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Industrial Policy for the 21st Century: Lessons from the Past

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European Commission
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Industrial Policy for the 21st Century

Lessons from the Past

Alessio Terzi, Aneil Singh and Monika Sherwood

Abstract

The urgent need to accelerate on, and make a national success of, the green and digital transition are leading to wide-spread calls for greater government involvement in the economy, including by means of an active industrial policy. After reviewing several case studies, it becomes evident that, against conventional wisdom, nearly all countries have systematically engaged in some form of industrial policy, especially large economies like the USA and China, notwithstanding their very different economic models. The same is true for Europe, both at national level and through EU policies. After analysing these experiences, we draw six key policy lessons to inform future debates on how to shape a successful industrial policy in the years to come, and mitigate its risks, while acting in a context of souring geopolitical tensions. Nonetheless, industrial policy should not undermine the integrity of the Single Market, which has been, and should remain, a central element to ensure Europe's prosperity going forward.

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1. INTRODUCTION

Europe cannot afford to lose the race for certain advanced technologies that will be crucial in the 21st century. Only one European company features currently among the 20 biggest tech companies by market capitalisation[1], which stem mostly from the U.S. and Asia. Whereas Europe is still doing relatively well in terms of presence among the largest green tech companies, it is clear that as China and India move up the supply chain, European firms will face increasing competition[2]. The U.S. clearly dominates the market for self-driving cars, and ICT more broadly, as does China in the market for electric vehicle batteries, and Taiwan for semiconductors. For what concerns unicorn start-ups (innovative private companies with a valuation of over 1 billion dollar), only four of the top 100 hail from the EU-27, with the biggest of them only in the 58th place[3].

Observing the lack of European behemoths in international rankings has led some to promote the creation of European champions, following the argument that this would help to counter competition from China and the USA[4]. The Commission's rejection of the proposed Alstom-Siemens merger in February 2019 reopened that debate and a Franco-German manifesto[5] outlined a potential reform of EU competition rules, which would facilitate the creation of European mega-companies. However, creating larger companies by facilitating mergers does not necessarily lead to more innovative companies able to compete globally. In fact, larger firms that establish a dominant position in the market, tend to maximise profit by exploiting this position, whilst reducing their relative investment in innovation and labour.[6]

In March 2019, the European Council invited the Commission to present a new "*assertive industrial policy allowing the EU to remain an industrial power*". In response to this, the Commission presented a Communication on "A New Industrial Strategy for Europe" in March 2020[7], and an update in light of the Covid-19 pandemic in May 2021[8]. In her 2021 State of the European Union Speech, Commission President Ursula von der Leyen underlined "*the importance of investing in our European tech sovereignty*", while inviting "*to double down to shape our digital transformation according to our own rules and values*"[9].

Against this background, this paper sets out the objective of reviewing the most relevant industrial policy interventions of the past, which have been taking place in EU Member States, as well as at EU

[1] The one European company is ASML, the Dutch chipmaker. Data available at: https://companiesmarketcap.com/tech/largest-tech-companies-by-market-cap/

[2] EPSC (2019).

[3] Source: CB Insights, The Global Unicorn Club (Data as of July 2019)

[4] See Horobin, W. (2019), "France Seeks Overhaul of EU Merger Rules to Fend Off China, U.S.", *Bloomberg*, June 3.

[5] See "A Franco-German Manifesto for a European industrial policy fit for the 21st Century".

[6] Building on previous work by Aghion et al (2005), Diez et al (2018) find evidence of a non-monotonic relation, with higher mark-ups being correlated initially with increasing and then with decreasing investment and innovation rates. For a recent review of the topic, see Griffith and Van Reenen (2021).

[7] COM(2020) 102 final.

[8] COM(2021) 350 final.

[9] For more information, see https://ec.europa.eu/info/sites/default/files/soteu_2021_address_en_0.pdf.

level, the United States and China. It will also look at the intersection of venture capital, sovereign wealth funds, and industrial policy, through a case study on Japan and the UAE. Armed with these insights, it will then sift out a set of guiding principles to maximise the chances of crafting an effective more activist industrial policy, fit for the challenges of the 21st century.

2. INDUSTRIAL POLICY IN THE TWENTY-FIRST CENTURY

Europe has no lack of innovative digital business ideas, but only few companies scale up and expand in Europe or shape the global markets, as the Commission noted in 2019 in a strategic communication[10]. Other major commercial players, who often benefit from state support, lower regulatory standards, or lower tax rates, present a risk to Europe's influence on technological developments and challenge European values and interests in the data economy and privacy. Europe should strive for open strategic autonomy, and therefore technological sovereignty, by reducing its dependence on third countries for some key technologies, notably from the security point of view. The point could further be made that in an increasingly geopolitically fragmented world with ever more assertive players, the EU can succeed in safeguarding the multilateral order, its position as a trade superpower, or its own social economy model, only if it possesses a degree of strategic autonomy that would not require it taking sides in a G-2 (U.S. and China) economic confrontation.

The question arises whether the EU's longstanding approach of providing the right regulatory framework and maintaining the current stringent competition rules is a sufficient strategy for the 21st century. From a global perspective, whilst the EU is investing substantially in research and development programmes as part of the Horizon innovation strategy, for a long time this has been done largely in a sector/technology neutral manner. While this might make sense if the goal is just to foster an innovative environment, it has resulted in Europe lagging behind in some key strategic sectors (e.g. electric batteries), as highlighted among others by the European Political Strategy Centre.[11]

More broadly, the green transition will require a drastic and rapid transformation of the economy, with a timeline imposed by the need to avoid catastrophic climate scenarios.[12] Within this context, a wide-reaching set of policies will be needed to support the transition, as exemplified by the breadth of the European Green Deal (EGD) agenda. A more active green industrial policy to serve the goals of the EGD is therefore warranted[13], and can be part of Europe's new green growth strategy.[14] Finally, within a context of growing geopolitical tension, the European Commission is aiming to achieve open strategic autonomy, diversifying its suppliers and therefore limiting excessive dependencies on single trade partners for sectors (or raw materials) considered strategic. To this end, an active industrial policy can be part of the toolkit.[15]

[10] European Commission (2019).

[11] EPSC (2019).

[12] Terzi (2022).

[13] See Tagliapietra and Veugelers (2020) for an in-depth review of the topic.

[14] Terzi (2020).

[15] SWD(2021) 352 final.

The economic case for an active industrial policy in the green and, more broadly, advanced technologies sector is strong. First, as carbon abatement is a global public good, and carbon is mispriced, the development of new green technologies generates positive social returns that are larger than the private returns captured by the original investors, leading to underinvestment.[16] Second, it has been shown that technological improvements tend to be path dependant, meaning that only an industrial policy push can jolt innovation in the green sphere, fast-tracking the demise of polluting production techniques.[17] In this sense, carbon pricing and green industrial policy have been shown to be complements, rather than substitutes. More broadly, under certain conditions, a first-mover advantage in certain key strategic technologies can tilt the future path of technological development in a direction that is closer to a country's initial comparative advantage.[18] In other words, failing to develop expertise in key technologies today could severely affect Europe's long-term economic prosperity and sovereignty. This is particularly true if, as should be, the green transition is treated as a new "industrial revolution", which seems appropriate given it will spark the adoption of clean general purpose technologies, with further innovation ripple down effects throughout production and consumption.[19] And indeed, it has been shown that governments have always taken a proactive role in the economy at the dawn of industrial revolutions, to ensure their national competitive edge.[20]

Europe is faced with the double challenge of ensuring that European home-grown and globally competitive companies will develop in key sectors, while at the same time retaining the dynamic nature of the Single Market. In order to achieve this goal, the EU could make use of a more active industrial policy, often by re-orienting or making greater use of tools that already exist. As a general principle, safeguarding or artificially boosting revenues for incumbents in traditional sectors, just because of the national location of their headquarters, is unlikely to prove particularly helpful. Such practices risk misallocating factors of production, reducing productivity, and fostering inefficient business practices fostering the creation of companies that are deemed too-big-to-fail, and do little to boost innovative practices. Instead, a successful industrial policy should induce entry and encourage young enterprises to grow, which in turn can lead to increased competitiveness and productivity growth.[21]

3. INDUSTRIAL POLICY AROUND THE WORLD

Industrial policy is a terminology that is often interpreted differently depending on the audience. The fact that it cuts through a variety of economic policy tools, ranging from innovation to trade and FDI, makes the matter even more complex (see Box 1). As such, it lends itself to easy misinterpretation.[22] At its core, it refers to "any type of selective intervention or government policy that attempts to alter the structure of production toward sectors that are expected to offer better prospects for economic

[16] Nordhaus (2019).

[17] Aghion et al (2016).

