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ARTICLE

Taiwan Machinery Manufacturing Corporation and the Role of State Firms in Economic Development

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This article examines the role of state-owned firms in economic growth. While some scholars denigrate state firms, most analysts of East Asian development have noted their importance. To date, however, little work has been done on how state firms operate and how they have actually contributed to industrial development and economic growth. Looking closely at postwar Taiwan as a newly industrializing country and the case of Taiwan Machinery Manufacturing Corporation (TMMC), this article argues that state enterprises resolved coordination failures and provided manufacturing capacity to infant industries. Drawing on company archives and state records, I argue that TMMC helped drive growth through the provision of manufacturing machinery, equipment, parts, repairs, and upgrading. By supplying firms with the necessary technology and materials to modernize production and be competitive on the global market, I show how TMMC helped facilitate Taiwan's economic miracle.

Keywords: manufacturing; industrialization; economic development; East Asia

In the mid-1960s, Taiwan's industrial development faced a setback. Over the previous decade and a half, import substitution had powered the domestic economy to double-digit growth, but as manufacturing shifted to exports, firms found themselves short on production capacity. Machinery was old and worn, or of lagging technology. In response, the government's fourth economic development plan (1965–1968) presented a series of new measures, including a call to develop key manufacturing equipment and processes. As President Chiang Kai-shek put it, "From now on, the focus of Taiwan's industrial development needs to be in the machinery industry."[1] To accomplish this goal the plan called on what would quickly become one of the most important state-owned firms, Taiwan Machinery Manufacturing Corporation (TMMC).[2]

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1. Quoted in Zhang Zheqi, "Yazhou jingji fazhang," 46.
2. Fourth Plan, 263–8.

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Founded in 1946 by the Republic of China government in Taiwan, this state-owned enterprise (SOE) came to assume center stage in Taiwan's late industrialization. As this article argues, TMMC played instrumental roles in both development initiatives and expanding domestic manufacturing capacity. From 1953–1986, Taiwan's economy grew at nearly 9 percent annually with per capita gross national product (GNP) increasing over 6 percent. Real earnings in manufacturing grew over 15 percent per year, and unemployment remained under 2 percent every year in the 1960s–1980s.[3] While scholars have long noted this astonishing development and named Taiwan as one of the tigers (or dragons) among the East Asian developmental states, relatively little attention has been paid to the role of public enterprises.[4] As observed in the government's fourth development plan, however, TMMC was specifically written into the program and would continue to be called upon in subsequent plans.[5] The pages below argue that state firms, and TMMC in particular, need to be seen as key actors in the development process.

Analysis of East Asian developmental states such as Taiwan has predominately focused on industrial policy and government-business alliances.[6] On the one hand, scholars have been keen to identify government policies of direct intervention in the economy—policies that not only facilitated development and growth but also led to structural transformations. These scholars have consciously rejected neoclassical and neoliberal explanations of macroconditions—such as currency stability or legal regimes—and instead found East Asian governments working to shape the market to "get prices wrong," in the words of one prominent developmental-state scholar.[7] They point to policies that protected and promoted certain domestic industries and sectors through measures such as tariffs and rebates, import and export controls, negative interest rates and credit control, tax incentives in certain sectors, subsidies, and even profit guarantees. Accordingly, policies shaped economic outcomes, facilitated structural shifts, and created the East Asian miracle economies.[8]

At the same time, other scholars have focused on state institutions and government relations with private firms. These studies show that economic policies often involved directing or disciplining private capital–such as incentivizing investment–and explore where those policies originated and how they were formed and implemented. Here scholars have examined state capacity as what Chalmers Johnson calls "administrative guidance": That is, why some

3. Taiwan growth figures from Wade, *Governing the Market*, 38.

4. For a general statement on Taiwan's development and place in East Asian growth see Vogel, *The Four Little Dragons*, 13–44.

5. The fifth plan, for example, called on TMMC to produce power generating machinery. Fifth Plan, 239. The sixth plan expanded TMMC's role in production. Sixth Plan, 204–7.

6. The literature on East Asian developmental states is large and covers both individual countries and the region as a whole. It contains strong and weak understandings of the developmental state, where the former is often undertaken by social scientists and implicates the political economy to make an argument of state necessity for economic growth, while the latter is usually undertaken by heterodox economists showing the role of the state and industrial policy in growth. For simplicity, I combine these different strands in the discussion below. The distinction is implicitly developed in Haggard, *Developmental States*.

7. Amsden, *Asia's Next Giant*.

8. Representative texts include Amsden, *Asia's Next Giant*; Chang, *The East Asian Development Experience*; Rodrik, "Getting Interventions Right; Wade, *Governing the Market*. For a general statement of these policies at work in late developers see Amsden, *The Rise of "the Rest*.

states were successful and how bureaucracies had autonomy to act yet did not succumb to corruption or rent-seeking as they developed close relations with private firms. Such inquiries have resulted in insights into the workings of the bureaucracies of developmental states and the nature of relations between the state and private capital.[9]

What has received less attention is the role of SOEs, not only in East Asian developmental states but in economic development generally.[10] SOEs are mentioned by developmental-state scholars, to be sure, and state-run firms constantly lurk in the background of development narratives, but the SOE is usually brought up to either counter neoclassical explanations and assumptions or to show how the state-guided markets and private capital. In the former case, for example, Robert Wade addresses neoclassical dismissals of SOEs by noting the heavy presence of state firms in Taiwan's economy, yet makes his argument through macro figures in a mere seven pages of a four-hundred-page book.[11] Likewise, in the case of the latter, a state-run steel company is key in Alice Amsden's story of South Korea but used to show government activity and upstream supply for private shipbuilding and automobile manufacturing.[12] Such studies do note the importance of SOEs, but they do not offer directed inquiries into their role and functions, leaving open the question of if the same contribution could have been made by a private firm.[13] Furthermore, the state firms mentioned in existing studies tend to be single-industry, such as steel or petrochemicals. The present article thus inquires into other types of SOEs at work in developmental economies, and if these SOEs did more than provide sectoral inputs. More generally, it examines the types of roles SOEs play in development.[14]

In order to fill this gap and better understand the role of SOEs in economic development, this article looks closely at one state firm, TMMC.[15] It examines TMMC's participation in Taiwan's industrialization and economy, probing not only the details of its direct contributions but also how it did so in multiple sectors. Somewhat of a grab-bag for machine production, TMMC did everything from foundry castings to shipbuilding to heavy machinery and sugar mills: it cultivated expertise in various areas with flexibility to quickly fill lacunae in Taiwan's postwar industrial development. It operated under the Ministry of

9. "Administrative guidance" is developed in Johnson, *MITI and the Japanese Miracle*. Other key texts include Chu Wan-wen *Taiwan zhanhou jingji fazhan*; Evans, *Embedded Autonomy*; Haggard, *Pathways from the Periphery*. For a recent take on this line of inquiry see Maggor, "Sources of State Discipline.

10. For a statement on the lack of research on SOEs see Singh and Chen, "State-Owned Enterprises and the Political Economy of State–State Relations." Also see Bernier, Florio, and Bance, eds., *The Routledge Handbook of State-Owned Enterprises*, 1; Sanchez-Carriera, Vence, and Rodil-Marzabal, "The Role of State-Owned Enterprises as Drivers of Innovation."

11. Wade, *Governing the Market*, 175–84.

12. Amsden, *Asia's Next Giant*, 291–318.

13. Ha-Joon Chang points out, for example, that in theory many of the economic roles of state firms can be performed by private firms operating under a regulatory regime. Chang, *State-Owned Enterprise Reform*, 13. Wan-wen Chu addresses this in a single case study but notes the need for further case studies. Chu, "Import Substitution and Export-Led Growth."

14. Recent literature on state firms today has begun to ask these question. For example see Kowalski et al., "State-Owned Enterprises"; Tõnurist and Karo, "State-Owned Enterprises as Instruments"; Gershman, Bredikhin, and Vishnevskiy, "Corporate Foresight and Technology Roadmapping"; Landoni, "Reconsidering Innovation in State-Owned Enterprises."

15. On the need for more case studies of state firms and their economic activities, see anchez-Carriera, Vence, and Rodil-Marzabal, "The Role of State-Owned Enterprises as Drivers of Innovation."

Economic Affairs (MOEA), where it helped serve the goals and visions of key planners like Li Kuo-ting in the rise of Taiwan's industrial sectors and the transformation of the economy.[16] It did this, I argue, by resolving coordination failures and developing Taiwan's manufacturing capacity; it enabled industrial diversification and provided both large firms and small and medium enterprises (SMEs) with the necessary technology and materials to modernize production and compete in the global market. In short, TMMC helped facilitate Taiwan's economic miracle.

The pages that follow build the argument through three sets of inquiries. First, what was TMMC's relation to the Taiwan state? TMMC was a public firm, majority owned by the state and under the jurisdiction of MOEA, but what did this mean in daily operations and long-term direction? The corresponding section investigates TMMC as an SOE in practice and charts the chain of command. Establishing that relationship leads to the next inquiry: How did TMMC contribute to industrialization and development? Or, to put it another way, how did TMMC resolve coordination failures? This section looks upstream to examine TMMC's provision of two essential products in Taiwan's economic development: tinplate and boilers. These products are case studies of how TMMC provided essential inputs and increased countrywide manufacturing capacity. The third question asks how TMMC acquired or developed the necessary technology and know-how. This last question deserves an entire study on its own, but, due to space limitations, it will be addressed throughout. Before taking up these three inquiries, however, the next section will outline Taiwan's early industrialization and the coordination problem.

Taiwan's Industrialization and Coordination Failure

In the postwar years—roughly 1952–1965—Taiwan underwent rapid industrialization as it transitioned from agriculture to industry. This transition occurred under the Kuomintang (KMT) one-party state as the Republic of China on Taiwan (ROC); the structural transformation began first by modernizing the agricultural sector then expanding manufacturing into other sectors of a growing economy before focusing on exports for global markets in the 1960s. This section offers an overview of these developments and in doing so situates TMMC in the Taiwan economy and the role that it would come to play. The section further explores a key problem of late industrializing countries undergoing the transition from agriculture to industry, namely encouraging investment in sectors of the economy that pose a greater risk and offer low to zero returns—or what is often referred to as coordination failure.

Taiwan's Industrialization

By the numbers, Taiwan's economic growth and industrialization were phenomenal—some of the fastest in world history. In the two decades from 1952 to 1972, the economy grew at a rate of

16. In a discussion with TMMC managers and executives in 1969, Li mentioned that in the four years since he had taken office as Minister of Economic Affairs he visited TMMC more frequently than any other company. The reason being, he said, was because "the machine industry is the foundational industry and TMMC shoulders an unusually heavy burden." Quoted in "Dongtai baodao: Jingjibu Li buzhang lilin dui bengongsi zhuguan renyuan xunhua," 6.

nearly 10 percent annually, and the structure of economic production was inverted from agriculture-dominant to industry-dominant: In 1952, agriculture accounted for 36 percent of net domestic product and over 56 percent of the labor force; by 1972 the share of production had fallen to around 14 percent and labor employment to 33 percent. It would continue to decline so that by 1980 agriculture was only 9 percent of production and 19.5 percent of employment. By contrast, industrial manufacturing took a reverse trajectory, accounting for less than 11 percent of output in 1952 and 12.4 percent of the labor force; by 1972, however, it was responsible for over 32 percent of output and 24.6 percent of the workforce. By 1980, manufacturing's share of production rose to 34 percent and employed over a third of workers. Exports exhibited the same patterns. In 1956, over 80 percent of exports were agricultural and only 17 percent industrial. By 1972, the figures had reversed, with industrial goods accounting for 83 percent of all exports.[17]

The shift began in the early 1950s when policymakers turned attention to shoring up the Taiwanese economy. Beginning with agriculture, the KMT-led government pursued a strategy of self-sufficiency, launching a series of reforms and economic plans to increase output and stabilize the macroeconomy. The first four-year plan (1953), for example, outlined a strategy to increase agricultural production to feed the expanded population (that had fled war-torn China) and improve the balance of payments.[18] In addition to modernizing agriculture with better inputs, the plan recognized the need to develop industry to serve agricultural needs, especially by producing machinery and machine tools. It called for investments in the millions of US dollars to develop machinery for casting, tire production, and tool making, among others. Moving downstream it emphasized the need for canning machinery for packaging, as well as refrigeration equipment to support the food and fishing industries.[19] Coupled with this manufacturing plan was an import-substitution policy, which leveled high tariffs and import restrictions to protect the nascent manufacturing sector from foreign competition.

