Did Government Intervention Target Technological Externalities?


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Abstract

After the Second World War, Japan experienced one of the most spectacular episodes of economic growth in history. At the same time, the government of Japan implemented an active industrial policy. What was the effect of industrial policy on economic growth in postwar Japan? In theory, industrial policy can accelerate economic growth by targeting industries with stronger technological externalities. Was the government of Japan able to do so in practice? I attempt to answer this question in two steps. First, I estimate technological externalities in every major manufacturing industry in postwar Japan. The identification strategy takes advantage of exogenous shocks to foreign supply and demand conditions, which affect the size and experience of Japanese industries through international trade flows, but are otherwise not related to domestic supply conditions. I find evidence of static (economies of scale) and dynamic (learning by doing) technological externalities that are relatively large and significantly different across manufacturing industries, providing an economic justification for industrial policy. These estimates also suggest that industries with stronger economies of scale and industries with stronger learning by doing are often different. Second, I evaluate industrial policy by comparing estimates of technological externalities with measures of government intervention. Both quantitative and qualitative measures of government intervention are used to provide a more complete picture of industrial policy. I find evidence that industrial policy in postwar Japan generally favored industries with stronger economies of scale but weaker learning by doing. Industrial policy does not appear to have been better targeted before than after the First Oil Shock, as is often believed.

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1 Introduction

In 1940, Japan’s income per capita ($2,874) was lower than in 2010 India ($3,372) and much lower than in 2010 China ($8,032). In 2000, Japan’s income per capita ($20,481) was similar to that of Germany ($18,944) or the United Kingdom ($21,046) and today Japan is one of the richest countries in the world.\(^1\) As can be seen in Figure 1, Japan caught up with the West between the end of the Second World War and the beginning of the First Oil Shock. From 1900 to 1940, Japan’s income per capita grew at 2.25% per year, somewhat faster than in most Western countries.\(^2\) However, economic growth accelerated after the Second World War and from 1945 to 1973 Japan’s income per capita grew at 7.9% per year, allowing Japan to catch up with the West. While Japan experienced fast economic growth, the government of Japan implemented an active industrial policy.\(^3\) National economic plans projected growth rates at the industry level to coordinate investment and production decisions. In a practice known as administrative guidance, government officials influenced business decisions through non-binding recommendations. Japanese buyers developed a preference for domestic over foreign manufacturing products. Most controversially, the government used several policy measures to favor some industries over others through the provision of directed credit (low-interest loans), import protection (tariffs, quotas, and other trade barriers), and tax incentives (exemptions and allowances).

This paper investigates the relationship between industrial policy and economic growth in postwar Japan. In theory, industrial policy can accelerate economic growth by targeting industries with stronger technological externalities.\(^4\) Was the government of Japan able to do so in practice? I attempt to answer this question in two steps. First, I estimate the magnitude of technological externalities in the form of (static) economies of scale and (dynamic) learning by doing in each major manufacturing industry. I use detailed, firm-level data from 1964 to 1983 to estimate industry-specific production functions and uncover the causal effect of industry size and industry experience on firm productivity.\(^5\) The identification strategy takes advantage of exogenous shocks to foreign supply and demand conditions, which affect the size and experience of Japanese industries through international trade flows, but are otherwise not related to domestic supply conditions. Second, I evaluate industrial policy by comparing measures of government intervention to estimates of technological externalities. Quantitative evidence of government intervention measuring more salient policies such as directed credit, import protection, and tax incentives, is combined with qualitative evidence measuring less salient policies such as national economic planning, “buy Japanese” practices, and administrative guidance. It is important to combine quantitative with qualitative evidence of government intervention because industrial policy

\(^1\)Data on income per capita are from the Maddison Project (2013), measured in 1990 USD and adjusted for PPP.

\(^2\)From 1900 to 1940, income per capita grew at 1.36% in the United States and 1.06% in the United Kingdom. Starting in 1940 and ignoring the massive war destruction of 1945, it would have taken Japan approximately 250 years to reach the income level of the United Kingdom at its prewar growth rate.

\(^3\)Throughout the paper, I use the term “active industrial policy” to mean a deliberate effort to favor some industries over others. Implementing an active industrial policy may therefore involve many forms of government intervention, including fiscal, monetary, trade, and tax policy.

\(^4\)The theoretical framework section shows how technological externalities such as economies of scale and learning by doing cause market failures that lead to suboptimal investment and production in some industries. These market failures may have level and growth effects on income per capita, and certain government interventions can accelerate economic growth by correcting them.

\(^5\)The effect of industry size on firm productivity will be referred to as “external economies of scale” and the effect of industry experience on firm productivity will be referred to as “external learning by doing” throughout the paper.
was implemented with many tools (not all of which can be measured) and formulated with many goals (not all of which were economic growth).

Japan was the first non-Western country to achieve high levels of income per capita; before Japan’s catch up, every industrialized country in the world was of European origin (Patrick 1997). Moreover, the experience of postwar Japan served as a model to other countries, most notably South Korea, Taiwan, and China. Like Japan, these countries combined government intervention with market forces, and achieved fast and sustained economic growth. The path taken by Japan may be followed by many poor countries today, which share many characteristics with prewar Japan, such as high population density, a large agricultural sector, and severe technological isolation. Therefore, a better understanding of the economic history of postwar Japan may lead us to a better understanding of economic growth elsewhere.

The closest contribution to this paper is Beason and Weinstein (1996). Richard Beason and David Weinstein collected industry-level data on directed credit, import protection, and tax incentives given by the government to each major manufacturing industry in Japan between 1955 and 1990. With these data, the authors investigate whether the government of Japan favored industries with higher growth of

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6For the case of South Korea see Amsden (1989), for Taiwan see Wade (1990), and for China see Naughton (2007). Like in Japan, the relationship between industrial policy and economic growth in these countries is not clear.

7I am very thankful to Richard Beason and David Weinstein for sharing their data, which are used in this paper.
gross output, higher growth of total factor productivity, or stronger economies of scale. Of these three sets of correlations, only the correlation between government intervention and economies of scale can be used to evaluate the effect of industrial policy on economic growth.\textsuperscript{8} Unfortunately, the industry-level nature of their data do not allow Beason and Weinstein to obtain precise estimates of economies of scale.\textsuperscript{9} Using their point estimates, the authors show a negative correlation between economies of scale and most of their measures of government intervention, and conclude that industrial policy favored industries with weaker economies of scale, and probably had a negative effect on economic growth in postwar Japan.

This paper expands previous work on industrial policy and economic growth in postwar Japan. First, the paper distinguishes between internal (firm-level) and external (industry-level) sources of productivity. This distinction is possible thanks to the availability of detailed firm-level data, and is important because external economies of scale and learning by doing provide a theoretically-grounded economic justification for industrial policy.\textsuperscript{10} Second, the paper considers the effects of external economies of scale as well as external learning by doing on firm productivity. These two technological externalities give rise to similar market failures involving too little investment and production in some industries, and should therefore be considered simultaneously to evaluate industrial policy. Third, the paper uses quantitative and qualitative evidence on government intervention in postwar Japan. Quantitative evidence is more precise but less complete than qualitative evidence, which is why a combination of the two gives a more adequate description of the general direction of industrial policy. Fourth, the paper evaluates industrial policy based on its ability to correct market failures caused by technological externalities. Previous work has focused on the ability of government intervention to target industries with higher growth of gross output or higher growth of total factor productivity, which do not provide a theoretically-grounded economic justification for industrial policy.\textsuperscript{11}

This paper is organized as follows. Section 2 discusses four strands of literature which are closely related to this paper. Section 3 summarizes the main facts about economic growth and industrial policy in postwar Japan. Section 4 presents a simple model to formalize the relationship between industrial policy and economic growth. Section 5 explains the main variables that will be used, their sources, and their limitations. Section 6 contains the empirical analysis, estimating technological externalities and evaluating industrial policy in postwar Japan. Section 7 offers an interpretation of the main findings and proposes possibilities for future research.

