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INDUSTRIAL POLICY:
LESSONS FROM SHIPBUILDING

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ABSTRACT

Industrial policy has been used throughout history in some form or other by most countries. Yet, it remains one of the most contentious issues among policymakers and economists alike. In part, this is because the empirical evidence on whether and how it should be implemented remains slim. Scant data on government subsidies, conflicting theoretical arguments, and the need to account for governments' short and long-run objectives, render research particularly challenging. In this article, we outline a theory-based empirical methodology that relies on estimating an industry equilibrium model to measure hidden subsidies, assess their welfare consequences for the domestic and global economy, as well as evaluate the effectiveness of different policy designs. We illustrate this approach using the global shipbuilding industry as a prototypical example of an industry targeted by industrial policy, especially in periods of heavy industrialization. Just in the past century, Europe, followed by Japan, then South Korea, and more recently China, developed national shipbuilding programs to propel their firms to global leaders. Success has been mixed across programs, certainly by welfare metrics, and sometimes even by growth metrics. We use our methodology on China to dissect the impact of such programs, what made them more or less successful, and how we can justify why governments have chosen shipbuilding as a target.

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Industrial policy refers to a government agenda to shape industry structure by promoting certain industries or sectors. Although casual observation suggests that industrial policy can boost sectoral growth, researchers and policymakers have not yet mastered predicting or evaluating the efficacy of different types of government interventions, nor how to measure the overall short-run and long-run welfare effects. In this article, we focus on one particular example of industrial policy, which we believe serves as a revealing case study: government support for shipbuilding in general, and China's industrial policy to support shipbuilding in particular.

Shipbuilding has been historically a classic target of industrial policy, pursued by several countries that devised national programs for heavy industrialization, such as Japan in the 1950s, and South Korea in the 1980s. Interestingly, shipbuilding has now entered industrial policy agendas in both the European Union (Folkman, 2024) and the United States (Forooher, 2024), with calls for re-shoring shipbuilding production. We begin this essay with an overview of global production patterns in shipbuilding, and how these patterns have shifted in the last century or so. The rich and tumultuous history of shipbuilding presents puzzles and leaves us with open questions: Why have governments subsidized shipbuilding throughout history? This is not obvious at first glance: the global market for sales of newly built ships is about $120 billion annually, which by global standards is not large. Was industrial policy successful? Although several national shipbuilding programs, such as in Japan or South Korea, seem to be behind tremendous sectoral growth, others, like support for shipbuilding in the United States, have seemingly failed.

We offer a brief overview of the two primary research approaches that have been used to study industrial policy: 1) a largely reduced-form empirical analysis has explored the impact of specific policies on available outcomes (primarily output growth and employment) exploiting natural or quasi-experimental variation; and 2) work based on strategic trade theory. However, we focus primarily on a third approach: structural modeling of the industry, and in particular an application of this approach to China's subsidies in support of shipbuilding. China is of particular interest more generally, given its strong advocacy for industrial policy, as well as its numerous trade conflicts with many countries across various industries. In recent years, China's government has been explicitly targeting sectors with the goal of turning its firms into world leaders. We outline the combination of structural modeling and data work needed to tackle the challenge of measuring explicit and implicit subsidies; our answer to how the global industry would have evolved if China had not subsidized shipbuilding, and in particular, how China's subsidies for shipbuilding affected shipbuyers, shipping costs, and world trade; the low economic payoffs that China received from its subsidies in the beginning and how it altered the policy design over time; and the broader economic and geopolitical reasons China may have chosen to subsidize shipbuilding. In conclusion, we offer some provisional lessons for researchers and policymakers considering industrial policies, whether in shipbuilding or in other industries.

A Brief History of Global Shipbuilding

The history of shipbuilding is as tumultuous as the seas themselves. Shipbuilding has always held an allure for governments, in its real and perceived interactions with industrialization, maritime trade, and military strength.

The Changing Leader

Figure 1 shows the succession of countries as the world's dominant shipbuilding nation. The United Kingdom holds the lion's share of the industry for the better part of the 19th and 20th centuries, fending off competition from other Western European economies (mainly Germany and Scandinavia) at times. After World War II, it is swiftly overtaken by Japan, which prevails as a world leader until the 1980s, when South Korea dominates the global market. In the mid-2000s, China has staked its claim. This succession is made even more dramatic by the notorious "shipbuilding cycles," a succession of booms and busts [Kalouptsidi, 2014]. Building large ships takes years, but demand for ships is governed by volatile macroeconomic fluctuations. When demand spikes but shipbuilding capacity is fixed and sluggish, shipping rates skyrocket, and shipbuilders pile up orders for new ships. Ship prices soar. But in the bust, shipbuilding capacity idles, and prices hit rock bottom.

Why have certain countries dominated global shipbuilding? The basic economics of shipbuilding certainly plays a role in fostering the high concentration of production in certain locations. Ship production requires a base on land, easy access to water (sea or rivers), as well as materials such as steel and engines, and (skilled) labor. Countries that dominate shipbuilding often have a strong maritime tradition and have often been important players in global shipping and trade. In addition, the shipbuilding leaders are often undergoing a phase of heavy industrialization. But a quick inspection of the history of shipbuilding also reveals the decisive role that industrial policy, of different forms and with different motivations, has played in shaping the global market for ships.[1]

The UK's leading position in shipbuilding, which lasted for decades up until the 1950s, initially stemmed from access to cheap iron and steel in the late 1800s [Hanlon, 2020].[2] From the late 19th century onwards, though, UK dominance in shipbuilding was in large part due to its strong maritime trade: UK trade flows dominated global trade, and the British Empire needed ships to execute this trade volume with its colonies and other trading partners. The UK also benefitted from strong integration between its shipowners and shipbuilders: British owners almost never bought foreign ships and instead maintained close relationships with domestic shipbuilders [Pollard, 1957, Stopford, 2009]. Access to a large and loyal home market allowed British shipbuilders to enjoy economies of scale, both internal and external: it facilitated the formation of a skilled pool of labor, enabled shipbuilders to specialize in producing specific ship types, and reduced their exposure to shipbuilding boom-and-bust cycles, allowing them to utilize their capacity more effectively [Pollard, 1957, Hanlon, 2020].

