūmon* [History of Industrial Technology] (Tokyo, 1974); and Tadashi Ishii, *Chitekizaisan no Rekishi to Gendai* [Intellectual Property Right, History, and Today] (Tokyo, 2005).

<sup>36</sup> Christopher Heath, “Intellectual Property and Anti-Trust,” in Wilhelm Röhl, ed., *History of Law in Japan since 1868* (Leiden, 2005), 415–17.

“backward” by adopting technologies and processes from frontier nations.<sup>37</sup> Analogously in the Japanese case, the absence of patent laws could have encouraged invention stealing, industrial espionage, and rent seeking to the point where Japan had closed the technology gap and was economically ready to impose rigorous intellectual property-rights laws. Yet, the early history of the Japanese patent system suggests an alternative path to development was foreseen. The responsibility for patents was given to the Ministry of Agriculture and Commerce (which later became MITI) rather than to the Ministry of Justice, so a developmental goal for patents was clearly envisaged. The evidence for patent-induced growth was backed up by observations on the structure and operation of intellectual property rights systems in frontier nations. In an oft-cited quote, Korekiyo Takahashi, the first patent office director, stated:

We have looked about us to see what nations are the greatest, so that we can be like them. We said, “What is it that makes the United States such a great nation?” and we investigated and found that it was patents, and we shall have patents.<sup>38</sup>

The first patent law (*Senbairyaku Kisoku*) was promulgated in 1871, but it was abolished a year later. Fukuji Hasebe argues that the law failed because of procedural defects (for example, no government office was established to actually receive patents) and because the demand for the patent system was not yet well developed because the industries that would use it were still at an embryonic stage of development.<sup>39</sup> While this latter point is debatable, the demand for patent protection certainly increased with industrialization and other efforts to diffuse technological knowledge, such as through an extensive program of innovation-inducement prize competitions that were sponsored by government departments.<sup>40</sup> Policy makers noted that an absence of patents had created incentives for widespread imitation and expropriation of inventor ideas.<sup>41</sup>

The promulgation of the Monopoly Patent Ordinance on July 1, 1885 marked the start of Japan’s national patent system. The patent term was initially a function of the fee paid, with ¥10 for a five-year patent, ¥15 for a ten-year patent, and ¥20 for a fifteen-year patent. On top of

<sup>37</sup> Alexander Gerschenkron, *Economic Backwardness in Historical Perspective: A Book of Essays* (Cambridge, MA, 1962).

<sup>38</sup> Heath, “Intellectual Property and Anti-Trust,” 405.

<sup>39</sup> Fukuji Hasebe, “*Nihon ni okeru Tokkyo Seido ni Kansuru Shiteki Kenkyu*” [History of Patent Law System in Japan] *Patento* 1, no. 30 (1977), 20–31.

<sup>40</sup> Tom Nicholas, “Hybrid Innovation in Meiji Japan,” *International Economic Review* (forthcoming).

<sup>41</sup> Agus Sardjono, “The Japanese Patent Law System,” World Intellectual Property Organization Working Paper, 2000.



this financial amount, inventors could be expected to pay roughly ¥100 in attorney fees to process their patent application. By the early twentieth century, the patent term was fixed at 15 years with the possibility of a discretionary extension to the patent term of more than 5 but 10 or less years if the exploitation of the patent had been hindered. Although the cost of patent protection was about three times higher in Japan than in the United States, fees were about one-third of the level charged in Britain, or about one-tenth of the level in Germany.<sup>42</sup> Low patent fees tend to promote the democratization of invention.<sup>43</sup>

Takahashi became an influential figure in developing the institutional and legal framework for patents. He visited the United States, France, and Germany to learn about their patent systems. As the above quote indicates, Takahashi was a strong admirer of the patent system in America, so it is no accident that Japan introduced US-based laws. The “first-to-invent” rule operated until 1921 when the “first-to-file” principle was introduced, and a robust examination procedure to prosecute a patent application was required after 1888. Japanese patent law also contained attributes from the other countries Takahashi visited. Following French patent law, a novelty requirement for patentability meant that inventors could not patent inventions they had imported from abroad. Based on the German system, Japan passed a Utility Model Law in 1905 to protect minor inventions.<sup>44</sup>