\textsuperscript{8}The fact that some industries have higher growth of gross output or total factor productivity than others does not constitute a market failure, and attempting to equalize these growth rates across industries will generally decrease economic efficiency. Instead, government intervention correcting market failures, such as (external) economies of scale, may increase economic efficiency (Rodrik 1994, pp. 32).

\textsuperscript{9}Their estimates are not able to reject the hypothesis of constant returns to scale in every manufacturing industry.

\textsuperscript{10}Internal economies of scale and learning by doing generate another kind of market failure (the rise of natural monopolies), but they do not provide a theoretically-grounded economic justification for industrial policy.

\textsuperscript{11}For example, Krueger and Tuncer (1982) consider the correlation between import protection and growth of total factor productivity, and Lee (1996) considers the correlation between import protection and growth of labor productivity and total factor productivity.
2 Related Literature

Economists and historians have long been interested in explaining the unprecedented fast and sustained economic growth that characterized Japan between the Second World War and the First Oil Shock. Several explanations have been proposed to explain Japan’s sudden catch up with the West. Human capital, as measured by literacy and numeracy rates, was relatively high in Japan and might have facilitated the adoption of more advanced, foreign technology. Japan’s labor force, usually described as hard-working and obedient, could have been particularly suited for manufacturing and facilitated the movement of workers from farm to factory. The savings and investment rates, which were exceptionally high in postwar Japan, caused the rapid accumulation of physical capital and may have been the main source of economic growth. Fiscal and monetary policy provided good macroeconomic conditions, such as low inflation rates, unemployment rates, and public deficits, which might explain Japan’s economic growth. Relatively low levels of income and wealth inequality, the result of numerous reforms both before and after the Second World War, may also have contributed to economic growth (Rodrik 1994, pp. 16). By far the most controversial explanation of all is the use of an active industrial policy by the government of Japan. While the idea that Japan had an active industrial policy is usually not disputed, the idea that such an industrial policy accelerated economic growth is often debated. On the one hand there are those who argue that industrial policy corrected inefficient market allocations, speeding up economic growth. According to this view, the government of Japan was able to identify industries with severe market failures, and target policies to correct these market failures while resisting political capture by special interest groups. On the other hand there are those who argue that industrial policy distorted efficient market allocations, slowing down economic growth. According to this view, the government of Japan was either not capable of identifying industries with severe market failures, or not capable of targeting policies to correct these market failures because of political capture by special interest groups.

From an economic point of view, the main justification for an active industrial policy is the presence of technological externalities (Rodrik 1994). Arguments in favor of an active industrial policy to accelerate economic growth by correcting technological externalities are very old. Alexander Hamilton (1791) argued that the presence of industry-level economies of scale and learning by doing in the manufacturing sector justified the implementation of an industrial policy to accelerate economic growth in the United States. Friedrich List (1841) used similar arguments to justify an industrial policy for Germany. Since then, economists have formalized the idea of technological externalities. John Stuart Mill (1848, pp. 839-840) acknowledged the potential usefulness of import protection for backward countries in the presence of industry-level learning by doing. Alfred Marshall (1890) identified the main sources of industry-level economies of scale and discussed their implications for the location of economic activity. More recently, economists following the pioneering work of Kenneth Arrow (1962)

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15 There are other economic justifications for an active industrial policy, such as pecuniary externalities (Murphy, Shleifer, and Vishny 1989) or financial frictions (Itskhoki and Moll 2015).
and Paul Romer (1986) have explored the role of technological externalities in generating endogenous economic growth.\textsuperscript{16} A central finding of this literature is that technological externalities generally lead the competitive equilibrium to a lower level and slower growth of income per capita compared to the social optimum. While theoretical work has made significant progress in formalizing the relationship between industrial policy and economic growth, there has been little empirical work on the ability of real-world governments to accelerate economic growth by implementing an active industrial policy (Harrison & Rodriguez-Clare 2010).

Given the importance of technological externalities in many economic situations, economists have been trying to measure them for a long time. In macroeconomics, attempts to measure technological externalities have been made to understand their role in short-run business cycles (Hall 1988; Caballero & Lyons 1989, 1990, 1992; Bartelsman, Caballero, & Lyons 1994) as well as their role in long-run economic growth (Chan, Chen, & Cheung 1995). In international economics, technological externalities have been studied as a source of comparative advantage and an explanation for international trade and specialization patterns (Backus, Kehoe, & Kehoe 1992; Irwin & Klenow 1994; Gruber 1998). In economic geography, technological externalities give rise to agglomeration forces that explain the location of economic activity (Henderson 2003, Rosenthal & Strange 2004, Drucker & Feser 2012). Despite the considerable effort that economists have made to measure them, technological externalities remain very elusive.\textsuperscript{17}

This paper joins a small body of work attempting to evaluate the effects of industrial policy on economic growth. This strand of literature is fundamentally different from papers studying the effects of a particular policy on a particular industry.\textsuperscript{18} Evaluating the effects of industrial policy on economic growth requires considering all relevant policies and industries at the same time.\textsuperscript{19} To my knowledge, the first attempt at evaluating the effects of an industrial policy on economic growth is Krueger & Tuncer (1982). Anne Krueger and Baran Tuncer studied the industrial policy of Turkey between 1963 and 1976, concluding that import protection was correlated with slower growth of total factor productivity at the industry level.\textsuperscript{20} However, Robert Lucas (1984) pointed out that this correlation is not enough to conclude that industrial policy slowed down economic growth, and Ann Harrison (1994) showed that the correlation between import protection and growth of total factor productivity was in fact positive. Noland (1993) is probably the first attempt at evaluating the industrial policy of postwar Japan. Marcus Noland argued that industrial policy changed Japan’s trade pattern, and concluded that it most likely had a negative effect on national welfare. Beason and Weinstein (1996), discussed above, also concludes that industrial policy did not contribute to economic growth in postwar Japan. A similar exercise is conducted in Lee (1996) for South Korea, where measures of import protection are compared to estimates of labor productivity and total factor productivity across manufacturing industries between 1963 and 1983. Jong-Wha Lee concludes that industrial policy decreased labor


\textsuperscript{17} Other work involving the estimation of technological externalities which do not fall into the categories described above includes Foster & Rosenzweig (1995), Branstetter (2001), and Thornton & Thompson (2001), among others.

\textsuperscript{18} Such as Jacobsson (1993), Head (1994), Luzio & Greenstein (1995), and Irwin (2000), among others.

\textsuperscript{19} Focusing on a particular policy does not take into account that incentives provided by one policy may be offset by another. Focusing on a particular industry does not take into account that benefits to one industry may be costs to another.

\textsuperscript{20} The authors use import protection as a proxy for the general direction of industrial policy in Turkey.
productivity and total factor productivity in South Korea, slowing down economic growth. More recently, Lane (2017) studies the role of industrial policy in moving South Korea from labor-intensive to capital-intensive industries. Nathan Lane argues that political and economic shocks in 1973 and 1979 provide exogenous changes in the industrial policy of South Korea, and concludes that temporary government intervention caused a persistent transition towards capital-intensive industries. Finally, Liu (2017) studies how industrial policy in China has been used to correct pecuniary externalities arising from financial frictions caused by credit constraints. Ernest Liu finds that different measures of government intervention in China and other Asian countries are correlated with estimates of financial frictions, and concludes that industrial policy probably increased economic efficiency in these countries.

3 Historical Context

This section briefly summarizes the main facts of economic growth and industrial policy in postwar Japan. The first half of the section focuses on the performance of the Japanese economy after the Second World War, with a brief summary of prewar Japan. The second half of the section focuses on the role of the Japanese government in this period, summarizing the process of formulation and implementation of industrial policy.

