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Lessons from Past Industrial Policies

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- Industrial policies aimed at the creation and development of specific sectors have made a comeback against a backdrop of a mounting number of crises, trade tensions, an accelerating innovation race and the imperative of combating climate change (see Chart on cover page). A study of policies in eight advanced and catching-up countries from 1945 to 2000 provides useful insight into the conditions determining their success or failure.

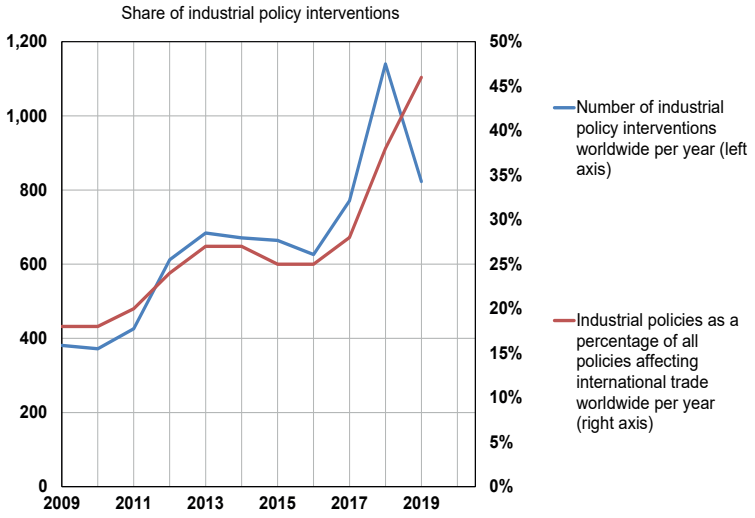
- Industrial policy had similar aims in all countries studied: (i) growth and competitiveness; (ii) support for major transitions (energy, space, etc.); (iii) strategic autonomy and sovereignty; and (iv) support for declining sectors.

- Although different models of industrial policy exist, most countries have intervened in a targeted manner in specific sectors. The catching-up countries (Japan followed by South Korea and China), France and the United Kingdom – up to the 1980s – directly intervened in the development of industrial production capacities. In the United States, sector measures were decentralised and limited to R&D support and government procurement in military and high value-added sectors.

- The advanced countries' sector-specific measures focused on emerging sectors with high stakes in defence- and sovereignty (aviation, energy and space in the post-war period followed, as in the catching-up countries, by electronics and IT). The catching-up countries initially focused on mature, but high-growth-potential mid-tech sectors (automobiles, chemicals and shipbuilding) and then on high-tech sectors (primarily electronics and IT).

- International sector-specific industrial policy experiences provide useful insight for shaping today's policies. For example, the success of both export aid conditional on performance in South Korea and the precise specification of ambitious technological goals in US development contracts suggests that setting high commercial and technological performance targets is a factor for success.

Boom in industrial policy measures, 2009-2019



Source: R. Juhász, N.J. Lane, E. Oehlsen & V. Pérez, The Who, What, When, and How of Industrial Policy: A Text-Based Approach, 2023.
Note: The blue curve represents the total number of new industrial policy interventions worldwide per year. The red curve represents the number of industrial policy interventions as a percentage of all policies affecting international trade worldwide per year, as contained in the Global Trade Alert database covering all countries. An intervention is counted from the time of its announcement for one year only. Source: Juhász et al. (2023).

1. Targeted or cross-sector industrial policies?

1.1 Shift from vertical to horizontal policies in the 1980s

From the post-war period to the 1980s, a number of countries actioned a raft of direct government interventions, known as "vertical" interventions, to develop specific economic sectors.[1] For some of these countries, such as South Korea and Japan, the goal was to catch up to the most advanced countries' level of industrialisation. For others, such as France, it was to lead in certain sectors by creating national "champions" that could compete internationally and take advantage of returns to scale.

These interventions started losing favour with the advanced countries in the mid-1980s[2] as a consensus took shape that they were costly and inefficient. Economists point to two main limitations of government intervention in specific sectors: a government's lack of information advantage i) can lead it to choose the wrong sectors, technologies or businesses; and ii) exposes it to a risk of capture by vested interests and to rents. In general, such targeted interventions are seen as potentially introducing competitive distortions resulting in greater losses for the economy than the intended gains.[3] In addition, these interventions can trigger a subsidy race on the international economic stage and subsidies granted by countries to develop leaders can turn out to be ineffectual if competing countries follow suit.

Moreover, this paradigm shift came as the European competition policy framework was strengthened and then while the international trade framework was consolidated with the creation of the World Trade Organization (WTO), which restricted the use of certain industrial policy tools.[4] At that time, the advanced economies consequently recentred on "horizontal" policies designed to create a positive environment for the development of all business (e.g. cross-sector support for innovation, skills, and tax and regulatory framework).

1.2 A comeback for sector-specific interventions driven by a changing international environment and the imperative to combat climate change

2010 marked a comeback for vertical industrial policies with a sharp increase in their use by governments. The number of new international trade-related industrial policy interventions worldwide rose from 381 in 2009 to 823 in 2019[5] (see Chart on cover page).

The major economic and international crises of the last 20 years – particularly the 2008 financial crisis and COVID-19 pandemic in 2020 – were addressed with active recovery policies, often including vertical industrial policy tracks. In France, they drove the launch of the first Invest for the Future Programme in 2009 (€35 billion) and the France Relance recovery plan in 2020 (€100 billion), the latter containing aviation and automotive industry tracks. Supply-chain disruptions during the COVID-19 pandemic, especially in medical supplies (medication, face masks, etc.) and semiconductors, also put reduced dependencies high on the industrial policy agenda. This prompted the introduction of targeted relocation policies in five sectors[6] deemed critical for the security of strategic supplies.