[18] Rodrik (2014).

[19] Aghion et al (2021).

[20] Beckert (2015).

[21] Aghion et al (2015).

[22] A frequent misunderstanding is that industrial policy does not refer only to supporting industry i.e. manufacturing, but rather it can refer to any sector, including favouring a shift to services, for example.

growth than would occur in the absence of such intervention".[23] This might include sectors/technologies where leadership might have geopolitical, security, and military implications.

As the academic literature highlights, nearly all countries engage in forms of industrial policy: including USA, China, Japan, Taiwan, and South Korea[24], just to name a few.[25] In this section, the industrial policies of the EU's main economic partners and competitors are presented. This is not meant necessarily to encourage direct emulation, especially given each country is likely to have its own peculiarities, but simply to map practices around the world, laying the ground for a comparison to the industrial policies taking place in Europe, which are then presented in the following section. It also serves to show just how vast the toolkit can be when aiming to achieve industrial policy objectives.

Box 1. **WHAT IS INDUSTRIAL POLICY?**

Industrial policy is a terminology that is often interpreted differently depending on the audience. The fact that it cuts through a variety of economic policy tools, ranging from trade to FDI and innovation, makes the matter even more complex. As such, it lends itself to easy misinterpretation. At its core, the concept builds however on two fundamental elements: (i) production in some sectors is more desirable than in others, and because of this, (ii) government should make an active effort in nudging the production structure in that direction.

Regarding the first concept, there are several reasons to believe this is the case. For starters, the academic literature has shown that "what you export matters". Hausmann, Hwang, and Rodrik (2007) show that some traded goods are associated with higher productivity levels than others and that countries that latch on to higher productivity goods will perform better in terms of economic growth over the medium and long term. Analytically, we know some sectors are more likely to disappear in the future, especially if they entail a high degree of repetitive tasks, while others are projected to become fundamental going forward (see for example World Economic Forum, 2018). Finally, leadership in certain sectors might have geopolitical, security, and military implications, as for example within the context of AI, 5G, Internet of Things, microchips, quantum computing, or the space industry. The same holds true for some critical raw materials, on which some of these technologies are based. Depending on a limited set of producers, or countries, for the supply of these materials exposes a country to the risk of such trade flow being used as leverage within the context of tense geopolitical relations. For instance, as ascertained by the WTO's Dispute Settlement Body, in 2010 China suspended its exports of rare earth minerals to Japan, within the context of a diplomatic standoff over some disputed islands.

There are reasons to believe that simply fostering an innovative ecosystem, investing in infrastructure, human capital and skills, will not necessarily ensure growth of these key strategic sectors. Reasons for this could include the fact that other systemic competitors are distorting the playing field to their advantage, for example supporting their domestic state-owned enterprises in their foreign operations, as in the case of China (EPSC, 2019). Moreover, for what concerns the digital economy, there seem to

[23] Pack and Saggi (2006).

[24] While not specifically covered in this document, recent papers have been looking specifically at South Korea's experience with industrial policy, suggesting the latter has substantially contributed to the country's growth acceleration and its achievement of high-income status (Kim et al, 2021; Choi and Levchenko, 2021; Irwin, 2021).

[25] Cimoli et al (2009).

be important 'winner-take-most' and network effects, setting technological standards that eventually spread globally[26], or subsequently limiting the ability of new competitors to emerge (Diez and Duval, 2019). In other words, industrial policy can, under certain conditions, have both strong economic and (geo-)political motives.

3.1 INDUSTRIAL POLICY IN THE UNITED STATES

In spite of the conventional wisdom that the U.S. "doesn't do industrial policy"[27], the country has a long bipartisan tradition of using various elements thereof, dating back to its very origins. This is perhaps best illustrated by Founding Father Alexander Hamilton's call for supporting manufacturing (through so-called infant industry protection)[28]. Elements of industrial policy were part of President Franklin Delano Roosevelt's New Deal, or the variety of tools put in place to contrast growing Japanese technological leadership in the 1980s. In recent years, American industrial policy has relied on various instruments that are being applied both at federal as well as sub-national (state or county) levels. These encompass federal grants, state and local subsidies, awarding government contracts to American national champions[29] (including IBM, Boeing, Caterpillar, Lockheed and Motorola), financing via the Export Import Bank, in particular in industries such as aerospace, energy and manufacturing, and helping U.S. companies win foreign procurement contracts.[30]

At the heart of the U.S. industrial policy are several national agencies, which provide funding for breakthrough innovation at an early-stage and play a crucial role in building networks of companies, scientists, engineers, venture capitalists and universities, which in turn enable the commercialisation of research. The most prominent example is the Defence Advanced Research Projects Agency (DARPA, see Annex I), born in response to the U.S. shock in the face of the Soviet launch of the first artificial satellite Sputnik. Major inventions, such as the Internet and the Global Positioning System (GPS), as well as the emergence of Silicon Valley, have all directly or indirectly been attributed to DARPA. The key to its success lies in its highly autonomous, mission-driven projects overseen by only a handful of managers who do not shy away from approving high-risk projects and tolerate failure[31].

Modelled after DARPA, the Advanced Research Projects Agency-Energy (ARPA-E) was established within the Department of Energy in 2007, in order to address the need for clean and affordable energy solutions. ARPA-E funds high-potential, high-impact energy technologies that are at a too early stage for private-sector investment. The agency's yearly budget has oscillated between USD 180 million and 400 million. Generally, projects are funded for a period of one to three years and receive awards

[26] Bradford (2020).

[27] See Wade (2017), who facetiously concludes: "*the most effective US industrial policy is make the rest of the world believe that the US does not do industrial policy*".

[28] Juhasz (2018).

[29] In this respect, see the recent application of the Buy American Rule issued by the Biden-Harris administration.

[30] Stensrud (2016).

[31] Mazzucato (2013).

between USD 500,000 and 10 million.[32] Along a similar approach, the Biomedical Advanced Research and Development Authority (BARDA) was founded in 2006, funding research in medical countermeasures against bioterrorism or emerging disease. This agency has received particular attention since the Covid-19 pandemic hit, taken as a positive example of targeted innovation[33].

The Advanced Technology Program (ATP) was created within the Department of Commerce as the civilian counterpart to DARPA in 1988. The goal was to stimulate early-stage investments in companies, which faced difficulties in attracting short-term funding in the private market, as well as building ties with academia and industry. Among others, small disc drives later laying the ground for consumer electronics such as the iPod, flat panel displays and biodegradable plastic are examples of achievements originating from ATP's funding. Nonetheless, the programme was eventually shut down by the Bush administration in 2007, after it became subject to public debate and was deemed as market-distorting.[34]

Apart from single departments' own research and development programmes, the federal government has set up cross-agency programmes to support small enterprises. The best-established initiative is the Small Business Innovation Research Program (SBIR) of 1982, which grants awards of USD 50,000 to 750,000 to for-profit companies with less than 500 employees. Together with the Small Business Technology Transfer (STTR) programme, SBIR fosters the objective of facilitating the transfer of technology developed by a Federal research institution through the entrepreneurship of a small business concern. All federal agencies with extramural R&D budgets of over USD 100 million are required to allocate a part thereof to SBIR. In 2017, eleven agencies distributed 3.2% of their research budget to SBIR, adding up to a total of over USD 2 billion.[35]

Many federal agencies have further established their own public venture capital (VC) funds following the example of Silicon Valley. Equity investments predominantly in new technology SMEs allow them to shape commercially viable technologies for their own use. The Central Intelligence Agency (CIA) was the first to establish its VC arm 'In-Q-Tel' in 1999 with the aim of overcoming the government's slow procurement practices. By procuring from large corporations, which obtained their technology from SMEs, the orders were delayed and the CIA received already outdated technologies at the time of delivery. With its own VC fund, the agency was able to invest in promising SMEs, directly receiving products tailored to its needs quicker. Other government bodies followed the CIA's example and established own VC funds over the 2000s, namely the Department of Energy, the Army, the Navy and NASA, which worked with a private non-profit fund.[36]

In terms of defensive instruments, U.S. legislation foresees blocking foreign investment, mergers and takeovers on 'national security' grounds. The President was granted far-reaching authority in that respect in the late 1980s, after growing concern of Japanese takeovers in the semiconductor industry. The entity responsible for screening foreign investment is the Committee on Foreign Investments in the United States (CFIUS), a multi-agency government body headed by the Department of Treasury.

[32] For more information, see https://arpa-e.energy.gov/?q=arpa-e-site-page/about.

[33] Aghion et al (2020), "How to strengthen European industries' leadership in vaccine research and innovation", VoxEU, 1 September.

[34] Wade (2008).

[35] SBIR Policy Directive (2019).

[36] Wade (2014).

