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An industrial policy framework for OECD countries: old debates, new perspectives

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The debate on industrial policy has made a comeback in both academic and policy circles. Yet, no consensus exists on an industrial policy paradigm and the absence of a common reference framework unduly obfuscates the debate – even which interventions are to be considered "industrial policy" is not clear-cut. Against this background, this paper proposes a coherent framework for analysing the formulation of industrial policy, relying on a purposefully broad definition of the latter. Leveraging the proposed framework and a companion paper (Criscuolo et al., 2022[1]) which synthetises the available empirical evidence, this paper stresses the complementarities between policy instruments, thereby justifying the use of industrial strategies, acknowledges the role of targeted industrial strategies, which can direct technological change and growth, and of demand-side instruments, which can contribute to transformative industrial change, but calls for a stronger emphasis on evaluation and the regular re-assessment of targeted industrial strategies.

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Keywords: industrial policy, industrial strategies

Executive summary

The debate on industrial policy has made a comeback in both academic and policy circles. The case for governments to perform a strategic and coordinating role in the business sector is gaining traction across OECD countries in the wake of major shocks, such as the 2008 Global Financial Crisis, the current COVID-19 pandemic, and long-term trends, e.g. globalisation and productivity slowdowns, the digital transformation and climate change.

Yet, no consensus exists on an industrial policy paradigm. The efficiency of horizontal (or untargeted) policies, but also their sufficiency to address global societal challenges, are increasingly questioned. In addition, targeted policies continue to raise concerns related to anticompetitive effects, capture by vested interests and the opportunity cost of public funds. Moreover, the absence of a common reference framework unduly obfuscates the debate – even which interventions are to be considered "industrial policy" is not clear-cut.

This paper proposes a coherent framework for analysing the formulation of industrial policy, presented schematically in Figure 1 below. Industrial policy is defined as "interventions intended to improve structurally the performance of the domestic business sector". It comprises a vast set of instruments, ranging from the design of intellectual property protection to public procurement, R&D incentives or public support to the provision of skills. By this purposefully broad definition, industrial policy encompasses much-studied realms such as science, technology and innovation (STI) and entrepreneurship policies. The breadth of the definition of industrial policy goes hand in hand with the recognition that aggregate performance is multidimensional and should not necessarily be conflated with aggregate productivity.

The proposed conceptual framework (Figure 1) hinges on the definition and description of the two main dimensions of the formulation of industrial policies, linked by the rationale underpinning policy intervention:

- *The design of industrial strategies*, defined as a consistent and articulated group of policy instruments aimed at achieving a given policy objective, which can go beyond productivity growth and innovation to include, e.g., sustainability, resilience and strategic autonomy. Beyond traditional sectoral or place-based orientations, "new" industrial strategies increasingly focus on specific technologies or "missions".
- *The choice of industrial policy instruments*. A new taxonomy allows identifying the channels through which instruments operate and potential complementarities. To that effect, in addition to keeping with the traditional distinction between horizontal and targeted policies, the taxonomy follows the neo-Schumpeterian growth literature in distinguishing between demand-pull instruments and two types of supply-push instruments: those that improve firm performance ("within" instruments) and those that affect industry dynamics ("between" or framework instruments).

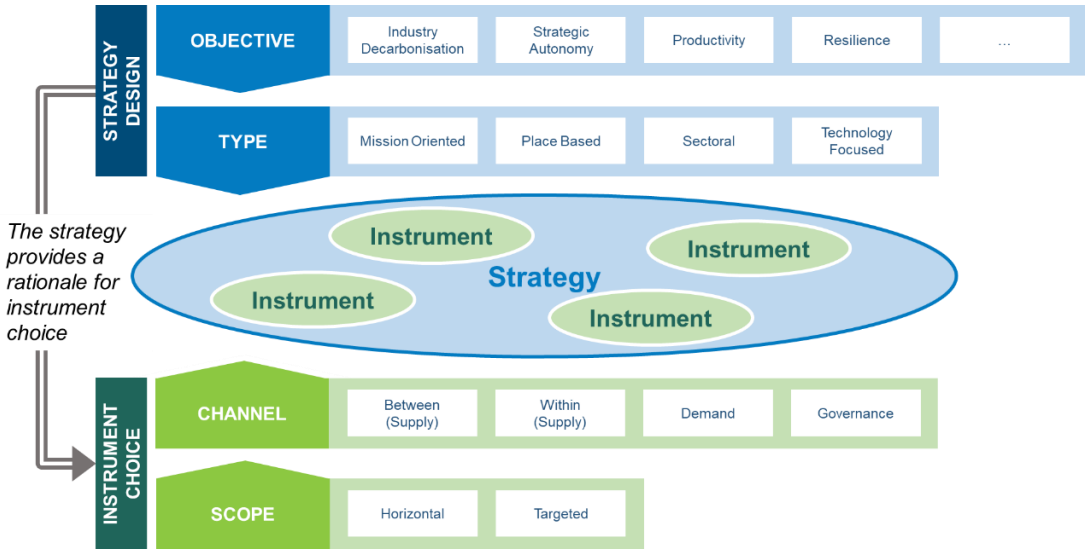
Leveraging the proposed framework and a companion paper (Criscuolo et al., 2022[1]) which synthetises the available empirical evidence on industrial policy, this paper provides **four policy messages**.

- **Complementarities between policy instruments justify the use of industrial strategies**. The available evidence supports the effectiveness of several categories of policy instruments such as firm-level investment incentives, instruments

favouring the access to inputs (e.g. skills, knowledge, infrastructure) and appropriate framework conditions (e.g. sound competition, well-functioning capital markets). For the instruments to be effective and to maximise their effectiveness, however, good policy design is crucial. In addition, the framework developed in this paper sheds light on the complementarity between investment incentives, instruments supporting access to inputs and framework conditions, thereby rationalising the use of policy packages, or strategies, to reach industrial policy objectives.