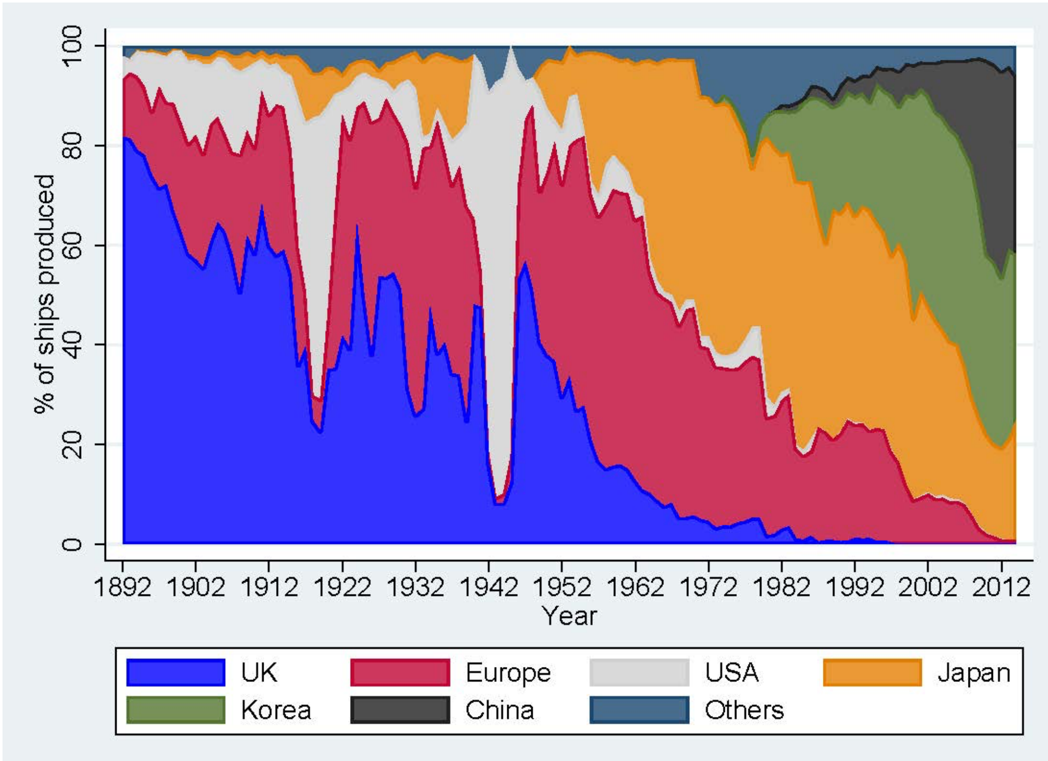
While government policy may have played a role in explaining the UK's leading position in global trade and shipping (which in turn boosted its shipbuilding sector), it is unclear if the UK directly subsidized the shipbuilding sector itself during this earlier period. But this would turn out to be a historical anomaly. Every major shipbuilding player that subsequently emerged did so at least in part

[1] The major types of ships currently produced include containerships, (oil) tankers, bulk carriers, as well as more niche products like cruise ships, liquefied natural gas carriers, and "Ro-Ro's," which are ships that allow vehicles to be rolled on and off the ship.

[2] The US dominated wood shipbuilding in the first half of 1800s until wood ships were replaced by metal ships in the 1850s.

with the aid of industrial policy.

Figure 1 Share of commercial ships produced by each country, 1892 - 2014.



Note: this figure plots the world market share in terms of the number of ships delivered from 1892-2014 for the major ship producing countries. *Source*: Data for 1892 - 1997 was obtained from historical issues of the World Fleet Statistics published by Lloyd's Register, while the data from 1998 onwards is based on Clarksons data. We group together all European shipbuilding countries except for the United Kingdom under "Europe."

The first major challenge to the UK's hegemony came from other Western European countries with strong maritime traditions, such as Scandinavian countries. Initially, many of these competitors were unable to compete globally with the significantly more productive UK shipyards and instead were propped up through the use of subsidies and various protective policies [Pollard, 1957]. Over the first half of the 20th century, other European shipbuilders built up a substantial market share in ship production, while British shipbuilding declined. Another part of this shift was that British shipbuilders failed to transition away from the "craft" style of production popular in the early 20th century to the more "industrial" style of production that became more common in the mid-20th century as ship sizes increased, ships became more standardized, and ship production became more capital-intensive; that said the protectionist policies used by Britain's competitors (including generous subsidies to shipbuilders) also contributed to Britain's decline [Lorenz, 1991].

During World War I and II, the United States both assembled and dismantled massive shipbuilding capacity in a very short time span [Thornton and Thompson, 2001, Thompson, 2001]. Beyond these two periods, the US was never globally competitive as a ship producer, despite the fact that the US had long been a proponent of industrial policy in shipbuilding. For instance, the Jones Act prohibits foreign vessels from transporting goods between two US ports, and the "construction differential subsidies" that were provided to US shipbuilders until the 1980s amounted to between 30 and 50 percent of the cost [Stopford, 2009]. Once high wartime demand for ships had evaporated, US shipyards, with their much higher costs, were unable to compete commercially with European and Japanese yards [Stopford, 2009]. That said, the US example shows that a massive shipbuilding program can be set up at an astonishing speed, but there is no guarantee that such a program can be sustained in the long run.

After World War II, Japan developed national programs for its shipbuilding industry as part of its efforts to rebuild its industrial base alongside several other heavy industries, such as steel and coal (which were viewed as complementary), chemical fertilizers, petrochemicals, and automobiles [Okuno-Fujiwara, 1991, Flath, 2022]. An island nation with a very strong maritime tradition, Japan swiftly became the world's dominant ship producer. Through a series of interventions, including subsidized financing, export credits, and protectionist measures, a number of large Japanese conglomerates--Mitsubishi, Kawasaki, Sasebo, and others—became global leaders in shipbuilding (and other sectors). Indeed, during the 1950s, 30 percent of the total loans made by the Japan Development Bank were for marine transportation (Stopford, 2009). Japanese shipbuilders were also well-positioned to take advantage of structural changes underway in global shipping (such as increased demand for transportation of oil) that increasingly favored the use of larger ships: Japan's shipyards were larger and more integrated with steelmaking facilities than their European competitors, and the Japanese industry was at the forefront of innovation in ship construction that significantly reduced construction time [Stråth, 1987]. By 1970, Japan's global market share in shipbuilding had increased to 48 percent (from only 4.7 percent in 1949), while Europe's market share had fallen from 75 percent to 48 percent, in spite of the heavy European subsidies to the shipbuilding industry as a response to increased Japanese competition [Stråth, 1987].

By the 1980s, however, Japan's shipbuilding was losing ground to South Korea. South Korean shipbuilding, similar to Japanese shipbuilding, grew as part of the government's large-scale push for heavy industrialization in the late 1970s (Choi and Levchenko, 2021; Lane, 2022). Recognizing shipbuilding as a strategic industry, Korea's government provided support primarily in the form of favorable financing (such as low-interest loans and government debt guarantees), as well as direct investment in shipbuilding facilities. Also like Japan, major South Korean conglomerates such as Hyundai, Samsung, and Daweoo grew quickly. Indeed, Korea's shipbuilding program was from the outset focused on producing very large ships in a small number of large shipyards owned by these conglomerates [Stopford, 2009]. Within 20 years, by 1995, South Korea's market share grew to 28 percent (from less than 1 percent in the early 1970s), reducing Japan's market share from 50 percent in 1975 to 41 percent and Europe's share from 32 percent to 23 percent.

However, unlike its predecessors in global shipbuilding, South Korea did not have a maritime tradition nor a large national fleet. Its maritime trade was much smaller than that of Europe or Japan. Even as South Korea emerged as one of the two leading shipbuilding countries, the share of the global shipping fleet registered in South Korea never exceeded 2 percent, whereas Japan's share had reached

10 percent by 1984 (Stopford, 2009).[3] In other words, this was the first time that shipbuilding had been targeted as a primarily exporting sector. In 1995, 78 percent of Korea's ships were exported, compared to 42 percent for Japan (Lloyd's, 1999). This shift can be partially attributed to the growing adoption of "flags of convenience": from the late 1960s, shipowners began choosing flags of countries that provided tax and licensing benefits, such as Panama or Liberia, instead of remaining listed in their national fleet registry. This trend rendered ship-owning a more "global" industry, breaking the link between shipowning and shipbuilding. Today, demand for ships remains globally fragmented and comes from many different countries and hundreds of different shipowning firms or fleet operators.[4]

Why did South Korea choose to subsidize shipbuilding? The development of heavy industries—including not just shipbuilding but also steel/metals, machinery, electronics, and petrochemicals—was seen by Korea's government as a prerequisite for long-term economic growth [Lane, 2022]. National security was another key motive: changing US foreign policy in the early 1970s, and in particular the withdrawal of one-third of all US troops from South Korea in 1971, led the Korean government to prioritize sectors perceived as being important for defense [Bruno and Tenold, 2011]. Finally, shipbuilding may have been targeted because the shipbuilding production process required skilled labor and sophisticated capital and machinery, and even just following the steps that Japan had taken.