The year 1960 is often taken as a turning point.[20] In that year, the government released a nineteen-point program for investment reform and export promotion that lifted constraints on investment and trade. Overall, the plan aimed to "encourage savings and investment, [and] to reduce expenditure and promote exports."[21] This was done through measures such as higher interest rates, increased lending, and the establishment of an export processing zone. The third fourth-year plan of 1961 noted a "big change in exports" with the overall ratio of the value of sugar and rice declining in favor of textiles, fasteners, and paper and wood products.[22] The plan did acknowledge, however, the export growth of machinery and other industrial parts, and laid out objectives of improving product quality and lowering production costs in order to make Taiwan-made equipment attractive and more competitive in overseas markets.[23] Further policy measures were carried out to encourage

17. Figures from Mao and Chi, "Agricultural and Industrial Development in Taiwan," 38, 41. The early emphasis on agriculture was on account of Taiwan's colonial past.
18. First Plan, 1.
19. First Plan, 45–9.
20. For example, see Lin, *Industrialization in Taiwan*, 114.
21. Quoted in Tsai, "Explaining Taiwan's Economic Miracle," 73.
22. Third Plan, 16.
23. Third Plan, 157–9.

industrial growth and exports so that by 1968 the industrial sector contributed more to the GDP than the agricultural sector for the first time, a trend that would not reverse.[24]

How this transformation was accomplished has been the subject of much discussion.[25] The standard story is that macroeconomic conditions facilitated Taiwan's comparative advantage in cheap labor. Accordingly, reforms, including currency stabilization, exchange rate unification, tax-free incentives for exporters, and tax-free imports of inputs, alongside higher interest rates to encourage savings and investment, all framed a free-trade regime that optimized prices and balanced supply and demand in global markets. In this environment, the story goes, Taiwan manufacturers were able to put their capital to work and maximize the advantage of low-cost labor in producing goods such as textiles and garments for international markets.[26]

The revisionist account emphasizes a developmental state. Scholars of this school argue that the state played a greater role than simply liberalizing markets and laying the macro-conditions for unlocking comparative advantage. By "governing the market," as Robert Wade puts it, and guiding investments, the state distorted prices and shaped comparative advantage in certain directions. This account sees a robust slate of policy measures that facilitated the industrial vision, including credit allocations, tax holidays, promotion of exports through tax exemptions on foreign exchange earnings, tariffs, and tariff rebates, and assistance to specific industries. The result was that the state consciously built up certain sectors with targeted interventions.[27]

More recently, scholars have argued that proponents of the developmental state thesis have given the state too much agency in shaping the direction of the economy. Although these scholars agree that the state did play a larger role than that purported by the neoclassical account, it was not the role of a mastermind successfully picking winning firms and targeting key sectors to guide the economy in the correct direction. For some, state policies were not planning, but rather the response to already existing problems. In this interpretation, policies were developed as reactions rather than visions, and the state followed winners rather than picked them.[28] Other scholars focus on the proliferation and success of Taiwan's SMEs, a phenomenon that lies beyond the developmental state explanation. In other words, a robust industrial policy, incentives, and subsidies still cannot account for the flexibility, innovation, and growth of small firms in the private sector. Scholars here give the state credit for many of the developmental aspects, such as infrastructure, upstream support, and incentives, but point to the importance of networks and a social environment that small firms leveraged for success.[29]

24. See Mao and Chi, "Agricultural and Industrial Development in Taiwan," 38.

25. My focus here is on the economy. For an overview of the politics involved, see Haggard and Pang, "The Transition Ot Export-Led Growth in Taiwan."

26. Two early texts outlining this position are Lin, *Industrialization in Taiwan;* Ho, *Economic Development of Taiwan*. For a more recent take, see Kuo and Myers, *Taiwan's Economic Transformation*.

27. The representative work is Wade, *Governing the Market*.

28. Tsai, "Explaining Taiwan's Economic Miracle." Also see Wu, *Taiwan jingji sibainian*.

29. Some works include Hamilton and Kao, *Making Money*; Hsieh, "Learning by Manufacturing Parts"; Wang, Lee, and Chen, "Taiwan jingji fazhan zhong de guojia jiaose"; Wu, *A Political Explanation of Economic Growth*.

Coordination Failure

Despite the disagreements, what is clear from each position is the need to coordinate investments in modern sectors. This coordination, it is understood—whether it came from macroconditions, incentives, or networks—facilitated the growth of industry and resulted in an economic take-off. Even in the free-marketeers case, economic transformation and growth could not have occurred in decentralized market conditions because, in the words of economist Dani Rodrik, "the imperfect tradability of key inputs (and technologies) associated with modern sector production, and some increasing returns to scale in those activities," created a situation of coordination failure.[30] This is to say, the rate of return to coordinated investments, e.g., aluminum production, was high, but the rate of return to individual investment was low, e.g., the individual entrepreneur. Thus private capital had little incentive to invest in modern sectors, making state intervention necessary. For the free-marketeers, this intervention was in the macroeconomy; for dirgists, it was in the sectors themselves and specific industries.

Coordination failure is a general affliction of economic development.[31] It besets economies undergoing structural transformation, whether from agriculture to manufacturing or from labor-intensive industry to skill-intensive and technological-driven industry. In such situations, the problem is manifest by the lack of sufficient intermediary producers manufacturing inputs to cater to and support the production of high-tech goods or advanced industry. Simply put, if there are no downstream producers in an advanced sector, then there is little incentive for upstream firms to produce inputs and necessary machinery due to the lack of demand. But if there are no upstream firms producing inputs or necessary machinery for more advanced production, then downstream firms cannot emerge. Take the case of canning preserved foods in postwar Taiwan, as discussed below. A huge global market had begun to boom in the postwar years; Taiwan, with an abundance of fruits, vegetables, and fish, stood poised to tap it. However, tin cans were needed to package the food, while can-making machines were needed to make the cans, and tinplate was required as a material input to feed the machines to press the cans. At the outset, each market segment remained a risk: without tinplate, no firm would purchase can-making machinery, but without the machinery, no firm would purchase or produce tinplate, and thus no cans could be produced and no food could be packaged.

To resolve investment failure, government intervention is almost always required.[32] In economic theory, there are at least four ways that states can do so: Foremost, improve the investment climate, as the neoclassical theory would assert. This includes stabilizing the macroeconomy, implementing a favorable monetary policy and exchange rate, and ensuring a functioning legal system of contracts. A second means is through subsidies, either directly through credit or even cash transfers, or indirectly through interest rates and tax incentives or holidays. A third response is for the state to actively coordinate investment decisions through

30. Rodrik, "Getting Interventions Right," 78.

31. For general statements on coordination failures, see Rodrik, "Coordination Failures and Government Policy"; Rodrik, *One Economics, Many Recipes*, 99–110.

32. Cf. For a market-centered approach to coordination failure that rejects government intervention, see Matsuyama, "Economic Development as Coordination Problems."

measures such as industrial parks and centers, or directing investors to take over and engage in certain sectors. A fourth way is through SOEs.[33]

This then is one answer to the question of the role of SOEs in economic development: SOEs can resolve coordination failure through the provision of key inputs and manufacturing capacity. The existing economics literature makes such a point in passing, to be sure, but not through a sustained and directed study. As critics have noted, the claim "requires further elaboration and empirical investigation."[34] The following pages endeavor to do just that by showing how TMMC resolved coordination failures in the Taiwan economy.

TMMC and the Taiwan State

By the time of Taiwan's rapid industrialization in the 1960s, TMMC had extensive manufacturing operations in numerous sectors. Often mobilized to undertake product development coordinating with manufacturing needs, TMMC grew to over 3,000 employees with multiple factory sites in Kaohsiung, including a machine works, foundries, and two shipyards.[35] The firm's multiple

Figure 1. TMMC machine shop c1950s. *Taiji sa'nian* (Tainan, TMMC: 1977), 44.

33. These points are elaborated in Rodrik, "Getting Interventions Right," 84–91.

34. Gene Grossman responding to Dani Rodrik, in Rodrik, "Getting Interventions Right," 99.

35. Overviews of TMMC operations can be found in company catalogs at the National Science and Technology Museum Library, Kaohsiung. Also see C.K. Chen, "Kuozhanzhong zhi Taiwan jixie gongsi," *Taiji yuekan*; Ma, Wilfred, "TMMC in Progress," *Taiji yuekan*.

factories worked integrally, supporting each other in the production of everything from steel-hulled deep-sea vessels to sugar refinery equipment and cement mills. The wide range of upstream and downstream production capacity enabled TMMC to fill all manufacturing requirements, including finished industrial equipment and products, the machines to make such products, the parts, as well as the tools to make the parts; it also produced materials, such as aluminum and steel.

This section presents an overview of the company's operations and its relation to the state. It highlights TMMC as a rather unusual SOE in that it did not specialize in a single product—it did not produce for a single industry or even sector—rather, it was something of a jack-of-all-trades, able to produce bicycles and fishing vessels, while at the same time capable of grinding gears, forging crankshafts, and casting steel casings. The lack of specialty limited the firm's efficiency in economic terms, yet it gave the state a coordinating flexibility to meet economic requirements and sector demands. TMMC was not designed as an all-purpose industrial tool for an economic program, but it came to play such a role, for it was ready at hand with the capacity to meet various needs.

Beginnings

From the beginning, TMMC worked to serve the developmental goals of state planners—or rather, planners and policymakers mobilized TMMC in fits and starts to help in the evolving developmental goals.[36] When the ROC government received the Taiwan island and its assets from the surrendered Japanese empire, planners combined the Japanese colonial ironworks and shipyards into a single firm. This firm would become TMMC, and it was immediately identified as a means to help rebuild after the war. The National Resources Commission (NRC), the government body in charge of economic assessments, noted that the ironworks and shipyard could combine to increase production and efficiency. Doing so would not only help revive Taiwan's machine and transportation industries after the war, according to the NRC but also serve in the rebuilding of industry in Guangdong and Fujian, two mainland Chinese provinces just across the Taiwan Strait.[37] Although production facilities had been destroyed in the war, the NRC was able to mobilize TMMC's remaining capacity to build and repair machinery. Within a few years, TMMC not only supplied local factories with simple machines and repaired their broken ones, but also shipped manufacturing equipment to mainland China.[38]

When the KMT lost the Civil War in China in 1949, TMMC turned its attention to import substitution in Taiwan. At the time, the firm largely supplied other state enterprises with parts and manufacturing needs. Sugar mills and equipment were essential, as Taiwan still relied on agricultural exports, while castings for train cars and other vehicles assisted in rebuilding

36. An internal company report notes that throughout the 1950s and much of the 1960s, TMMC operated with little government guidance, backing, or funding. Not until the mid to late 1960s did it get more support and direction. "Ershiwu nian lai zhi Taiwan jixie gongsi," *Taiji shuangyuekan*, 15.

37. "Taiwan gongkuang shiye kaocha baogao." Also see Hong Sao-yang, *Jindai Taiwan zaochuanye de jishu*, 70–1.