China's entry into the WTO in 2001 and the boom in subsidies in the country also played a role. CEPII (a Paris-based research institute in international economics) estimates that subsidies disbursed from 2005 to 2019 totalled approximately 5% of Chinese GDP.[7] The OECD notes in particular their

(1) China, Finland, France, Germany, Japan, South Korea, United Kingdom and United States.
(2) J.-L. Levet (2005), "Les politiques industrielles dans le monde: illustrations, enseignements et perspectives" (in French only).
(3) This change of heart was expressed by Gary Becker, 1992 economics Nobel laureate, with his assertion that "*The best industrial policy is none at all*" (*Business Week*, 26 August 1985).
(4) France Stratégie (2020), "Industrial policies in France", Report for the French National Assembly.
(5) See R. Juhász, N.J. Lane, E. Oehlsen & V. Pérez (2023), "The Who, What, When, and How of Industrial Policy: A Text-Based Approach". This indicator is not necessarily exhaustive, since it only covers international trade-related policies. As pointed out by the French Government Audit Office in its 2024 report "10 years of public policies in favour of industry" (executive summary available in English), industrial policy is hard to measure.
(6) Healthcare products, critical inputs for industry, electronics, agrifood and telecommunications.
(7) F. Chimits (2023), "What Do We Know About Chinese Industrial Subsidies", CEPII Policy Brief. Chart 1 presents the breakdown by type of subsidy. The data for China only covers the manufacturing sector, but subsidies to all private firms are included for the other countries (see OECD 2023, "Quantifying industrial strategies across nine OECD countries", OECD Science, *Technology and Industry Working Papers*, No. 150).

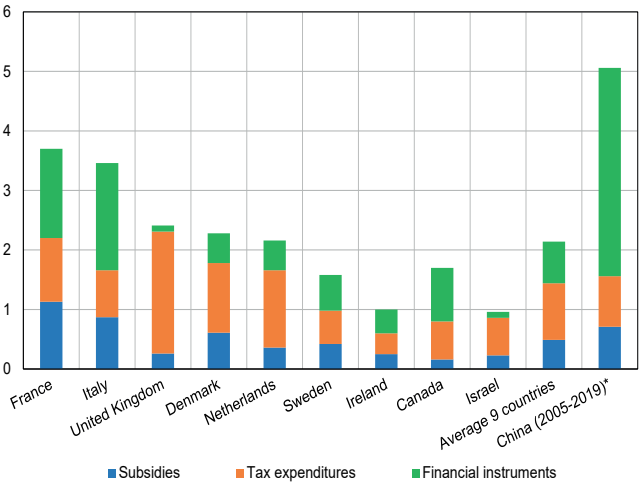
weight in sectors such as solar panels,[8] aluminium,[9] shipbuilding[10] and semiconductors.[11]

In 2022, the United States passed the Inflation Reduction Act (IRA) to introduce massive industrial support including local content criteria to give local industry advantages over imported products. Russia's invasion of Ukraine, in addition to prompting a slew of sanctions and retaliatory measures significantly limiting trade between Russian and Western countries, triggered a rise in geopolitical tensions worldwide and rekindled fears of manipulation of national dependencies by other countries.

This climate of trade tensions and supply difficulties was met with a European sovereignty agenda for certain critical products (e.g. food products, healthcare products, critical commodities and semiconductors). It was also behind the EU's adoption of the State Aid Temporary Framework in March 2022 (amended in late 2023) to facilitate aid to companies facing high energy prices, inject more generous aid into key sectors and introduce a clause to authorise aid to match any support offered in third countries for a given project.

Delivering on decarbonisation goals was also a justification for the use of vertical industrial policies. A consensus emerged on the role of low-carbon technologies to achieve these goals, alongside other means, and on the need for government intervention to develop these technologies exposed to numerous market failures. The European Commission consequently proposed the Net-Zero Industry Act in March 2024 to scale up government support for the development and industrial deployment of technologies crucial to meeting the European carbon neutrality goal by 2050. It was in this same spirit that France enacted the Green Industry Act in 2023 with three pillars: facilitate the establishment and development of industrial sites, promote virtuous businesses, and

Chart 1: Estimated public support to businesses by country in 2021 (% of GDP)



Source: OECD (2023), "Quantifying industrial strategies across nine OECD countries", OECD Publishing, and Chimits (2023), "What Do We Know About Chinese Industrial Subsidies", CEPII Policy Brief.

* Financial instruments include export support, with the exception of China (also excluded from the average for the nine countries) for which this category covers low-interest loans and equity injections. In China, unlike the other countries, only the manufacturing sector is taken into account.

finance them mainly by providing for support for green technologies with the Green Industry Investment Tax Credit (C3IV).[12]

Industrial policies are therefore deployed increasingly today to meet three goals: (i) growth and competitiveness, (ii) green and digital transitions, and (iii) strategic autonomy and sovereignty.[13]

This industrial policy comeback does not negate the abovementioned limitations of government intervention,[14] but it does seek to learn from past experience to build measures that will overcome its disadvantages by identifying principles to give government action maximum effectiveness, in particular in terms of fostering the emergence of new technologies and sectors.[15]