By 2000, European shipbuilders were focusing on niche high-tech products, such as cruise ships. Their overall market share is 14 percent. Japan and South Korea compete head to head, with an overall market share of 38 percent each, but focused on different segments. Japanese yards dominate the production of bulk carriers (with a share of 70 percent), while South Korean yards lead the production of higher-end, specialized oil tankers (61 percent) and containerships (50 percent).

In the 2000s, China enters the shipbuilding scene. In 2002, former Premier Zhu inspected the China State Shipbuilding Corporation (CSSC), one of the two largest shipbuilding conglomerates in China, and pointed out that "China hopes to become the world's largest shipbuilding country (in terms of output) [...] by 2015." Within a few years, China overtook Japan and South Korea to become the world's leading ship producer in terms of output. By 2009, China's market share had reached 53 percent, from less than 10 percent in 2000; the combined market share of Japan and South Korea decreased from 75 percent in 2000 to 42 percent in 2009.

Industrial Policy and Shipbuilding: Some Key Questions

This narrative suggests that industrial policy has played a pivotal role in shaping the evolution of the modern shipbuilding industry. Since the start of the 20th century, each new successor to the throne of the world's biggest shipbuilding region - continental Europe, Japan, South Korea, and China - has done so

[3] This estimate based on whether ships are registered in certain countries is likely a gross underestimate of the ships owned by companies from a given country, because of flags of convenience; for instance, according to Stopford [2009] in 2005, 90 percent of Japanese-owned ships sailed under foreign flags.
[4] Industry structure for bulk carriers (tankers and dry bulk carriers) is highly fragmented with hundreds of firms operating globally (Kalouptsidi, 2014). In container shipping, although operators are fairly concentrated, they often lease their vessels from a large number of small shipowners.

on the back of a deliberate program of supporting shipbuilding. Yet this dive into history also leaves at least three open questions.

First, why do governments subsidize shipbuilding? Our narrative suggests a wide variety of reasons: the connection between trade, shipping, and shipbuilding; the development of heavy manufacturing as a strategy for promoting economic growth; employment; national security and military considerations; and the desire for national prestige (or "pride and machismo," as Stråth [1987] puts it). Yet, in none of the historical cases is it self-evident exactly what mix of objectives led to industrial policy in shipbuilding.

Second, was industrial policy successful? It is challenging to evaluate if industrial policy worked. There are certainly examples of "apparent success" in Japan, South Korea, and China, where a country with a negligible initial share of the global industry embarks on a program of industrial policy and rapidly becomes a global leader. But the history of shipbuilding is also filled with examples of unsuccessful industrial policy, such as the long-standing US policy of protecting its shipbuilding sector through cabotage laws, European governments' prolonged and costly attempts to subsidize their shipbuilders in the face of Japanese and Korean competition [Stråth, 1987], or an earlier attempt by South Korea to promote shipbuilding in the 1960s [Amsden, 1989]. Other countries have failed to launch a shipbuilding industry as well, as in the case of Brazil's failed attempt to launch its own shipbuilding sector in the late 1970s [Bruno and Tenold, 2011]. Even the apparent success stories required massive support, leading to the question (rarely answered in the literature) of whether the benefits from subsidizing shipbuilding are worth its large cost.

Third, how large is government support for shipbuilding? Even this seemingly straightforward question does not have an easy answer due to the "obscure jungle of subsidies" (Stråth 1987) that governments have used to subsidize shipbuilding. After all, governments have little incentive to be transparent about policy support, especially if there is a risk of triggering retaliatory policy by rivals. Many subsidies to shipbuilding favored by governments - such as preferential access to land or favorable financing - are implicit in nature, with their true cost difficult to uncover.

In our research, we address each of these questions through a detailed study of industrial policy in the context of the Chinese shipbuilding industry. We begin by describing China's industrial policy in shipbuilding.

Chinese Industrial Policy in Shipbuilding

As early as 2003, China's National Marine Economic Development Plan proposed constructing three shipbuilding bases centered in the Bohai Sea area (Liaoning, Shandong, and Hebei), the East Sea area (Shanghai, Jiangsu, and Zhejiang), and the South Sea area (Guangdong). However, China's 11th National 5-year Economic Plan 2006-2010 was the first to appoint shipbuilding as a "strategic industry" in need of "special oversight and support"; the central government "unveiled an official shipbuilding blueprint to guide the medium and long-term development of the industry." As part of the national plan, the central government set specific output and capacity goals: annual production was to reach 15 million deadweight tons by 2010 and 22 million deadweight tons by 2015. Remarkably, both goals were met several years in advance.

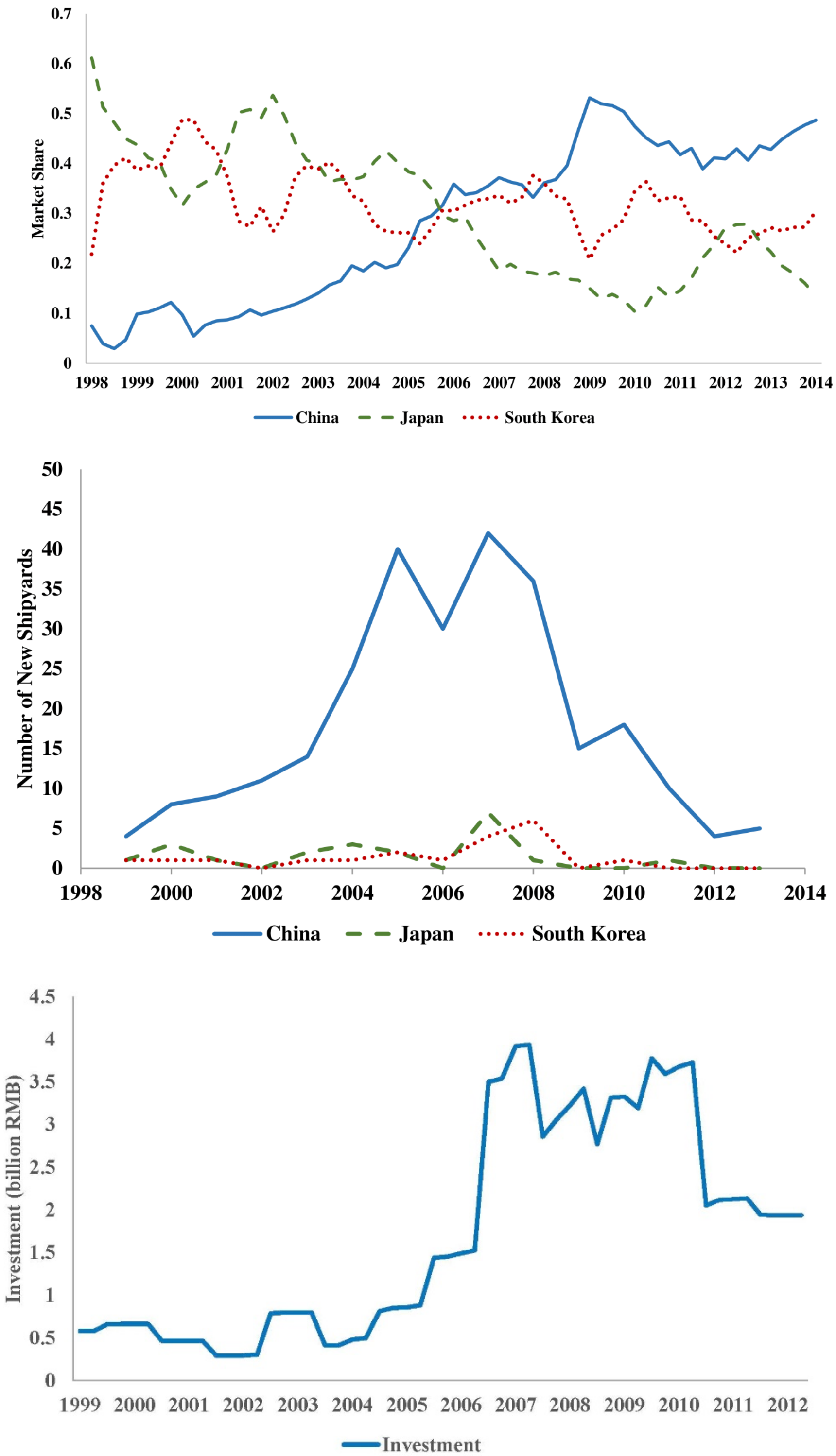
Figure 2, Panel A shows the rise in China's global market share of shipbuilding by plotting China's total shipbuilding output as a share of global output. During this period, a boom-and-bust cycle took place in global shipbuilding. In the early 2000s, China's international imports (mostly commodities) and exports (mostly manufacturing) boomed, commodity prices soared, and as a result shipping rates spiked to a historical high. Shipowners placed heaps of new ship orders, and shipyard backlogs grew exponentially; by the end of 2008, the global ship backlog was more than five times larger than in 2001. But the shipbuilding boom was stopped short by the Great Recession of 2008-09. The crisis led to an idling of the existing fleet, while at the same time another 70 percent of that fleet was still scheduled for delivery by 2012. Ship prices plummeted and threatened the survival of many shipyards.