38. On the destruction of TMMC in WW2 and its contribution to postwar rebuilding, see Zheng Damou, "Zhongjixie gongchang jianjie," *Jiexie tongxun*; "Taiwan gongkuang shiye kaocha baogao," 28. Estimates put 9 percent of TMMC sales to China in 1948. See Hong Sao-yang, "Zhanhou Taiwan gongyehua," 113.

efforts.[39] Two key products stand out in this early transition and both mark the firm's relation with the state: bicycles and fishing boats. On bikes, the influx of mainland Chinese after the Civil War led to a spike in demand for transportation, translating into a rapid increase in bicycle sales. Between 1949–1950, imports reached up to as many as 80,000 bikes. In order to stem the outflow of foreign reserves, TMMC was commissioned to begin manufacturing bicycle frames for domestic consumption. These frames were then fitted with parts and components from a growing network of local manufacturers. Once the industry was up and running, and successfully replacing overseas models, TMMC turned over all of production to domestic SMEs.[40]

Fishing vessels was another key focus of TMMC.[41] The company was formed out of shipyards turned over by Japan, and in the 1950s this capacity was mobilized in a government program to equip each fisherman with a new boat.[42] Over the course of the decade, TMMC engaged in building small wooden fishing boats with an outboard motor for the island's fishermen. Most of these vessels were small at around 20 tons for coastal fishing and could be constructed quickly—within a matter of weeks. TMMC was not the only shipbuilding firm to be engaged in the frenzy of fishing boat replacement, to be sure, for thousands of fishermen were promised a modern vessel equipped with an engine, but it led the charge. In April 1953, for example, the government commissioned eighty-seven boats, of which over two-thirds were to be built by TMMC; the order was to be completed within two months.[43] By 1958, TMMC's reputation had grown and its shipbuilding was highly sought after both domestically and internationally, with reports noting that orders for eighty-ton vessels were full through the end of the year.[44] Some years later, the shipbuilding industry association representing private firms complained that TMMC received too many government orders and favorable treatment at the expense of private shipbuilders.[45]

The TMMC product list went far beyond just bikes and boats: it stretched deep into all things metal and casting. A catalog from the early 1970s spells out the diversity of products and manufacturing.[46] The catalog divides the firm into five production plants with each plant responsible for a different operation and output. The heavy machinery plant engaged in the manufacturing of machines and industrial equipment, such as diesel engines, boilers, sugar and cement machines, dust collection equipment, and cranes. The foundry made castings and parts for the engines and machines; it further produced boat engine propellers, gear reduction boxes, roller shells, flywheels, and flood control pump blades. The shipbuilding plant, in addition to small and medium vessels, also manufactured pumps and 20- and 40-foot steel containers. The steel mill turned out tinplate, but also rail and tank cars, among other things.

39. See outline in Chen Jeng-horng, *Zhuandong shiji*.

40. Chen Jeng-horng, "Taiwan jixie gongsi chanye," 22–3.

41. For an overview of TMMC early boat building, see Chen Jeng-horng, "Taiwan jixie gongsi chanye," 206–7.

42. The state policy of offering fishing boats to the local population was done in order to win political support and encourage food production. See Luo Chuan-chin, *Taiwan yuye fazhanshi*, 41–6.

43. "Shouci fangling yuchuan jiao Taiji jianzao," *Weixin xinwen*.

44. "Jianzao yuchuan daikuan," *Weixin xinwen*.

45. Lin Yu-hsuan, "Minying chanye de nengdongxing," 71–2.

46. The catalog bears no publication date but has clues throughout. It can be found in the TMMC collection at the National Science and Technology Museum Library, Kaohsiung.

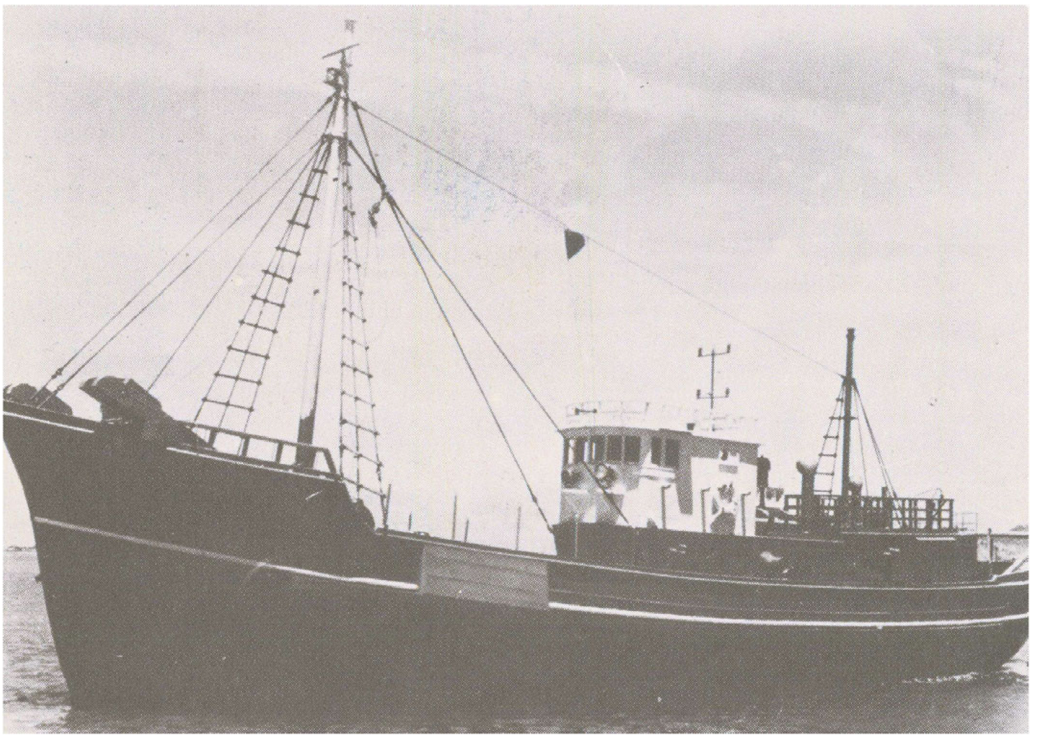

Figure 2. Wooden-hull fishing boats manufactured by TMMC c1950s. *Taiji sa'nian* (Tainan, TMMC: 1977), 105.

Lastly, an alloy mill was founded in 1969 and produced items of forged steel, such as generator shafts, piston heads, pinions, and propeller shafts, as well as rolled steel in the form of bars and stainless steel.

As industrialization continued, TMMC moved to the design and production of entire mills.[47] In end-of-year remarks in 1966, TMMC Chairman Wang Shizhe addressed the issue of specialization and offered a direction for the company in accordance with the state economic plan. "Being a state-owned enterprise," he said, "the government has given us a mission and business direction to pursue." That direction, he continued, is the overall development of the machine industry, which, for TMMC was a seven-point plan to improve products and production, including a new focus on the designing and making of complete mills.[48] The Minister of Economic Affairs, Yang Chi-cheng, drove the point home when he toured TMMC plants the previous year (1965). He remarked, "I think it is not enough [to just make parts]: the most important part of a machine factory is the factory design. To speak of doing business today, no matter domestic or foreign, most [companies] want the entire factory mill."[49] This is what TMMC did in the 1970s.

47. See "Jingjibu Yang buzhang lilin ben gongsi," *Jixie tongxun.*
48. Shi Xuanjing, "Peihe jingjian jihua," *Jixie tongxun.*
49. See "Jingjibu Yang buzhang lilin ben gongsi," *Jixie tongxun.*

TMMC as a Public Enterprise

Statements on the direction of the firm raise the question of the relation between TMMC and the Taiwan state. This is to ask: How much autonomy did TMMC have in deciding its investments and product lines? To hear state policymakers tell it, TMMC and other SOEs were no different than private firms. As the Minister of Economic Affairs, Li Kuo-ting put it in 1968, "[SOEs] are no different than private firms in that they must pay attention to costs."[50] TMMC internal publications like *Taiji jikan* (TMMC quarterly) mimicked such statements, noting that TMMC operated like a private firm in its need to pursue markets and sales.[51] By contrast, senior executives, while never outright contradicting these statements, were often quick to point out that TMMC's mission was to follow the government's economic policy. Chief Executive Officer (CEO) Gu Guangfu stated it rather bluntly in a television interview in 1970, "As a public enterprise, we should be obeying government policy on economic objectives and acting in accordance with the economic plans…" He went on to outline exactly how TMMC adhered.[52] In short, despite claims that it operated like a private firm, executives looked to the state for direction.

While the firm was given operational autonomy, in practice it meant certain constraints. The CEO had to appear before the Legislative Yuan, for example, and answer for the company budget and business plan. In 1964, through discussion with the legislature, the CEO was able to successfully negotiate the retention of company profits for investment rather than turn them over every year to the treasury. He put it this way, "Private enterprises do not have a problem [in retaining their profits], but public enterprises, no matter how much we make, need to turn over everything to the treasury at the end of the year. This makes it hard [to plan investments]…I communicated this difficulty to the legislature and they sympathized with me."[53] Some years later, however, legislators pressed the CEO on why TMMC was not making any profit, to which he replied that the government had ordered him to absorb old steel mills with dated equipment that operated at a loss.[54] Oversight did not stop there: the previous year, the Executive Yuan launched an investigation into TMMC's business practices due to losses.[55]

What is clear is that TMMC's product line was not about company profit but rather economy-wide benefit. As the CEO noted in his response to the legislature, the firm was forced to absorb two steel mills at a loss. Although this appears to be an extreme case, TMMC was often engaged in the production of things that were not profitable and even somewhat eclectic, but which served larger social and industrial goals. Bicycles in the early 1950s, for example, were ordered by the state with the aim of supplying transportation to the growing population and reducing imports. Similarly, fishing boat production and provision endeavored to win

50. "Ben gongsi bennian yizhi qiyuefen yewu jingje shikuang," *Taiji yuekan*.

51. Hu Suhong, "Ruhe jianli ben gongsi shangqingwang," *Taiji jikan*.

52. This included reducing imports, developing export sectors, and increasing foreign exchange reserves. "Gu zongjingli ying Zhongguo dianshi gongsi zhi yaoqing," *Taiji yuekan*.

53. "Ben gongsi jinhou fazhan de tujing," *Jixie tongxun*.

54. "Dongtai baodao: Fayuan yusuan weiyuanhui," *Taiji shuangyuekan*.

55. "Dongtai baodao: Guoying qiye shidi kaocha xiaozu," *Taiji shuang yuekan*; "Dongtai baodao: Jianchayuan jingjizu weiyuan lilin shicha," *Taiji yuekan*.

popular support for the foreign government. A sale to clear out the storage in 1967 further illustrates the matter: Found in the storage and on offer were funicular wheels, steel balls, Bakelite lamp plugs, old partial diesel motors, rice huskers, various grades of tinplate, and some different types of steel sheets. The report stated that these products had been made at government requests over the years but had either fallen out of use or now being produced by private firms.[56] A few years later the company chairman put it this way, "The government wants us to make devices that the private sector can't [or won't]."[57]

Such operational proceedings are not surprising given the chain of command. An internal pamphlet compiled by the TMMC personnel department outlines the organizational structure and leadership hierarchy in direct relation to MOEA. Discovered in a box in the TMMC collection at the National Science and Technology Museum Library in Kaohsiung, the document shows the level of central government control across four areas: organization, personnel, investment and capital allocation, and business decisions.[58] All decisions and final approvals for key operations and business lay with the MOEA. Staff quotas and management criteria, for example, were also the jurisdiction of the MOEA, as was the appointment of the company chair and CEO. All major investment decisions and capital decisions rested with the MOEA, as did short and long-term business plans. Even technological cooperation agreements went through the MOEA. Not only that, but in some instances final approval had to be sent up to the Executive Yuan. A capital allocation plan, for example, or fundraising through the issuance of stock needed an Executive Yuan sign-off.

The role of company executives appears to have been restricted to lesser decisions and the management of everyday operations. In the organization of the firm, while the state laid down the operating procedures, the chair could set the terms and conditions of operations while the CEO could make adjustments throughout the departments.[59] In appointments and hirings, the chair could decide on managers of first rank through thirteenth, while the CEO from second rank through twelfth on down. The CEO could also make decisions on who traveled.[60] In capital allocations, the CEO could decide to apply for loans for funding on matters already approved in the annual budget; he could also make decisions about implementations on the approved budget. Anything that lay outside of the budget, however, had to go through the state. This was the same for scrapping capital goods: the CEO could proceed on items already itemized in the budget, but anything not listed had to seek state direction.[61] For business decisions, a clear chain of command was in effect, whereby planning lay with the MOEA, important contracts with the chair, and secondary contracts with the CEO. The chair could initiate cooperation agreements among factories but not technological transfers.[62]

56. "Yewu yu fuwu: Jieshao ben gongsi," *Taiji yuekan*.
57. "Dongtai baodao: Ben gongsi chenli ershisi zhounian jinian," *Taiji yuekan*.
58. *Taiwan jixie gufen youxian gongsi*, appendix.
59. ibid., appendix p. 3–5.
60. ibid., appendix p. 5.
61. ibid., appendix p. 17–8.
62. ibid., appendix p. 25–6.

Figure 3. TMMC chairman Chang Ching-yu (second from right) and economics minister Li Kuo-ting (center) inspect diesel engine production at a TMMC factory in 1969 as part of a technology cooperation with Danish shipyard B&W. *Taiji yuekan* 4.2 (Feb, 1969), inside cover.