Although international technology transfer was encouraged during the Meiji era, it was not until 1899 that foreigners were formally able to patent in Japan under the legal system.<sup>45</sup> This policy was due to Japan becoming a signatory country of the Paris Convention for the Protection of Industrial Property, which established the principle that inventors from any convention country would be treated equally under each country’s patent systems. Proponents of foreign patenting cited the boost to technology transfer and realized that industrialization could more optimally take place through intersecting foreign and domestic technologies that were suited to domestic circumstances and factor endowments.<sup>46</sup>

Amendments to the law in 1899 and 1909 also enabled inventors to transfer ownership of their patents, and furthermore the laws included additional protections against infringement.<sup>47</sup> The patent system evolved

<sup>42</sup> Josh Lerner, “150 Years of Patent Protection,” Harvard Business School Working Paper, 2000, Table 2.

<sup>43</sup> B. Zorina Khan, *The Democratization of Invention: Patents and Copyrights in American Economic Development, 1790–1920* (Cambridge, 2005).

<sup>44</sup> *Ibid.*, 295–96.

<sup>45</sup> Prior to this point, only bilateral treaties existed with selected countries such as Germany, Denmark, Britain, and the United States.

<sup>46</sup> Sardjono, “The Japanese Patent Law System.”

<sup>47</sup> Heath, “Intellectual Property and Anti-Trust,” 424–25.

during the Meiji and Taishō eras until Japan passed the landmark 1921 Patent Act. Among other things, the new law clarified the conditions when firms owned employee inventions versus when employees were able to commercialize, or sell, their technological discoveries themselves.

*The Rise of Patent Attorneys.* The literature on inventive activity in the United States during the period when patent laws were still in their infancy powerfully illustrates the significance of attorneys in the market for ideas.<sup>48</sup> This intermediary function matters because inventors may not be able to observe the full set of potential buyers for their innovations, or they may simply be ineffective sellers, in which case a division of labor between the two functions enhances efficiency.<sup>49</sup> On the other hand, if specialized knowledge is hard to come by, there are not enough complementary specialists, or coordination costs are too high to facilitate interaction, then the economy can become locked into an underdevelopment trap.<sup>50</sup>

But the rise of attorneys as intermediaries in Japan as in the United States should not be seen as inevitable. Rather it was the outcome of an evolution of their normal functional activities and an endogenous response to the growth in the scale of invention. During the process of preparing patent documents, as a byproduct, attorneys became a repository of knowledge about both sides of the market for new technology, which they then used to facilitate trade between inventors and buyers. Takahashi implies as much about US attorneys in his memories when he mentions the significance of the patent-drafting function.

I visited New Haven for the first time on March 22. My primary objective was to interview Mr. Earle who had been introduced to me by Mr. Zory during my stay in Washington. Earle is a renowned patent attorney and has been practicing for 35 years; he is a veteran of his profession . . . Earle informed me that his primary duty lay in the preparation of patent descriptions and drawings at the behest of inventors, and that the basis for this undertaking lay in determining the scope of the invention's claim.<sup>51</sup>

As the task of writing descriptions and preparing the drawings that were required for filing imposed a considerable burden on Japan's inventors, they increasingly relied on outsourcing to attorneys to perform these functions for them. Despite the lack of provision in the Monopoly Patent Ordinance, in the late 1880s the number of attorneys undertaking

<sup>48</sup> Lamoreaux and Sokoloff, "Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries."

<sup>49</sup> Arora, Fosfuri, and Gambardella, *Markets for Technology*.

<sup>50</sup> Ben Jones, "The Knowledge Trap: Human Capital and Development Reconsidered," NBER Working Paper no. 14138 (2008).