China's national and local governments provided numerous subsidies for shipbuilding, which we classify into three groups. First, below-market-rate land prices along the coastal regions, in combination with simplified licensing procedures, acted as "entry subsidies" that incentivized the creation of new shipyards. As shown in Panel (b) of Figure 2, between 2006 and 2008, the annual construction of new shipyards in China exceeded 30 new shipyards per year; in comparison, during the same time period, Japan and South Korea averaged only about one new shipyard per year each. In the booming mid-2000s, many of the orders for new ships were placed in these Chinese "greenfields," which were taking orders as they were getting built themselves.

Second, regional governments set up dedicated banks to provide shipyards with "investment subsidies" in the form of favorable financing, including low-interest long-term loans (a common industrial policy tool, as illustrated also by the programs in Japan and South Korea) and preferential tax policies. China's rise in total capital invested in shipyards is illustrated in Panel (c) of Figure 2.

Third, China's government also employed "production subsidies" of various forms, such as subsidized material inputs, export credits, and buyer financing. The government-buttressed domestic steel industry provided cheap steel, which is an important input for shipbuilding. Export credits and buyer financing by government-directed banks made the new and unfamiliar Chinese shipyards more attractive to global buyers.

Figure 2: The Rapid Expansion of China’s Shipbuilding Industry



Notes: Market shares by country are computed from quarterly ship orders. Number of new shipyards is computed annually and by country. Industry aggregate quarterly investment by Chinese shipyards in billions of 2000 yuan. Source: Barwick et al. [2024a], using data from Clarksons Research and China’s National Bureau of Statistics.

The combination of these policies was followed by a sharp expansion in China's shipbuilding production, market share, and capital accumulation. China's market share grew from 14 percent in 2003 to 53 percent by 2009, while Japan shrunk from 32 percent to 10 percent and South Korea from 42 percent to 32 percent. This impressive output growth was partially achieved via a massive entry wave of new firms: there were 173 new Chinese shipbuilding firms, a 230 percent increase in five years. Indeed, one intriguing characteristic of China's industrial policy in shipbuilding—which also applies to its industrial policy in other sectors such as solar panels, auto manufacturing, and steel—is that the industrial policy led to a large number of small firms. This pattern is in sharp contrast to the policies adopted by Japan and South Korea, which relied on promoting a handful of large conglomerates that became global industry leaders. Most of China's shipbuilding growth at this time was concentrated in the least high-tech ships (50 percent global share in bulk carriers) rather than in oil tankers or containerships (28 percent and 23 percent, respectively) where it also concentrated on smaller sizes.

Then came the Great Recession of 2008-09, which drove the global shipping industry to a historic bust. The large number of new Chinese shipyards exacerbated low capacity utilization and contributed to plummeting ship prices around the world. The effectiveness of China's industrial policy was questioned. In response to the crisis and in an effort to promote industry consolidation, the government unveiled the "2009 Plan on Adjusting and Revitalizing the Shipbuilding Industry" that resulted in an immediate moratorium on entry and subsequently shifted support towards only selected firms in an issued "White List." Concentration in China's shipbuilding industry started increasing.

Since 2013, China has been the world's leading shipbuilder, accounting for 54 percent of all tonnage delivered in 2022, compared to 28 percent for South Korea and 18 percent for Japan. Moreover, China has begun to slowly move up the product ladder: between 2018 and 2022, Chinese shipbuilders delivered 45 percent of all new containerships (versus 36 percent for Korea), up from 23 percent between 2006 and 2010. Chinese shipyards still tend to build smaller containerships, although they have begun to build bigger ships in simpler ship types, such as bulk carriers.

How to Estimate Effects of Sectoral Industrial Policy

The case of shipbuilding illustrates how industrial policy can at least in some cases lead to rapid and substantial sectoral growth. But how can researchers evaluate the welfare impact of such growth, both domestically and internationally, as well as the efficacy of different types of government interventions? Such questions pose considerable challenges.

Any methodology for estimating the effects of industrial policy must grapple with a basic data challenge: government subsidies to industries are notoriously difficult to detect and measure. Indeed, "systematic data are non-existent; reliable sources of information are scarce and mostly incomplete [...] because governments do not systematically provide the information" (WTO, 2006). Researchers and policymakers end up relying mostly on data reported by governments, like budgetary subsidies that are generally exempt from regulation, including R&D, environmental, and agricultural subsidies. However, reported measures of output subsidies tend to be crude and untrustworthy. Even worse, certain industrial support initiatives may be almost unmeasurable: consider a government-built airport in a small city, which builds a longer-than- needed runway (at considerable cost) that is used by an aircraft manufacturer for large plane trials.[5]

Beyond the data limitations, we need a methodology to assess the effect of industrial policy. The research in this area falls into three broad categories. An earlier approach traditionally relied on descriptive analyses that regress firm or sectoral outcomes on available measures of industrial policy [Noland and Pack, 2003, Pack and Saggi, 2006]. But more recently, there has been a proliferation of studies that leverage natural or quasi-experimental variation in historical contexts to derive plausibly causal estimates of industrial policies on outcomes such as industry output, revenue, employment, exports, and sometimes productivity. As one example, Juhász [2018] uses a natural experiment, the Napoleonic blockade of Britain from 1806-1813, to estimate the causal effect of temporary trade protection on long-term economic development. Though the blockade was not an explicit industrial policy, it created exogenous and differential variation in trade costs, effectively protecting northern French cotton spinners more than southern ones against British imports. In another notable example, Lane [2022] studied South Korea's Heavy and Chemical Industry Drive in 1973-1979, in which industrial policy reshaped Korea's long-term dynamic comparative advantage.[6]

Other studies suggest more nuanced findings. For example, in another study of South Korea's Heavy and Chemical Industry Drive, Kim et al. [2021] report that misallocation worsened significantly during the period.[7] Using exogenous variation in the eligibility criteria of place-based investment subsidies in the United Kingdom, Criscuolo et al. [2019] find that these subsidies increased manufacturing employment for small firms but not large firms, with positive effects on investment but not productivity.[8] Similarly, exploiting changes in the eligibility criteria for India's small-firm subsidy programs, Rotemberg [2019] finds almost complete output crowd-out among domestically consumed products but much less crowd-out for those that were exported. Aggregate productivity rose by 1−2 percent due to the higher productivity of newly eligible firms. This finding echoes an obvious but often forgotten message: firms are heterogeneous, so policies that promote the participation of more efficient firms tend to be more effective (Barwick et al. 2024a).