(8) OECD (2021), "Measuring distortions in international markets: Below-market finance", *OECD Trade Policy Paper,* No. 247.
(9) OECD (2019a), "Measuring distortions in international markets – the aluminium value chain", *OECD Trade Policy Papers*, No. 218.
(10) OECD (2019b), "An analysis of market distorting factors in shipbuilding", *OECD Science*, *Technology and Industry Working Papers,* No. 67.
(11) OECD (2019c), "Measuring distortions in international markets – the semiconductor value chain", *OECD Trade Policy Papers*, No. 234
(12) The Green Industry Investment Tax Credit (C3IV) is the French embodiment of the flexibility introduced by the European Temporary Crisis and Transition Framework (TCTF). It is designed to support the entire production chain in the batteries, wind power, solar panel and heat pump sectors.
(13) Other long-standing considerations in addition to these overarching goals include the use of industrial policy at times for regional planning purposes: ad-hoc sector interventions to protect jobs or address the repercussions of the green transition in certain sectors.
(14) Aside from the budget cost, the global upturn in industrial policy interventions has a macroeconomic cost: they risk triggering a subsidy race, raise barriers to trade, threaten fair and effective competition between countries, and can compromise the integrity of the EU single market. Moreover, the limitations justifying the criticism of vertical industrial policy in the 20th century remain today (capture by vested interests, unpredictability of future technologies and sectors, etc.).
(15) R. Juhász, N. Lane & D. Rodrik (2023), "The New Economics of Industrial Policy", *NBER, Working Paper* 31538.

2. In France, a historically strong reliance on industrial policy

2.1 French industrial policy switched focus from major projects to a horizontal mode in the 1980s

"Large project" policies formed the mainstay of industrial policy from the 1960s[16] to the mid-1980s.[17] Major projects were designed to foster the emergence of national high-tech "champions". Initially developed for reasons of economic security and defence (nuclear power, a high-speed train – TGV – an IT development programme – the Calcul Plan – etc.), major projects were assigned a more general economic performance objective in the 1970s.. Major projects formed part of a directed innovation policy[18] channelling scientific and financial resources across the entire development process to seed and industrialise certain technologies in identified key sectors. Implementation was generally handled by a small number of large firms, referred to as "national champions", that were often in monopoly positions and partially nationalised. They were closely associated with ad-hoc funding agencies and public applied research institutions (creation of IRIA, ONERA, CNES,[19] etc.). These institutions were tasked with remedying public and private research weaknesses identified at the time.[20] The government stepped in as coordinator and government support took the form of large public procurement procedures, multiannual orders and low-interest loans.

In the 1970s, this major project model was rounded out by action at business level to promote diversification by large groups in future "strategic activities" (robotics, office automation, consumer electronics, biotechnology, etc.).[21] These interventions took the form of development contracts stipulating the respective obligations of the government (support provision) and businesses (securing significant international market shares).

In the mid-1980s, the major projects were phased out and sector interventions shed their industrial component to focus on basic and applied research consistent with the increasingly horizontal nature of government support at the time[22] and the privatisation of national champions now open to competition. With the "large innovation projects", the French Ministry for Industry shifted the focus to funding research programmes bringing together large industrial players and public research institutes for the development of future strategic technologies.[23] This development was due mainly to new European competition rules incompatible with the major programme policy and the promotion of national champions,[24] but also to dwindling centralised policy effectiveness due to the internationalisation of leading French groups and the diversification of their geographic locations.[25]

French vertical policy has sometimes taken on a European scale, first in connection with the major projects (e.g. Airbus) and then via the European R&D programmes. For example, Eureka is a European R&D support platform launched in 1985 to improve the competitiveness of European industry in a number of sectors (smart cards, automobiles, homes of the future, etc.). It is a decentralised model whereby businesses propose collaborations on projects of their choice for which they receive public funding.

(16) General de Gaulle's government launched the first major projects following his election as President of the French Republic.
(17) The government's decision not to save steel company Creusot-Loire marked a policy shift from a vertical to a horizontal model (Source: "La politique industrielle en France", *BSI Economics,* 2013).
(18) An innovation policy designed to support the development of a particular technology as opposed to public policy measures supporting cross-sector R&D.
(19) Institute for Research in IT and Automation (IRIA, later renamed to INRIA), French Aerospace Lab (ONERA) and National Centre for Space Studies (CNES).
(20) G. Owen (2012), "Industrial Policy in Europe Since the Second World War: What Has Been Learnt?", *ECIPE Occasional Paper,* No. 1/2012.
(21) The government first asked the Boston Consulting Group to define the future sectors.
(22) The research tax credit, a cornerstone of the horizontal support policy for innovation, was introduced in 1982.
(23) For example, the PREDIT transport programme and BIOAVENIR biotechnology programme.
(24) Centre d'Analyse Stratégique (2011), "Investissements d'avenir et politique industrielle en Europe: quel ciblage et quelle sélection des projets innovants ?" (in French only).
(25) E. Cohen (1992), "Le colbertisme high-tech", *Pluriel Enquête* (in French only).

2.2 Three examples of major projects: nuclear power, aviation and the Calcul Plan

The shining success story[26] is that of the launch of Airbus in 1970, although it did not actually emerge as such until nearly two decades later when the consortium[27] posted an operating profit from 1991. Launched by France and Germany, the Airbus project undertook to develop a wide-body aircraft to challenge the dominance of American giant Boeing and reap the benefits of the growing mass air travel market. The joint venture was designed to share the growing development costs of new aircraft and the associated financial risks, share experiences and access new market opportunities. Unlike in the case of Concorde,[28] the definition of the project's objectives, programmes and implementation was the responsibility of the sector's manufacturers rather than the governments. The project benefited from government advances, repayable in the event of commercial success,[29] and public procurement (for example, France bought the first six airplanes in 1971).