U.S. presidents blocked transactions based on CFIUS recommendations in only six instances. The last time was in March 2020, when, at the recommendation of the Committee, a presidential order unwound the StayNTouch, Inc.-Beijing Shiji Information Technology Co., Ltd. deal.[37] Beyond this specific episode, CFIUS has received widespread attention in response to increased Chinese investments in U.S. companies. In 2018, the Trump administration significantly overhauled the agency's statute, enlarging its mandate and widening the type of transactions subject to the CFIUS investment review process.[38]

Moreover, there is evidence that the U.S. has been making use of tariffs as an industrial policy tool. For instance, the first round of tariffs (worth USD 50 billion) decided by the Trump administration against China in 2018 were targeted at China's high-end exports with a view to contain the country's technological advance, with 7 percent of the tariffs on very high-technology products and 55 percent on high-technology products. Crucially, some of the products included in the US tariff list had not yet been exported by China to the US, including aircraft, aerospace, arms and ammunition. This indicates that the US's likely intention behind the tariffs was not reduction of trade deficit, but containment of China's upgrade on the technology ladder.[39] The Biden administration has so far not reversed these measures.

After reviewing 18 different industrial policies in the United States between 1970 and 2020, Hufbauer and Jung (2021) conclude that they have been most successful when focussing on fostering innovation, such as in the DARPA programme, and surely not when betting all chips on a single firm. At the same time, we note that while it might be true that specific technological breakthroughs were pioneered also thanks to an activist government policy, such as the Internet or GPS, or the very creation of the Silicon Valley, these technologies spread thanks to private sector ingenuity operating in a dynamic ecosystem with deep capital markets[40]. In other words, the American experience with industrial policy shows the importance of early stage funding, but also the fact that these interventions should be targeted to innovation, and in any case not directed at propping up incumbents or artificially creating behemoths[41]. They also show the importance of safeguarding in parallel the efficiency of the overall market environment.

To sum up, the U.S. actively engages in industrial policy through several initiatives and agencies, including important projects in the defence sector. Similarly to Europe, competition from Chinese companies enjoying extensive state support has spurred public discussions regarding the potential for an even more active industrial policy in the U.S. in the future, echoing the challenge of competition from Japan in the 1970s and 1980s. An example of that was the report "Made in China 2025 and the Future of American Industry" published by Senator Marco Rubio, which called for opening a debate

[37] See Burnett, G. M. (2020), "CFIUS Reforms Came Just in Time for Pandemic, Downturn", *Bloomberg Law 2020*, May 18.

[38] See Rubenfeld, S. (2018), "The Morning Risk Report: CFIUS Reform Becomes Law", *The Wall Street Journal*, August 15.

[39] Garcia-Herrero (2019).

[40] Terzi (2022).

[41] Hufbauer and Jung (2021, 105) conclude: "Our study did not find single-firm triumphs that compare with the Manhattan Project. Perhaps they exist, but when government confines its support to a single firm to advance frontier technology, it forecloses alternative solutions that might be advocated by different scientists or business leaders. […] The highly successful model of Operation Warp Speed vividly demonstrated that competition is an American strength."

on developing new instruments of industrial policy in the face of "*China's blatant industrial espionage and coercion*". Despite the change in the U.S. administration, managing the economic relation with China has remained a pressing point on the agenda, and an active use of industrial policy to protect and project American interest globally retains a bipartisan support[42].

3.2 CHINA'S INDUSTRIAL STRATEGY

Following a socialist market economy model, or "state capitalism"[43], China clearly engages extensively in industrial policy. As in many other socialist countries, the government has been involved in economic planning by setting clear development targets through its Five-Year-Plans. Since the market reforms of Deng Xiaoping in the 1980s, the Chinese Communist Party has pursued a mixed economic model that combines socialist planning with elements of private enterprise. Economic planning has remained a cornerstone of Chinese economic policy up until this day, and is meant to support Beijing's ultimate goal of reducing China's dependence on foreign technology and becoming a leading advanced manufacturing power by 2049.

Following this approach, the government published the Medium- and Long-Term Plan on the Development of Science & Technology[44] in 2006. The 15-year plan focused on developing "indigenous innovation" in advanced technologies through investment from state and industry sources. Accumulation of intellectual property, setting of distinct technical standards, and leveraging access to the Chinese market in exchange for foreign technologies were other methods to achieve this goal. The strategy culminated in the selection of seven "strategic emerging industries" in 2010, which were perceived as vital for further economic development.

Figure 1: **Ten priority sectors of Made in China 2025**

Source: Institute for Security and Development Studies (2018).

The current Chinese industrial strategy, Made in China 2025, can be read as the successor of the aforementioned policy. Initially inspired by Germany's "Industrie 4.0" initiative, this ten-year plan

[42] See Gayer, T. (2020), "Should government directly support certain industries?", Brookings Institution, March 4.

[43] Milanovic (2019).

[44] For more information, see https://www.itu.int/en/ITU-D/Cybersecurity/Documents/National_Strategies_Repository/China_2006.pdf.

launched in 2015 aims at modernising the country's industrial capacity and moving it up the value chain. Different to the Medium- and Long-Term Plan of 2006, the strategy focusses not only on innovation, but rather on the entire manufacturing process. Furthermore, it promotes the development of services and traditional industries, whereas the previous strategy emphasised advanced manufacturing only.[45]

The focus of Made in China 2025 lies on the domestic manufacturing process of ten priority sectors (see Figure 1). One of these sectors is power equipment, where large subsidies for lithium-ion battery producers have led to the emergence of the world's largest electric vehicle battery industry (see Annex II). The strategy set the overall goal of raising domestic content of core components and materials to 40% by 2020 and 70% by 2025. In more detail, the strategy measures twelve key performance indicators along four broad categories (innovation capability, quality & value, IT & industry integration, green industry). An increase in R&D as a percentage of sales from 0.95% in 2015 to 1.68% by 2025 is an example of such an indicator.[46]

Different tools are in use to achieve the goals set in the strategy. Three cornerstones of the strategy are notable:[47]

Direct subsidies. The Chinese government supports the initiative financially through direct state funding, tax cuts, low-interest rate loans and other subsidies, especially for SMEs. Several agencies and funds also offer direct financial support[48]. The Advanced Manufacturing Fund offers USD 3 billion to upgrade technology in key industries, while the National Integrated Circuit Fund has access to USD 21 billion. The total amount of the initiative remains unclear, but commentators have estimated that China has already spent around USD 300 billion since 2015.

State-backed enterprises. The Chinese government seeks greater influence over the private sector by routinely embedding party representatives in private companies. Furthermore, state-owned enterprises still play an important role in the Chinese economy, accounting for a third of GDP and two thirds of outbound investments. These private state-linked and public state-owned enterprises profit from large subsidies and access to cheaper loans, allowing them to underbid their international competitors.

Technology transfers. Foreign companies must enter into joint ventures (JV) when doing business in China, requiring them to share technological know-how and sensitive intellectual property.[49] Moreover, both state-owned and private companies have invested substantially in overseas firms in order to acquire advanced technology. As a result, once a foreign firm is acquired, the supply chain routinely moves to China at the expense of the original suppliers.

[45] See Kennedy, S. (2015), "Made in China 2025", Centre for Strategic and International Studies, June 1.

[46] Institute for Security and Development Policy (2018).

[47] See McBride, J. and Chatzky, A. (2019), "Is 'Made in China 2025' a Threat to Global Trade?", Council of Foreign Relations backgrounder, May 13.

[48] Garcia-Herrero and Ng (2021).

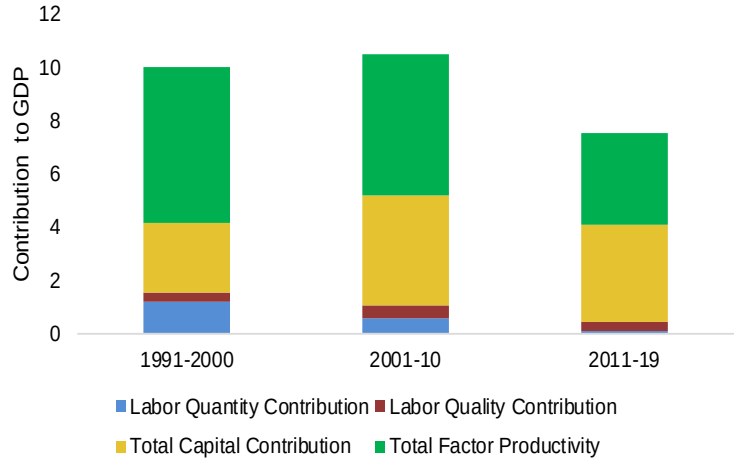
[49] As discussed later in the paper, the recent EU-China Comprehensive Agreement on Investment foresees a relaxation of strict local content rules for joint ventures, designed to facilitate EU investment in China with less obligation of technological transfer.