Such studies have greatly enriched our understanding of the effects of industrial policy and mark a substantial improvement over the earlier, largely correlational studies (Juhász et al. 2023). On the other hand, these studies are bound by their research designs. None of them can readily conduct a cost-benefit analysis, leaving open the question of whether these industrial policies passed the "Bastable test"—that is, whether the discounted future gains in consumer and producer surplus exceed the costs of

[5] To address this challenge, researchers have in recent years compiled information on industrial policies by different countries across sectors using Global Trade Alert (Juhász et al. [2022] and Evenett et al. [2024]). These sources fill an important data gap because it is often hard to even know which sectors are targeted or which policies are in place; but these databases do not in general have complete information on the size of government subsidies.

[6] See also Aghion et al., 2015 and Harris et al., 2015. Lane [2020] and Juhász et al. [2023] provide reviews of recent studies. There is also a growing literature that examines the effect of industrial policy on quality upgrading [Bai et al., 2024]. See Verhoogen [2023] for a review.

[7] An earlier literature (for example, Krueger and Tuncer [1982], Birdsall et al. [1993]) and plenty of anecdotal evidence indicate that industrial policies often lead to misallocation and excess capacity, a topic we return to below.

[8] See Neumark and Simpson [2015] for a review of place-based policies.

protection [Harrison and Rodríguez-Clare, 2010]. These studies are limited in their ability to make counterfactual predictions, such as how industries would have evolved in the absence of industrial policy, and sometimes uninformative in terms of mechanisms by which industrial policy affects the economy. Finally, these papers are silent on the comparison across alternative policy instruments and how to design effective and welfare-enhancing policies.

A second approach builds on the significant body of work on "strategic trade," whereby government interventions alter the strategic interactions of firms that compete globally. The literature focused on when such policies benefit the domestic economy. Early prominent work in this area, including Helpman and Krugman (1989) and Brander (1995), was based on models that were simple enough to remain analytically tractable. However, it turned out that different specifications of the model could entirely alter the conclusions: for instance, the theoretical predictions about the welfare implications of industrial policies depend on whether firms compete in prices or quantities. If firms are choosing quantities produced (Cournot competition), subsidies can improve national welfare. But subsidies would reduce the welfare of national players if firms competed in prices (Bertrand competition) because that would intensify competition. This ambiguity in terms of when it is optimal to use subsidies or taxes to help the national champion in a globally oligopolistic industry obstructed the evolution of this literature.

That said, in follow-up literature, empirical studies applied these models to study the effect of industrial policies in specific industries, often using calibration or simulation to assess welfare effects (see Harrison and Rodríguez-Clare, 2010 for an excellent review).[9] This literature acts as a precursor to the third approach we discuss below. The lessons of this approach are more tempered. While industrial policies led to growth in the targeted industry, several of the policies evaluated [Baldwin and Krugman, 1988a, Luzio and Greenstein, 1995, Irwin, 2000] did not pass the Bastable test. Given the multiple objectives of industrial policy—including distributional considerations, national security, and international competitiveness—the Bastable test may be too narrowly focused. Nevertheless, welfare calculations serve as a valuable benchmark. Finally, these studies often relied on aggregate data, stylized models, and calibration techniques. Few examined investment and capacity decisions directly, which are arguably the most critical margins that industrial policy seeks to influence.

A third approach to the study of industrial policy applies structural methodology in the field of industrial organization [Ackerberg et al., 2007, Ho et al., 2021]. This approach essentially seeks to combine the two previous approaches, harnessing the benefits of each. Unlike reduced-form analysis, model-based empirical work looks at the data through the lens of an empirical industry equilibrium model. Unlike the strategic trade models, it relies on devising the simplest model that is realistic enough to capture the main features of the environment under study. Most importantly,

[9] Baldwin and Krugman [1988a] and Baldwin and Krugman [1988b] analyze the US-Japan rivalry in the 16K RAM sector during 1978-1983, and Airbus' rise of world market share in the 1970s, as a result of trade protection and subsidies, respectively. Head [1994] studies the effect of tariff protection and learning-by-doing on the emergence of the steel rail industry in the US between the civil war and World War I, Irwin [2000] analyzes the effect of tariff protection on the growth of U.S. tinplate industry in the 1890s, and Luzio and Greenstein [1995] study the effects of Brazil's protection of the microcomputer industry in the 1980s.

the combination of data and theory allows the researcher to test or validate the modeling assumptions imposed [Nevo and Whinston, 2010]. Finally, structural methodology allows the researcher to infer a measure of industrial subsidies that are otherwise unobserved (more on that below), as well as evaluate welfare and other (policy) counterfactuals of interest.

In this approach, the researcher builds a "custom" model for the industry under study: say, shipbuilding. This modeling requires a deep understanding of the environment: for example, the market structure of producers and buyers, how firms compete, how prices are formed, the production cost function, and other important firm decisions, such as whether the industry sells a homogeneous or differentiated good, and finally how government subsidies affect firms. Possible answers to these questions come from extensive discussions with industry participants, industry press or reviews, as well as the prior academic literature. The model must account for the key features of the industry under study and allow for the key mechanisms the researcher is interested in analyzing. The model must then "meet" the data. The researcher collects data, usually in the form of firm actions, such as quantities produced, prices, investments, and product characteristics. Then, one estimates key relationships like the demand curve and the firm's cost curve. The goal is to "assign numbers" to key parameters of interest, such as the demand elasticity and the marginal cost of production or investment. Finally, this quantitative model is used to compute counterfactuals of interest; for example, predict the evolution of an industry with subsidies (as observed) or without, or change the policy mix and compare the new equilibrium in the model to the observed outcomes.

A small but growing literature applies this third approach to evaluate industrial policies in various contexts: for example, Spain's decade-long effort to promote its domestic automobile industry (Miravete and Moral [2024]); the optimal design of China's electric vehicle subsidies (Barwick et al. 2024b); the positive global spillovers of the electric vehicle subsidies implemented in China, Europe, and the United States, as well as the negative implications of local content requirements, in the presence of steep learning-by-doing in the upstream electric vehicle battery sector (Barwick et al. 2024c); and China's research and development subsidies in its InnoCom Program (Chen et al. 2021).

The structural approach is not without its concerns. Does the model capture the key characteristics of the industry? Does it allow for potential confounding factors, and is there rich enough data variation to consider such factors? Put differently, the findings are conditional on modeling assumptions, and the data must allow one to test these assumptions. Finally, this approach focuses on partial equilibrium or sector- specific analysis, which allows the researcher to exploit rich data and institutional details to answer important "what-ifs." However, general equilibrium analysis may be important in exploring spillovers of industrial policy (Liu 2019, Choi and Levchenko 2021).