The large-scale French nuclear programme launched in the early 1970s is another major project policy success story. It installed 75% of France's current nuclear power capacity in just ten years. Launched in response to a need for energy and sovereignty, it followed a preliminary civil nuclear energy development phase in France, which started with the founding of the French Atomic Energy Commission in 1952 and went on to build a large network of businesses and know-how. This industrial policy programme was underpinned by comprehensive planning coordinated by EDF, the restriction of foreign competition and serial contracting to reduce economic uncertainty for players.[30]

The Calcul Plan, an IT development programme, launched in 1966 did not deliver the outcomes hoped for in that the government did not manage to create a French industry. The starting point for the plan was that French computer companies lacked the competitiveness of American companies, especially IBM. The plan comprised a training and research track and an industrial base structured around Compagnie Internationale pour l'Informatique (CII) set up to produce Made in France computers. Government action also took the form of substantial R&D subsidies and incentives to buy French in the public sector. The resulting range of general-purpose computers, with operating systems incompatible with the competing IBM computers, failed to win over the private sector. The CII continued to lag behind IBM and stacked up losses, and the Calcul Plan was abandoned in 1975. Among the reasons for the failure of the Calcul Plan were unsuitable technological positioning and too great a focus on a small number of large players.

(26) L. Warlouzet (2021), "Airbus, modèle ou exception pour les ambitions industrielles européennes, 1967-1984", *Nacelles (*in French only).
(27) Airbus is the product of French-German collaboration put in place with the creation of a consortium in the form of an Economic Interest Grouping (EIG), a status that enables separate legal entities to work together as a network.
(28) E. Cohen (1992), op. cit. Concorde, also the product of European cooperation, was a commercial failure.
(29) Nonetheless, the actual repayment of the sum total of these advances following the project's success was to become the subject of a dispute between the United States and the EU.
(30) EDF enjoyed a monopoly position due to playing a triple role of contractor, project manager and sole operator of the nuclear power stations. Although the technology of US nuclear OEM company Westinghouse was initially used under licence, the French government called for a transition to entirely French technology in the 1970s. Competition consequently played out abroad, where EDF was able to offer expertise that was lacking. The industry focused on the national markets before branching out into the international markets. See F. Torres (2016), "Le système nucléaire français des années 1950 à nos jours, acteurs et structures. Une mise en perspective", *La Revue de l'Énergie*, No. 634 (in French only).

Table 1: Examples of major French projects

	Airbus	Nuclear Power	Calcul Plan
Objective	Develop a wide-body aircraft capable of penetrating a market dominated by Boeing and reap the benefits of the growing air travel market.	Meet a growing energy demand while retaining sovereignty.	Create a French computer industry and compete with American companies (especially IBM) following the observation of French computers' lack of competitiveness.
Organisation	• Led by France and Germany. • Creation of Airbus in the form of a consortium (Economic Interest Grouping), enabling separate legal entities to work together as a network.[a] • Choice of a unified industrial and commercial command and a limited role for the governments in operational management.	• Comprehensive planning led by EDF.	• A training and research track (1967 creation of the Institute for Research in IT and Automation (IRIA, later renamed to INRIA). • An industrial base structured around Compagnie Internationale pour l'Informatique (CII) set up to produce Made in France computers.
Other ures	• Definition of the objectives and programmes and their implementation by sector manufacturers rather than the governments. • Government advances repayable in the event of commercial success. • Public procurement assistance.	• Restriction of foreign competition. • Serial contracting to reduce economic uncertainty for players and trigger investment.	• Substantial R&D subsidies (80% of R&D costs for the first three years) • Incentives to buy French in the public sector.
Key dates	1969: France and Germany launch the Airbus project despite the commercial failure of previous European cooperation projects (Concorde, Mercure and VFW-Fokker). 1970: Founding of Airbus. 1991: First operating profit posted by the joint venture after two de cades.	1952: Nuclear Research Centre opens at the French Atomic Energy Commission (CEA). 1956-1960: First reactors built using a technology developed in France (UNGG). 1969: Decision to drop development of national technology in favour of an American solution and launch of the second civil nuclear energy development phase in France underpinned by a large network of businesses and skills.	1966: Project launch. 1969: The CII releases its range of IRIS general-purpose computers whose operating systems are incompatible with previous products and IBM computers. The CII starts accumulating losses without penetrating the market. The company's main customers are the French public sector, French-speaking African countries and communist countries, but it fails to win over the private sector. Early 1970s: Failure of a European consolidation undertaking. 1975: Abandonment of the plan.
Outcome	*Success* – Shared growing development costs for new aircraft and financial risks, shared experiences and accessed new market opportunities.	*Success* – Installed 75% of France's current nuclear power capacity in just ten years.	*Failure* – The government did not manage to create a French industry.

a. An Economic Interest Grouping serves a dual commercial and technical purpose. It is a flexible solution for collaboration between different firms without the need for a full merger.

Source: DG Trésor (French Treasury).

3. Different industrial policy models in other countries

The industrial policies conducted by Germany, the United States, Finland, the United Kingdom, South Korea, Japan and China over the period evidence different industrial policy models.

3.1 Asian models: a planned, vertical industrial policy to reach the technological frontier

Japan, South Korea and China – which underwent rapid productivity catch-up phases in the 1950s, 1960s and 1990s respectively – conducted a mainly vertical, centralised, protectionist and export-oriented industrial policy leveraging foreign technology transfers.