The aforementioned practices are a major reason why China is frequently accused of protecting its domestic industry by restricting foreign competition. Complaints target the vast subsidies for Chinese companies, which international competitors see as an unfair advantage. Furthermore, manufacturers complain that it is hard to produce abroad and sell to China, while producing in China directly also encounters difficulties, since foreign equity restrictions are in place. As stated above, in many sectors market access for foreign firms is only possible through joint ventures with Chinese firms at the cost of technology transfers and intellectual property loss. This was the case in the high-speed rail sector, where international competitors formed JVs with Chinese counterparts and were forced to shift the production of key parts to China.

China has maintained a rather tough and opaque investment screening system. On 15 March 2019, China's National People's Congress passed a new foreign investment law, designed to ease restrictions on foreign firms' operations in the country and explicitly address some major U.S. concerns during trade talks with President Trump. The new law states that China will "*establish a foreign investment security screening system*" although China already has laws and regulations to conduct *ad hoc* investment screening based on security, as well as restrictions on investments on a sectoral basis, the so-called negative list, covering 151 areas.[50]

While the Chinese activist intervention in the economy is often framed in positive terms, also in light of the astounding growth acceleration the country has experienced over the last three decades, this should not be seen as a panacea. Indeed, some evidence suggests that this economic model is already showing some limits, not least in the fact that it rests heavily on SOEs, which however display high inefficiencies and comparatively low productivity[51]. As a result, the country's overall total factor productivity is shrinking, contributing to a long-term growth decline (Figure 2). While China has managed to reach the technological frontier in several fields, thanks to its industrial policy practices, and also large investments in R&D, whether a highly planned economy and a non-democratic illiberal political system guarantee fertile ground for sustained innovation in the long run remains to be seen.

Figure 2. **Contribution to Chinese GDP growth (1991-2019)**



Source: Total Economy Database.

[50] Garcia-Herrero and Xu (2017).

[51] Lardy (2019).

3.3 JAPAN: FROM INDUSTRIAL POLICY TO VENTURE CAPITAL

Following World War II destruction, Japan's economy got swiftly back on its feet, close to becoming the largest in the world in less than three decades, thanks to a very active industrial policy. The "economic miracle" that occurred (not dissimilar to West Germany's) was partly a result of Japanese government intervention and partly due to U.S. support. The Japanese Ministry of International Trade and Industry (MITI) played a key role in this, by promoting rapid industrialisation with the help of the Japanese Investment Bank that it established. The Bank of Japan was another key actor which "over-lent" to city banks and then onto conglomerates (*Keiretsu*) which were focused on strategic industries[52]. This coupled with complex cross-shareholdings by the banks and conglomerates made it difficult for foreign firms to penetrate the market and provided protection for fledgling industries to grow and prosper which they did in spectacular fashion, for a period. Since then, both the role of MITI and Bank of Japan are far less pronounced, but investment screening mechanisms that go beyond security and include a range of identified strategic sectors have remained in place and were further strengthened in 2017. Nonetheless, many have suggested that this "Japanese business model" reached its limits in the 1990s and contributed to the so-called "lost decade" that has characterised the country, slowing down the required economic adjustment process.[53]

The institution that is now grabbing headlines is Japan's SoftBank Group, which is a technology conglomerate founded by Masayoshi Son in 1981 as a computer parts store. It is now one of the top 50 companies in the world and has set up in 2017 the Vision Fund: the world's largest technology fund. In establishing the USD 100 billion fund, Softbank did not actually receive support from the Japanese government but instead from Saudi Arabia who have pledged a USD 45 billion investment via its sovereign wealth fund (Public investment Fund PIF) and also Mubadala, a UAE sovereign wealth fund. In just over a year, the Vision Fund has invested more than USD 20 billion in 60 selected companies (typically USD 100 million – USD 1 billion in each). It is picking winners and allegedly prodding its companies to work together, in a sort of cross-national keiretsu.[54] In the past four years, SoftBank has poured around USD 84 billion into start-ups. In February 2019, it was announced that the Vision Fund and Mubadala have invested USD 400 million in a new fund focused on investing in European technology start-ups.

The scale and pace of investment by the Vision Fund, which aims to be a 'virtual Silicon Valley' has raised national security concerns in the United States. In April 2019, it was announced that following talks with the U.S. Committee on Foreign Investment in the United States (CIFIUS – see above), SoftBank agreed a number of concessions in order to get clearance for its investments in the United States. These concessions include giving up board seats and access to sensitive information as well as taking a more passive role in the companies targeted. For example, while Softbank is the largest shareholder in Uber and would normally have two seats on the board, this is still under discussion with the U.S. authorities. By way of comparison, there is no comparable dialogue between SoftBank and the EU despite SoftBank's similar investment objectives in the region.

Whilst the governance arrangements of SoftBank and Vision Fund are coming under increasing scrutiny, Vision Fund II was launched in 2019, funded solely by SoftBank (EUR 30 billion) due to

[52] Landes (1998).

[53] See Abe, N. (2010), "Japan's Shrinking Economy", Brookings Institution, February 12.

[54] See The Economist (2021), "Hard truths about SoftBank", June 19.

scarce external investor demand. The sheer speed and volume of investment dwarfs venture capital operations in Silicon Valley. There is nothing comparable in Europe despite European firms being targeted in many cases. Perhaps the largest VC company in Europe is HV Holtzbrinck Ventures based in Munich, which since 2000, had developed a portfolio of EUR 1 billion in total. Whether this approach will pay off remains to be seen. Whilst there are some listed investments, many investments are in unlisted firms making valuations difficult.

As this section details, the EU's main trading partners and competitors all engage in various types of industrial policy. The U.S. actively supports the uptake of new technologies by providing vast early stage funding opportunities through several of its federal agencies, most notably DARPA. More aggressively, China's industrial strategy focuses on SOEs, direct subsidies and technology transfers with the ultimate aim of reducing the country's dependence on foreign suppliers and becoming a leading advanced manufacturing power by 2049. Other countries, such as Saudi Arabia and UAE use their Sovereign Wealth Funds instead to actively steer innovation in a certain direction. On the defensive side, all actors have some investment screening procedures in place to protect their key industries from foreign takeover. At the same time, all the industrial policies discussed above have some drawbacks. As such, the preliminary conclusion could be that industrial policy can be a useful tool to foster innovation and long-term prosperity, but equally it is no panacea, requiring careful design.

4. THE EUROPEAN INDUSTRIAL POLICY LANDSCAPE

Industrial policy in Europe is carried out largely at national level, with policies often targeted to supporting Small and Medium Enterprises in their activities[55]. In the recent past, Germany published its National Industrial Strategy 2030, sparking discussions among a wider European public. Moreover, France has had a long tradition of *dirigiste* policies in which state intervention directed the economy through five-year development plans and the nationalisation of entire sectors, particularly in the aftermath of World War II, but also during François Mitterrand's presidency[56]. Evidently, the Covid-19 crisis has led to a very strong involvement of governments in the economy, in an effort to stem a wave of insolvencies and therefore reduce the long-term impact of the pandemic on the economy. This in turn has led to a resurgence in the debate regarding how these large stakes could be used to orient production towards certain political goals, especially given it has in practice contributed to support incumbent firms and risks entrenching the status quo.

In some instances, EU governments have joined forces and set up joint industrial policy initiatives. The most successful example is the creation of Airbus in the 1960s (see Annex IV). The development of the first supersonic passenger aircraft Concorde is another similar example of intergovernmental industrial policy in Europe (see Annex V). More recently, the French and German governments have established a Joint European Disruptive Initiative (JEDI) in an attempt to create a European counterpart to the U.S. DARPA.

[55] See for instance the case of the German export credit guarantee, also known as "Hermes scheme", designed to protect companies, and in particular SMEs, from the risk of non-payment by foreign debtors. Effectively, the scheme promotes exports in order to create and protect jobs and revenues in Germany. In 2020, the Export Credit Guarantees recorded the second highest cover volume in its history with EUR 29.8 billion.

[56] Timoney (1984).

Through the years, the European Commission has been actively engaging in industrial policy through its legal mandate under art. 173 TFEU. The complex, but quite fragmented, policy developed over time in response to the changing market situation. The Commission Communication of September 2017 on a renewed EU Industrial Policy Strategy brings together the different elements thereof. The declared – and rather broadly defined - goal of the strategy is "*to make the EU the world leader in innovation, digitisation and decarbonisation*". This strategy aims at "*empowering industries to create jobs and growth, defending its regions and workers most affected by industrial change and reinforcing Europe's leadership role, competitiveness and technological cutting-edge*". The 2020 Communication, and its 2021 update in light of Covid-19, can be seen as walking in the footsteps of this broad objective.