<sup>51</sup> Benrishi Seido 100 Shūnen Kinen Jigyō Jikkō Inkai Kaishi Hensanbu, ed., *Benrishi Seido 100 nenshi* [100-Year History of Patent Attorney] (Tokyo, 2000), 12–13.

to prepare application documents on behalf of inventors began to increase. This increase is evident in an instruction issued on April 27, 1889, by Takahashi in response to an increase in the number of patent applications being filed via attorneys. The examination department of the patent office was informed of the following procedure when handling patents that had been prepared by a proxy:

Where an inventor has used an attorney to file a patent application and such application has been invalidated due to the failure of the attorney to submit duly requested amendments to the description and/or drawings, etcetera within the designated time limit, the chief examination officer or the commissioner is to be informed to that effect.<sup>52</sup>

Clearly another function—learning about the potential for exchange in the market for ideas—became more relevant as the number of patents began to increase. In a practical handbook to Japanese laws, one patent attorney clearly states that both prosecuting patents through the Japanese patent office and bringing patents to market were activities he performed:

For some years I have negotiated and carried through successfully a large number of patents in Japan. As I am in intimate touch with all the industrial markets in Japan, and the various Government Departments, I am excellently placed and fully qualified to advise, not only as to the possible utility of a patent in Japan, but also to undertake negotiations for the sale of any patent either outright, or on the basis of royalty.<sup>53</sup>

To facilitate such transactions patent attorneys began establishing offices that specialized in accepting commissions to represent clients in obtaining patents around this time. In September 1890, Naomichi Manaka founded *Tokyo Tokkyo Daigensha* [Tokyo Patent Agency], Japan's first patent agent office; he had left his post as patent office commissioner, together with Saburō Asamura and Toshitsugu Ōmori in Tokyo's Kanda and Tsukiji districts. These attorneys established a branch office in Osaka and took out numerous advertisements in newspapers and magazines. Figure 7 shows an advertisement for *Tokyo Tokkyo Daigensha* that appeared in the morning edition of the *Yomiuri Shimbun* on March 22, 1890. The advertisement states that the office handled all principal matters and procedures relating to patent law including application filing, design, and patent registration.

<sup>52</sup> *Ibid.*, 18.

<sup>53</sup> H. S. Bickerton Brindley, *Japanese Patents: A Practical Handbook to the Japanese Laws Relating to Patents, Utility Devices, Designs, and Trade Marks for the Patent Agent and Inventor* (London, 1909), 13.



Although Japanese law was such that criminal and civil proceedings involving a patent were undertaken in Common Court, the patent office was responsible for proceedings in the area of patent validity. Since litigation attorneys made allegations on behalf of their clients, the agents that appeared at the patent office in connection with patent disputes were generally referred to as “patent agents.” Their actions helped to establish a credible system of intellectual property rights in Japan. Inventors were unlikely to be incentivized to invent or engage in the process of patenting, unless they were able to exploit the specialized capabilities of attorneys in order to navigate the legal complexities associated with defending their patents.

There were, however, a number of problems associated with these early patent attorneys. The majority of attorneys that were practicing during the 1890s had no technical knowledge or legal expertise. Added to which, there were no rules on attorney qualifications, which meant that anyone could practice as a patent agent without having to register with the authorities. There was, thus, a growing need to establish a system to govern Japan’s patent attorneys. In 1890, Yoshito Okuda, who had succeeded Takahashi as patent office commissioner, made the following remarks regarding the necessity of organizing a patent-attorney system in the form of “An Outline of Opinions concerning Future Patent Office Policy”:

The absence of restrictions on (patent) agents has had a detrimental effect on numerous cases. There are individuals that have failed to undertake any of the duties required of an agent and those that have profited through fraud or extortion. Such agents have been established to benefit inventors and any individual that is unfit for this purpose cannot be tolerated in terms of the public interest. It is not, however, possible to place a ban on such agents because no rules have been established on attorney qualifications and so forth. It would be difficult to debar such individuals even were detailed regulations to be appended to the (Monopoly Patent) Ordinance. To this end, a patent attorney system needs to be established in order to put an end to such dishonest practice.<sup>55</sup>