Illustration: China's 21st Century Shipbuilding Program

We illustrate the structural approach to studying the impact of industrial policy on industry evolution and global welfare in the context of China's 21st-century shipbuilding program in Kalouptsidi (2018) and Barwick et al (2024a). To our knowledge, this work is the first attempt at evaluating quantitatively industrial policy in shipbuilding globally and among the first papers employing the structural industrial organization methodology to understand the welfare implications and effective design of industrial policy more generally.

Framework

We build a model of a global market for ships. On the demand side, a large number of shipowners across the world are deciding whether to buy new vessels. Their willingness-to-pay for new ships depends on present and expected future market conditions, notably world trade and the current fleet level. On the supply side, our model considers shipyards located in China, Japan, and South Korea (which account for 90 percent of world production). Each shipyard decides how many ships to produce, by comparing the market price of a ship, dictated by the willingness-to-pay of shipowners on the demand side, and its production costs. Shipyards are price-takers (an assumption we relax below) and will keep producing as long as the price exceeds the marginal cost of an additional vessel. Thus, we can use the assumption of profit-maximizing behavior, along with observed ship prices and firm-level production, to uncover the shipyard's cost function. We assume the cost function is convex—that is, marginal costs of production rise with quantity—a feature that may capture capacity constraints.

To bring this model to data, we employ a rich dataset consisting of firm-level quarterly ship production between 1998 and 2014, firm-level investment, entry and exit, and new ship market prices by ship type (containerships, tankers, and dry bulk carriers, which together account for 90 percent of global sales). In other words, for each shipyard in the world we know how many ships are ordered and delivered every quarter, how much new capital is invested, whether the shipyard exits or is a new entrant, as well as the prevailing global ship price. Such data on the shipbuilding industry are available from several data providers, at a relatively small cost to the researcher, such as Clarksons Research (which we use), Lloyds, and S&P Global.

As a starting point, we need to measure the size of China's subsidies for shipbuilding. But how can we do this when the subsidies are both direct and indirect and poorly measured? We know that China's subsidies for shipbuilding started in 2006. We use data from all countries before 2006 to estimate a shipbuilding cost function. This cost function should then continue to predict shipbuilding outside of China after 2006; however, it can only match China's shipbuilding after 2006 by including a measure of what subsidies must have been. With the model in hand, we can compare China's observed shipbuilding production with subsidies to the outcome that would have arisen had China not subsidized shipbuilding.

In other words, our methodology relies on combining available data on firm choices and an economic model. It aims at uncovering a "gap" between the observed production and the optimal production the economic model implies (that is, the production that equates price to marginal production cost). We estimate the marginal cost from variation in prices and examine its behavior around 2006.[10] We are particularly interested in whether this cost function exhibits an abrupt and

[10] The cost function relates output to operating expenditures. As in many industries, however, costs of production are not readily observed. Standard methodology in industrial organization [Bresnahan, 1982, Berry et al., 1995] estimates costs from rich variation in demand. In our context, price is equal to marginal cost of production. If we impose a functional form on the marginal cost (say quadratic in quantity), we can use the observed price, and the level of output to estimate the cost

otherwise inexplicable change around 2006 that makes Chinese shipyards' production costs all of a sudden lower. The idea is to essentially ask whether Chinese firms are "over"-producing, compared to our prediction from the earlier production function.

How Big Were China's Production Subsidies?

Our estimates suggest that China provided $23 billion in production subsidies between 2006 and 2013. This finding is driven by the cost function obtained from this analysis, which exhibits a significant drop for Chinese producers equal to about 13-20 percent of the cost per ship. Simply put, Chinese shipbuilding firms were "over"-producing after 2006 compared to our prediction of output without subsidies.

Might some confounding factor, like a technological advance or a particular type of ship being built, explain this pattern? A general change in shipbuilding technology does not seem to be the cause because the cost reduction is only present for Chinese shipyards– there are no "breaks" in the estimated cost functions of Japanese or South Korean shipyards. In addition, the results are robust to many different specifications, as well as different ways of accounting for temporal changes. For example, the results hold when only shipyards that existed prior to 2001 are considered—which in turn suggests that cost declines are not driven by new shipyards, which may have a different technology or may be learning-by-doing. Moreover, the results hold if we focus on the smallest size category of bulk vessels (called Handysize), where China was already an important producer before 2006. China's production process for shipbuilding does not seem to be characterized by significant technological advances, and product differentiation is very limited.

Finally, one may wonder about certain modeling assumptions, such as the price-taking assumption for shipyards. This industry is globally fragmented, with the Herfindahl-Hirschman Index ranging from 230 to 720 between 2006 and 2013, and China alone having more than 250 shipyards during the peak of the boom. Nonetheless, we carry out a version of our analysis where we relax the price-taking assumption, as industrial policy is often motivated by strategic trade considerations and these considerations only come into play if firms can exert market power. Here we face a choice between assuming Bertrand competition (firms compete in prices) and Cournot competition (firms compete in quantities). In the shipbuilding industry, capacity constraints are first-order; a typical shipyard can only work on a handful of ships at a time; therefore it makes more sense to assume ships compete by choosing quantity. When we estimate a model of Cournot competition and calculate the implied markups, we find these are tiny: the average markup for bulk carriers is only 6.39 percent of the price of a new bulk carrier, and markups are even smaller for tankers (4.26 percent) and container ships (2.12 percent). Similarly, the assumption that ships are homogeneous (conditional on category and size) is motivated by the empirical pattern that prices of new ships are almost perfectly predictable from ship type, ship size, and time fixed effects.

Taking Dynamics into Account

function coefficients.

The basic framework as we have sketched here misses several important features, which can affect the long-run behavior of firms. China's industrial policy in shipbuilding included subsidies not just for production but for entry and investment as well; Figure 2 showed a dramatic rise in investment and the number of new shipbuilding firms in China. Entry and investment have long-run implications for industry structure, especially with the severe volatility that characterizes this industry, because entry, exit, and investment are sluggish to adjust. For instance, during busts, firms do not necessarily exit or divest: these decisions are largely irreversible and firms may delay them in the hope that demand will recover. Even the decision of how many ships to produce is subject to dynamic considerations: building a ship takes two to five years and thus shipyards accumulate backlogs, which can affect their future production costs, either negatively (capacity constraints) or positively (expertise acquisition or larger input orders).

The model used in our empirical analysis of industrial policy is flexible enough to capture these dynamic features of the market for ships. Both the demand for shipping and the supply of ships are at the mercy of large macroeconomic swings, and firms operate in the shadows of severe uncertainty regarding both demand for international trade as well as input cost shocks (for example, steel prices). Demand for new ships is driven by demand for international sea transport, which is uncertain and volatile. On the supply side, we employ a dynamic model of industry evolution, where firms can enter, exit, invest to increase their capital, and compete by producing ships. Shipyards decide whether to enter by comparing their lifetime expected profitability to entry costs, which include the costs to set up a new firm (such as the cost of land acquisition, shipyard construction, and any initial capital investments) and the implicit cost of obtaining regulatory permits. They exit if expected profitability from remaining in the industry falls below a given threshold, capturing the shipyard's "scrap" value (that is, the proceeds from liquidating the business, as well as any option values of the firm). Optimal production decisions involve comparing current margins to expected costs, given input price fluctuations and backlog accumulation. The industry is globally fragmented enough that we assume firms do not engage in strategic dynamic interactions; that said, they form expectations about the evolution of the industry, and in equilibrium these are correct on average [Hopenhayn, 1992].

Entry and investment subsidies are identified following the same strategy as for production subsidies. As before, we use firms' observed entry and investment behavior to back out entry and investment costs. This is done by finding the cost parameters that bring observed behavior as close as possible to the optimal behavior implied by the dynamic model. Once entry and investment costs are estimated, subsidies are estimated by comparing Chinese to non-Chinese firms, before and after 2006. The three types of subsidies can be separately identified because they affect different decisions that firms make on which we have rich firm-level data.