Four-year Economic Plans

Government economic development plans provided much of the direction and inspiration for TMMC. The first plan was articulated in 1953 and over the next three decades, a new one came out every four years. The plans were adroitly titled four-year economic development plans and sought to analyze and address the immediate issues facing Taiwan's industrial and agricultural development, offering clear guidelines on the island's economy. The first two plans, covering the 1950s, focused on increasing agriculture production and developing light industry for import substitution. As the economy grew, however, firms required more advanced and heavy machinery, which led to more imports. Beginning with the third four-year plan (1961–1964), greater emphasis was placed on transitioning from light to heavy industry—not just making heavy machinery, such as engines but also the machines and capacity to make the machines. Here TMMC came to assume a central role.

It was not uncommon in these plans to assign SOEs with certain roles to coordinate investments, sometimes very specific in accordance with the developmental direction. While other SOEs might appear, the flexible and eclectic production capabilities of TMMC meant it was often singled out in everything from machine-industry development to shipbuilding. Throughout the plans and across two decades, TMMC made heavy machines in core industries, such as internal combustion engines, heavy transportation equipment, agricultural

machines, and pumps. It also undertook the development of more efficient processes in casting and forging, cold work, and heat treatment.[63] TMMC's initial success in these areas in the 1960s led to rapid economic gains. In the mid-1960s, the machine industry grew 22.5 percent—faster than manufacturing as a whole, which still saw impressive growth of 16.6 percent. In 1968, the total output of the machine industry was 4 percent of manufacturing, nearly double that of four years prior. The new processes and upstream support also translated into the rapid growth of end-user products by SMEs, such as sewing machines: in 1964, 91,000 sewing machines were produced; by 1968 the number had nearly quintupled to 448,000.[64] TMMC's work in these areas continued through the 1970s, with the CEO confirming close adherence to the fifth plan (1969–1972) with investments of NT$140 million in the production of diesel engines and precision machinery, among other key equipment.[65]

An important feature of the four-year economic development plans is that they present a candid analysis of the shortcomings in Taiwan's industrialization. Each of the plans lays out the state of the industry at that point in time and the issues faced for advancing. The investigations then serve as the point of departure for a general outline of what is to be done, not just to improve the immediate problems of industrial development, but also how doing so will contribute to Taiwan's overall economic growth. The fifth plan (1969–1972), for example, notes that despite outstanding growth of the machinery industry up to that point, and continued strong production in the manufacturing sectors, especially from TMMC, the scale of production remained small and equipment old. Indeed, despite advances, Taiwan still operated with lagging technology and inadequate manufacturing capacity. Moreover, machine factories could not supply precision machinery, especially in the printing and textile industries. Given these problems, the plan identified the need for greater investment in capital goods, and it pointed to TMMC striking technology-sharing agreements with foreign firms to develop more advanced power-generating and precision machinery.[66]

As industrialization deepened, new requirements in upstream and downstream manufacturing arose and subsequent plans pointed to continuing problems in capital coordination. The sixth plan (1973–1976), for instance, identified nine core issues in the now quickly growing machine industry, among which quality and the need to import materials and some machinery were at the top of the list. "[We need to] demand higher quality, and for the domestic market to replace imports," the plan declared.[67] Other problems included the lack of standards, poor quality, and cheap copies of foreign machines. As these shortcomings were resolved, other matters arose. "Currently, development of the machine industry still faces several problems," read the 1981 plan. It went on to identify these problems as the lack of design capacity and the copying or buying of blueprints, as well as a lagging spare parts industry.[68] In addition, the machinery sector had begun to face a shortage of skilled workers with operational knowledge of the manufacturing processes and equipment.[69]

63. Third Plan, 157–8.
64. Figures from Fifth Plan, 238–9.
65. Tan Fuping, "Jixie gongye," *Taiji yuekan*.
66. Fifth Plan, 238–42.
67. Sixth Plan, 200.
68. 1982 Plan, 52.
69. Both the sixth plan and the 1982 plan make explicit mention of this problem.

The plans put TMMC at the forefront of the efforts to address these coordination problems and develop Taiwan's manufacturing capacity. In addition to explicitly pointing to the firm, the plans also served as a basis for TMMC to chart a business direction. In response to the lack of precision machinery, for example, the fifth plan declared that TMMC would be mobilized.[70] Likewise, the 1981 plan enumerated eight development projects for TMMC to address in the machine industry that ranged from upstream to downstream: producing cast steel and copper, developing forging plants, and manufacturing spare machine parts. Furthermore, the plan assigned TMMC to make heavy machinery, including large diesel engines and cylinders, as well as equipment for water, steel, and power generation.[71]

TMMC also took the initiative to outline a trajectory of its productions in relation to what the plans articulated as Taiwan's economic needs. As noted above, executives constantly reiterated that TMMC operated in accordance with the state directives, that its developmental line followed the plans, and that its manufacturing direction was inspired by the plans. The fourth plan, for example, noted the lack of sufficient and proper machinery in the economy, especially boilers and construction equipment. It also cited the need for complete mills, not just mill parts. In response, TMMC Chairman Wang Shizhe spoke on how the firm was following the plan and charted a new direction, declaring that the firm would "move from the usual production, repair, and updating of equipment, to designing and making the complete factory." He noted that over the past three years (1963–1966), TMMC focused on making sugar mill boilers, centrifuges, pumps, engines, and dryers, as well as parts for cement factories and rolling mills, but needs to be making the mills. "We should keep innovating in design, production, and tools" so as not to have to rely on others' designs, he said.[72] The next year, the firm issued an internal report outlining six new products that would fulfill the needs of the plan, including cement makers, industrial boilers, and high-pressure cold rollers for plastics.[73] It is clear that TMMC executives and managers closely read the plans and made initiatives to pursue various areas, even when TMMC was not singled out.

In addition to machines and metal manufacturing, shipbuilding and the fishing industry remained central, both in state economic plans and TMMC activity. TMMC had a prominence in shipbuilding in the 1950s, which it mobilized to help realize the government policy of providing small fishing vessels to local fishermen. By the 1960s, the coastal waters were overfished, forcing the industry offshore and into deep-sea fishing, which required not only larger boats with larger motors but also steel-hulled vessels. The third plan (1961–1964) noted that over the course of the previous plan (1957–1960), TMMC turned out 4,000 tons of small eighty-ton wooden vessels and 1,500 tons of 130-ton steel-hulled vessels. It was now tasked with transitioning to completely new boats, and over the next four years was to produce 10,000 tons each of wooden and steel vessels as well as 20,000 tons of oil tankers and cargo ships.[74] This shipbuilding trend continued into the 1970s with demands on TMMC to improve its shipbuilding capacity. The sixth plan, for instance, called for

70. Fifth Plan, 242.
71. 1982 Plan, 66.
72. Shi Xuanjing, "Peihe jingjian jihua," *Jiexie tongxun*, 3.
73. "Ben gongsi jinkuan jianjie," *Jixie tongxun*.
74. Third Plan, 160.

TMMC to build passenger ships, timber ships, and cargo and tankers of up to 5,000 tons. To facilitate this project, the plan established a new TMMC shipyard in Kaohsiung to specialize in the manufacture and repair of large ships.[75] In short order, TMMC shipyards were turning out just under two dozen 250-ton vessels a day and had the capacity to manufacture ships up to 10,000 tons.[76] Among other signs of this success, and in accordance with the government export policy, it received an order in 1982 for 125 fishing vessels from Ecuador.[77]

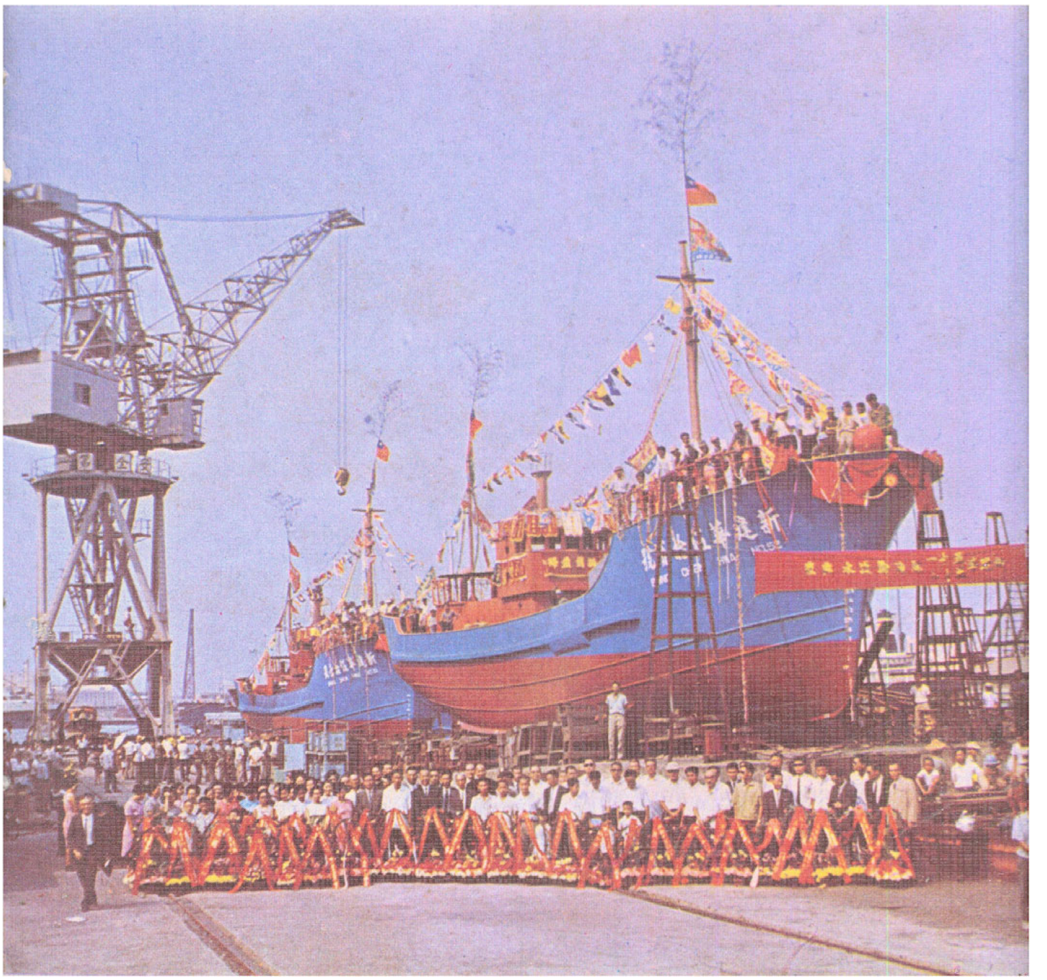

Figure 4. Ceremonial ship launching of two steel-hulled vessels at TMMC shipyard, Kaohsuing in 1969. *Taji yuekan*, 6.1 (Jan, 1970), cover.

75. Sixth Plan, 204–5.
76. C.K. Chen, "Kuozhanzhong zhi Taiwan jixie gongsi," 5–6.
77. "Taiji jiehuo Eguo dingdan," *Jingji ribao*.

The preceding discussion has emphasized that apart from machines and machine equipment, TMMC did not have a specialization. Unlike Taiwan Aluminum Co., say, or China Steel, TMMC did not have a product that stood at the core of its business and mission. While such a distinction came with certain problems—most immediately economies of scale—it did add flexibility and enabled the state to draw upon the firm at different developmental stages to serve different industrial goals. TMMC could make fishing boats to help reduce food imports; it could also develop machine-making processes and techniques, manufacture parts, and even design and construct entire sugar and alloy mills. This range of manufacturing capabilities made TMMC invaluable in Taiwan's economic development.

In its economic and industrial interventions, TMMC had restricted decision-making autonomy. As a state-owned enterprise under the MOEA, final decisions needed approval from the MOEA and Executive Yuan, and executives had to answer to the legislature. At times the MOEA would exercise control and request TMMC produce certain products or machinery it deemed essential; it could also write TMMC into development plans, outlining the broad tasks or direction of production. At other times, it was up to executives to chart the company's direction. In doing so, they relied on the development plans and general industrial direction laid out by planners.[78] While a few examples of explicit production directives from planners are noted above (bicycles and shipbuilding), it is beyond the scope of this article to interrogate the chain of economic decisions and orders from the planner or policy maker to TMMC—such questions must be taken up elsewhere. Rather, the argument here is that a state-run firm played an instrumental role in Taiwan's economic development, and did so by responding to coordination problems, thereby facilitating the country's industrial production and manufacturing capacity.