In 1899, Japan consolidated its domestic laws and undertook a widespread amendment of existing ordinances on patents, designs, and trademarks in an attempt to streamline the patent-attorney system that would enable it to become a signatory to the Paris Convention for the Protection of Industrial Property. The Patent Act (Act No. 36), the Design Act (Act No. 37), and the Trademark Act (Act No. 38) were established on March 1, 1899, with these acts entering into force on July 1,

<sup>55</sup>Ibid., 18.

1899. Imperial Ordinance (No. 235) on June 9, 1899 established the Rules on Patent Attorney Registration, and these too became effective on July 1, 1899. With the enactment of these rules it became mandatory to register to practice as a patent attorney. As of the end of December 1899, 138 individuals had registered as patent attorneys, including Naomichi Manaka and Saburō Asamura of *Tokyo Tokkyo Daigensha* and other former examination officers and administrative officials of the patent office.<sup>56</sup>

The outcome of the patent-attorney system was ostensibly specialization and a division of labor in invention, as inventors focused on the creation of new ideas and intermediaries performed increasingly complex administrative functions and, where necessary, matched buyers and sellers of patents in the market for ideas. In that sense, the rise of patent attorneys in Japan crucially affected how the economy was able to benefit from specialized knowledge production and from trade in new ideas. While it is likely that the most significant boost to invention through intermediation came after the patent laws were revised in 1899 and the rules under which patent attorneys could practice were formally established, as we outline in the case study below on Tomogorō Ono, even in the early stages of Japanese technological development there is evidence to suggest that a division of labor in invention was present.

### Tomogorō Ono (1817–1898) and Salt-Production Technology

Tomogorō Ono is one of a handful of Meiji (or indeed Taishō) inventors for whom primary source materials are available in the form of records of his correspondence with his patent attorneys. Ono was a salt-industry inventor and entrepreneur who embarked on his quest to develop new technologies for this industry just prior to the Meiji Restoration in 1868 and continued his activities thereafter. Ono used patent attorneys extensively both in the process of protecting and transferring his inventions and in his efforts to commercialize. Our evidence highlights the importance of the intermediary function at a time when Japan was still in the process of formally institutionalizing its patent-attorney system.

*Early Years of Invention.* Tomogorō Ono was born in Hitachi Province (present-day Ibaraki Prefecture) in 1817, the third son of a low ranking member of the Komori family. Adopted by Ryūgorō Ono, Tomogorō began studying Japanese mathematics at sixteen, later moving to Edo (present-day Tokyo) where he studied arithmetic, surveying,

<sup>56</sup> Ibid., 22–23.

navigation, and Dutch. Ono's skills in surveying and navigation led to his appointment as navigating officer on the *Kanrin Maru* (Japan's first steam-driven warship), in which capacity in 1860 he embarked on a voyage to America to escort the mission to ratify the new treaty of Friendship, Commerce, and Navigation between the United States and Japan. Upon his return to Japan from the United States, Ono was appointed captain of a naval battleship and became a vassal of the Tokugawa shogunate. In later years he undertook surveying work for the shogunate and was involved in the auditing of administrative agencies.

Ono's activities as an inventor began after the Meiji Restoration. He developed an interest in salt-production technologies towards the end of the Tokugawa period, committing himself fully to the business of salt production in the years that followed the Meiji Restoration.<sup>57</sup> Ono was engaged in the development of vertical evaporation racks for use in salt production. Vertical evaporation racks were used on sloping salt terraces, with seawater flowing over the terraces onto the evaporation racks where the sun and the wind evaporated the water to produce salt concentrate. A German doctor devised the technology in the sixteenth century, and except for a few isolated places in Germany, the technique had already fallen out of use when Ono turned his attention to it some three hundred years later. Wind strength and the dryness of the air, as opposed to sunshine, determined the degree of evaporation and salt concentrate produced using this technology, which meant that it was possible to compete with the salt producers working along the sun-drenched coast of the Seto Inland Sea, even in areas where there was less sunshine. Ono thus chose present-day Chiba Prefecture as the location for his work. Although it had fewer hours of sunlight, it was blessed with strong winds.