Our estimates suggest that China provided \$91 billion in subsidies along all three margins—production, entry, and investment—between 2006 and 2013, averaging over \$11 billion per year, which totaled nearly 50 percent of Chinese shipbuilding industry revenue over that period. This is considerably larger than the \$23 billion that (according to our estimates) was provided in production subsidies alone. Thus, all firm decisions -- entry, exit, and capacity investment in addition to production -- matter in evaluating the impact and effectiveness of industrial policy. Indeed, entry subsidies were 69 percent of total subsidies, while production subsidies were 25 percent, and investment subsidies accounted for the remaining 6 percent. This empirical pattern reflects that shipbuilding firms "over-entered"– recall the astonishing entry rates during the boom years of 2006-2008 and "over-invested" – recall the striking increase in investment *during the bust* – as shown earlier in Figure 2.

Output and Welfare

Perhaps the biggest advantage of building a quantitative model for an industry is that it can evaluate hypothetical scenarios. For example, what would have happened to China's shipbuilding industry absent Chinese subsidies? Presumably, China's market share would still have increased, especially during the boom years, but by how much?

Our structural model suggests that China's industrial policy in support of shipbuilding boosted China's domestic investment in shipbuilding by 140 percent, and more than doubled the entry rate: 143 shipbuilding firms entered with subsidies vs. 64 without subsidies from 2006 to 2013. It also depressed exit. Overall, industrial policy raised China's world market share in shipbuilding by more than 40 percent.

Calculating whether this increase in sectoral output should be counted as an increase in welfare is a more delicate question. Here are several slices at an answer. First, 70 percent of China's output expansion occurred via business stealing from rival countries. From a global perspective, Chinese subsidies reduced South Korea's world market share from 48 percent to 39 percent and Japan's market share from 23 percent to 20 percent during 2006-2013, with profits earned by shipyards in these two countries falling by ¥144 billion (in US dollars, roughly $21 billion). There is evidence (backed by our cost estimates) that Chinese shipyards are less efficient than their Japanese and South Korean counterparts; thus, the transfer of shipbuilding to China that occurred constitutes a misallocation of global resources.

Second, China's industrial policy for shipbuilding led to considerable declines in ship prices. Lower ship prices benefited world ship-buyers somewhat, though only a modest amount accrues to Chinese ship-buyers, as they accounted for a small fraction of the world fleet.

Finally and most importantly, although China's shipbuilding subsidies were highly effective at achieving output growth and market share expansion, we find that they were largely unsuccessful in terms of welfare measures. The program generated modest gains in domestic producers' profit and domestic consumer surplus. In the long run, the gross return rate of the adopted policy mix, as measured by the increase in lifetime profits of domestic firms divided by total subsidies, is only 18 percent, meaning that for every $1 the government spends, it gets back 18 cents in profitability. In other words, the net return when incorporating the cost to the government was a negative 82 percent, with entry subsidies explaining a lion's share of the negative return.

Alternative Design of Industrial Policy

Our structural model also allows us to consider alternative industrial policy designs. Policy design is bound to be crucial, especially when some producers are more efficient than others, and when demand in the industry is highly volatile.

Table 1: Welfare Effects of Industrial Policy

	Δ Net Profit/Subsidy.	Δ Revenue/Subsidy
Panel A: Comparison of different policy instruments		
Investment Subsidy	74%	153%
Production Subsidy	50%	153%
Entry Subsidy	32%	66%
All Subsidies	18%	72%
Panel B: Industrial policy and the business cycle		
Pro-cyclical subsidies	38%	189%
Counter-cyclical subsidies	70%	168%
Panel C: Targeted industrial policy		
Subsidize all firms	37%	85%
Subsidize "White List" firms	71%	105%

Note: Panel A compares the actual policy mix where firms received all three kinds of subsidies ("All Subsidies"), with counterfactual policy mixes where the government provides only one type of subsidy. In the counterfactuals reported in Panel B and Panel C, firms receive a combination of production and investment subsidies. Panel B compares the effect of providing subsidies during the boom (2006 - 08) vs. the bust (2009 onwards). Panel C compares a policy where all firms are eligible to receive subsidies versus a "White List" policy where only selected firms (chosen on the basis of how profitable they are) are eligible for subsidies. "ΔNet Profit/Subsidy" is our measure of the gross return on the policy, and equals the change in the discounted sum of net profits (relative to the scenario with no subsidies), divided by the discounted sum of subsidies. Likewise, "ΔRevenue/Subsidy" refers to the change in the discounted sum of revenue (relative to the scenario with no subsidies), divided by the discounted sum of subsidies. Source: Barwick et al. [2024a].

We first begin by comparing the efficacy of production, investment and entry subsidies (panel A of Table 1). Although none of the policies (in isolation nor together) yield positive returns in terms of lifetime profits,[11] production and investment subsidies can be justified if the goal is industry revenue maximization (the ratio of increased industry revenue to subsidies is 153 percent, meaning that $1 in subsidies generates about a $1.5 increase in lifetime revenue). This finding might explain the popularity of these subsidies in China, because the promotions of local individuals are often linked to quantity and revenue targets. Indeed, several shipbuilding programs were local, motivated in part by the important implications of increased shipbuilding output on local industrial growth. This led to regional duplication, with several provinces having their own local shipbuilding industry.

Entry subsidies are wasteful—even by the revenue metric—and lead to increased industry fragmentation and idleness. Entry subsidies attract small and inefficient firms. In contrast, production and investment subsidies increase the backlog and capital stock, which lead to economies of scale and drive down both current and future production costs. As such, they favor large and efficient firms. Indeed, the take-up rate for production and investment subsidies is much higher among efficient firms: 82 percent of production subsidies and 68 percent of investment subsidies is allocated to firms that are more efficient

[11] Benefits to domestic consumers are negligible and not included for simplicity.

than the median firm, whereas only 49 percent of entry subsidies goes to more efficient firms.

Another important consideration is the volatile nature of the shipbuilding industry, which is subject to boom and bust cycles. Our model suggests that a counter-cyclical policy would outperform the pro-cyclical policy that was adopted by a large margin: strikingly, subsidizing firms in production and investment during the boom leads to a gross rate of return of only 38 percent (a net return of -62%), whereas subsidizing firms during the downturn leads to a much higher gross return of 70 percent (a net return of -30%), as shown in Panel B of Table 1. In boom periods, the industry is operating close to full capacity, so further expansion is costly and entails the utilization of high-cost resources. During a bust, the industry operates well below capacity and subsidies mobilize underutilized facilities, resulting in smaller distortions. In addition, subsidies during a boom attract inefficient firms, which pushes down the rate of return. Despite the benefits of a countercyclical policy, the actual policy mix was overwhelmingly pro-cyclical: 90 percent of total subsidies was handed out between 2006 and 2008 vs. 10 percent between 2009 and 2013.

Finally, we examine the consolidation policy adopted in the aftermath of the financial crisis, whereby the Chinese government implemented a moratorium on entry into shipbuilding and issued a "White List" of firms prioritized for government support (Panel C of Table 1). Indeed, China adopted this strategy in several industries to curb excess capacity and create national champions that can compete globally, following the examples of Japan and South Korea. In our calculations, if an "optimal White List" is formed—that is, the most productive firms are chosen for subsidies—the gross rate of return climbs to 71 percent vs. 37 percent when all firms are subsidized. Why? Subsidizing all firms encourages suboptimal entry; in contrast, the White List subsidizes existing firms and does not distort entry. Moreover, firms on the White List have lower production costs; shifting support to more efficient firms reduces misallocation. However, China's actual White List was suboptimal, as it favored state-owned enterprises. This illustrates a further difficulty with designing industrial policy: regulatory capture.