3.1 Economic Growth

The industrialization of Japan was set in motion by the arrival of Commodore Perry in 1853 and the subsequent revolution that transformed Japan’s economy and society. During the Tokugawa period (1603-1868), agriculture employed most of the labor force, providing only low income levels. Japan was ruled by a hereditary aristocracy, perpetuating high levels of inequality and feudal traditions that obstructed economic growth. Foreign trade was banned, as was foreign travel. A revolution marked the beginning of the Meiji period (1868-1912), in which a new government committed Japan to industrialization, seeking economic growth to secure military power and ultimately catch up with the West. The government protected and promoted the manufacturing sector, with particular emphasis first on light industries (such as textiles) and later on heavy industries (such as chemicals). During this period, the army and the navy were modernized, a meritocratic bureaucracy was established, mass schooling was expanded, foreign trade and foreign travel were allowed, there was massive adoption of foreign technology, communication and transportation were improved with the adoption of telegraphs and railroads (Huber 1981). Despite these changes, and the fact that structural transformation was fast, economic growth was still relatively slow. Income per capita, which had grown at 0.1% per year in the Tokugawa period, grew at 1.4% per year in the Meiji period. Even during the Taisho (1912-1926)

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23In the United States, income per capita grew at 0.5% during the Tokugawa period and 1.7% during the Meiji period; in Great Britain, income per capita grew at 0.4% and 1.0%, respectively.
and Showa (1926-1945) periods, when income per capita grew at 2.7% per year, Japan was lagging behind the West; it was not until after the Second World War that Japan began to catch up.

In 1945, the United States occupied Japan and used the existing bureaucracy to rule the country. During the first two years of occupation, the economy was in disarray. War destruction had cut in half income per capita. Millions of people had been displaced by the war effort and were returning to the labor force, finding employment mostly in a backward agricultural sector. Food shortages caused by bad crops and the disruption of trade were accompanied by energy shortages caused by the loss of Japanese colonies in Korea and China, and their coal mines (Nakamura 1981, pp. 21, 22). Inflation was high due to the payment of war reparations and the disbursement of war-related compensations. Initially, the US policy towards Japan focused on dismantling the Japanese army and navy, restricting production in war-related industries, and providing little assistance for economic recovery. At the same time, the United States did provide immediate relief to avoid mass starvation (Nester 1991, pp. 9).

During the occupation, the US authorities carried out a land reform that redistributed farmland from large to small owners, an industrial reform that fragmented several large corporations (the zaibatsu), and a labor reform that promoted the establishment and expansion of labor unions. There was fast economic growth in this period, which was mostly the result of rapid accumulation of physical capital; approximately a third of Japan’s stock of physical capital had been destroyed during the Second World War. When tensions between the United States and the Soviet Union spiked in 1949, the US policy towards Japan began to shift. The United States eased the payment of war reparations and several restrictions on the economy, and allowed foreign trade under direct government control (Nakamura 1981, pp. 35, 36). Also in 1949, the US authorities began the implementation of the Dodge line, a set of fiscal and monetary policies aimed at ensuring balanced national budgets, maintaining price stability, and establishing a fixed exchange rate of 360 Yen per Dollar. The outbreak of the Korean War (1950-1951) benefited several industries in Japan due to extensive procurements from the US military. Many of the policies used by the US occupation authorities to control the economy were kept in place after independence and used by the government of Japan to implement industrial policy well into the 1960s. Among these policies, the most important ones were the control of foreign exchange and foreign investment, and the system of tariffs and quotas providing import protection.

The United States ended the occupation of Japan in 1952. Defeat in the Second World War forced Japan to abandon its military ambitions, but not its economic ones. After regaining independence, the government of Japan embarked in a renewed effort to catch up with the West, giving support to certain manufacturing industries such as chemicals and machinery, and basic industries such as coal mining and power generation. Throughout the 1950s, the domestic savings rate increased and, since

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34 Patrick & Rosovsky (1976, pp. 12), Trezise & Suzuki (1976, pp. 785), Magaziner & Hout (1980, pp. 8), Suomela et
international capital flows were restricted, domestic investment rates increased as well (Kosai 1997, pp. 173). At the same time, Japan rapidly adopted foreign technology, which was generally more advanced than domestic technology due to wartime isolation. The process of technology adoption was facilitated by the government through the allocation of foreign exchange.\textsuperscript{35} In 1960, the government of Japan issued the National Income Doubling Plan, which embodied a new national consensus for the conscious pursuit of economic growth. The plan set the expectation of fast and sustained economic growth beyond war recovery, and committed the government of Japan to that end.\textsuperscript{36} After the publication of the plan, private sector investment rates increased, as was true after the publication of subsequent national economic plans.\textsuperscript{37} During the 1950s and early 1960s, the government of Japan implemented extensive import protection through controls on foreign exchange and foreign investment, and the use of tariffs and quotas.\textsuperscript{38} In the early 1960s, Japan began the liberalization of international trade and capital flows due to increasing foreign pressure, particularly from the United States (Kosai 1997, pp. al. 1983, pp. 51, Prestowitz (1988, pp. 27), Kosai (1997, pp. 198-199), Flath (2005, pp. 197), O’Bryan (2009, pp. 4, 10).

\textsuperscript{35} Nakamura (1994, pp. 185), Kosai (1997, pp. 185).

\textsuperscript{36} Before the National Income Doubling Plan, the Japanese people were not very optimistic about the possibility of economic growth beyond war recovery (The Economist 1963, pp. 60; Johnson 1982, pp. 4; Kosai 1997, pp. 189; O’Bryan 2009, pp. 6, 11).


\textsuperscript{38} Patrick & Rosovsky (1976, pp. 45), Trezise & Suzuki (1976, pp. 784).
In 1964, Japan became an Article 8 member of the International Monetary Fund, committing itself to the full liberalization of international trade and capital flows, losing its control on foreign exchange (Kosai 1997, pp. 187). Also in 1964, Japan joined the OECD, a club of countries committed to the liberalization of international trade and capital flows (Kosai 1997, pp. 187). In the late 1960s, the government of Japan undertook a gradual and selective liberalization process. Import protection was slowly relaxed, particularly after “strategic” domestic industries had become internationally competitive. More salient measures of import protection, such as tariffs and quotas, were substituted by less salient ones, such as quality standards. In 1971 the Yen to Dollar fixed exchange rate was devaluated after repeated trade surpluses, and in 1973 Japan adopted a floating exchange rate. By 1973, Japan had fully liberalized its international trade and capital flows, at least in theory (Tanaka 1973, pp. 34). Despite the policy limitations imposed by this liberalization process, the government of Japan was still committed to the pursuit of economic growth (Patrick & Rosovsky 1976, pp. 12). During this period, Japan moved from light to heavy manufacturing industries, partly as a result of an industrial policy favoring the chemical and the iron and steel industries, which made Japan extremely dependent on foreign oil. By 1964, Japan had reattained its prewar trend of income per capita, marking the beginning of economic growth beyond war recovery. The fact that Japan managed to maintain fast and sustained economic growth from around 1964 to 1973 remains one of the most puzzling facts that economists and historians of postwar Japan have tried to explain.

The First Oil Shock of 1973 broke Japan’s national consensus for economic growth. The government was pressed to tackle many issues besides economic growth, such as keeping inflation and unemployment rates low, or improving housing and environmental conditions. The government of Japan responded to the First Oil Shock with aggressive anti-inflationary policies that led to a recession (Nakamura 1994, pp. 253). The quadrupling of oil prices made Japan’s dependence on foreign resources very salient (Trezise & Suzuki 1976, pp. 811). The Japanese people began questioning the usefulness of an industrial policy that had been pushing Japan towards energy-intensive industries, such as chemicals and iron and steel, which were extremely dependent on foreign resources (Komiya et al. 1988, pp. 92, 93). After 1973, the goal of industrial policy was to move Japan towards knowledge-intensive industries, such as machinery and electronics, which would be less vulnerable to foreign shocks and bring Japan closer to the technological frontier. Economic growth slowed down considerably after 1973, but it was still fast enough to allow Japan to keep up with Western economies. In 1990, income per capita in Japan ($18,789) was 81% that of the United States ($23,201) and 112% that of Western

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39Between 1960 and 1962, approximately 90% of import value was free from tariff or quota restrictions.
43The specific year in which Japan reattained its prewar trend of income per capita depends on the source and the measure of income. Data from the Maddison Project (2013) imply that if income per capita in Japan had grown at the same rate as in 1900-1940 and avoided war destruction in 1945, Japan would have reattained that prewar trend in 1945. Nakamura (1994, pp. 27, 28), Nakamura (1994, pp. 273).
45Income per capita in Japan grew at 2.4% per year between 1974 and 2000.
3.2 Industrial Policy

The Ministry of International Trade and Industry (MITI) was the main organization in charge of formulating industrial policy in postwar Japan. Nearly all manufacturing industries were under the jurisdiction of the MITI, except for transportation, communications, pharmaceuticals, and shipbuilding, which had their own specialized ministries (Okimoto 1989, pp. 114). The Ministry of Finance (MoF) also had an important role in the formulation of industrial policy, through the approval of national budgets covering revenue and spending across ministries, and through the control of the Bank of Japan and other public financial institutions. Besides these ministries, the most important government agency related to the formulation of industrial policy was the Economic Planning Agency (EPA), which regularly issued national economic plans covering periods of about five years, and provided industry-level guidelines for government policies as well as business decisions (Nakamura 1981, pp. 80-91).