The success of this technology hinged on two factors: the height of the evaporation racks and the efficiency of the method used to convey the water onto the racks. Ono began his research into these two elements of the technology in August 1869 in present-day Ichikawa, Chiba Prefecture. After a year of continuous observation of seawater evaporation rates, he concluded that six meters was the optimal height for his evaporation racks. On the strength of this experiment, Ono constructed a pilot salt works for his evaporation-rack technology on a plot of land he had rented for the purpose in the village of Ichihara, Chiba. Small-scale trial operations began in July 1870. Ono also developed the pump that was needed to cascade seawater over the racks.

<sup>57</sup> On Ono Tomogoro's life and his salt making business, see Tetsuhiro Fuji, *Kanrin Maru Kōkaichō Ono Tomogorō no Shōgai: Bakumatsu Meiji no Technokurāto* [Captain of Japanese War Ship Kanrin Maru, Ono Tomogoro's Life: Technocrat of the End of Edo and Meiji Period] (Tokyo, 1985).

To raise the funds he needed to expand production and begin full-scale salt production using his evaporation racks, in February 1875, Ono sold his pilot salt works to the samurai Yukitaka Kawabe. Two months later, Ono had drawn up plans for the construction of a large-scale salt works in the present-day city of Kimitsu (Chiba). In 1876, the Meiji government abolished the stipends that had been paid to samurai as a hereditary privilege with a view to securing the funds needed to create a centralized state, and this policy meant that there were warriors in search of a safe haven in which to invest their assets. By raising this capital, Ono invested in the construction of a full-scale evaporation-rack salt works that was to have a production capacity approximately four times greater than that of the original pilot works. Construction commenced in December 1879, and the salt works went into operation in February 1880. This salt works employed the large seawater pump that had been invented by Ono.

Ono expected to profit from this large-scale salt works, but a typhoon devastated the works in October 1880. Then, the great fire that swept through Tokyo in January 1881 destroying more than ten thousand houses in its path also incinerated Ono's home and the tenement houses he owned for leasing. Ono had planned to rebuild the salt works, but had to downscale his plans as the result of the damage sustained in this typhoon and conflagration. He reduced the height of the evaporation racks from the original six meters and replaced his pump with one powered by an existing windmill. Although the original plans for the evaporation rack salt works at Kimitsu had been thwarted, the salt produced at Ono's salt works was acclaimed for its quality at the Second National Industrial Exposition of 1881.<sup>58</sup> The salt went on sale in Nihonbashi, the commercial heart of Tokyo, the following year. Moreover, because this technology of salt production with evaporation racks could be utilized in Tohoku and Sanin, areas that were not blessed with a favorable natural climate, experimental salt works were set up in Fukushima Public Salt Production Experimental Laboratory (Fukushima Prefecture), Nenjyu Salt Works (Yamagata Prefecture), Kitsuki Elevated Salt Works (Shimane Prefecture), and Onahama Hirai-Suzuki Salt Works (Fukushima Prefecture).

*Patenting and Interactions with Patent Attorneys.* Between the late 1870s and the early 1880s when Tomogorō Ono entered the salt-production business, Japan had yet to establish a patent system. Until 1885, he operated without any formal legal protection to exclude others

<sup>58</sup>Nōmushō Hakurankaigakari, *Meiji 14 nen Dai 2 kai Naikoku Kangyōhakurankai Hōkokusho, Dai 2 Ku, Dai 1 Rui* [Report on the Second Domestic Industrial Exhibition Second Segment, Type 1] (Tokyo, 1883).



from using his inventions. Ono began filing patent applications for the technologies he had invented soon after the Monopoly Patent Ordinance was enacted. He submitted an application to patent his “vertical-oscillating rotating device” on the day the Monopoly Patent Ordinance went into effect and this was granted on October 30 that year. On December 18, 1885, Ono filed an improvement patent that built upon his previously disclosed invention, and this was granted on September 14, 1886. These patents related to the pump invented by Ono to draw up seawater. The fact that Ono filed for patent protection as soon as the Monopoly Patent Ordinance went into effect gives some indication of the strength of demand for intellectual property rights protection among inventors at this time.