In the 1950s, Japan introduced targeted support for identified high-growth-potential sectors (automobiles, heavy electric machinery, IT, etc.) with investment grants and protectionist measures (customs tariffs, import quotas and foreign direct investment regulation). Japan also regulated technology imports[31] to encourage the introduction of foreign cutting-edge technologies to catch up on their lag. Starting in the 1960s, Japan actively engaged in vertical innovation policies in a climate of trade liberalisation to adopt and develop innovations, especially American innovations. Strictly time-bound collaborative R&D programmes were launched with companies in direct competition[32] working together to meet technological challenges. The government also sought to restrict competition, in particular by organising mergers on the basis that too much competition would result in companies that were too small, thereby undermining competitiveness. In practice, in the sectors succeeding in the export market, domestic competition was invariably fierce in spite of the government's position.[33]

Likewise, from the 1960s, South Korea prioritised in turn sectors defined as strategic in five-year plans (heavy industry, chemicals, automobiles, shipbuilding and electronics followed by the information industry). One of the main tools was loans on preferential terms conditional on export performance in the targeted sectors or for rewarding new entrants in high-risk, high-tech sectors. Innovation was also based on imitating foreign technologies.

The Chinese catch-up policy launched in the 1990s took a similar approach,[34] but differed in terms of the influence of the state, a shareholder in the majority of the country's large corporations. Strategic industries were identified based on their importance to national security (e.g. defence, electricity generation and aviation) and their growth potential. The innovation and scientific policies were also subject to state planning, as the state devised research programmes while encouraging technological transfers from advanced countries.

Once they had reached the technological frontier, Japan (1980) and South Korea (1990) gradually shifted to a more horizonal policy designed to improve business performance, in particular by means of innovation policy.[35] Japan, for example, refocused its research system on more basic research in response to American pressure (rejections of Japanese mid-range products and introduction of import quotas), drawing on financial resources from Japanese businesses.[36]

3.2 The United Kingdom: an interventionist vertical industrial policy turned horizontal

Like the French policy, the United Kingdom's industrial policy at the end of World War II was vertical and focused on creating national champions to revive an industry on its knees at the end of the war. To create national champions, business mergers were facilitated and subsidised by a national agency called the Industrial Reorganisation Corporation. The underlying idea was that large structures would make for economies of scale. The results of this policy were underwhelming with many failures as in the case of British Leyland in the automotive industry.

The government also paid subsidies to support certain sectors, including high-tech sectors such as aviation, computers and nuclear power. Once again, results were mixed with ex-post evaluations indicating the inconsistency of the subsidies policy and confusion over objectives.[37] Public procurement was used to develop certain industries such as defence and pharmaceuticals, this time with positive outcomes for the two sectors.

Following Margaret Thatcher's election in 1979, industrial policy became mainly horizontal. Starting in 1980, many public enterprises were privatised. The emphasis was placed on cross-sector measures and

(31) Foreign licence agreements had to be approved by the government. Although this measure appeared to be a barrier to imports, businesses benefited from government support with negotiating contracts and also received in return a foreign currency payment guarantee, which were in short supply at the time. The effects of this policy are much debated.
(32) The Japanese Ministry of International Trade and Industry (MITI) put in place coordination incentives with "technological research associations" partnering private companies to meet a technological challenge with financial support from the government. J.-F. Sabouret (2007), "L'empire de l'intelligence, Politiques scientifiques et technologiques du Japon depuis 1945", CNRS Editions (in French only).
(33) M. E. Porter & M. Sakakibara (2004), "Competition in Japan", *Journal of Economic Perspectives*.
(34) As in South Korea, the main instrument was credit: bank loans were granted in keeping with industrial policy objectives. Ferri & Liu (2010).
(35) Expenditure in Japan on SME support programmes, R&D and export promotion accounted for 88% of total industrial policy spending in 1989 and 87% in 1993. OECD (1998), "Spotlight on Public Support to Industry", *OECD Publishing*.
(36) R&D funding was therefore essentially private. In 1987, over 2.6% of GNP was spent on R&D activities, of which only 19.9% was financed by the government as opposed to 48.2% in the United States and 37.7% in West Germany. J.-F. Sabouret (2007), *op. cit*.
(37) See S. Broadberry & T. Leunig (2009), "The impact of Government policies on UK manufacturing since 1945" or Owen (2009), "Business in Britain in the XXth Century: Decline and Renaissance?" Chapter 2, *Industrial Policy in Twentieth Century Britain.*

support for innovation with the exception of a few sectors (e.g. aviation and shipbuilding). Access to financing for innovative firms was taken forward with the development of venture capital supported by tax policy.

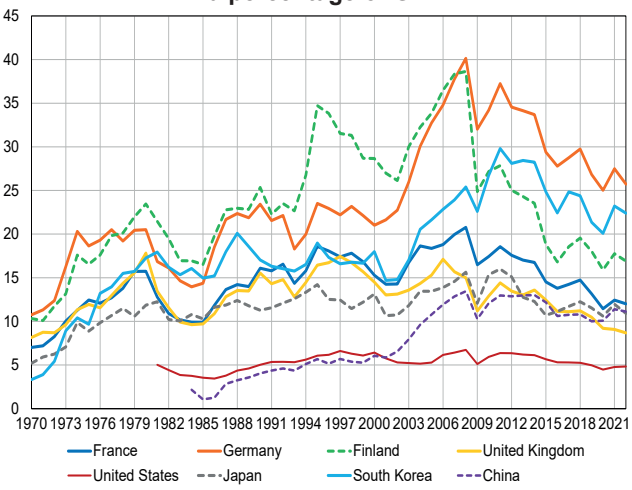
3.3 Germany: an industrial policy involving multiple players