The industrial policy of postwar Japan had at least two goals. On the one hand, industrial policy aimed at establishing production in new “sunrise” industries which would contribute to economic growth. To that end, the government of Japan protected and promoted industries with high capital intensity (and therefore high labor productivity), high income elasticity, and strong externalities (both pecuniary and technological). On the other hand, industrial policy aimed at maintaining production in old “sunset” industries which would contribute to economic security (Prestowitz 1988, pp. 252). To that end, the government took measures to ensure the orderly decline of shrinking industries, closing inefficient plants, retraining workers to minimize unemployment, and preventing whole industries from disappearing (Patrick and Rosovsky 1976, pp. 46).

Industrial policy was implemented largely by the MITI and the MoF, although virtually every ministry was involved to some degree. In most cases, industrial policy was implemented through markets, and not through government ownership. The MoF channelled funds to targeted industries through commercial banks, which depended on the Bank of Japan, and through public financial institutions related to the Fiscal Investment and Loan Program (FILP). During the 1950s and early 1960s, the MITI had control over foreign exchange and foreign investment, as well as the system of tariffs and quotas, which were gradually substituted by less salient measures of import protection, such as domestic public

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47 Western Europe is defined in Maddison (2013) as Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.


49 Prestowitz (1988, pp. 257), Okimoto (1989, pp. 50, 51), Thurow (1992, pp. 145), Johnson (1995, pp. 27). Neither high capital intensity or high income elasticity constitute a theoretically-grounded economic justification for industrial policy, unless they are accompanied by other market failures. While these are the main criteria that were explicitly used to justify targeting particular industries, some observers consider that the government targeted industries so as to move the industrial structure of Japan closer to that of more advanced countries, such as the United States and West Germany.

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Figure 3: Manufacturing industries targeted by industrial policy in Japan (1950-1990).

procurements, delayed import permits, stringent quality standards, and “buy Japanese” practices.51 The MoF provided tax incentives to certain industries through numerous tax exemptions, subsidies, allowances, and depreciation schemes.52 The EPA regularly published national economic plans with projected growth rates by industry to coordinate private investment decisions (Yamamura 1995, pp. 121). In a practice known as administrative guidance, public officials made recommendations to the private sector with the understanding that the government may act to enforce them (Caves & Uekusa 1976, pp. 493). The MoF implemented window guidance, a form of capital rationing that channeled funds to targeted industries.53 The government was the main actor in formulating and implementing industrial policy, while parliament played a minor role; new pieces of legislation related to industrial policy were almost always approved by parliament, which was dominated by the Liberal Democratic Party throughout the postwar period (Prestowitz 1988, pp. 258).

4 Theoretical Framework

This section presents a simple model describing the allocation of resources across industries. The first half of the section considers the consequences of technological externalities, and the second half of the section considers the role of industrial policy.

4.1 Baseline Model

Consider a small open economy with two industries, \( i = \{1, 2\} \). International prices \( P_{1t} \) and \( P_{2t} \) are taken as given. Firms produce according to a Cobb-Douglas technology, \( Y_{fit} = A_{it} K_{fit}^{\beta_{K,i}} L_{fit}^{\beta_{L,i}} \), where \( Y_{fit} \) is the value added by firm \( f \) in industry \( i \) at time \( t \), \( A_{it} \) is the total factor productivity of firms in industry \( i \) at time \( t \), \( K_{fit} \) and \( L_{fit} \) are the capital and labor inputs of firm \( f \) in industry \( i \) at time \( t \), and \( \beta_{K,i} \) and \( \beta_{L,i} \) are the output elasticities with respect to capital and labor in industry \( i \).

In the competitive equilibrium, the marginal product of capital and labor will be equated across industries, so as to maximize national income:\footnote{The following conditions for the allocation of resources in the competitive equilibrium and the social optimum are derived from the capital market; equivalent conditions can be derived from the labor market.}

\[
P_{1t} A_{1t} K_{1t}^{\beta_{K,1}} L_{1t}^{\beta_{L,1}} = P_{2t} A_{2t} K_{2t}^{\beta_{K,2}} L_{2t}^{\beta_{L,2}} \tag{1}
\]

Without technological externalities or other market failures, the allocation of resources across industries in the competitive equilibrium given by Equation (1) is the same as in the social optimum, and there is no scope for welfare-enhancing industrial policy.

4.2 Economies of Scale

Consider the possibility of external (industry-level) economies of scale, which are perceived by individual firms as an exogenous component of their total factor productivity. External economies of scale are usually modeled as a function of current industry-level production \( Y_{it} \); for simplicity, assume that external economies of scale enter the production function of individual firms as \( A_{it} = Y_{it}^{\gamma_{it}} \). External economies of scale are caused by threshold effects and indivisibilities, such as the establishment of new input markets or the construction of infrastructure, which cause firm productivity to increase with industry size.

Given (multiplicative) policy incentives \( \tau_{1t} \) and \( \tau_{2t} \), the competitive equilibrium allocation of resources across industries with external economies of scale is given by:

\[
P_{1t} \tau_{1t} K_{1t}^{\beta_{K,1} + \gamma_{1t} - 1} L_{1t}^{\beta_{L,1}} = P_{2t} \tau_{2t} K_{2t}^{\beta_{K,2} + \gamma_{2t} - 1} L_{2t}^{\beta_{L,2}} \tag{2}
\]

However, the social optimum allocation of resources across industries, which takes into account external economies of scale, is given by:

\[
P_{1t} K_{1t}^{\beta_{K,1}} L_{1t}^{\beta_{L,1}} = P_{2t} K_{2t}^{\beta_{K,2}} L_{2t}^{\beta_{L,2}} \tag{3}
\]
Equations (2) and (3) imply that the government can lead the competitive equilibrium to the social optimum by setting $\tau_{1t}$ and $\tau_{2t}$ such that:

$$\tau_{1t} \left(1 - \gamma_{1t}\right) = \tau_{2t} \left(1 - \gamma_{2t}\right) \quad (4)$$

All else equal, the optimal industrial policy given by Equation (4) favors industries with stronger external economies of scale (higher $\gamma_{it}$) over industries with weaker external economies of scale (lower $\gamma_{it}$).

### 4.3 Learning by Doing

Next, consider the possibility of external (industry-level) learning by doing, which is also perceived by individual firms as an exogenous component of their total factor productivity. External learning by doing is usually modeled as a function of cumulative industry-level production $\sum_{s=0}^{t-1} Y_{is}$; for simplicity, assume that external learning by doing enters the production function of individual firms as $A_{it} = \left(\sum_{s=0}^{t-1} \delta Y_{is}\right)^{\theta_{it}}$, where $\delta$ represents forgetting or obsolescence. External learning by doing is caused by the diffusion of tacit knowledge, which causes firm productivity to increase with industry experience.