Resolving Coordination Failure: The Contribution of Tinplate and Industrial Boilers

Among its products, TMMC produced two key inputs that helped power Taiwan's exports and industrialization: tinplate and boilers. The former was the raw material for the canning industry, which accounted for over 10 percent of all exports at one point; the latter was the machinery required for everything from power generation to machine operation, sanitation, and heating processes. Both of these products provided the necessary inputs that enabled the flourishing of firms and sectors, not only for the food canning industry but also for a range of other supporting firms and industries. The provision of affordable upstream inputs had the effect of lowering the barrier of entry for exporting firms and spurring further industrialization. Drawing on cheap tinplate and tin cans, food canneries increased exponentially during this period. Likewise, boilers were–and still are–an instrumental piece of industrial equipment used across a wide range of industries from petrochemicals to sugar refining; ready availability enabled firms to enter new sectors and compete in global markets.

The provision of such inputs resolved coordination failures in various sectors of Taiwan's industrializing economy. As fishing industrialized, for example, TMMC developed modern

78. Li Kuo-ting papers also show that he frequently met with TMMC executives, although minutes of those meetings are not extant. See Li Kuo-ting personal papers at IMH.

Figure 5. TMMC electrolytic tinning line. TMMC catalog *Diandu maokoutiepi* (1976), inside cover.

fishing vessels and engines, producing first smaller craft and then larger deep-sea boats in support of the finishing industry. This was then backed by the emergence of canneries engaged in packaging fish,as well as fruits and vegetables,for export. But canneries could only operate with a sufficient and steady supply of the tinplate required for packaging. Canneries also needed boilers to sanitize the cans. TMMC not only provided boilers and produced tinplate, but it also continued to invest in output and upgrading as demand soared. This supply gave birth to private tin-can makers, who emerged as product producers and machine manufacturers.[79]

Tinplate

Tinplate was one of postwar Taiwan's most important upstream products. A thin steel sheet with a coat of rust-resistant tin, it was most often pressed into cans and used in packaging, especially for canned foods. At one point in the postwar global economy, tinplate accounted for 80 percent of all packaging worldwide and helped drive food exports, as processing and preservation for shipping and future consumption became convenient and economical.[80] Taiwan in the 1950s and 1960s capitalized on this trend by canning and exporting large amounts of pineapple and mushrooms, as well as asparagus, tangerines, bamboo shoots, water

79. Shin I Machinery Works, for example, was founded in 1956 as a tin can machine maker. See https://www.shinican.com/webls-zh-tw/msg/history.html

80. Qian Xilai, "Makouteipi shengchan zhi quxiang," *Taiji jikan*.

chestnuts, and fish, among other foods.[81] Foreign exchange earnings soared and the Taiwan state worked to ensure the canning industry had enough tinplate at its disposal for its packaging needs. At the forefront of the effort was TMMC as the main supplier of tinplate.

TMMC began producing tinplate in 1958 and gradually increased production capacity over the next three decades.[82] Early production processes used hot dip, which consisted of running the steel sheet through a solution of molten tin to coat the steel. Although slow and inefficient, the process was not uncommon in the 1950s: around half of the production globally used hot dip, for it was easy and required low initial capital expenditures. The alternative was electrolytic or electrostatic plating, which passes the steel through a plating bath of positively charged ions. For this latter process, initial capital expenditures were over two and a half times larger than for hot dip, but production costs were significantly lower, as it involved less labor and fewer resources. Furthermore, an electrolytic mill could plate over 2,500 inches per mint, versus less than 40 inches for hot dip.[83] By the 1960s over 90 percent of mills in North America used electrolytic processes, but, given the capital outlay, TMMC opted to add hot dip production in 1965 through a purchase from Yahata Steel.[84] The next year TMMC set a new production record of 35,000 cases of tinplate, which it forecast to smash in 1967 with 180,000 cases.[85] Despite the increased output, TMMC only produced around 15,000 tons of tinplate annually by 1970, an amount that fell far short of domestic demand for 100,000 tons.[86] In 1973, the firm made the auspicious investment of NT$333,666,000 in a new electrolytic plant with a ferrostan plating process licensed by Aetna-Standard Engineering and in technological cooperation with USS Engineering.[87] The plant came online in 1976 and produced 70,000 tons a year, an amount MOEA declared sufficient to meet domestic demand.[88]

The contribution of tinplate by TMMC cannot be understated.[89] The steady supply of tinplate enabled canned food exporters to quickly enter the market and operate efficiently and effectively while keeping down costs. By the mid-1960s, over two hundred canneries flourished and continued to expand into the global market and bring in foreign exchange earnings.[90] In 1955, for instance, Taiwan firms exported just over 1 million cases of canned foods worth US$5.73 million, which accounted for 4.29 percent of Taiwan's exports that year.

81. Fifth Plan, 167. Also see "Taiji yu ri hezuo chanzhi makoutie," *Zhongguo shibao*.

82. TMMC took over Taiwan Steel in 1958, inheriting production lines for tinplate. See "Taiwan jixie gongsi hebing Taiwan gangchang," *Zhongguo shibao*.

83. Qian Xilai, "Makou teipi shengchang zhi qushi," 36, 38; Chen Xigeng, "Jianjie diandu makouteipi zhi zhizao chengxu," *Taiji jikan*.

84. "Taiji yu ri hezuo chanzhi makoutie"; "Taiji yu Bafan shang jishu hezuo," *Lianhebao*; "Taiji yu ri hezuo zhi makoutie nexiao," *Zhongguo shibao*; "Gangpinchang shiling," *Jixie tongxun*; "Gangpinchang wushisi niandu gongzuo taolun," *Jixie tongxun*.

85. "Gangpinchang wushisi niandu," *Jixie tongxun*.

86. The shortfall was made up through import. "Taiji diandu makoutiepichang shi kaigong," *Jingji ribao*.

87. "Taiji maokoutiepi xinchang jungong," *Jingji ribao*; also see discussion in the TMMC catalog *Diandu maokoutiepi/Electrolytic Tinplate*.

88. Sufficient after accounting for the tinplate output of private firms. "Tesu baozhuang guantou gangkou yandui," *Zhongguo shibao*.

89. At the 1973 shareholder meeting, TMMC chairman explicitly stated that the firm would increase tinplate production to serve the canned food industry. "Taiji gongsi liushiernian gudong changhui."

90. Fifth Plan, 167; Chapin, "Taiwan Pressing Food Specialties," *The New York Times*; Xiong Zhongguo, "Taiwan shipin jiagong waixiao," *Taiwan yinhang jikan*, 128.

Within a decade (1965), producers turned out over 7.5 million cases worth US$57.9 million, accounting for 12.86 percent of total exports. The industry continued to grow exponentially and brought in record-high foreign exchange earnings. Within just a few years (1969), 11.6 million cases shipped worth over US$100 million, and by 1977 exports of canned foods reached nearly 20 million cases worth US$329.2 million.[91] TMMC continued to invest in tinplate capacity, as its electrolytic catalog noted in 1976, "[in order to] keep pace with domestic food industry development trends."[92] This helped stabilize prices in the face of fluctuating costs of imported tinplate, giving firms greater control over their costs.[93]

Boilers

In addition to raw materials and parts, the Taiwanese economy and its firms also needed industrial equipment to operate. Boilers were an essential piece of machinery used throughout an industrializing economy like Taiwan. Employed in large factories for power generation, and in smaller firms for running equipment or generating heat, boilers offer an efficient, nonexplosive means of producing energy. A seemingly simple device, the boiler is essentially a closed vessel or box that heats water into steam. It is somewhat like a large pressure cooker, which does not necessarily boil water but vaporizes it: water is turned into steam, which exits the boiler under pressure and can be put to work to generate power, run equipment, distill and separate petrochemicals, sanitize, and even cook. The size and type of boiler depends on the industry. Large industrial boilers, for example, are built in place on-site and can rise as high as five stories. Such boilers are water tube boilers, whereby water or steam runs through pipes encased in a drum structure that is heated from within. A smaller, mobile-type boiler is the package boiler, which is manufactured in a boiler factory and sold to the end user. Package boilers are fire tube boilers, whereby heat is induced through tubes that run throughout the drum filled with water. TMMC made both water and fire tube boilers of all sizes for all industries.[94]

As Taiwan's industrialization intensified in the 1960s the need for boilers grew. Widely used in all industries for everything from sanitation and cooking to metal working and the distillation of petrochemicals, TMMC began manufacturing boilers in the late 1950s but could not keep pace with demand; by 1966 around half of all boilers purchased by Taiwan firms had to be imported.[95] Canneries, for example, needed boilers to wash and cook food, as well as sanitize cans. Neighboring food processors also used boilers to dry and package fruit and pasteurize juices. Similarly, the garment industry used boilers to iron and dye fabrics, while paper makers used them to break down pulp and to run driers.[96] In an article on TMMC's

91. Li Kunmu, "Taiwan zhi shipin guantou chanye," *Taiwan yinhang jikan*.

92. *Diandu maokoutiepi/Electrolytic Timplate.*

93. The issue of controlling prices by means of inputs is discussed in Zhang Huixun "Taiwan zhi guantou shipin gongye," *Taiwan yinhang jikan*, 64.

94. See Bases, "The History of the Steam-Generating Boiler and Industry"; "The Role and Application of Boilers in Today's Economy," *KS Technology*; Office of Regulatory Affairs, "Steam Generation in Canneries"; Hongsheng Engineering, "Guolu jichu zhishi daquan."

95. "Xingao jixie gongsi," *Jingji ribao*; "Ben gongsi jinkuan jianjie," *Jiexie tongxun.*

96. Department of Health, Education, and Welfare, "Steam Generation in Canneries."

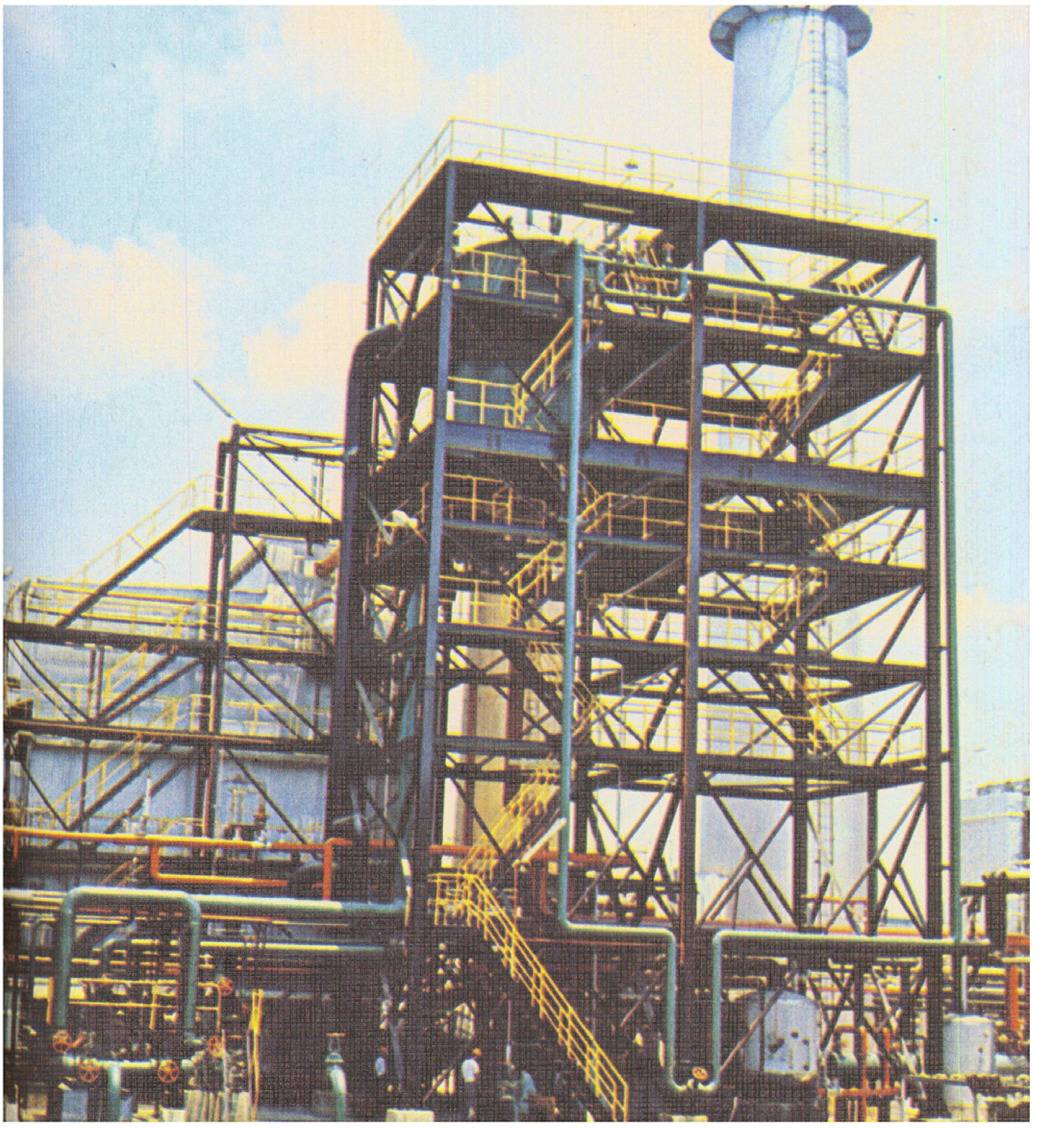

Figure 6. A large industrial boiler manufactured and installed by TMMC for Chinese Petroleum Corp. in Kaohsuing in 1971. This boiler has a capacity of producing steam at a rate of 240,000 lbs per hour. *Taiji yuekan* 8.5 (Oct, 1971), cover.

developments, the journal *Jixie tongxun* (Machinery news) put it succinctly, "boilers are a fundamental equipment."[97]

Three of the most important firms requesting boilers from TMMC were Taiwan Power Company (Taipower), Taiwan Sugar Corp (TSC), and Chinese Petroleum Corp (CPC). Each of these large enterprises required water boilers for both power generation and equipment operation.