The path to patent protection, however, did not run smoothly. The patent examiner rejected Ono’s initial filing for a patent, in response to which Ono filed an opposition to appeal the decision. His application had failed to specify that the invention was to be used in salt production, and the omission delayed the process of examination. On July 3, 1890, the courts upheld the patent rejection (Decision No. 13). Added to which, on March 2, 1891, Yoshito Okuda, commissioner of the patent office, sent a notice to Ono requesting the amendment of ambiguities in the description, scope of claims, and drawings attached to the patent application.<sup>59</sup> A notice dated March 11, advised Ono that his application for a patent concerning a novel salt manufacturing process had been rejected.<sup>60</sup>

The monopoly patent description that Ono filed and registered in 1885 did not list an attorney, although Ono did secure the services of other intermediaries. According to available documents, Tarō Hirai, Nobunari Kawai, Masataka Nakamura, Shōzō Kawano, and Mitsuta Komori were among the first appointed to serve on a committee that would represent Ono to facilitate the process of obtaining patents for his salt-manufacturing inventions.<sup>61</sup> There are no records to suggest these men were patent attorneys even after Japan established the Rules on Patent Attorney Registration. In fact, in 1891, Tarō Hirai and the other advisors sent a document to Ono that contains a report on the quality of salt produced at the experimental salt works in Hiratsuka. In 1894, Ono appointed Mitsuta Komori as his agent in obtaining permission to build a

<sup>59</sup> *Shin 5 dai 3455 gō. Meisai Teisei Tsūchisho* [no. 5-3445. Notification for Patent Specification Correction] (2 Mar. 1891). Reference Number 198909-47, Hiroshima Prefecture Archives, Hiroshima, Japan (hereafter, HPA).

<sup>60</sup> *Sōfusho Shin 5 dai 3483 gō. Shinkō Shokuenseihō Shutsugan ni Kansuru Sateisho Sōfu* [no. 5-3483. Decision Report on New Salt Production Patent Application] (11 Mar. 1891). Reference Number 198909-48, HPA.

<sup>61</sup> *Senbai Seienhō Kakuchō nitsuki Iin Yakuteisho* [Agreement on Extension of Salt Making Patent] (3 Dec. 1890). Reference Number 198909-42/43, HPA. It is worth noting that the Komori family was Ono’s parental home and that Ono was thus related to Mitsuta Komori by blood.

salt works in Ichihara, Chiba. As such, Ono retained at least Hirai and Komori to represent him in the process of commercialization rather than to file patents or act as his attorneys in patent disputes.

The first reference to a patent attorney in documents relating to Ono was made prior to the establishment of the attorney-registration system in 1899. Dated September 11, 1893, the oldest record is an agreement that Ono sent to Yoshiaki Fukabori concerning his representation in patent-filing procedures and his contingency fee.<sup>62</sup> The agreement states that, in the event of securing a patent, Fukabori would be paid a fee of ¥100 within thirty days of registration as a reward for his services. This fee was substantial given prices at the time, and it gives some indication of the importance that was placed on the services provided by patent attorneys. In fact, this patent was established in March 1894, and Fukabori is cited in the description as the patent attorney.<sup>63</sup> On December 29 that year, the patent agent office of Fukabori sent Ono a letter of receipt for the contingency fee paid in connection with the salt-manufacturing equipment patent.<sup>64</sup> In a further instance, the patent agent office of Shōjirō Nukiyama sent Ono a receipt dated September 10, 1894 for expenses incurred in patent filing.<sup>65</sup> Nukiyama had worked as an examiner's assistant at the patent office and registered as a patent attorney soon after the establishment of the attorney registration system in 1899. A draft version of the patent description for Ono's salt-manufacturing equipment named him as patent attorney.<sup>66</sup> These documents show that Tomogorō Ono was simultaneously utilizing the services of at least two patent attorneys in connection with his patent filings.