Given (additive) policy incentives $\tau_{1t}$ and $\tau_{2t}$, the competitive equilibrium allocation of resources across industries with external learning by doing is given by:

$$\tau_{1t} + P_{1t} \left(\sum_{s=0}^{t-1} Y_{is}\right)^{\theta_{it}} \beta_{K,1} K_{1t}^{\beta K,1-1} L_{1t}^{\beta L,1} = \tau_{2t} + P_{2t} \left(\sum_{s=0}^{t-1} Y_{2s}\right)^{\theta_{2t}} \beta_{K,2} K_{2t}^{\beta K,2-1} L_{2t}^{\beta L,2} \quad (5)$$

However, the social optimum allocation of resources across industries, which takes into account external learning by doing represented by the shadow value of future productivity increases $\lambda(Y_{K,i,t}, \theta_{it})$, is given by:

$$\lambda(Y_{K,i,t}, \theta_{it}) + P_{1t} \left(\sum_{s=0}^{t-1} Y_{is}\right)^{\theta_{it}} \beta_{K,1} K_{1t}^{\beta K,1-1} L_{1t}^{\beta L,1} = \lambda(Y_{K,2,t}, \theta_{2t}) + P_{2t} \left(\sum_{s=0}^{t-1} Y_{2s}\right)^{\theta_{2t}} \beta_{K,2} K_{2t}^{\beta K,2-1} L_{2t}^{\beta L,2} \quad (6)$$

Equations (5) and (6) imply that the government can lead the competitive equilibrium to the social optimum by setting $\tau_{1t}$ and $\tau_{2t}$ such that:

$$\lambda(Y_{K,1,t}, \theta_{it}) - \tau_{1t} = \lambda(Y_{K,2,t}, \theta_{2t}) - \tau_{2t} \quad (7)$$
All else equal, the optimal industrial policy given by Equation (7) favors industries with stronger external learning by doing (higher $\theta_{it}$) over industries with weaker external learning by doing (lower $\theta_{it}$).

5 Data

5.1 Firm-level Variables

Firm-level data on value added, capital inputs, and labor inputs come from the balance sheets and income statements of all publicly-traded firms in Japan between 1964 and 1990.\textsuperscript{55} The original variables are measured in nominal terms (current Japanese Yen) and are converted to real terms using industry-level price indices provided by the Statistics Bureau of Japan, described below. The data set contains 16,522 observations, corresponding to 1,052 firms over 27 years.\textsuperscript{56} Firms are divided into 88 subindustries, which are grouped into 17 industries roughly corresponding to 2-digits standard industrial classification codes.\textsuperscript{57}

Output is measured as value added (in millions of current Yen, deflated with industry-level price indices) as reported in the income statement of firms.\textsuperscript{58} Measuring output as nominal value added implies that measures of total factor productivity will capture changes in the firm’s market power as well as changes in technical efficiency.\textsuperscript{59} Capital input is measured as the book value of fixed assets (in millions of current Yen, deflated with an economy-wide price index) as reported in the balance sheet of firms.\textsuperscript{60} Measuring capital input as the book value of fixed assets assumes that the capital stock is a good measure of the flow of capital services derived from it, and that all firms in an industry have the same depreciation rate.\textsuperscript{61} Labor input is measured as the wage bill (in millions of current Yen, deflated using an economy-wide price index) as reported in the income statement of firms. Measuring labor input as the wage bill provides a quality-adjusted measure of the labor input to the extent that wages are tied to the marginal product of labor.

\textsuperscript{55}This data set has been collected by Toyo Keizai, a Japanese firm specialized in commercializing economic data. Besides all publicly traded firms, the data set also includes subsidiaries of these publicly traded firms. Foreign companies, investment corporations, or exchange traded funds are not included.

\textsuperscript{56}The original data set contains 41,734 observations. Keeping one observation per firm per year, and restricting the sample to firms in the manufacturing sector with data on output and inputs (dropping negative values), the number of observations becomes 16,546.

\textsuperscript{57}These are (1) processed foodstuffs, (2) textile products, (3) pulp and paper products, (4) chemical products, (5) drugs, (6) petroleum and coal products, (7) rubber and leather products, (8) stone, clay, and glass products, (9) iron and steel products, (10) fabricated metal products, (11) general machinery, (12) electric machinery, (13) shipbuilding and repairing, (14) motor vehicles and parts, (15) other transportation equipment, (16) precision instruments, and (17) other manufacturing products.

\textsuperscript{58}Value added is the difference between revenue and intermediate costs. It includes the cost of labor, the cost of capital (rent, depreciation, royalties, interest, dividends, etc.), gross profits, and taxes.

\textsuperscript{59}In other words, measures of total factor productivity will be revenue-based ($TFP_R$) and not quantity-based ($TFP_Q$).

\textsuperscript{60}Fixed assets are composed of property, plant, and equipment.

\textsuperscript{61}If there are large differences in capacity utilization across firms or across time, the capital stock will not be a good measure of capital input and measures of total factor productivity will capture changes capacity utilization as well as changes in technical efficiency.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Processed Foodstuffs</td>
<td>33</td>
<td>51</td>
</tr>
<tr>
<td>Textile Products</td>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td>Pulp and Paper Products</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Chemical Products</td>
<td>81</td>
<td>101</td>
</tr>
<tr>
<td>Drugs</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>Petroleum and Coal Products</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Leather and Rubber Products</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Stone, Clay, and Glass Products</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>Iron and Steel</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>Fabricated Metal Products</td>
<td>33</td>
<td>54</td>
</tr>
<tr>
<td>General Machinery</td>
<td>68</td>
<td>104</td>
</tr>
<tr>
<td>Electric Machinery</td>
<td>71</td>
<td>89</td>
</tr>
<tr>
<td>Shipbuilding and Repairing</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Motor Vehicles and Parts</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>Transportation Equipment</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Precision Instruments</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>455</td>
<td>613</td>
</tr>
</tbody>
</table>

Figure 4: Number of firms in the balanced panels.

Given that there is a significant drop in the number of observations after 1983, the empirical analysis will be restricted to the years between 1964 and 1983, divided into two periods of equal length. Coincidentally, 1973-1974 is a natural breaking point for the period under study because the First Oil Shock of 1973 caused a change in the rate of economic growth and a change in the goals of industrial policy. The data set will be further restricted to a balanced panel of firms for each of the periods to avoid issues related to the entry and exit of firms. The balanced panel for the decade between 1964 and 1973 has 455 firms (4,550 observations) and the balanced panel for the decade between 1974 and 1983 has 613 firms (6,130 observations).

### 5.2 Industry-level Variables

All price indices have been obtained from the Statistics Bureau of Japan, and have been normalized using 1990 as the base year. The price index for value added is the GDP deflator for manufacturing output before 1970, and the industry-specific GDP deflator for output after 1970. The price index for capital input is the GDP deflator for private sector fixed capital formation in machinery, plant, and equipment, which is common across all industries. The price index for labor input is the general consumer price index excluding imputed house rent, which is also common across industries.

Industry-level output data (value added and gross sales) has been obtained from the Statistics Bureau of Japan, and industry-level trade data (value of imports and value of exports) has been obtained from the United Nations Comtrade Database. Output data is measures in current Japanese Yen and given at the 2-digits industry level. Trade data is measured in current US dollars and converted to
constant Japanese Yen using the nominal exchange rate and the GDP deflators for output provided by the Statistics Bureau of Japan. Trade data is reorganized into 2-digit industries to match the level of aggregation of output data.


6 Empirical Analysis

The first part of this section estimates technological externalities across manufacturing industries in postwar Japan, and the second part of this section evaluates industrial policy according to different measures of government intervention.