The bedrock of European industrial policy has been the EU Single Market, seen as the main instrument to ensure competitiveness, sustained productivity, and long-term prosperity. A deep internal market remains the EU's best tool to promote an innovative ecosystem. As highlighted by many authors recently, a fragmented internal market in some dimensions (e.g. digital, services) is possibly the largest barrier to scaling up for EU businesses[57]. Completing it, including by achieving deep wide and liquid capital markets, must therefore remain a key policy priority, and any further active industrial policy must not undermine this goal. In turn, a large and open single market grants the EU the key advantage of setting technological and regulatory standards, which then have the potential to spread globally, to the benefit of European firms. Any reflection on a more active industrial policy, both on the offensive and defensive side, should take this element into account.

While completing the Single Market is the core EU industrial policy, a wide array of active industrial policy instruments complement this approach[58]. For starters, the EU leverages its budget to actively promote the development and pick-up of innovation. Horizon 2020, the EU's biggest ever research and innovation programme, was designed to help Europe produce world-class science and technology that drives economic growth. Within Horizon 2020, 32% of the overall financial envelope was allocated to promoting research excellence *per se*, 22% was assigned to 'industrial leadership', meaning to support key technologies, such as microelectronics and advanced manufacturing, across existing and emerging sectors; and 39% to 'societal challenges', hence fostering R&I that targets society and citizens (climate, environment, energy, transport, and so on). Moreover, a European Innovation Council (EIC) Pilot with a budget of over EUR 2.7 billion (2018-20) was set up to support projects focused on breakthrough and disruptive innovation. The funding available is supposed to support innovators and companies with high potential to scale-up and which experience difficulty raising sufficient private investment (see Box 2). With a budget allocation of EUR 95.5 billion[59], the new Horizon Europe, successor of the Horizon 2020 programme, retains many of the goals of the previous programme, and confirms the EIC[60]. On top of Horizon 2020/Europe, smaller scale initiatives include the European Institute of Innovation and Technology: an independent EU body that brings together companies, academia and research labs to reinforce Europe's innovation capacity. In another domain, but with a similar objective, the Commission and the European Investment Fund have

[57] See Enderlein et al (2019), Tagliapietra (2019), EPSC (2019).

[58] With no pretence of being complete, we review in what follows the main EU policies that have industrial policy implications.

[59] For more information, see https://ec.europa.eu/commission/presscorner/detail/en/IP_20_2345

[60] Horizon Europe also introduces so-called 'EU Missions', meaning concrete goals to be achieved through research and innovation, and with clear managers put in charge of each goal. These five missions cover: Adaptation to climate change, cancer, restoring oceans and water, climate neutral and smart cities, and soil.

launched a Pan-European Venture Capital Funds-of-Funds programme (VentureEU) to boost investment in innovative start-up and scale-up companies across Europe.

Box 2: **EUROPEAN INNOVATION COUNCIL (EIC)**

The European Innovation Council brings together the parts of Horizon 2020 that support high-risk/high-return, breakthrough research or market creating innovation. Its funding is open for researchers and companies with ideas in any field of innovation that: (i) are radically different from existing products, services or business models, (ii) are highly risky, and (iii) have the potential to scale up internationally. Its supportive instruments are structured among four schemes and combine grant and equity investments (see figure below).

The EIC has been in pilot phase with a budget of EUR 2.7 billion (2018-2020). Based on its success, the Commission proposed to increase the budget of a fully-fledged EIC, which has been launched with the Horizon Europe R&I programme in 2021, up to EUR 10 billion under the new budgetary cycle (2021-27).

Welcomed as a European equivalent to DARPA, a major difference to the U.S. agency exists. Apart from the missing defence sector focus, the EIC does not attempt to steer innovation into a certain direction. Among its four funding schemes, only the smallest instrument 'EIC prizes' follows the mission-driven approach that is widely believed to be a key to DARPA's success. Furthermore, EIC staff will most likely be much less involved in the direct steering of projects than DARPA officers.

Perhaps another key difference with DARPA, but no less critical, is attitude to risk and flexibility. As a U.S. Department of Defence instrument, DARPA is less subject to the public scrutiny and has special procurement rules. Indeed, DARPA notes that it "benefits greatly from special statutory hiring authorities and alternative contracting vehicles that allow the agency to take quick advantage of opportunities to advance its mission."[61]

Instrument →	SME-Instrument		FTI	FET-Open	EIC prizes
	Phase 1	Phase 2			
For whom	One or more European[1] SMEs		From 3 to 5 European[1] entities (mostly industrial[2])	At least 3 entities[3]	At least one entity (which must be European[1] for some of the prizes)
Maximum funding[4]	50,000 €	2.5 M€	3 M€	3 M€ (RIAs) 0.5 M€ (CSAs)	Varies for each prize
Total budget 2018-20	163 M€	1421 M€	300 M€	705 M€ (RIAs) 10 M€ (CSAs)	40 M€
Focus	Exploring the feasibility of a business idea (~ 6 months)	Breakthrough innovation & international growth (12-24 months)	Close-to-market innovation	Radically new technologies	6 different topics (major societal issues)

Source: European Commission.

[61] For more information, see https://www.darpa.mil/about-us/about-darpa.

EU programmes focussed on fostering investment or regional development also have a strong industrial policy component. Regions are called upon to develop smart specialisation strategies as a condition for receiving funding for innovative projects from the European Structural and Investment Funds. The European Fund for Strategic Investment, established under the so-called Juncker Plan in November 2014, triggered additional investment in digital infrastructure, energy, research, and so on.

The European Investment Bank has also provided equity investments, which are of particular importance for innovative companies in their infancy. Going forward, under InvestEU (EUR 26.2 billion), guarantees will be provided to attract investment in taking research results to the market, digitisation of industry, scaling up larger innovative companies, and so on[62]. Moreover, the recently established European Defence Fund (with a budget of EUR 8 billion under the current Multiannual Financial Framework) promotes cooperation among Member States in producing state-of-the-art and interoperable defence technology and equipment. In doing so, it strongly encourages participation of start-ups and SMEs in collaborative projects and fosters breakthrough innovation solutions.

More recently, the Commission has embraced an even more active industrial policy agenda. Within the context of the Renewed EU Industrial Policy Strategy (from September 2017), the European Commission has set up the Strategic Forum for Important Projects of Common European Interest (IPCEI). The latter is assigned to identify key value chains of strategic importance to Europe, paving the way for joint investments by public authorities and industries from several EU countries, thus seeking to make value chains more robust in a specific area or technology, as for example in microelectronics. Modifying its state aid rules, the Commission has set out criteria under which Member States can support transnational projects of strategic significance for the EU and for the achievement of Europe 2020 objectives. This initiative has already been used by France, Germany, Italy and the UK, when it was still a member of the EU, for a joint project for research and innovation in microelectronics in 2018. The 2020 Commission Communication on a new Industrial Policy doubles down on this instrument, seen as a crucial arrow in the EU's economic policy quiver. In this regard, the industrial strategy was framed around 14 different ecosystems, encompassing all players in a specific value chain, recognising the multifaceted dimensions of production. Along similar lines, the Commission initiated the European Battery Alliance in 2017, which brings together interested national authorities, the European Investment Bank, key industrial stakeholders and innovation actors.[63] The objective is to provide support for establishing a full supply chain in battery production in Europe and prevent a technological dependence on competitors in that respect. Moreover, France and Germany have filed a request for an IPCEI on car batteries (see Annex III), which was approved in early 2021. In light of Covid-19, and the consequent disruption in global value chains, the Commission started monitoring strategic dependencies, identifying 137 products in sensitive ecosystems (ranging from health to industries crucial for the green and digital transition) for which the EU is highly dependent on foreign sources[64]. Over half of these dependencies originate in China. Going forward, the Commission will take steps to facilitate a diversification of supply and demand, pursuing international partnerships to increase preparedness, while also encouraging some stockpiling.

[62] For more information, see https://europa.eu/investeu/about-investeu_en

[63] Other such industrial alliances exist for hydrogen, zero emission aviation, raw materials, processors and semiconductor technologies, and for Industrial Data, Edge and Cloud, and might be soon created for space launchers.