Records pertaining to Ono made no further reference to Fukabori, but Ono's relationship with Nukiyama lasted until 1898. A receipt for expenses incurred in amending a patent application was sent from Nukiyama's patent agent office in 1895 while a deposit receipt dated 1896 for the balance of various patent application costs demonstrates that Ono was using Nukiyama to serve as his representative in obtaining patents for his inventions. Another receipt dated 1896 shows patent-filing

<sup>62</sup> *Shokuken Seizō Sōchi Tokkyonegai Ishoku nitsuki Tokkyonegai Seikō nosetsu Hōshū no Keiyakusho* [Contract of Contingent on Success of Patenting Salt Making Facility] (11 Sept. 1893). Reference Number 198909-73, HPA.

<sup>63</sup> Patent Number 2181.

<sup>64</sup> *Shokuken Seizō Sōchi Tokkyonegai Seikō Hōshūkinn Ryōshūsho* [Receipt of Fee Contingent on Success of Patenting Salt Making Facility] (29 Dec. 1894). Reference Number 198909-98, HPA.

<sup>65</sup> *Tokkyonegai Jippi Uchikinn oyobi Inshiryōkinn Uketorisho* [Receipt of Actual Expense for Patent Application and Official Stamp Fee] (10 Sept. 1894). Reference Number 198909-99, HPA.

<sup>66</sup> *Shokuken Seizō Sōchi Shitagaki Meisaisho* [Draft of Salt Making Facility Specification]. Reference Number 198909-206, HPA.

expenses sent from the Nukiyama Patent Agent Office in Tokyo to Tomogorō Ono, and several letters survive between the two men from 1898.<sup>67</sup>

In 1898, Ono appointed new representatives. That year he drew up a letter of attorney appointing Naomichi Manaka and Yonosuke Hosokawa to serve as his representatives, and he submitted a notice to the Ministry of Agriculture and Commerce to advise them that Naomichi Manaka would be acting as his attorney in connection with the request to register the transfer of the patent rights to his salt-manufacturing equipment.<sup>68</sup> This was a key patent for salt-manufacturing equipment and concerned one of Ono's more significant inventions regarding the production of sun-dried salt. There are no documents from 1898 onwards that refer to Nukiyama in his capacity as Ono's representative; Manaka's name is the only one that appears in all subsequent documents pertaining to patent attorneys. This suggests that Ono had replaced Nukiyama with Manaka and Hosokawa to act as his attorney. As stated above, Manaka was one of the founders of *Tokyo Tokkyo Daigensha*, the first office in Japan to specialize in accepting commissions to represent clients in obtaining patents and other related matters. Surviving documents provide no indication of the reason for Ono's decision to appoint new representatives. However, given that numerous attorneys were already practicing in the 1890s and many newspapers carried advertisements for patent-agent offices, it would seem that competition became increasingly significant when it came to appointing legal representative services.

Ono died of an illness in the summer of 1898 while field-testing his method of producing sun-dried salt; he was 81. Efforts to commercialize the vertical-evaporation-rack method of salt production that Ono invented during the Meiji era were not a success. While Japan's weather and climate were amenable to this method of salt production, Japan had yet to accumulate the pump technologies needed to lift seawater or the technologies used in the separation of salt that were necessary to the success of the vertical-evaporation technology. Ono's main contribution was to achieve partial improvements to existing methods of salt production, such as his method of producing high quality salt that is still referred to as Japanese-style sun-dried salt. For the substantial contribution he made to Japan's salt industry, in 1918, Ono was posthumously awarded the Blue Ribbon Medal of Honor, the medal awarded

<sup>67</sup> *Shō Seichi Tokkyonegai Zankinn no Uchikin Azukarisho* [Receipt of Remaining Account for patent filing expenses] (28 Apr. 1897). Reference Number 198909-405, HPA; *Nukiyama Shōjirō Shokan* [Letter from Shōjirō Nukiyama] (18 Aug. 1898). Reference Number 198909-681, HPA.