6.1 Estimation of Technological Externalities

From the point of view of an individual firm, technological externalities (such as external economies of scale and external learning by doing) are part of their total factor productivity (TFP). In a Cobb-Douglas production function, TFP is given by

\[ Y_{fit} = TFP_{fit}K_{fit}^{\beta_{K, it}}L_{fit}^{\beta_{L, it}} \] (8)

where \( Y_{fit} \) is the output of firm \( f \) in industry \( i \) at time \( t \), \( TFP_{fit} \) is its total factor productivity, \( K_{fit} \) is its capital input, and \( L_{fit} \) is its labor input; \( \beta_{K, it} \) and \( \beta_{L, it} \) are the output elasticities of capital and labor in industry \( i \) at time \( t \). Taking natural logarithms gives the linear estimation equation

\[ \log (Y_{fit}) = \log (TFP_{fit}) + \beta_{K, it} \log (K_{fit}) + \beta_{L, it} \log (L_{fit}) \] (9)

or, equivalently

\[ TFP_{fit} = \exp \left( \log (Y_{fit}) - \beta_{K, it} \log (K_{fit}) - \beta_{L, it} \log (L_{fit}) \right) \]

TFP measures the efficiency with which inputs are transformed into output; changes in output that are not accounted for by changes in inputs are attributed to changes in TFP.

The Cobb-Douglas production function is a first-order approximation to a generic production function.

Throughout the paper, it will be assumed that all firms in an industry share the same output-elasticities at any given point in time. Therefore, estimates of industry-level output elasticities which are computed for 10-years periods will capture an average output elasticity in that period.
We are interested in measuring two components of TFP: external economies of scale and external learning by doing. To do so, decompose TFP into a vector of controls, the effect of industry size on firm productivity, the effect of industry experience on firm productivity, and all other determinants of firm productivity:

\[ y_{fit} = tfp_{fit} + \beta_{K}k_{fit} + \beta_{L}l_{fit} \]  

(10)

In the equation above, \( x_{fit} \) is a vector of controls containing a constant, a linear time trend, and the age of the firm; \( (\text{size})_{it} \) is the logarithm of current industry sales in industry \( i \) at time \( t \); \( (\text{experience})_{it} \) is the logarithm of cumulative industry sales in industry \( i \) at time \( t \); and \( u_{fit} \) is a residual containing all other determinants of firm productivity.\(^65\) The goal of this estimation equation is to measure technological externalities generated by the size and experience of an industry on its firms. There may be other sources of technological externalities (across industries or across countries) which will not be captured by this specification.\(^66\)

The main challenge with the estimation of production functions is that firms make their input choices knowing their TFP. Since we are not able to observe TFP or output elasticities, input choices will generally be correlated with the residual term, making them endogenous. Similarly, industry size and experience may be correlated with unobserved determinants of firm productivity. This section first presents the conditional correlation between firm productivity and industry size and experience given by an Ordinary Least Squares (OLS) estimator, and then turns to the causal estimation of external economies of scale (\( \gamma_{it} \)) and external learning by doing (\( \theta_{it} \)) given by a combination of First Order Conditions (FOC) and Instrumental Variables (IV) estimators.\(^67\)

6.1.1 Ordinary Least Squares

Given the endogeneity problem described above, OLS estimates of the parameters of interest, \( \gamma_{i} \) and \( \theta_{i} \) will generally be biased and inconsistent. However, OLS estimates provide a useful benchmark for

\(^{65}\)The variable \((\text{experience})_{it}\) is constructed as the cumulative sum of the variable \((\text{size})_{it}\), using a discount factor of 10%. All results are robust to alternative discount factors of 5% and 15%. The discount factor is necessary to account for the possibility that knowledge can be forgotten or become obsolete. The variable \((\text{size})_{it}\) includes all firms in the industry. Ideally, one would subtract the sales of each firm from the sales of the industry to measure production that is external to the firm. However, doing so would imply constructing a \((\text{size})_{fit}\) variable for each firm, complicating the computation process. For most industries, there is no difference between the practical measure \((\text{size})_{fit}\) and the ideal measure \((\text{size})_{fit}\) of industry size because each firm represents a very small fraction (<10%) of its own industry. This is true for all industries and periods except for Electric Machinery in 1964-1973 (21%), Rubber and Leather in 1964-1973 and 1974-1983 (19%), Iron and Steel in 1964-1973 and 1974-1983 (32%), and Transportation Equipment in 1974-1983 (10%).

\(^{66}\)Own-industry technological externalities are generally found to be stronger than other technological externalities, and should therefore be easier to measure (Jaife et al. 1993; World Bank 1993, pp. 93, 326; Henriksen et al. 2001; Branstetter 2001).

\(^{67}\)Estimates from OLS and IV regressions are presented given that neither method is clearly better than the other (Young 2017). The second part of the empirical analysis will evaluate industrial policy based on the IV estimates.
the subsequent analysis.\footnote{Griliches and Mairesse (1997, brackets added) note that “simple OLS regressions yield plausible parameter estimates of output elasticities, in line with evidence from factor [cost] shares and generally consistent with constant returns to scale [at the firm level].”}

\begin{equation}
\begin{align*}
y_{fit} = & \beta_{0i} + \beta_{Ki} k_{fit} + \beta_{Li} l_{fit} + \gamma_{it} s_{it} + \theta_{it} e_{it} + \psi_{i} YEAR_{t} + \phi_{i} AGE_{fit} + e_{fit} \\
& (12)
\end{align*}
\end{equation}

OLS estimates of external economies of scale are statistically distinguishable from zero in 12 out of 15 industries in each period, all of them positive. Point estimates are on the neighborhood of $\gamma = 1$, implying that a 1% increase in the size (measured as current sales) of an industry is associated with an increase of 1% in the total factor productivity of firms in that industry. Most importantly for the purposes of this paper, there are are notable differences across industries in the magnitude these effects. External economies of scale are stronger Chemical Products and Drugs and weaker in Fabricated Metal Products in the 1964-1973 period. In the 1974-1983 period, external economies of scale are stronger in Electric Machinery and weaker in Pulp and Paper Products.

OLS estimates of external learning by doing are statistically distinguishable from zero in only 2 out of 15 industries in each period. In the 1964-1973 period, estimates of external learning by doing are larger in Chemical Products & Drugs and weaker in Fabricated Metal Products, while in the 1974-1983 period these effects are stronger in the Fabricated Metal Products (not statistically distinguishable from zero) and weaker in Iron and Steel Products. In the Iron and Steel Products, the coefficient is negative and significant in 1974-1983, suggesting forgetting or obsolescence of tacit knowledge in that industry, which was in decline. Differences across industries in the magnitude of external learning by doing are also notable.

### 6.1.2 First Order Conditions

The optimal behavior of profit-maximizing competitive firms with constant returns to scale has observable theoretical implications in their cost shares. In particular, firms operating under these three conditions will optimally set their cost shares of capital and labor equal to the output elasticities of capital and labor, respectively. Assuming a Cobb-Douglas production function such as $Y_{t} = A_{t} K_{t}^{\beta_{K}} L_{t}^{\beta_{L}}$ (where $Y_{t}$ is value added at time $t$, $A_{t}$ is total factor productivity, $K_{t}$ is the capital input, and $L_{t}$ is the labor input), firms will optimally rent capital and hire labor until $\beta_{K} = (rK) / (rK + wL)$ and $\beta_{L} = (wL) / (rK + wL)$. These first order conditions can be used as estimates of output elasticities, under the assumptions of (1) profit maximization, (2) perfect competition, and (3) constant returns to scale at the firm level.\footnote{These assumptions will not be satisfied if (1) there are frictions preventing firms from maximizing profits at all times, (2) some firms have market power, (3) firms operate under increasing or decreasing returns to scale.} The income statements of firms provide the share of value added dedicated to the payment of labor costs. In the rest of the paper, the labor cost share will be used as the estimate of $\beta_{L,it}$, after averaging labor cost shares across firms within the same industry, and applying a 3-year moving average. The estimate for $\beta_{K,it}$ will simply be $1 - \beta_{L,it}$.
Figure 5: OLS estimates of external economies of scale ($\gamma_k$).
Figure 6: OLS estimates of external learning by doing ($\theta_i$).
6.1.3 Instrumental Variables

To obtain estimates of the causal relationship between industry size and firm productivity, or industry experience and firm productivity, we need to measure movements of industry size and experience that are otherwise independent of firm productivity. In general, industry size and industry experience may be correlated with unobserved firm productivity, making OLS estimates biased and inconsistent. This section presents estimates based on an instrumental variable approach that takes advantage of exogenous shocks to foreign supply and demand conditions, which affect the relative size of Japanese industries through international trade flows, but are otherwise not related to domestic supply conditions.