Right from the formation of the Federal Republic of Germany (FRG), West Germany's industrial policy combined horizontal government action centred on the business environment (innovation, SME market access and regional economic cohesion) with strong involvement by the Länder[38] and a "neo-corporatist" system[39] structured around trade organisations. The federal government officially rejected a vertical or interventionist industrial policy in accordance with the German social market economy model[40] and concentrated on framework conditions. Nevertheless, the Länder, which did not subscribe to the federal government's ordoliberal narrative, actively used industrial policy tools for regional development (regional development banks, training policy, SME support, establishment of research and technological transfer centres, etc.). The federal government tasked the trade organisations – in particular the major confederations of industry and trade union confederations – with steering functions to replace or supplement public regulations in certain areas and contribute to implementation (collective bargaining agreements, industrial standardisation, vocational training and regulation of certain sectors).[41]

In practice, vertical components were also included in federal policy on an ad-hoc basis to support declining sectors (coal in the 1950s[42] and shipbuilding in the early 1960s)[43] and to promote what were considered to be strategic emerging technologies (starting in the 1960s: data processing and computer hardware, nuclear power and civil aviation projects), all to little effect.[44]

The success of the German export industries was driven by a combination of specialisation based on long-standing competitive advantages, a highly skilled workforce and an array of facilitating institutions.

Chart 2: Share of exports of industrial goods as a percentage of GDP



Source: National accounts, OECD, UN Comtrade, DG Trésor calculations.

Note: Goods defined as industrial correspond to Section 5 (chemicals), Section 6 (manufactured goods classified chiefly by material), Section 7 (machinery and transport equipment), Section 8 (miscellaneous manufactured articles) and military goods under the Standard International Trade Classification (SITC). Series breaks can be found in 2000 and 2010 due to the change in SITC year. The indicators used to calculate the percentages are expressed in current US dollars.

3.4 The United States and Finland: strong support for innovation

The US and Finnish industrial policies were strongly focused on innovation and targeted technology-intensive sectors.

The United States stands out for the federal government's huge contribution to R&D expenditure,[45] increasingly specialised as of the 1980s. This contribution has been driven by a high level of defence spending in the relevant technologies. Alongside defence, R&D support has concentrated on sectors

(38) Länder refers to the German regional administrative subdivisions. They are the federated states that form federal Germany and have their own powers in such areas as police, education and culture.
(39) The neo-corporatist model involves close coordination between the government and a small number of recognised and non-competitive interest groups in support of government action. H. Uterwedde (2007), "Politique industrielle ou politique de la compétititvité ? Discours et approche en Allemagne", Cerfa-Ifri (in French only), and B. Domingo (2014), "Néo-corporatisme", *Dictionnaire d'administration publique* (in French only).
(40) The social market economy balances the market economy with social justice considerations.
(41) H. Uterwedde (2007), "Politique industrielle ou politique de la compétitivité? Discours et approche en Allemagne", Cerfa-Ifri (in French only).
(42) These measures were not always successful and the share of coal in power generation continued to drop in favour of oil and gas.
(43) C. Grabas & A. Nützenadel (2013), "Industrial policies in Europe in historical perspective", European Commission, *Working Paper*, No. 15.
(44) O. Keck (1993), "The National System for Technical Innovation in Germany", *National innovation systems, A Comparative Analysis,* Richard R. Nelson (ed), Oxford.
(45) Federal funding stood at over 60% of total R&D expenditure in the 1960s. D. C. Mowery (1992), "The U.S. national innovation system: Origins and prospects for change", *Research Policy,* Vol. 21, pp. 125-144.

relating to national security (e.g. health and energy) and high value-added industries (e.g. aerospace, electronics and telecommunications). The federal government has been supported in this by government agencies[46] in the selected sectors. These agencies modelled on the Defense Advanced Research Projects Agency (DARPA)[47] – held up as a shining example of success – steered support toward advanced research and breakthrough innovations with significant technological and commercial payoffs. The federal government also started supporting technological transfers in the 1980s with such measures as the Bayh-Dole Act for universities funded by federal grants to patent their inventions and the Stevenson-Wydler Act to encourage federal laboratories to contribute to technological transfers. The new industrial firms also played a significant role in the post-war innovation system. The technologies that emerged, in particular semiconductors and computers, were commercialised and partially developed by these new firms.[48]

In addition to support for R&D, the United States also conducted direct decentralised[49] and mainly horizontal interventions by such means as government procurement to support small businesses and local production.[50]

The Finnish innovation policy launched in the 1980s has been more centralised. It initially targeted the ICT sector before opting for a more horizontal policy, albeit implicitly targeting technology-intensive sectors. The government focused on structuring full and effective access to funding for innovation (basic research in the universities, public applied research and R&D by firms working in the technological and venture capital sectors). Finland became one of the most R&D-intensive economies in the 2000s, at the cutting edge in the ICT sector with players such as Nokia, despite public funding accounting for a much lower share of business R&D than the OECD and EU average.[51] The horizontal nature of Finland's innovation policy, in promoting competition, was to be a factor for success.[52] The Finnish research and training systems also evolved quickly in response market demand,[53] providing the country with a highly skilled workforce.

4. Takeaways from sector-specific policies in the second half of the 20th century

The success of a sector-based development policy can be assessed at first glance from the ability of the supported business or product to penetrate a market and sustain market share once the support has come to an end, i.e. through commercial success. If the government is the sole customer, success can also be gauged from the achievement of the government's technological goal (e.g. the Manhattan Project for the nuclear bomb in the United States, civil nuclear energy in France, space projects, etc.). The examination of historical experiences reveals four factors conducive to the success of sector-emergence policies.