97. "Ben gongsi jinkuan jianjie," *Jiexie tongxun*.

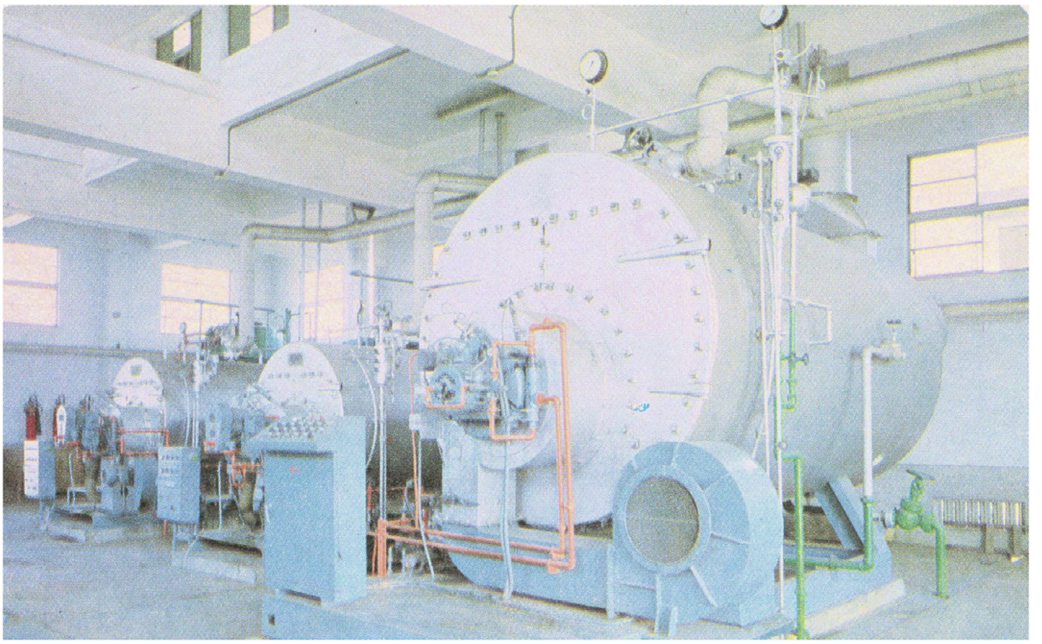

Figure 7. Package boilers like the one pictured here were manufactured at TMMC factories and transported to the end user. The TMMC catalog notes this boiler has 150hp. *Taiji sa'nian* (Tainan, TMMC: 1977), 74.

Taipower supplied the island with its electricity, and it relied on huge boilers generating over 90,000 pounds of steam per hour to do so efficiently. TSC made use of several large boilers to boil sugarcane and run centrifuges in the manufacturing of granular sugar; CPC needed a series of boilers running at different temperatures to refine oil and separate different elements in the distilling of petrochemical products. These last two firms made no small contribution to Taiwan's economy. TSC produced sugar, Taiwan's largest export, accounting for US$1.42 billion in foreign earnings from 1950–1970; CPC not only provided petroleum fuel but also the raw materials for the petrochemical industries.[98] Taipower, of course, kept on the island's lights.

In service of such industries, TMMC had begun making boilers early and continued product development. In 1967, an internal company report stated, "In order to provide various industries with the necessary equipment, we have had nearly ten years of experience manufacturing boilers."[99] TMMC capitalized on this experience to not only increase production but also expand its range and size of boilers as demand grew. The fourth economic plan—put out just a few years prior—called specifically on TMMC to produce more boilers for domestic industry and help reduce imports.[100] In response, TMMC announced the ambitious aim to immediately ramp up production and supply the Taiwan industry with 80 percent of its boiler needs for

98. Throughout the 1950s, TSC exports were 50-60 percent of Taiwan foreign earnings, and up until 1966, they remained in double digits. Yang Naifan, "Ershiwu nianlai de Taiwan tangye," *Taiwan yinhang jikan*, 44, 63.

99. "Ben gongsi jinkuan jianjie," *Jiexie tongxun*, 1.

100. Fourth Plan, 265.

1967. It partnered with Mitsubishi to use American technology to develop a large TMMC-specific boiler product. Producing steam at 90,000 pounds an hour, the firm claimed that it had made the first boiler in the world that stood on par with American-made boilers—and it came in 10 percent cheaper than any import. TMMC continued to perfect the boiler to increase output to 100,000 pounds an hour, while simultaneously working on fire tube package boilers with 3,000 to 25,000 pounds of steam an hour for use in small factories, hospitals, and restaurants.[101]

Up until the 1970s, however, most of TMMC's expertise was still in assembly rather than the complete manufacturing of boilers. The firm made various parts and components for the boiler, but some of the key parts, such as the head box, drum, and furnace still needed to be imported. In 1967, it tried to make a complete boiler with 6,500 pounds capacity for TSC, manufacturing the drum and furnace in-house, but failed and those parts had to be ordered.[102] Similarly, TMMC lacked the technology to be able to make a high-pressure drum for specialized boilers for CPC and the petrochemical industry.[103] A few years later, TMMC still did not have the full range of production capacity to make the complete boiler and had to order various components from the US.[104] Two TMMC engineers stated it bluntly, "We are good at making the boiler body, tubes, and the assembly components, but we cannot do the drum design and construction ourselves. This makes it hard to lower costs and compete in the market."[105]

In 1970, TMMC sent five engineers to Japan to learn boiler design and manufacturing from Mitsubishi.[106] Over the next decade, the firm developed the necessary manufacturing expertise to not only make needed boilers for domestic firms but also to repair and overhaul them. In 1977, TMMC could design and build a complete boiler for TSC, and a few years later do a specialty package boiler for CPC at the latter's oil refinery.[107] Similarly, a private acrylic manufacturer needed a boiler to produce high temperatures for the polymerization of acrylic monomers, which TMMC was able to provide and continue to maintain through at least the mid-1980s.[108]

The cases of tinplate and industrial boilers show the complex and layered production processes in Taiwan's economy. While scholars have long focused on key export sectors, such as processed foods and textiles, the manufacturing capacity necessary for those sectors to operate has received less attention. Yet these key export sectors relied on directed interventions in inputs and equipment from state-run firms like TMMC. In the 1960s, canned food and sugar exports together accounted for over 40 percent of Taiwan's foreign exchange revenues. Both of these industries relied on TMMC to provide manufacturing capacity: tinplate packaging for the former, and boilers for the latter. Similarly, the garment industry, which emerged as one of the dominant export sectors in Taiwan's economy, used TMMC boilers for dying and ironing; further upstream, synthetic fabric manufacturers required calibrated boilers for

101. "Ben gongsi jinkuan jianjie," *Jiexie tongxun*.
102. Wang yangxiong, "Guolu zhizao yanxi baogao," *Taiji yuekan*, 33–4.
103. "Ben gongsi jinkuan jianjie," *Jiexie tongxun*.
104. NAA, A313370000K/0059/3343/12; NAA, A313370000K/0059/3343/31.
105. Cai Shuitai and Chen Xinxing, "Ben gongsi TM xing xiuzhen guolu," *Taiji yuekan*.
106. Wang Yangxiong "Guolu zhizao yanxi baogao," *Taiji yuekan*; "Benqi neirong jianjie," *Taiji yuekan*.
107. NAA, A313370000K/0067/3221/4; NAA, A313370000K/0073/3302/40.
108. NAA, A313370000K/0060/3625/15.

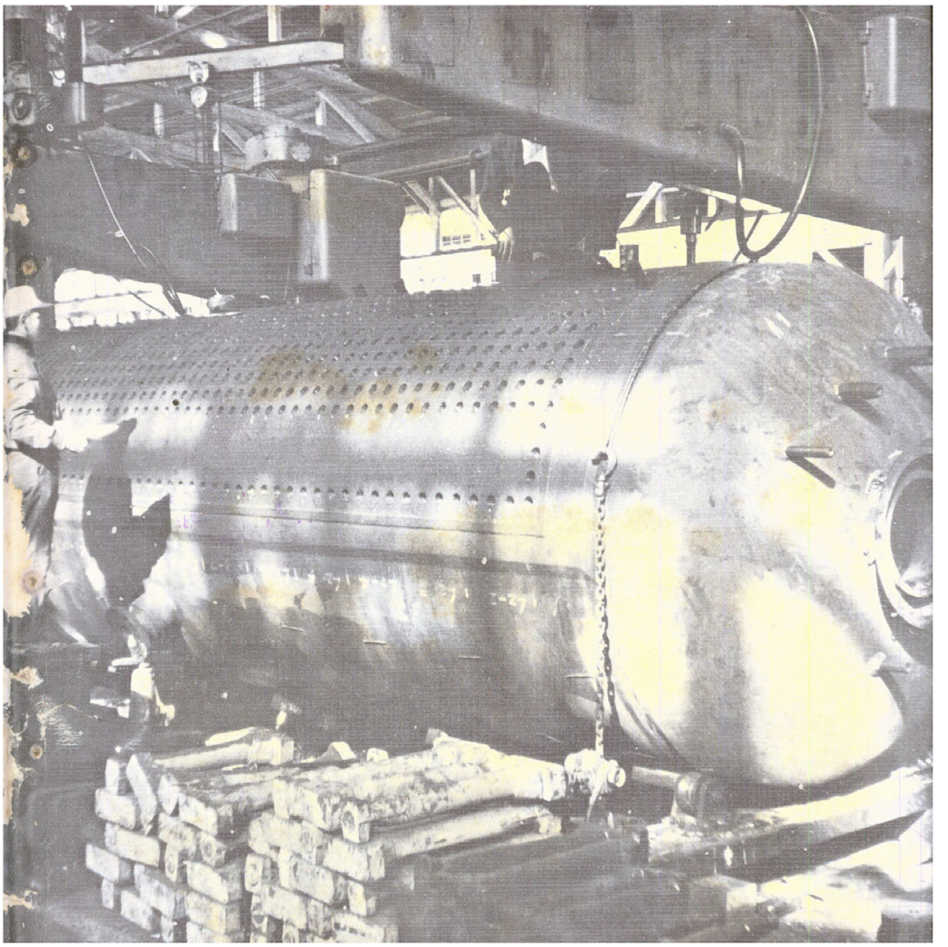

Figure 8. TMMC's first boiler steam drum capable of producing 240,000 lbs of steam an hour. This breakthrough enabled the firm to manufacture large industrial boilers fully in-house. *Taiji yuekan* 8.1 (Feb, 1971), cover.

heating petrochemicals at different temperatures in various manufacturing stages. In this way, TMMC developed the necessary manufacturing capacity not only for key industries but also for the upstream inputs in support of entire sectors.