The instrumental variables are constructed as follows. For each manufacturing industry, divide all countries in the World into three groups: Japan, Japan’s main trading partners, and the rest of the World. Here, “Japan’s main trading partners” are the 10 countries with the largest volume of net exports with Japan in a given industry, and all other countries except Japan are in “the rest of the World”. The basic idea of this identification strategy is to use net exports between Japan’s main trading partners and the rest of the World as an instrumental variable for the size of industries in Japan.\(^{70}\)

Define \(NX_{it}\) as the value of net exports from Japan to Japan’s main trading partners in industry \(i\) at time \(t\), and define \(NX_{\text{it}}^\ast\) as the value of net exports from the rest of the World to Japan’s main trading partners in industry \(i\) at time \(t\). The size of a given industry in Japan \((Y_{it})\) depends on domestic supply and demand conditions \((S_{it}^{JP}, D_{it}^{JP})\), foreign supply and demand conditions in Japan’s main trading partners \((S_{it}^{TP}, D_{it}^{TP})\), and foreign supply and demand conditions in the rest of the World \((S_{it}^{RW}, D_{it}^{RW})\). A valid instrumental variable for the size of a Japanese industry should include some of these components (inclusion restriction) but not include domestic supply conditions (exclusion restriction). Such an instrumental variable would capture movements in the size of a Japanese industry which are not driven by movements in domestic supply conditions, allowing the identification of supply parameters such as \(\gamma_i\) and \(\theta_i\) in Equation 12.

First, consider using \(NX_{it}\) as an instrumental variable for the size of an industry in Japan \((Y_{it})\). Since \(NX_{it}\) depends crucially on domestic supply conditions \((S_{it}^{JP})\), it violates the exclusion restriction. Next, consider using \(NX_{it}^\ast\) as an instrumental variable for the size of an industry in Japan. \(NX_{it}^\ast\) is mostly determined by foreign supply and demand conditions in Japan’s main trading partners and in the rest of the World. As can be seen in Figure 8, this instrumental variable satisfies the inclusion restriction because net exports from Japan’s main trading partners to the rest of the world are a good

\(^{70}\)This instrumental variable approach is very similar to the one used in Autor, Dorn, and Hanson (2013), which is an extension of the widely-used Bartik (1991) instrumental variable approach. Autor, Dorn, and Hanson (2013) “instrument for the growth in US imports from China using Chinese import growth in other high-income markets.”
predictor of the size of Japanese industries. The validity of the exclusion restriction depends on how much \( \text{NX}_{it}^* \) is affected by supply conditions in Japan. For example, if trade with Japan represents a large fraction of all trade by Japan’s main trading partners, then supply conditions in Japan will affect \( \text{NX}_{it}^* \) by displacing or absorbing net exports with the rest of the World. However, general equilibrium effects such as these can be made arbitrarily small by including enough countries in the “Japan’s main trading partners” group, so that \( \text{NX}_{it} \) represents a very small fraction of \( \text{NX}_{it}^* \). 71 The validity of the exclusion restriction also depends on the correlation between foreign supply conditions and domestic supply conditions. Given that there are several countries in each of the groups, only aggregate shocks affecting supply conditions worldwide would pose a threat to the identification strategy.

IV estimates of external economies of scale are statistically distinguishable from zero in 10 out of 15 industries in each period, all of them positive. External economies of scale are stronger in Chemical Products and weaker in Textile Products in 1964-1973. In 1974-1983, these effects are stronger in General Machinery and weaker in Shipbuilding and Repairing. As with the OLS estimates, IV estimates of external economies of scale are notably different across industries, suggesting an economic justification for industrial policy.

IV estimates of external learning by doing are statistically distinguishable from zero in only 3 out of 15 industries in 1964-1973, and 6 out of 15 industries in 1974-1983, all of which are positive except for Chemical Products in 1964-1973. In the 1964-1973 period, Textile Products has the strongest external learning by doing effects, while Chemical Products has the weakest. In the 1973-1983 period, Textile Products again has the strongest external learning by doing effects, while Other Transportation Equipment has the weakest (but not statistically distinguishable from zero). Again, there is considerable differences in IV estimates of external learning by doing across industries, suggesting an economic justification for industrial policy.

6.2 Evaluation of Industrial Policy

This section evaluates the industrial policy of postwar Japan by comparing estimates of technological externalities to measures of government intervention. First, I focus on five quantitative measures of government intervention related to directed credit, import protection, and tax incentives. Second, I consider qualitative evidence from historical accounts on the general direction of industrial policy. It is important to combine quantitative and qualitative evidence of government intervention because industrial policy was formulated with many goals (not all of which were economic growth) and implemented with many tools (not all of which can be easily measured).

Ideally, the effect of industrial policy on economic growth can be evaluated by comparing (1) actual productivity levels under government intervention with (2) counterfactual productivity levels under no government intervention. However, this approach is not feasible because counterfactuals are not

71 For each industry and period, domestic net exports \( \text{NX}_{it} \) represents less than 5% of foreign net exports \( \text{NX}_{it}^* \) except for Rubber and Leather Products (47% in 1973-1984), Electric Machinery (15% in 1964-1973), and Other Transportation Equipment (6% in 1964-1973, 16% in 1974-1983).
Figure 8: OLS regressions of domestic production ($Y_{it}$) on foreign net exports ($NX_{it}^*$).
Figure 9: IV estimates of external economies of scale ($\gamma_i$).
Figure 10: IV estimates of external learning by doing ($\theta_t$).
observable. Instead, I will rely on standard prediction of economic theory and compare the severity of technological externalities with the intensity of government intervention across manufacturing industries.

6.2.1 Quantitative Evidence

Beason & Weinstein (1996) provides comprehensive and systematic quantitative evidence on industrial policy in postwar Japan. Their data set contains five five measures of government intervention for each manufacturing industry over the period 1955-1990.\textsuperscript{72}

The first measure of government intervention is the fraction of loans provided by the Japan Development Bank, which is a measure of directed credit: the government’s effort to channel funds to targeted industries to increase their investment and production. Figure 11 shows the fraction of loans provided by the Japan Development Bank to each major manufacturing industry in Japan, from 1955 to 1990. The Japan Development Bank was the largest public financial institution providing low-interest loans to the manufacturing sector. Although their relative size was small, public loans were often followed by private loans from commercial banks, as government support was interpreted as a sign of creditworthiness.\textsuperscript{73} The main source of funds used by the Japan Development Bank and similar public financial institutions was the Fiscal Investment and Loan Program, which was under the control of the Ministry of Finance.\textsuperscript{74} The government of Japan also implemented directed credit by other means. For example, the Bank of Japan encouraged commercial banks to lend to targeted industries in a practice known as window guidance.\textsuperscript{75} Directed credit is considered one of the main tools that the government of Japan used to implement industrial policy. Japanese firms relied heavily on loans (as opposed to equity) to finance their operations, making directed credit a very effective policy tool.\textsuperscript{76} Lowering the cost of capital, directed credit presumably stimulated investment and production in targeted industries.

The second measure of government intervention is the tariff rate as measured by the effective rate of protection, which is a measure of import protection. The effective rate of protection, taken from Shouda (1983), measures the effect of the whole tariff schedule on each manufacturing industry, taking into account forward and backward linkages between industries. An industry will have a high effective rate of protection if that industry has high tariff rates or if industries selling its inputs or buying its output have high tariff rates. Despite Japan’s liberalization process during the 1960s, effective rates of protection were relatively high throughout the period, ranging from 30% to 40%.\textsuperscript{77} Unfortunately, effective rates of protection are not very different across manufacturing industries, which reduces their

\textsuperscript{72}I am very thankful to Richard Beason and David Weinstein for sharing the underlying data used in Beason & Weinstein (1996).


\textsuperscript{74}Most funds used by the Fiscal Investment and Loan Program were raised by the postal savings system and the public pension system (Prestowitz 1988, pp. 232).