4.1 Role of market opportunities

First of all, the different examples show the importance of credible market opportunities for the development of emerging industries. The industrial policies that succeeded in developing a new industry were based either on markets where the government was the main buyer or on a credible medium-term trajectory of competitiveness.[54]

In cases where a market is entirely or predominantly public, a sector can emerge even in the absence of the price competitiveness of national production, since the government – as coordinator and main customer – can

(46) At federal level: Defense Advanced Research Projects Agency (DARPA), National Institutes of Health (NIH), National Institute of Standards and Technology (NIST), etc.
(47) DARPA is a US government agency of the Department of Defense created in 1958 for research and development of new technologies for military use. It contracts out R&D activities to partner contractors (laboratories, businesses, etc.).
(48) A number of factors contributed to this: the research ecosystem, government defence procurement rules, workforce mobility and the relatively permissive legal environment facilitating the universities' role as incubators. D. C. Mowery (1992), *op. cit.*
(49) Public buyers (ministries, agencies and states) had autonomy of action for industry and there was little coordination of them at federal level.
(50) The Buy American Act (1933) required government agencies to prefer buying American provided that the price was reasonable and the Small Business Act (1951) facilitated SME access to loans and government contracts.
(51) OECD (2023), "Main Science and Technology Indicators".
(52) O. Toivanen (2006), "Innovation and research policies: Two case studies of R&D subsidies", European Investment Bank, EIB Papers.
(53) CORDIS (2006), Finland's road to prosperity.
(54) For example, by means of economies of learning or external economies of scale.

guarantee a market if necessary by accepting a higher cost than the foreign competition on such grounds as sovereignty for example. It is in these types of sectors that French industrial policy has seen some of its greatest success stories: in defence, space, nuclear power and the TGV high-speed train.[55]

When a market is more diffuse, especially in mass consumer goods, the ability of industrial policy and industrial players to identify promising markets and develop medium-term competitiveness becomes key. In the case of fledgling markets, governments may intervene to advance the emergence of a private market with such measures as support for uptake (e.g. the retail price for a Minitel teletext terminal helped create a market for the product in France). For example, some countries managed to develop sectors by entering niche or new segments where there was little initial competition. TSMC – the Taiwanese semiconductor foundry champion – entered what was still a new value chain segment at the time, and German champions have often positioned themselves in niche markets where they dominate at global level.

In the case of existing markets where barriers to entry are high and national players are not initially competitive, certain industrial policies have been successful by taking action to support catch-up by local industries (domestic market protection in Japan, export support measures to offset a lack of competitiveness in South Korea, repayable advances in the case of Airbus in France, etc.).

Conversely, if no credible market opportunity can be identified, industrial policies may prove ineffectual for the sector's industrial development (e.g. the French Bioavenir programme in biotechnologies) or, if substantial resources are invested, may create a sector that will ultimately be a commercial failure. For example, the failure of the Concorde project is attributed largely to the very small market for the aircraft due to its technical characteristics.[56] Similarly, the French and, more broadly, European lag in computers and semiconductors is seen as being due in part to the low level of domestic demand in the 1950s and 1960s when these two industries started to take shape[57] and to the decision to develop products in direct competition with IBM.

4.2 Role of performance standards and competition

The risk of poor decisions or rents due to ineffective subsidies is significantly reduced when industrial policy choices refrain from giving precedence to influential business players and strong competition is guaranteed. In the examples studied, the successful sector development policies required supported players to be highly competitive (on the domestic or international market) or were based on stringent technological and commercial performance standards[58] with clear criteria for the termination of aid and protection or with ad-hoc technological and commercial objectives. High performance standards are particularly important in markets with less competition between businesses, in particular concentrated markets and markets in which the government is a major player, if not the main customer.

In advanced countries, the programmes that drove the emergence of new sectors often had technologies and businesses competing with one another in the development phase and laid down ambitious technological specifications. In the IT sector in the United States, R&D support was systematically granted to meet technological targets specified in development contracts. Similarly, in public procurement, governments sustained competition between companies by diversifying supplies.[59] The relationship between government and business is therefore not permanent. In the French electronics sector, after years of support provided to one single company (Sescosem) ended in failure, a change of strategy in the shape of allocating financial support to a number of companies resulted in the development of new microelectronics players in the 1980s (Components Plan and Peripheral Technology Plan).

In the catching-up countries (South Korea and Japan), high commercial standards and credible support termination schedules were used in mature sectors where a market had already formed (e.g. automobiles and telephony). In this way, South Korea made continued support to catching-up sectors conditional on their export performance. Similarly, protection and investment support measures in Japan were temporary

(55) The emergence of this last sector was partly an industrial response to the need to renew the SNCF's rolling stock.
(56) E. Cohen (1992), "Le colbertisme high tech, Economie des Télécom et du grand projet", Hachette (in French only).
(57) G. Owen (2003) "Succès et échecs dans l'industrie électronique: les leçons ont-elles été apprises ?", *Entreprises et Histoire*, No. 33, pp. 57-75 (in French only).
(58) M. Porter (1990), "The competitive Advantage of Nations".
(59) S. Nora & A. Minc (1978), *The Computerization of Society*, report to the President of the French Republic.

and phased out in keeping with a pre-set timeframe.[60] The internationally successful sectors were moreover those that were highly competitive on the domestic market (e.g. automobiles and robotics).[61]

In China, the most high-end companies were in highly competitive sectors easily accessible to foreign investors and with barriers to neither the entry or exit of national companies (e.g. telecommunications and construction equipment).[62] Sector targeting proved more effective in competitive sectors or when support targeted a large number of firms.[63] However, the strategy of placing state-owned firms at the centre of the industrial policy could have undermined the development of the sectors concerned (e.g. internal combustion engine vehicles[64] and shipbuilding).[65]

4.3 Role of technological neutrality

Technological neutrality was a positive factor for success in new sectors with as yet uncertain growth prospects, including where the government was a dominant player. Success stories in the United States (e.g. in the computer sector) were helped along by reserving technological choices for downstream of development (industrial scale-up) and basing them as far as possible on commercial criteria. It is believed that having a number of funding players and operators supported technological development in diffuse emerging sectors (biomedical, information technology and semiconductors)[66] by enabling a proliferation of decentralised initiatives and alternative technologies at a time when it was impossible to know in which way innovations would come about and succeed.