A state-owned firm like TMMC was required to provide these products. The production of tinplate and boilers required large capital outlays as well as engineering and manufacturing expertise that the private sector could not provide nor the market immediately reward. Downstream producers relied on imports up into the mid-to-late 1960s but doing so restricted growth at both the level of the firm and the sector. Not until TMMC ramped up production of tinplate and boilers were Taiwan firms able to control their prices and gain market advantages, and thereby increase in sales and number.

Conclusion

The preceding pages argue that TMMC helped facilitate Taiwan's industrialization and economic growth in the postwar years. They show that TMMC did so by resolving coordination failures and increasing manufacturing capacity. Rather than investigating intent, the article delves into how TMMC worked and how its actions contributed to Taiwan's economy. Like most late-developing economies, Taiwan was beset with coordination problems in its industrialization process: as an agriculture colony of Japan, it lacked industrial infrastructure or sectors that would advance both upstream and downstream investments. TMMC's interventions helped overcome these constraints, largely through the production and provision of manufacturing inputs and machinery. Economic plans constantly pointed to the poor condition of the machinery of the island's firms as old and lacking in technology—problems that affected efficiency, cost, and even capability. TMMC addressed these problems through the development and upgrading of required machinery and equipment.

TMMC obtained technology through a combination of in-house development and foreign cooperation. The lack of space here prevents a separate investigation, but the above analysis touched on the matter throughout. Foremost, TMMC undertook its own development to advance products and manufacturing capabilities. Steel-hulled deep-sea fishing vessels, for example, as well as sugar mills were developed in-house. When greater technological expertise or licensing was required, TMMC partnered with US, European, and Japanese firms. The development of diesel engines beginning in the 1960s saw TMMC partner with numerous foreign firms, including Mitsubishi, B&M, Man, and Sultzer Marine. Each partnership sought the technology and production know-how to build a required diesel engine, which was frequently used for outfitting deep-sea vessels. In some instances, the technology was licensed and applied, and in others jointly developed.[109] This was similar in boiler development, where TMMC licensed US technology and then worked jointly with Mitsubishi to develop and produce various boilers. Cooperation with Mitsubishi continued with training, sending TMMC engineers to Japan to study and obtain skills and know-how. Meanwhile, new tinplate capacity involved the purchase of technology from US firms and help with onsite setup.

This exposition of TMMC helps rethink the role of state-owned firms in economic development. Whereas the literature on development has largely overlooked SOEs, this article shows that state firms could be instrumental, especially in the important function of resolving coordination failure. When markets could not coordinate investments in modern sectors, policymakers had several levers to pull, from monetary policy to subsidies and incentives. They could also rely on SOEs, a practice that was widespread in Taiwan yet remains relatively unexplored by scholars. As this case shows, SOEs were an important tool for intervention, not necessarily as an economic engine or export producer, but rather as a resolver of coordination failure and developer and facilitator of manufacturing capacity. The SOE could intervene and respond to the market and work with private firms, both furthering the economic aims of policymakers and addressing market needs.

109. The NAA archive is rich in TMMC contracts with foreign firms to develop diesel engines. Also see Chen Jeng-horng, *Zhuandong shiji*, 130-165.

While TMMC was unique in its flexibility, Taiwan had other SOEs that also helped address economy-wide coordination failures. Although all single industry, other state firms similarly made targeted interventions in key sectors and parts of the economy, resolving coordination failure in everything from petrochemicals to shipbuilding. Taiwan Aluminum Co., for example, coordinated with downstream producers to provide aluminum inputs across industries beginning in the 1950s and 1960s. As the electronics and garment sectors grew in the 1960s and 1970s, Talco developed specific grades of aluminum for manufacturers, providing low-cost yet high-quality aluminum for everything from circuits to spindles, both guaranteeing access to the essential metal and helping exporters lower costs to remain competitive in global markets.[110] Likewise, the Taiwan government formed China Steel in the 1970s: Facing a lack of private investment in the steel industry, and downstream firms increasingly relying on imports, the state moved to create its first large-scale integrated steel mill in China Steel. In addition to supplying the domestic market with flat steel products and tubes, China Steel also provided technical assistance and expertise to private steel-making firms.[111]

What makes the case of state firms in the economy so compelling is that it diverges sharply from assumptions of inefficiency and economic drag. Since at least the 1980s, much of the debate about state firms has been mired in questions of efficiency and direct comparisons with private firms, often with conclusions pointing directly to privatization.[112] Yet economies like Taiwan, as well as other miracle economies such as Korea, relied on SOEs to help coordinate investments and develop markets. State firms were a key to developmental success. Rather than planning or displacing markets, SOEs created markets and worked within them as they aided private firms across sectors. SOE interventions created unseen opportunities and allowed experimentation: they gave rise to new industries and an ecosystem of firms engaged in manufacturing and producing. As the case of TMMC shows, a state firm can help to develop a national economy and also further the work of opening markets while encouraging the growth of small private firms.[113]

In closing, a few words on future research directions. This article has not endeavored to investigate intent, nor does it discuss alternative resolutions to coordination problems in an economy. As Taiwan archives continue to open and more documentary materials are made available, it should become possible to understand how state-makers intended to use public firms in the economy and their policy design, if any, behind SOE mobilization. Did Taiwan economic planners, for example, strive to foster an economy of SMEs and thus intentionally turn to state firms to help construct that particular kind of economy? More specifically, did policymakers actively promote SOEs in the economy with certain designs and plans in mind, or were these practices and their outcomes random? Answers to such questions will

110. Keliher, "Manufacturing Capacity and Economic Development in Postwar Taiwan."

111. Wade, *Governing the Market*, 99–100.

112. For overviews of this trend, see Hao and Kotz, "The Impact of State-Owned Enterprises on China's Economic Growth"; Tõnurist and Karo, "State Owned Enterprises as Instruments of Innovation Policy."

113. Such findings correspond to the idea and program of economic democracy developed in Tamara Lothian, *Law and the Wealth of Nations: Finance, Prosperity, and Democracy* (New York: Columbia University Press, 2017), ch. 3.

not only shed greater light on the role of the state and state planning in economic development but also help identify the range of economic models and possibilities.

This last point is perhaps one of the most pressing inquiries that the preceding pages were unable to explore: What are the patterns of economic growth and how do different models emerge in different countries? Taiwan's economy was particularly reliant on SOEs, as noted above, whereas Japan's was not. Korea had a large number of SOEs, although still fewer than Taiwan, but they tended to serve conglomerates rather than SMEs.[114] Is there a relation between SOEs and SMEs? The Japanese and Korean economies promoted and nurtured large enterprises and conglomerates, with state firms employed to offset markets in favor of chosen enterprises. Yet, the example of Hong Kong provides a model of prolific small firm entrepreneurship similar to Taiwan with no SOE support or development—in fact, on the surface, it appears that the Hong Kong state had little to no involvement in the economy.[115] As we come to know more about these East Asian miracle economies it becomes clear that there was no single path to success—no one set of practices and policies that equaled economic development or accounts for their growth. In the words of Dani Rodrik, there are "many recipes" for economic growth.[116] As more comparisons are made among the successful models, the recipes can be worked out, and the different ways the different countries responded to similar challenges and problems understood.[117] Such insights ought help lead to an answer to the question of growth and the range of possibilities for the interactions of markets and states.

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114. For example, see prime minister Chiang Ching-kuo's discussions with his minister of economic affairs on the role of SOEs in the economy on August 5, 1971. *Chiang Ching-kuo riji, 1971* (Taipei: Guoshiguan, 2023), 214.

115. From 1970-1973, for example, Taiwan SOEs accounted for over 30 percent of the economy's gross fixed capital formation, whereas in Japan, over the same period, it was 9.9 percent. Korea was 21.7 percent. Wade, *Governing the Market*, 176–7.

116. cf. My research in progress challenges the free market thesis on Hong Kong and argues that China and Taiwan acted like developmental states in Hong Kong.

117. Rodrik, *One Economics, Many Recipes*.

Bibliography

Archives

IMH, *Institute of Modern History*. Academia Sinica, Taiwan.
NAA, *National Archive Administration*. Xinzhuang, Taiwan.
NSTM, *National Science and Technology Museum*. Kaohsiung, Taiwan.

Industry and Company Sources

"Taiji gongsi liushiernian gudong changhui," October 20, 1973, 7. Found in the Institute of Modern History, Academia Sinica archive, no. 035-34211.
Hongsheng Engineering. "Guolu jichu zhishi daquan," 2018, http://hons.com.tw/modules/tadnews/index.php?nsn=733 (accessed October 2023).
"Ben gongsi bennian yizhi qiyuefen yewu jingje shikuang," *Taiji yuekan*, 3.3 (September 1, 1968): 4.
"Ben gongsi jinhou fazhan de tujing," *Jixie tongxun*, no. 5 (November 1, 1964): 9.
"Ben gongsi jinkuan jianjie," *Jixie tongxun*, no. 14 (June 1, 1967): 1–2.
"Benqi neirong jianjie," *Taiji yuekan* 6.6 (June 1, 1970): 49–50.
"Dongtai baodao: Ben gongsi chenli ershisi zhounian jinian," *Taiji yuekan* 7.2 (August 1, 1970): 9.
"Dongtai baodao: Fayuan yusuan weiyuanhui weiyuan lilin ben gongsi shicha," *Taiji shuangyuekan* 9.1 (February 16, 1972): 17–8.
"Dongtai baodao: Guoying qiye shidi kaocha xiaozu," *Taiji shuang yuekan* 8.2 (April 1, 1971): 13–4
"Dongtai baodao: Jianchayuan jingjizu weiyuan lilin shicha," *Taiji yuekan* 8.6 (December 16, 1971), 36–7.
"Dongtai baodao: Jingjibu Li buzhang lilin dui bengongsi zhuguan renyuan xunhua," *Taiji yuekan* 4.4 (April 1, 1969), 6–7.
"Ershiwu nian lai zhi Taiwan jixie gongsi," *Taiji shuangyuekan* 8.1 (February 1, 1971), 11–34.
"Gangpinchang shiling," *Jixie tongxun*, no. 7 (July 1, 1965), 26
"Gangpinchang wushisi niandu gongzuo taolun," *Jixie tongxun*, no. 8 (January 15, 1966), 22–3.
"Gu zongjingli ying Zhongguo dianshi gongsi zhi yaoqing," *Taiji yuekan*, no. 3 (September 1, 1970), 15–6.
"Jingjibu Yang buzhang lilin ben gongsi xunshi quanwen," *Jixie tongxun*, no. 6 (January 1, 1965), 1–2.
"The Role and Application of Boilers in Today's Economy," *KS Technology* (November 16, 2021).
"Yewu yu fuwu: Jieshao ben gongsi kucun chengpin," *Taiji yuekan* 1.5 (November 1, 1967): 11–3.
Bases, Gary. "The History of the Steam-Generating Boiler and Industry," *Insulation Outlook Magazine* (May 2011).
Cai, Shuitai and Chen Xinxing. "Ben gongsi TM xing xiuzhen guolu yu Huasiwei Titan xing xiuzhen guolu zhi bizhao," *Taiji yuekan* 6.5 (May 1, 1970), 27–35.
Chen Xigeng, "Jianjie diandu makouteipi zhi zhizao chengxu," *Taiji jikan*, 1.1 (1964), 44.
Chen, C.K. "Kuozhanzhong zhi Taiwan jixie gongsi," *Taiji yuekan* 6.3 (March 1, 1970), 2–7
Department of Health, Education, and Welfare. "Steam Generation in Canneries," Washington, D.C, February 11, 1972.
Diandu maokoutiepi/Electrolytic Tinplate. TMMC catalog, c.1976.
Hu, Suhong. "Ruhe jianli ben gongsi shangqingwang," *Taiji jikan* 2.1 (January 1, 1965), 16–9.
Li, Kunmu. "Taiwan zhi shipin guantou chanye yu jingji fazhan," *Taiwan yinhang jikan* 31.2 (June 1980), 95–114.
Ma, Wilfred. "TMMC in Progress," *Taiji yuekan* 6.4 (April 1, 1970), 2–7.
Office of Regulatory Affairs. "Steam Generation in Canneries," November 3, 2018.