<sup>68</sup> *Shokuen Seizō Sōchi Tokkyoken Baiyo Tōrokuseikyū ni Kanshi Manaka Naomichi o Dairinin tosuru Todoke* [Attorney Registration: Naomichi Manaka as Attorney regarding to Patent of Salt Making Facility] (1898). Reference Number 198909-190, HPA.

by the Government of Japan to individuals who have made significant achievements in the area of public welfare.

Ono first employed a representative before the attorney-registration system was established in 1899. His case demonstrates that Japan's inventors were using agents prior to the 1899 enactment of the Rules on Patent Attorney Registration and the establishment of the patent-attorney examination as a prerequisite to practicing as a patent attorney. Ono used attorneys both to represent him in filing patents and patent disputes and to act on his behalf in the commercialization of his inventions. Even as early as the 1890s, we believe these attorneys enabled inventors to be more productive by protecting their intellectual property rights, engaging in transfers, and reducing the transaction costs involved in commercialization.

### Conclusion

In this article we have attempted to make two main points about the factors that determined Japan's push towards technological modernization during the late nineteenth and early twentieth centuries. The first is that a significant market for ideas existed, with approximately 14 percent of patents sold in arm's-length transactions between 1886 and 1926. When benchmarked against contemporaneous and modern patent data for the United States and Germany, that is an economically important proportion of patents involved in technology trade. Our second point is that the evolution of institutions predicated this market, especially patent law and the rise of attorneys as intermediaries for which our evidence is both quantitative and case-study based. Although we have not established causal relationships between patents, a market for ideas and economic growth, our evidence highly suggests one.

Furthermore, our aim is not to discount the importance of other factors that the literature has covered, such as infrastructure development, the pace of urbanization, banking, or business conglomerates. Rather, on the basis of our evidence, it is plausible to argue that technology trade should be considered additionally within the range of explanations offered for Japanese industrialization. The existence of a market and intermediaries permitted a division of labor between inventors and those who were more able to perform legal or commercial functions in a way that created incentives for innovation. Here we follow the argument of Lamoreaux and Sokoloff, who suggest that these attributes are crucial when attempting to explain the rapid pace of technological progress in the United States. In their view, "the [US] data show that an extensive trade in new technological ideas did develop over the course of the nineteenth century, supported by the patent

system and by the emergence of information channels and intermediaries that facilitated the sale of patents at arm's length. The growth of this market for technology had important implications . . . for the extent to which invention was integrated with development."<sup>69</sup>

Given the similarities between Japan and the United States in this regard, there are broader implications for our findings. It is often argued that especially favorable intellectual property rights institutions induced American economic development, and yet Japan, and indeed other countries at this time such as Britain and Germany, developed markets for technology, to one degree or another, under very different patent systems.<sup>70</sup> While the absence of patent laws may stymie inventive activity, or at least shift it to areas where inventors have a comparative advantage in maintaining secrecy, the presence of heterogeneous patent systems across countries does not appear to have constrained markets for technology from developing. In the Japanese case, the system of intellectual property rights was credible and conducive to enforcing basic rules of law. From there, it followed that inventors and intermediaries in the Meiji and Taishō eras could simultaneously develop their functional activities to satisfy the country's overarching objective to push out the frontier of technological development.

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<sup>69</sup> Lamoreaux and Sokoloff, "Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries," 20.

<sup>70</sup> See further, Nicholas, "Independent Invention during the Rise of the Corporate Economy in Britain and Japan"; and Burhop, "The Transfer of Patents in Imperial Germany."