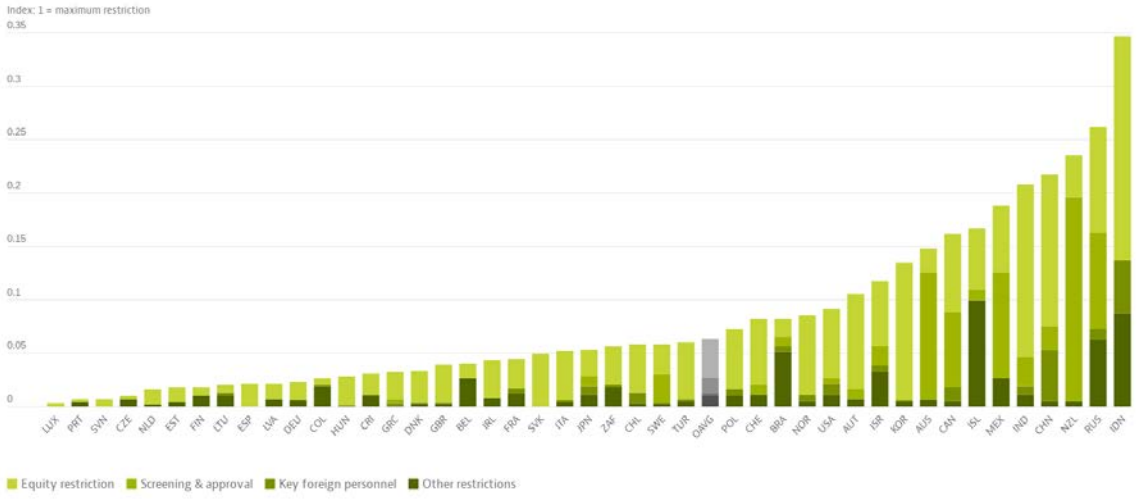
[64] SWD(2021) 352 final.

On the defensive side, the EU has made limited use of public procurement rules for industrial policy purposes. Over the years, the EU has opened up its public procurement markets to third countries to a large degree, which came with important advantages in terms of increased competition and reduced prices for the public sector. However, this was problematic insofar as many of these trading partners have not granted the EU a similar privilege and do not ensure reciprocity in terms of market access. The United States for instance has in place since 1933 a Buy American Act, which favours American companies in public procurement. These principles were underscored by an Executive Order passed by US President Joe Biden in January 2021.[65]

The Commission therefore has been calling for a swift adoption of its revised proposal for an International Procurement Instrument whose aim would be to improve the conditions under which EU businesses can compete for public contracts in third countries and to give the EU more leverage when negotiating its access to foreign public procurement markets. The recent EU-China Comprehensive Agreement on Investment (CAI) could be seen as a positive development in this respect, if ratified.

Moreover, in May 2021, the Commission has proposed a new regulation to address potential distortive effects of foreign subsidies in the Single Market.[66] Under the proposed Regulation, the Commission will have the power to investigate financial contributions granted by public authorities of a non-EU country, which benefit companies engaging in an economic activity in the EU, and redress their distortive effects, as relevant.

Figure 3: **Restrictions on FDI by international comparison**



Source: OECD Foreign Direct Investment Regulatory Restrictiveness Index, 2020.

Likewise, in comparison to other international actors, foreign investment screening is very limited across the EU (see Figure 3). To an extent, this open market principle is positive insofar as FDI carries innovation and technology, which can then spread locally, feeding European innovation. While investment policy remains a shared competence with EU Member States, to date only 12 out of 28 have any type of screening mechanism in place. The Commission published a Communication[67] in

[65] For more information, see https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/25/executive-order-on-ensuring-the-future-is-made-in-all-of-america-by-all-of-americas-workers/.

[66] COM(2021) 223 final.

[67] Towards a comprehensive European international investment Policy, COM (2010)343 final.

order to explore how the EU could develop its investment policy including investment screening. In March 2019, a new regulation[68] was passed on screening of FDI in the EU. However, this screening is limited to security and public order considerations with final decisions resting with EU Member States. It is therefore a process that facilitates information sharing between EU Member States and provides for the Commission to give its opinion on particular cases. Indeed, there is competition between EU Member States and their regions to attract FDI, and there are clear differences in approach to the concept of screening.

To sum up, a lot of effort is put at the EU level into supporting competitiveness of European industry by providing a level playing field, continuously adjusting the regulatory framework to the changing economic reality and fostering investment. The examples of inter-governmental industrial cooperation such as Airbus and Eurofighter, show that European governments, companies and research centres are able to join forces to successfully deliver desired results, on the condition that the objectives of such cooperation are clearly defined and that the project is endowed with a clear political mandate. The priority put on accelerating the green and digital transition by the von der Leyen Commission sets out a clear vision on the type of orientation needed going forward.

5. LEARNING FROM FAILURES

A standard line of criticism against active industrial policy is that it comes with certain risks. Something that is true of all policies. Nonetheless, let us consider various points of contention. For starters, given it is about propping up a certain sector or technology, industrial policy is at (high) risk of being captured by interest groups. Moreover, at a time of rapid technological breakthroughs, there is the risk of focussing resources on boosting leadership in areas/technologies that might quickly lose their strategic relevance. Lastly, there remains a risk of maintaining support even when it is no longer needed, or when it is clear that the policy has failed, as well as a risk of withdrawing support too early. This is particularly the case when political leaders are actively involved in the process, associating the success of the policy to the success of a specific firm, framed as a national champion.[69]

As discussed by Rodrik (2014), a good industrial policy does not rely on government's omniscience. Mistakes are an inevitable and necessary part of a well-designed industrial programme. The key is to have mechanisms in place that recognise the mistakes and rectify the policies accordingly. As highlighted by Commission President von der Leyen: "*As we increase investment in disruptive research and breakthrough innovation, we must accept that failure will be part of our path*".[70]

Indeed, there are examples of industrial policy that failed. Arguably, Germany's promotion of its photovoltaic sector represents such a case. In the wake of Germany's Renewable Energy Act (EEG) in the year 2000, the country's solar panel producers ascended to global leadership in less than a decade. The EEG gave precedence to renewable energy sources and foresaw feed-in tariffs that guaranteed

[68] Regulation EU 2019/452 establishing a framework for screening of FDI into the Union.

[69] An example of this could be US President Obama's visit to Solyndra in May 2010, a solar cell company in Fremont, California, praised as a "symbol of progress". The company went bankrupt in August 2011, leading political opponents to use this case in order to question the overall industrial policy approach.

[70] For more information, see https://ec.europa.eu/info/sites/default/files/political-guidelines-next-commission_en_0.pdf.

investors' returns for a 20-year period. This success was followed by a severe collapse of the German photovoltaic industry in 2012 due to pressures from Chinese competitors, leading to a loss of 80,000 jobs after major companies such as SolarWorld filed for bankruptcy. Some commentators lamented that the support policy effectively meant that German power customers subsidised Chinese producers who like their German counterparts profited from the German de-facto subsidies. Others found the German industry to be uncompetitive vis-à-vis China due to higher labour costs and stricter environmental regulation. Nevertheless, the European Commission found unfair competition practices and imposed anti-dumping tariffs on Chinese imports as a response in 2013.[71] This highlights the need to design offensive and defensive elements of industrial policy in tandem. Failure to do so will either risk subsidising production abroad, as the German solar panel case study shows, or alternatively risk hampering the growth prospects of domestic strategic sectors by reducing their access to foreign finance without putting in place alternative public financing programmes.

Another prominent example of a failed industrial policy is the case of Italy with its national airline company: Alitalia. The latter has been losing competitiveness over the years, as evidenced by a market share in long-term decline. Every time the company approached bankruptcy, different Italian governments took direct or indirect measures to ensure its continued financial viability. This was a prominent case of decision-makers picking a specific company, rather than a sector, and surely not one that is characterised by high innovation, and defending it as a "national champion". Over almost 50 years, the public cost for the Italian State related to the management of Alitalia amounted to around EUR 11 billion.[72] At times, acting in violation of European State aid rules.[73] And the end result has been that in 2021 the company finally went bankrupt, yielding way to a new national airline: ITA. Beyond the specific Italian case, it is these types of misguided government interventions in the economy in the 1960s and 1970s across Europe that earned industrial policy its bad reputation, suggesting it had limited positive impacts on innovation and the aggregate economy, generating however large financial liabilities for governments.[74]

6. GUIDING PRINCIPLES FOR A SUCCESFUL INDUSTRIAL POLICY

Drawing from the case studies we have identified, both successes and failures, and crosschecking our findings with the relevant recent literature[75], we can conclude that six basic design characteristics should be kept in mind when designing a successful industrial policy in order to maximise its impact and minimise its risks. These include:

[71] See Wehrmann, B. (2020), "Solar power in Germany – output, business & perspectives", *Clean Energy Wire*, April 16.

[72] See Mediobanca (2015), "Stima dei costi diretti, pubblici e collettivi, originati dalla gestione Alitalia (1974-2014)" and authors' calculations.