Qian, Xilai, "Makouteipi shengchan zhi quxiang," *Taiji jikan* 1.1 (February 15, 1963), 36–8.
Shi, Xuanjing. "Peihe jingjian jihua zhuzhong zhuanye fuzhi tigao gongzuo xiaolu dacheng zenchan shiming," *Jixie tongxun*, 9 (April 10, 1966), 2–3.
Taiwan jixie gufen youxian gongsi yu suoshu hejin gangchang quanze huafenbiao. Kaohsiung: Taiji renshichu, 1989. (Found in the National Science and Technology Museum.)
Tan, Fuping, "Jixie gongye zai weilai jingji fazhanzhong," *Taiji yuekan* 4.3 (March 1, 1969), 4.
Wang, Yangxiong "Guolu zhizao yanxi baogao," *Taiji yuekan* 6.6 (June 1, 1970), 33–48.
Xiong, Zhongguo. "Taiwan shipin jiagong waixiao wenti zhi yanjiu," *Taiwan yinhang jikan* 25.4 (December 1974), 124–61.
Yang, Naifan. "Ershiwu nianlai de Taiwan tangye zhi yanbian," *Taiwan yinhang jikan* 22.3 (September 1971), 38–68.
Zhang, Huixun "Taiwan zhi guantou shipin gongye," *Taiwan yinhang jikan* 26.1 (March 1975), 54–90.
Zhang, Zheqi. "Yazhou jingji fazhang ji jihua," *Taiji yuekan* 3.2 (August 1, 1968), 43–6.
Zheng, Damou, "Zhongjixie gongchang jianjie," *Jiexie tongxun*, 8 (January 15, 1966), 26–7.

Government Reports

First Plan. "*Zhonghua minguo diyiqi Taiwan jingji jianshe sinian jihua*," Taipei: Ministry of Economic Affairs, 1971.
Third Plan. "*Zhonghua minguo disnqi Taiwan jingji jianshe sinian jihua*," Taipei: Ministry of Economic Affairs, 1971.
Fourth Plan. "*Zhonghua minguo disiqi Taiwan jingji jianshe sinian jihua*," Taipei: Ministry of Economic Affairs, 1995.
Fifth Plan. "*Zhonghua minguo diwuqi Taiwan Jingji jianshe sinian jihua*," Taipei: Executive Yuan, 1969.
Sixth Plan. "*Zhonghua minguo diliuqi jingji jianshe sinian jihua,"Taipei*: Executive Yuan, 1973.
1982 Plan. "*Zhonghua minguo Taiwan jingji jianshe sinian jihua*," Taipei: Xingzhengyuan, 1982.

Published Sources

"Taiwan gongkuang shiye kaocha baogao," Taipei: Ziyuan weiyuanhui, 1946. Reproduced in Chen Niaozhong and Chen Xingtang, *Taiwan guangfu he guangfuhou wunian shengqing*. Nangjing: Nanjing chubanshe, 1989, 30–1.
Chang Ching-kuo riji, 1971. Taipei: Guoshiguan, 2023.

Newspaper Reports

Chapin, Emerson. "Taiwan Pressing Food Specialties: Finding Canned Goods Help in Farm Diversification," *The New York Times*, December 27, 1965, 39–40.
"Jianzao yuchuan daikuan jin kaishi shenqing Taiji jianzao yuchuan yewu fada eryuefen yuchan wan qiqianyu dun," *Weixin xinwen*, April 9, 1958, 2
"Shouci fangling yuchuan jiao Taiji jianzao gong wushiqi sou wuyuedi wancheng," *Weixin xinwen*, April 18, 1953, 1.
"Taiji diandu makoutiepichang shi kaigong," *Jingji ribao*, May 15, 1976, 7.
"Taiji jiehuo Eguo dingdan," *Jingji ribao*, May 4, 1982, 3.
"Taiji maokoutiepi xinchang jungong," *Jingji ribao*, April 23, 1976, 4
"Taiji yu Bafan shang jishu hezuo," *Lianhebao*, February 13, 1963, 5

"Taiji yu ri hezuo chanzhi makoutie," *Zhongguo shibao*, August 18, 1962, 5–6.
"Taiwan jixie gongsi hebing Taiwan gangchang," *Zhongguo shibao*, April 30, 1958, 2.
"Tesu baozhuang guantou gangkou yandui," *Zhongguo shibao*, June 13, 1976, 8.
"Xingao jixie gongsi chanzi sanhuilu xiuzhen zhengqi guolu," *Jingji ribao*, April 5, 1968, 4

Secondary Sources

Amsden, Alice. *Asia's Next Giant: South Korea and Late Industrialization*, New York, NY: Oxford University Press, 1989.
Amsden, Alice. *The Rise of "the Rest": Challenges to the West from Late-Industrializing Economies*, Oxford, UK: Oxford University Press, 2001.
Bernier, Luc, Massimo Florio, and Philippe Bance, eds. *The Routledge Handbook of State-Owned Enterprises*, London, UK: Routledge, 2020.
Chang, Ha-Joon. *State-Owned Enterprise Reform*, New York, NY: United Nations Department for Economic and Social Affairs, 2007.
Chang, Ha-Joon. *The East Asian Development Experience: The Miracle, the Crisis and the Future*, Bloomsbury Academic, 2006.
Chen, Jeng-horng. "*Taiwan jixie gongsi chanye wenhua zichan qingcha jihua qimo baogao*," Kaohsiung, Taiwan: TMMC, 2005.
Chen, Jeng-horng. *Zhuandong shiji: Taiwan jixie gufenyouxian gongsi*, Taipei, Taiwan: National Archive Administration, 2011.
Chiang Ching-kuo riji, 1971. Taipei, Taiwan: Guoshiguan, 2023.
Chu, Wan-wen, "Import Substitution and Export-Led Growth: A Study of Taiwan's Petrochemical Industry," *World Development* 22.5 (1994): 781–94.
Chu, Wan-wen. *Taiwan zhanhou jingji fazhan de qiyuan*, Taipei, Taiwan: Lianjing, 2017.
Evans, Peter. *Embedded Autonomy: States and Industrial Transformation*, Princeton, NJ: Princeton University Press, 1995.
Gershman, Mikhail, Sergey Bredikhin, and Konstantin Vishnevskiy. "The Role of Corporate Foresight and Technology Roadmapping in Companies' Innovation Development: The Case of Russian State-Owned Enterprises," *Technological Forecasting and Social Change* 110 (2016): 187–95.
Haggard, Stephan, and Chien-Kuo Pang. "The Transition to Export-Led Growth in Taiwan," in *The Role of the State in Taiwan's Development*, ed. Joel D. Aberbach, David Dollar, and Kenneth Lee Sokoloff, 47–89. *Taiwan in the Modern World*, Armonk, NY: M.E. Sharpe, 1994.
Haggard, Stephan. *Developmental States*, Cambridge University Press, 2018.
Haggard, Stephan. *Pathways from the Periphery: The Politics of Growth in the Newly Industrializing Countries*, Ithaca, NY: Cornell University Press, 1990.
Hamilton, Gary, and Chengshu Kao. *Making Money: How Taiwanese Industrialists Embraced the Global Economy*, Stanford, CA: Stanford University Press, 2018.
Ho, Sam P. S. *Economic Development of Taiwan, 1860-1970*, New Haven: Yale University Press, 1978.
Hong, Sao-yang, *Jindai Taiwan zaochuanye de jishu zhuanyi yu xuexi*, Taipei, Taiwan: Yuanliu, 2011.
Hong, Sao-yang. "Zhanhou Taiwan gongyehua fazhan zhi ge'an yanjiu: yi 1950 nian yihou de Taiwan jixie gongsi weili." *Gendai chuugoku kenkyuu kyoten* 6 (2011): 107–39.
Hsieh, Michelle F. "Learning by Manufacturing Parts: Explaining Technological Change in Taiwan's Decentralized Industrialization." *East Asian Science, Technology and Society: An International Journal* 9, no. 4 (December 1, 2015): 331–58.

Johnson, Chalmers. *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975*, Stanford, CA: Stanford University Press, 1982.
Kowalski, Przemyslaw, Max Bügei, Monika Sztajerowskai, and Matias Egelandi. "State-Owned Enterprises: Trade Effects and Policy Implications," *OECD Trade Policy Papers* 147 (2013).
Kuo, Tai-Chun, and Ramon Myers. *Taiwan's Economic Transformation: Leadership, Property Rights and Institutional Change 1949-1965*, New York, NY: Routledge, 2012.
Landoni, Matteo. "Reconsidering Innovation in State-Owned Enterprises." In *The Routledge Handbook of State-Owned Enterprises*, ed. Luc Bernier, Massimo Florio, and Philippe Bance, 605–17, London, UK: Routledge, 2020.
Lin, Ching-yuan. *Industrialization in Taiwan, 1946-72: Trade and Import-Substitution Policies for Developing Countries*, New York, NY: Praeger, 1973.
Lin, Yu-hsuan, "Minying chanye de nengdongxing: Zhanhou Gaoxiung minying zaochuanye de quwei bianqian (1945-1990)," MA Thesis, National Taiwan University, 2023.
Lothian, Tamara. *Law and the Wealth of Nations: Finance, Prosperity, and Democracy*, New York, NY: Columbia University Press, 2017.
Luo, Chuan-chin. *Taiwan yuye fazhanshi*, Taipei, Taiwan: Luo Chuan-chin Legislative Office, 1998.
Keliher, Macabe. "Manufacturing Capacity and Economic Development in Postwar Taiwan: The Case of Aluminum," Working Paper.
Maggor, Erez. "Sources of State Discipline: Lessons from Israel's Developmental State, 1948–1973," *Socio-Economic Review* 19.2 (April 1, 2021): 553–81.
Mao, Yu-Kang, and Schive Chi. "Agricultural and Industrial Development in Taiwan," in *Agriculture on the Road to Industrialization*, ed. John Mellor. Baltimore: Johns Hopkins University Press, 1995, 199–220.
Matsuyama, Kiminori. "Economic Development as Coordination Problems," in *The Role of Government in East Asian Economic Development: Comparative Institutional Analysis*, ed. Masahiko Aoki, Hyung-Ki Kim, and Masahiro Okuno-Fujiwara. New York, NY: Clarendon Press, 1997, 134–62.
Qi, Hao, and David M. Kotz. "The Impact of State-Owned Enterprises on China's Economic Growth," *Review of Radical Political Economics* 52, no. 1 (2020): 96–114.
Rodrik, Dani. "Coordination Failures and Government Policy: A Model with Applications to East Asia and Eastern Europe," *Journal of International Economics* 40, no. 1–2 (1996): 1–22.
Rodrik, Dani. "Getting Interventions Right: How South Korea and Taiwan Grew Rich," *Economic Policy* 10.20 (1995): 55–107.
Rodrik, Dani. *One Economics, Many Recipes: Globalization, Institutions, and Economic Growth*, Princeton, NJ: Princeton University Press, 2007.
Sanchez-Carriera, Maria del, Xavier Vence, and Oscar Rodil-Marzabal. "The Role of State-Owned Enterprises as Drivers of Innovation," in *The Routledge Handbook of State-Owned Enterprises*, ed. Luc Bernier, Massimo Florio, and Philippe Bance. London, UK: Routledge, 2020, 618–37.
Singh, Jewellord Nem, and Geoffrey C. Chen. "State-Owned Enterprises and the Political Economy of State–State Relations in the Developing World," *Third World Quarterly* 39, no. 6 (June 3, 2018): 1077–97.
Tõnurist, Piret, and Erkki Karo. "State-Owned Enterprises as Instruments of Innovation Policy," *Annals of Public and Cooperative Economics* 87, no. 4 (2016): 623–48.
Tsai, Pan-Long. "Explaining Taiwan's Economic Miracle: Are the Revisionists Right?" *Agenda: A Journal of Policy Analysis and Reform* 6, no. 1 (1999): 69–82.
Vogel, Ezra. *The Four Little Dragons: The Spread of Industrialization in East Asia*, Cambridge, MA: Harvard University Press, 1991.
Wade, Robert. *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*, Princeton, NJ: Princeton University Press, 1990.

Wang, Jenn-hwan, Lee Zong-rong, and Chen Tsung-yuan. "Taiwan jingji fazhan zhong de guojia jiaose: lishi huigu yu lilun zhanwang." In *Weijing de qiyi: zhuanxing zhong de Taiwan jingji yu shehui*. Taipei, Taiwan: Institute of Sociology, 2017, 50–88.

Wu, Tsung-min, *Taiwan jingji sibainian*, Taipei, Taiwan: Qunshan, 2023.

Wu, Yongping. *A Political Explanation of Economic Growth: State Survival, Bureaucratic Politics, and Private Enterprises in the Making of Taiwan's Economy, 1950-1985*, Cambridge, MA: Harvard University Asia Center, 2005.

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