Our results highlight why industrial policies have worked better for some countries. In East Asian countries where industrial policy was often considered successful, the policy support was often conditioned on firm performance. In contrast, in Latin America where industrial policies often aimed at import-substitution, no mechanisms existed to weed out non-performing beneficiaries (Rodrik, 2009). In China's modern-day industrial policy in the shipbuilding industry, the policy's return was low in earlier years when output expansion was primarily fueled by the entry of inefficient firms but increased over time as the government relied on "performance-based" criteria via its White List. Such targeted industrial policy design can be substantially more successful than open-ended policies that benefit all firms.

China's Industrial Policy in Shipbuilding: Why?

If industrial policy related to shipbuilding had a low payoff, then what objectives, economic or non-economic, was China's government trying to attain?

Many of the standard arguments for industrial policy do not seem to apply especially well to shipbuilding in our sample period. The shipbuilding industry is fragmented globally, market power is limited, and markups are slim; thus, there are no "rents on the table" that, when shifted from foreign to domestic firms, outweigh the cost of subsidies. The possibility of industry-wide learning-by-doing ("Marshallian externalities") is another common rationale for industrial policy, but we find little evidence of learning-by-doing, perhaps because the production technology for the ship types that China expanded the most, such as bulk ships, was already mature. Another industrial policy argument focuses on spillovers to other domestic sectors (like steel production or the labor market), but we find limited evidence for such spillovers in this context. In addition, more than 80 percent of ships produced in China are exported, which limits the fraction of subsidy benefits that is captured domestically. A scenario whereby Chinese output growth in shipbuilding eventually forces competitors to exit does not seem first-order either: by 2023, no substantial foreign exit has been observed.

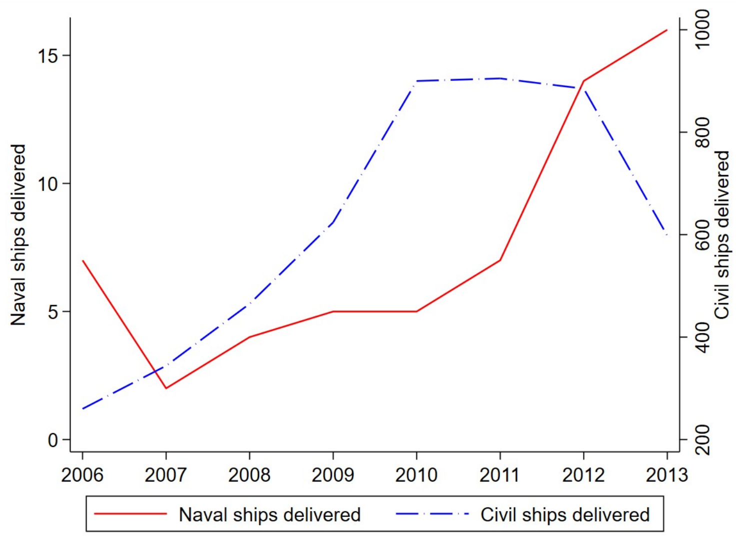
Of course, one possibility already noted is that the structure of China's incentives for local political leaders rewards readily observed results, so the observed growth in shipbuilding output and global market share is sufficient to offer a political justification for the subsidies. However, we also find support for two different rationales.

First, as China became the world's biggest exporter and a close second largest importer during our sample period, transport cost reductions from increased shipbuilding and reduced shipping costs can lead to substantial increases in its trade volume. China's imports consist mainly of raw materials and are carried by bulk carriers and tankers; while its exports are mostly manufactured goods and are transported in containerships. To evaluate this argument, we carry out a back-of-the-envelope calculation of the subsidies' impact on China's trade flows. Shipbuilding subsidies reduced bulk carrier freight rates by 6 percent and containership freight rates by 2 percent between 2006 and 2013. Using trade elasticities from the literature (Brancaccio et al., 2020, Jeon, 2022), the industrial policy raised China's annual trade volume by 5 percent ($144 billion) between 2006 and 2013. This increase in trade was certainly large relative to the size of the subsidies (which averaged $11.3 billion annually between 2006 and 2013). Of course, "more trade" does not translate directly into economic well-being, but the relative magnitudes are suggestive.

Second, China's military ship production might have benefited from industrial policy with regard to shipbuilding. Military ship production is concentrated at state-owned yards, especially at 13 subsidiaries of China State Shipbuilding Corporation (CSSC) and China Shipbuilding Industry Corporation (CSIC), the two largest conglomerate shipyards that are state-owned.[12] These subsidiaries are typically dual-use, producing both commercial and military ships in the same complex. Figure 3 plots the annual deliveries of naval and commercial ships from 2006 to 2013. Both types of deliveries experienced a several-fold increase during this period, although military production appears to have accelerated after the financial crisis and continued to increase throughout the sample period, providing suggestive evidence that China's supportive policy might have benefited its military production as well.

[12] Our primary sources are the yearly report known as IHS Jane's Fighting Ships, produced by the intelligence company IHS Jane's Saunders [2015] , as well as "Chinese Naval Shipbuilding: an Ambitious and Uncertain Course", a 2017 book about the Chinese naval shipbuilding industry Erickson [2017]. We are grateful to Elliott Mokski for discovering and collecting these datasets.

Figure 3: Military Ship Production.



Note: This figure plots the number of commercial ships and naval ships delivered by Chinese shipyards over time. Source: Barwick et al. [2024a], using data from Clarksons and IHS Jane's.

Ongoing Challenges of Research on Industrial Policy

In many ways, the example of China's industrial policy with regard to shipbuilding echoes patterns observed in other countries and industries, and thus illustrates the academic and policy-making challenges of industrial policy.

First, studying industrial policy in shipbuilding showcases the issue of scant and mismeasured data on government interventions; thus, we had to derive estimates of subsidies from a structural model and firm-level data. More generally, government subsidies to industries are notoriously difficult to detect and measure. Indeed, partly because international trade agreements prohibit direct and in-kind subsidies, "systematic data are non-existent" [WTO, 2006] and thus the presence and magnitude of industrial subsidies are often unknown. This lack of both information and compliance has obstructed the role of global policy-makers and prompted them to reevaluate their guidelines.

Second, it showcases the problem of designing industrial policy; indeed, given the pressures that politicians face to support certain industries, the relevant question they face with regard to industrial policy may not be whether to do it, but how [Rodrik, 2009]. China's industrial policy for shipbuilding started with large subsidies, such as cheap land and subsidized credit, without many restrictions on the firms that could access them. This policy approach proved costly and inefficient, as it led to a massive entry wave of new firms that were not high performers. The negative consequences of the poor design were hidden during the boom years but painfully revealed when excess capacity came to plague the industry during the Great Recession of 2008-09. The government then subsidized only firms on a White List; this pattern seems to continue today in the "Made in China 2025" program.

Third, economists need an improved methodology for assessing the welfare impact of industrial policy, domestically and globally. Measuring welfare effects necessitates a modeling framework, with non-trivial choices to be made as to what is included (for example, partial vs. general equilibrium). Most important, in our view, is that evaluations of industrial policy need to reach beyond purely economic objectives: for instance, how do researchers incorporate the geopolitical considerations that are so common in industrial policy agendas today? Understanding noneconomic objectives requires economists to think outside their standard toolbox and thus poses both a great challenge and an opportunity for research.

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