[73] For more information, see https://ec.europa.eu/commission/presscorner/detail/en/ip_21_4664

[74] From the 1980s onwards, such belief in the limited power of industrial policy (and government more broadly) was exported abroad to developing countries, which after two decades of large public investments were instead pushed towards market-based liberalisations as part of the so-called 'Washington Consensus' (Boccaletti, 2021, 262).

[75] See for instance Cherif and Hasanov (2019).

I. **Future-oriented.** Focus must be on the future, not the present (or the past). This means one cannot identify strategic sectors by simply looking at current competitive advantage.[76] Industrial policy must be future, and hence innovation, oriented. Its aim is to kick-start sectors where market failures are preventing a desirable equilibrium, not lean against the wind of global structural change. Of course, this recommendation comes with no prejudice to an approach that simultaneously improves the management of critical dependencies on foreign trade partners and promotes strategic autonomy.

II. **Sector- and Technology-driven.** Focus on areas/technologies and not companies. One should refrain from designing a policy around specifically 'picking winners', i.e. single companies that are considered a strategic asset, as this is likely to lead to perverse incentives, decrease the innovativeness of the 'champion', and in the end go against the very objective of industrial policy i.e. fostering long-term competitiveness and sustained growth, on top of harming consumers.[77] On the other hand, the objective of an effective industrial policy must be built around sectors or technologies where advanced capabilities are desirable (e.g. semiconductors).

III. **Competition is a strength.** An effective industrial policy should not be about making incumbents bigger. Clearly, having companies that grow to become global leaders would be a sign of competitiveness in a specific sector. However, artificially fostering scale to increase the number of corporate behemoths in rakings is similar to treating the symptom rather than the root cause of an illness. In other words, an effective industrial policy should not weaken competition policy, and specifically M&A provisions.

IV. **Top-down, but also bottom-up.** By definition, an industrial policy is setting a direction of economic development top down. However, in any form it takes, it must not transform itself in economic planning. In other words, it should encourage experimentation and bottom-up innovation and creativity. This is why the policy goal must be defined in a balanced way that is tangible enough to make it concrete, but broad enough to allow for creativity in achieving it. It should therefore not undermine the entrepreneurial ecosystem. As such, it complements and perhaps even reinforces the crucial role of strict competition policy enforcement[78]. Within the EU context, completing the Single Market, including for capital markets, remains a priority. It is within this context of balancing top-down and bottom-up that European alliances and IPCEIs were set up.

V. **Accountable, non-partisan and adaptable.** Transparency is key to avoid or reduce the risk of capture by interest groups. Moreover, politicians should avoid the tendency of tying their political success (or failure) with the success of a specific domestic company. Failure to do so creates a strong incentive to continue providing funds, even when an objective assessment would suggest otherwise. The fact that industrial policy remain as much as possible an independent policy assessed against clear

[76] Zettelmeyer (2019).

[77] EPSC (2019).

[78] A point also made by Philippon, T. (2019), "Concurrence: le syndrome du PSG", LesEchos, April 24.

targets allows adaptability. This implies that policies, outcomes, and assumptions must be constantly monitored, questioned, and quickly adapted if need be.

VI. **Holistic approach.** Supply and demand considerations, together with offensive and defensive tools, must be designed consistently, shaped in tandem with a supportive regulatory environment. A successful industrial policy should not only foster the development of innovation in critical technology areas (e.g. through targeted R&D), but also use tools to ensure demand for those sectors picks up. In a way, the German case study on solar panels shows that the country did well to prod demand, but this was poorly matched by another plank of industrial policy, specifically the defensive side.[79] Likewise, as home-born capacity starts being developed in a critical technological area, investment-screening defensive measures can be envisaged to prevent so-called 'killer acquisitions' by current incumbents or forced technological transfers.

Industrial policy, even if successful in its objective, could possibly have some negative side effects that will need to be mitigated. For instance, it is not impossible to imagine that an industrial policy aimed at making the best even better (to compete on the global stage) will augment the wide existing gap between frontier and laggards.[80] This could also potentially aggravate regional heterogeneity of outcomes. As underlined by Iammarino et al (2019), the point here is not to squeeze a regional dimension into industrial policy tools, but rather beef up other tools aimed at alleviating regional inequality. Within the EU context, the role of the Just Transition Fund, for what concerns an acceleration on the green transition, and of cohesion policy more broadly, hence becomes all the more important.

7. CONCLUSION

Nearly all countries engage in forms of industrial policy, including the EU's main partners and competitors, such as the USA and China. On top of their own national industrial policies, EU Member States, acting in consortium, have pursued joint industrial policies over the past decades. This provides an ample variety of examples from which lessons can be learnt in order to maximise the impact, and minimise the risks, of a more active industrial policy. The latter is justified by the need to accelerate on the green and digital transition, together with achieving a greater degree of European open strategic autonomy in an increasingly tense geopolitical environment. While to some this more active use of industrial policy will seem like a Copernican change of paradigm, the examples we detail show that, as a matter of fact, at least some degree of industrial policy has always been used as part of governments' standard toolkit.

Also for the European Commission, actively engaging in industrial policy will not be new, as it has done so in the past through its legal mandate under art. 173 TFEU. Horizon 2020, EFSI, the European Structural and Investment Funds as well as the European Defence Fund can all be seen in some of

[79] Similar considerations apply within the context of the green transition, and provide a solid case for a Carbon Border Adjustment Mechanism, which allows European companies to make green investments, while facing high carbon prices at home, without being outcompeted by foreign polluting alternatives.

[80] Andrews et al (2016).

their parts as industrial policy. More recent examples include the European Innovation Council, the Important Projects of Common European Interest (IPCEI), or the Strategic Value Chains initiative. However, a comparative Eurobarometer survey on citizens' 'perceptions and expectations', conducted for the European Parliament shows a majority of Europeans (54%, up from 47% in 2016) would like the EU to intervene more in industrial policy.[81]

A reinforced industrial policy for the EU, focussed on the green and digital transition, and informed by the policy successes and failures of the past, is all but warranted. Nonetheless, it should be seen as only one prong of a broader economic policy effort to guarantee Europe's prosperity in the 21st century. A successful industrial policy should therefore aim at complementing, rather than substituting, ongoing efforts to complete the Single Market and strictly enforce competition policy, while avoiding excessive territorial divergences, all of which have been, and should remain, the bedrock of Europe's economic success. Given these multiple objectives, future research looking at the optimal level at which different industrial policy measures should take place (EU, national and regional) will carry particular importance.

[81] Eurobarometer 89.2 (2018).

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ANNEX I: US DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)

DARPA was founded in 1958, initially as ARPA, in response to the launch of the Soviet Sputnik satellite. Since then, DARPA's mission has been to make the U.S. "the initiator and not the victim of strategic technological surprises". It continues doing so today by making the link between academic work and the incremental innovation taking place within the military (Block, 2008).

Projects funded by DARPA contributed significantly not only to new military capabilities, such as precision weapons and stealth fighters, but also to modern civilian society. Landmark inventions such as the Internet, the global positioning system (GPS), automated voice recognition and language translation resulted from strategic early-stage funding by DARPA. Furthermore, the development of Silicon Valley has been attributed to the agency (Wade, 2014). By channelling vast amounts of federal funds to Stanford University, the University of California Berkley and the Lawrence Livermore National Laboratory, it encouraged the creation of private spin-off firms in the nearby valley.

Another success was the initiation of SEMATECH (Semiconductor Manufacturing Technology), a not-for-profit consortium established in response to the decline of the U.S. semiconductor industry in the late 1980s. The consortium, consisting of 14 semiconductor manufacturers and initially funded by DARPA with USD 100 million yearly, successfully helped U.S. firms to regain significant market share from Japanese competitors. By 1996 international competitiveness in the U.S. chip manufacturing industry was restored, and SEMATECH was able to fund its budget without government support (Block, 2008).

The agency has around 220 employees and an annual budget of USD 3 billion. It employs 100 program managers (PM) to oversee some 250 research and development programs in six specialised offices, including biotechnology, information innovation and microsystems technology. Managers must have a record of excellence in their field and are recruited on short-term, three to five year contracts from academia, industry and other government agencies. This approach of attracting the best talent and continuously refreshing it has been a cornerstone of DARPA's success.

Three other features characterise DARPA's functioning. First, the agency is highly autonomous, agile and speedy[82]. Only a handful of directors and their deputies supervise programme managers who can engage and disengage quickly from research projects. Moreover, the managers' short-term engagement serves as an incentive to boost technological development quickly. Second, the projects are strongly goal-oriented: technical offices define the technological capabilities they seek and curate a research agenda. Third, the agency takes on high-risk projects and tolerates failure as an accepted part of the mission of driving breakthrough scientific progress in a short period[83].