A number of successful major French projects also had different technologies on the table through to the industrialisation phase (TGV, nuclear power, etc.) when technological choices were finally made based on commercial arguments, even when the main buyer was public. For example, a number of train technologies were studied and the TGV model was ultimately chosen because it met the criteria of railway compatibility and specialisation in saturated intercity connections better than its competitor Aérotrain.

Technological non-discrimination was also a defining element in a number of large French programmes, which often employed and adopted foreign cutting-edge technologies when they were more suitable. Such was the case with nuclear power, where a decisive technological decision to undergo industrial scale-up was to be made between two solutions: one American (a light water reactor designed by Westinghouse and already internationally tried-and-tested) and the other French. Whereas the French Atomic Energy Commission (CEA) wanted France to use its own gas-cooled graphite-moderated technology, EDF opted for the American technology to avoid technological isolation from the rest of the world: the government followed EDF's recommendation and the American solution was chosen.

4.4 Role of the research ecosystem and framework conditions

The economic literature makes clear the key role played by framework conditions (venture capital, quality of research and training, regulations, market access, etc.) in the emergence and development of new sectors.[67] The appearance of technological frontier sectors was systematically preceded by the development of a research ecosystem, i.e. an interconnected network of public and private players working in a field covering a spectrum from basic research to marketing innovative solutions. It was only then that the development of the advanced countries' public research capacities could feed into industry by means of knowledge transfers and a skilled workforce.

In France, leading bodies[68] and major projects were deployed to concentrate on and develop public

(60) The Japanese Ministry of International Trade and Industry (MITI), for example, temporarily protected the Japanese automotive industry, but announced from the outset that this protection would be temporary by setting in advance an imperative timeframe for the gradual reduction in tariffs on imports of motor vehicles. See M. Okuno-Fujiwara (1991), "Industrial policy in Japan: a political economy view", *NBER.*

(61) M. E. Porter & M. Sakakibara (2004), "Competition in Japan", *Journal of Economic Perspectives*, No. 1, pp. 27-50.

(62) L. Brandt & E. Thun (2016), "Constructing a Ladder for Growth: Policy, Markets, and Industrial Upgrading in China", *Elsevier, World Developmen*t, Vol. 80, pp. 78-95.

(63) P. Aghion & J. Cai, M. Dewatripont, L. Du, A. Harrison & P. Legros (2015), "Industrial policy and competition", *American Economic Journal.*

(64) L. Brandt, D. Ma & T. Rawski (2016), "Industrialization in China", Institute for the Study of Labor, *Discussion Paper Series,* No. 10096.

(65) P.J. Barwick, M. Kalouptsidi & N.B. Zahur (2019), "China's Industrial Policy: an Empirical Evaluation", *NBER Working Paper.*

(66) D.C. Mowery, R.R. Nelson & B.R. Martin (2010), "Technology policy and global warming: Why new policy models are needed", *Research Policy,* Vol. 39, Issue 8, pp. 1011-1023.

(67) W. Polt, H. Gassler, A. Schibany, C. Rammer & D. Schartinger (2001), "Benchmarking industry-science relations: the role of framework conditions", *Science and Public Policy*, Vol. 28, Issue 4, pp. 247-258.

(68) Multidisciplinary bodies (French National Centre for Scientific Research – CNRS) and specialised bodies (French National Institute of Health and Medical Research (INSERM), French National Institute for Agricultural Research (INRA), National Institute for Research in Digital Science and Technology (INRIA), National Centre for Space Studies (CNES), French Atomic Energy Commission (CEA), etc.).

research activities: the CNRS and the CEA worked on the development of nuclear power, for example. In the United States where research was less centralised, the research ecosystems were supported by funds allocated by certain public agencies (NASA and DARPA) and universities. Relations between public research and industry mainly took the form of workforce training and business start-ups founded by researchers.

5. The France 2030 investment plan seeks to learn from these lessons

The €54-billion France 2030 investment plan launched in 2021 embodies, in its targeted track, the return of vertical industrial policies in France. It is designed to steer innovation and industrial development to meet major societal challenges and sustainably transform key sectors of the French economy (e.g. decarbonisation of industry, development of digital technologies and scaling up innovation in healthcare). It is structured by critical sectors and technological challenges with a target of 50% of funding in the green transition. It supports innovation at different levels of technological development from research to initial industrialisation. It is designed as a mission-oriented innovation policy[69] with its governance providing for collaboration by field players to develop strategies defined to meet the major technological challenges identified.

The design of the France 2030 investment plan marks a move to prevent the risks specific to government intervention in industrial policy. The sector-specific strategies are developed following consultation with industrial players. The distribution of subsidies is generally based on calls for projects – maintaining a certain level of competition and a form of technological neutrality – reviewed by independent experts. In addition to the targeted track, the structural track focuses on developing the research and innovation ecosystem. For example, the €14-billion budget earmarked for innovation ecosystem structural funding supports research facilities(e.g. teaching hospital institutes and high-risk research programmes), technology transfer institutions (e.g. Technology Transfer Acceleration Companies and technological research institutes) and venture capital structures (e.g. multi-cap funds of funds).

(69) P. Larrue (2023), “Répondre aux défis sociétaux: le retour en grâce des politiques " orientées mission "?”, La Fabrique de l'industrie, *Les Docs de la Fabrique* (in French only).

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