\textsuperscript{75}The Ministry of Finance consulted the Ministry of International Trade and Industry regarding which industries to target.


\textsuperscript{77}The government of Japan might have used tariffs to protect the manufacturing sector as a whole, with little distinction across manufacturing industries.
Figure 11: Fraction of loans from the Japan Development Bank by industry.
value as a proxy for the general direction of industrial policy. The third measure of government intervention is the quota coverage as measured by the fraction of items under quota restriction, which is also a measure of import protection. Quota coverage is significantly different across manufacturing industries, particularly before 1973. Presumably, both measures of import protection raised domestic prices for targeted industries, leading to more investment and production in those industries.

The fourth measure of government intervention is the effective rate of indirect taxation, as given by net indirect taxes over gross output, which is a measure of tax incentives. The government of Japan gave different tax treatment across industries by providing more generous tax exemptions and indirect subsidies to targeted industries, lowering their effective indirect tax rate. The fifth and last measure of government intervention is the effective rate of corporate taxation, as given by corporate taxes over taxable profits, which is also a measure of tax incentives. The government of Japan provided different tax exemptions and allowed different depreciation schemes across industries, lowering their effective corporate tax rate. Presumably, both measures of tax incentives made certain economic activities more profitable, leading to more investment and production in those industries.

Figure 14 summarizes the statistical relationship between estimates of technological externalities (obtained in the previous section) and measures of government intervention (described in this section). The table shows the slope coefficients (and their standard errors) obtained from OLS regressions of estimates of technological externalities on measures of government intervention. The evidence suggests that industrial policy, as measured by these government interventions, did not systematically target industries with stronger technological externalities. In fact, there is an inherent tension between targeting industries with stronger external economies of scale and targeting industries with stronger external learning by doing, as these industries are often different. Also, the evidence suggests that the targeting of industrial policy was not systematically better in 1964-1973 than in 1974-1983, as is commonly believed.

In the 1964-1973 period, industries with stronger external economies of scale were favored by directed credit but not by import protection or tax incentives. In the same period, directed credit and tax incentives (corporate taxation) favored industries with weaker learning by doing. In the 1974-1983 period, industries with stronger external economies of scale were targeted by tax incentives (corporate taxation), while industries with stronger learning by doing were encouraged by tax incentives (indirect taxation) but discouraged by import protection. Figure 14 suggests a more nuanced role of industrial policy than is often portrayed.

It is possible, however, that these five measures of government intervention do not provide a complete picture of the general direction of industrial policy. The next section considers the comparison of targeted and non-targeted industries, as defined in numerous historical accounts of postwar Japan.

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78 Effective rates of protection are particularly similar across manufacturing industries after 1973, as noted by Magaziner and Hout (1980, pp. 40).
Figure 12: Tariff rates (above) and quota coverage (below) by industry.
Figure 13: Effective rate of indirect (above) and corporate (below) taxation by industry.
6.2.2 Qualitative Evidence

Not all policy tools used to implement the industrial policy of postwar Japan can be easily measured, but this does not mean that they were not important. The effects of directed credit, import protection, and tax incentives certainly played a role in shaping Japan’s industrial structure, but so did the effects of national economic planning and administrative guidance. This subsection considers qualitative evidence on industrial policy in postwar Japan, based on numerous historical accounts, which provide a more complete picture of the general direction of industrial policy.

Many historical accounts of industrial policy in postwar Japan identify a consistent set of industries that were targeted in different periods. In particular, the First Oil Shock of 1973 caused a shift in the goal of industrial policy. Before 1973, industrial policy favored energy-intensive (materials) industries such as Chemicals Products, Iron and Steel Products, and Fabricated Metal Products. After 1973, industrial policy favored knowledge-intensive (assembly) industries such as the General Machinery, Electric Machinery, and Other Transportation Equipment. These were the main “sunrise” industries, which were favored by the government to increase economic growth.

Figure 15 presents mean estimates of external economies of scale ($\gamma$) and external learning by doing ($\theta$), weighted by the value added of each industry, for targeted and non-targeted industries as defined...
above. In both periods, targeted industries have significantly stronger external economies of scale than non-targeted industries, but weaker external learning by doing.

<table>
<thead>
<tr>
<th></th>
<th>Targeted Industries</th>
<th>Not Targeted Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1964-1973</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economies of Scale</td>
<td>3.026</td>
<td>0.712</td>
</tr>
<tr>
<td></td>
<td>(3.211)</td>
<td>(0.840)</td>
</tr>
<tr>
<td>Learning by Doing</td>
<td>-2.723</td>
<td>-0.074</td>
</tr>
<tr>
<td></td>
<td>(3.099)</td>
<td>(0.927)</td>
</tr>
<tr>
<td><strong>1974-1983</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economies of Scale</td>
<td>1.426</td>
<td>0.742</td>
</tr>
<tr>
<td></td>
<td>(0.244)</td>
<td>(0.521)</td>
</tr>
<tr>
<td>Learning by Doing</td>
<td>-0.924</td>
<td>0.216</td>
</tr>
<tr>
<td></td>
<td>(1.644)</td>
<td>(1.076)</td>
</tr>
</tbody>
</table>

Figure 15: Correlation between technological externalities and government intervention.

7 Conclusions

I estimate technological externalities generated by external economies of scale and learning by doing across major manufacturing industries in postwar Japan. Both OLS and IV estimates suggest that external economies of scale and learning by doing were relatively large and significantly different across manufacturing industries, providing a theoretically-grounded economic justification for industrial policy. Assuming that prices in the competitive equilibrium do not take into account the effects of technological externalities, there is room for government intervention to accelerate economic growth. An industrial policy that targets industries with stronger technological externalities, giving incentives for further investment and production in those industries, can increase economic growth in principle. My estimates suggest that industries with stronger economies of scale do not always have stronger learning by doing and vice versa, which would make the implementation of an industrial policy very difficult in practice.

I evaluate industrial policy in postwar Japan by comparing quantitative and qualitative measures of government intervention to estimates of technological externalities. Industrial policy in postwar Japan was not very consistent, as different policies favored different sets of industries. At the same time, some policies targeted industries with stronger external economies of scale and others targeted industries with stronger external learning by doing. Quantitative measures of government intervention, which attempt to encapsulate the effects of all government interventions, show that in 1964-1973 industries with stronger economies of scale were not systematically favored, while industries with weaker learning
by doing were; in 1974-1983, government intervention encouraged industries with stronger economies of scale and discouraged industries with stronger learning by doing. A similar picture emerges from qualitative measures of government intervention, showing that industrial policy favored industries with stronger economies of scale and weaker learning by doing in both periods.

There are many possibilities for future research regarding the causes of economic growth in postwar Japan. Industrial policy may have accelerated economic growth in postwar Japan by favoring manufacturing over agriculture, accelerating structural transformation. A large fraction of economic growth in postwar Japan is likely connected to high savings and investment rates, but it is not clear the extent to which these high savings and investment rates were the result of policy. The role of national economic planning is not well understood, as projected growth rates may or may not have a direct effect on actual growth rates through expectations. It is also possible that fiscal policy and monetary policy were enough to create conditions leading to economic growth, while industrial policy had no significant effect. Yet another possibility is that international trade allowed the decoupling of consumption and production, providing the opportunities for Japan to move into economic activities more favorable for economic growth (as in Lucas 1993). The causes of economic growth in postwar Japan may be found in the prewar Japan, in which the government also implemented an active industrial policy to establish domestic production in every major manufacturing industry, allowing Japan to gradually approach the technological frontier. Lastly, economic growth in postwar Japan may have been the result of economies of scale and learning by doing that would have been realized with or without industrial policy, as Japan enjoyed the advantages of economic backwardness.

81 This possibility has been suggested by Nakamura (1981, pp. 49, 81), Francks (1992, pp. 279), the World Bank (1993) and Harrison & Rodriguez-Clare (2010, pp. 4069) among others, while the opposite has been suggested by Patrick & Rosovsky (1976, pp. 46) and Trezise & Suzuki (1976, pp. 773, 800, 809) among others.
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