[82] See Valero, J. (2016), "Ex-DARPA chief: 'Innovation with no goals is not efficient'", Euractiv, April 29.

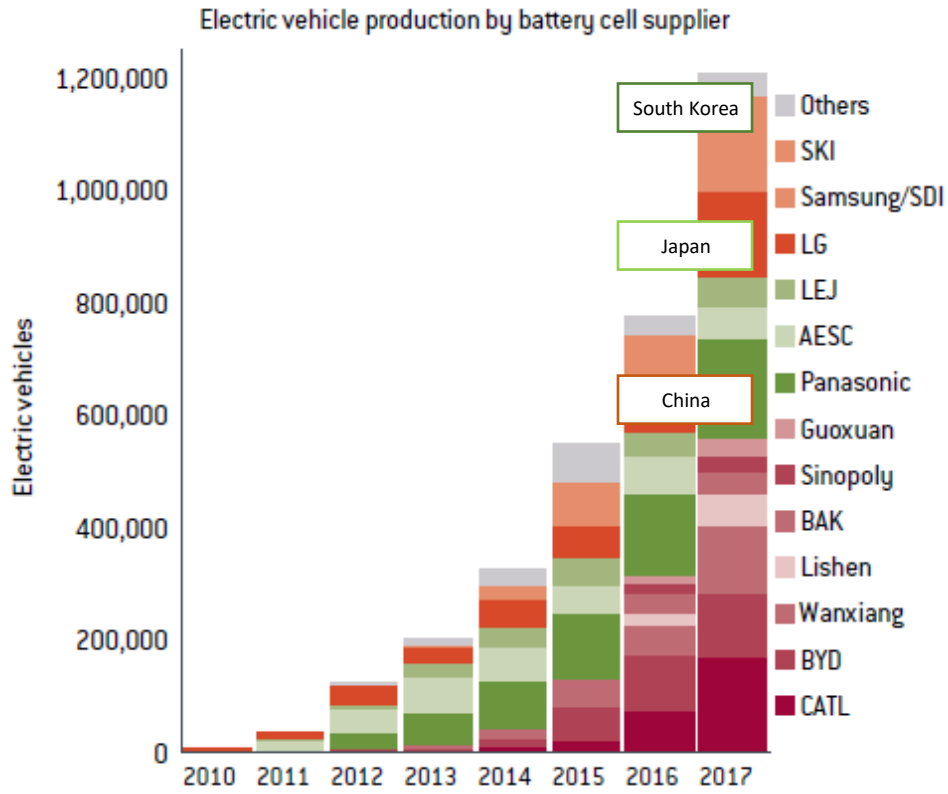
[83] Ständer and Dittrich (2017).

ANNEX II: CHINA'S ELECTRIC VEHICLE BATTERY INDUSTRY

Over the last years, China has rapidly established itself as the global leader in the electric vehicle (EV) industry, leaving Europe and other regions behind. This rise becomes especially clear in the EV battery sector. While no globally significant EU or US firm has been present in this segment, China surpassed its Japanese and South Korean competitors between 2014 and 2017 to become the global leader with a market share of 51% in 2017 (see figure below). In 2018, the EU only had about 3% of the global production capacity of Lithium-ion battery cells, while China had about 66% and South Korea together with Japan and other Asian countries about 20%.[84]

The country's upsurge has been driven by its "Made in China 2025" industrial strategy, which envisages a significant global market share in 10 high-tech industries, with the EV industry being among these. Since 2012, Chinese authorities have poured more than $10 billion in terms of subsidies into the EV battery sector, giving rise to more than 90 currently operating manufacturers. This strategy was accompanied by policies stimulating domestic demand for EVs and regulatory entry barriers for foreign companies.

Now that global leadership in the sector has been established, the generous subsidies have been phased out in 2020, leaving only the few most competitive Chinese companies to lead the future global market of EV batteries. CATL, the largest manufacturer, already announced plans to expand abroad and open its first battery plant in Germany in 2022.



Source: Lutsey et al. (2018).

[84] SWD(2021) 352 final.

ANNEX III: FRANCO-GERMAN CAR BATTERY INITIATIVE

Acknowledging the crucial role that battery production will play in the transformation of the car industry in Europe, in May 2019 the economy ministries of France and Germany addressed a joint letter to the European Commission in which they sought the approval for granting up to 1.2 billion euro in subsidies to a cross-border car battery consortium. According to the plan, European private companies, mainly carmakers and energy firms, would invest around 4 billion euro.

The consortium would consist of, among others, French carmaker PSA with its German subsidiary Opel and French battery maker Saft, a unit of French oil giant Total. Reportedly, other Member States, including Austria, Belgium, Finland, Italy and Poland, also expressed interest in the project. Thirty-five companies have pledged to sign up. The idea behind the consortium is to develop a European supply chain in car battery production and thereby lower Europe's dependence on external providers – mainly in Asia, and in particular China.

One of the first projects of the Franco-German consortium to be carried out in the near future will be establishing a pilot factory in France employing 200 people. Parallels to establishing of the Airbus consortium are being made while discussing this new initiative on developing homemade car batteries in Europe.

ANNEX IV: AIRBUS

The creation and commercial success of Airbus is one of the examples of an inter-governmental industrial cooperation in Europe. In the 1960s, there was a clear understanding that without a joint programme of aircraft development and production, the role of the European aviation companies would be reduced to being sub-contractors to American producers and therefore Europe would have to depend on the US for development of new technologies.

Throughout the 1960s, firms like France's Sud Aviation and the British Aircraft Corporation planned developing new aircrafts, which would respond to the emerging boom in air travel. But it gradually became clear that if all these aircraft were built, none of them would sell enough to make it commercially viable, as they would be competing against one another in the same, relatively small, market. Only by combining the talents and expertise of individual companies and nations to develop jointly one aircraft could Europeans compete against the U.S. based Boeing.

At a meeting in July 1967, ministers from France, Germany and the UK signed a declaration in which they agreed "*for the purpose of strengthening European co-operation in the field of aviation technology and thereby promoting economic and technological progress in Europe, to take appropriate measures for the joint development and production of an airbus.*"

The subsequent work on Airbus' first aircraft A300 was an exemplary model of European cooperation. The French made the cockpit, the control systems and the lower centre section of the fuselage. The British produced the wings, while the Germans made the forward and rear fuselage sections, plus the upper part of the centre section. The Dutch were responsible for the moving parts of the wing such as flaps and spoilers and the Spanish the horizontal tail plane. The beginnings of Airbus were not without technical difficulties (e.g. how to bring together the different sub-parts produced in several countries) and commercial challenges (e.g. how to build a customer base from scratch). Fifty year onwards, the company is the only competitor to Boeing, with which it has been in a duopoly in the large jet airliner market since the 1990s.

ANNEX V: CONCORDE

Concorde was conceived in the 1950s and designed in the 1960s. France and the UK decided to work together on the Concorde project, since it was an investment that neither could manage alone. With the UK moving towards EC membership, there were also strong underlying political motivations for such a partnership. In parallel, Russia worked on its Tupolev Tu-144 project whilst the United States, which had already developed the military X-1, worked on its own supersonic transport (SST) project.

The European collaboration on Concorde was a genuine success in innovation, resulting in the world's only supersonic commercial service which operated from 1976-2003. By contrast, the Tupolev had a high failure rate and was cancelled after a limited number of flights. The U.S. SST project, which absorbed a large investment from the federal government, was cancelled in 1971. The U.S. invested around USD 1 billion in its failed project. Concorde cost an estimated USD 3-5 billion in development costs.

From a successful innovation perspective, 50 years on, the Concorde remains unmatched. For almost three decades, Concorde was the fastest and one of the safest ways to fly. Crucially, both British Airways and Air France were able to operate Concorde at a profit, in spite of very high maintenance costs, because the aircraft was able to sustain a high ticket price. It should be noted however that the UK-French government development costs were never recouped. Indeed, as well as the high running costs and the issue of the sonic boom, which prevented overland flights, ultimately limited Concorde's commercial potential – a range of airlines that initially placed orders, decided to cancel.

Interestingly, nowadays we see renewed interest in supersonic travel. NASA is currently working with Lockheed Martin on an experimental aircraft, the X-59 QueSST, that will reduce the supersonic boom to a quiet thump. In terms of commercial travel, an aerospace start-up called Aerion is working with Lockheed Martin and GE on a supersonic business jet, the AS2. Boom, another U.S. based start-up is also working on a supersonic jet, with investments from Japan Airlines and the Virgin Group (the UK company which previously attempted to continue the Concorde service by offering to buy several planes from British Airways). Whilst these are of course being developed with new technologies and materials, the know-how developed for the Concorde will be of great use, as confirmed by the co-founder of Boom Supersonic.

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