- **Targeted industrial strategies can direct technological change and growth**. Governments having a strong role to play in tackling societal challenges, in particular climate change, this may explain and justify the renewal of targeted industrial strategies, such as mission-oriented and technology-focused strategies. Targeted instruments can usefully complement horizontal policies within a strategy to achieve a given objective. However, it is important to be aware of well-identified pitfalls of targeted interventions, whose governance model should be built so that young competitors are not excluded, specifying objectives rather than means, scheduling assessments and evaluations and building in exit options.
- **Demand side instruments can contribute to transformative industrial change.** These instruments, which affect the demand for products through either their price, availability or public demand, have become more and more common, in particular in transformative mission-oriented strategies. The underlying rationale is the creation of demand in order to support scaling-up and improving efficiency through, e.g., learning by doing. In the context of targeted industrial strategies, demand side policies are particularly interesting as they may be less distortive than targeted supply-side policies. For instance, they are more likely to affect indirectly all the relevant firms, irrespective of their size, age or connections with the administration. The evidence supports the effectiveness of these instruments, although the optimal policy mix between demand and supply side instruments remains an open question.
- **Governments need to put a strong emphasis on evaluation and the regular re-assessment of targeted policies**. While the evidence on the effectiveness of targeted interventions is limited and mixed so far, digital technologies have the potential to improve the effectiveness of these interventions, in particular by making evaluation cheaper and more timely.

Figure 1. The formulation of industrial policy



Source: OECD.

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The case for governments to more actively direct the structure of the business sector is gaining traction across OECD countries in the wake of major shocks and long-term trends, such as the 2008 Global Financial Crisis, the current COVID-19 pandemic, tensions in international trade, the productivity slowdown, the digital transformation and climate change. The question on the role of industrial policy in advanced economies has returned to the forefront of discussions in both academic and policy circles.

Yet, no consensus exists on an industrial policy paradigm. The absence of a common reference framework unduly obfuscates the debate – even which interventions are to be considered "industrial policy" is not clear-cut. So-called horizontal policies, i.e. interventions available to all firms and which include business framework conditions, are increasingly questioned on both efficiency and sufficiency grounds – see e.g. the recent Franco-German Manifesto (2019[2]). At the same time, particularly lively debates surround targeted industrial policies, i.e., interventions restricted to a subset of eligible firms – see Box 1. On the one hand, supporters stress success stories, such as the Defense Advanced Research Projects Agency (DARPA) deemed to have led to the emergence of technological breakthrough like the internet, and insist on the potential of such initiatives to tackle grand challenges – see, e.g., Mazzucato (2013[3]). On the other, sceptics caution against exaggerating the role of governments ex-post and point to numerous instances where targeted policies fail to achieve their objectives while leading to anticompetitive effects and capture by vested interests, at great opportunity cost for public funds – see, e.g., Lincicome (2021[4]).

As these old debates are raging, an increasing number of scholarly contributions aim at reformulating industrial policy frameworks in the light of recent major shocks and growing global challenges. Primary examples include the OECD's *Design principles for mission-oriented innovation policies* (Larrue, 2021[5]); Bruegel's *Blueprint on a green industrial policy for Europe*, which focuses on serving the EU Green Deal (Tagliapietra and Veugelers, 2020[6]); and frameworks for reconsidering the role of industrial policy interventions in the success of the "Asian Miracles" (Cherif and Hasanov, 2019[7]). These frameworks, however, either focus on selected types of interventions and objectives, or on emerging economies. A notable exception is Warwick (2013[8]), who adopts a broad definition of industrial policy and proposes a new typology based on policy orientation and domain. However, both the economic and the policy environment have changed dramatically since that work.

The COVID-19 crisis and climate change are reinforcing the perceived urgency of global societal challenges and stress the role of industrial policy, notably through the large-scale recovery plans that are now being implemented around the world (Hepburn et al., 2020[9]). Industrial policy is gaining traction as countries seek to ensure a green, digital and inclusive recovery after the COVID-19 pandemic, with a goal of building back better. Following these urgent needs, in recent years governments have announced new industrial strategies such as the European Green Deal (2019), the Next Generation EU fund (2020), the Korean New Deal (2020), the American Rescue Plan Act (2021) and the EU New Industrial Strategy (2020, updated in 2021). The COVID-19 crisis also prompted the emergence (or the revival) of new industrial policy objectives, such as economic resilience and strategic autonomy.

Against this backdrop, the present paper offers new perspectives on a present-time industrial policy paradigm for OECD countries.[1] It proposes a coherent framework for

analysing the formulation of industrial policy, defined here as interventions intended to improve structurally the performance of the domestic business sector. By this purposefully broad definition, industrial policies comprise a vast set of instruments, ranging from the design of intellectual property and public procurement, to government support and fiscal incentives for research and development (R&D) or the public support to the provision of skills, and encompass other much-studied realms such as science, technology and innovation (STI), and entrepreneurship policies.

The proposed conceptual framework hinges on the definition and description of the two main dimensions of the formulation of industrial policies, bound by the rationale underpinning policy intervention:[2]

- *The design of strategies*, defined as a consistent and articulated set of policy instruments aimed at achieving a given policy objective, which can go beyond productivity growth and innovation to include, e.g., sustainability, resilience or strategic autonomy. Beyond standard sectoral orientation, industrial policy notably includes technology-focused, place-based strategies and, increasingly, mission-oriented strategies. A categorisation of these four main types of strategies and their underlying rationales complements the conceptual framework, including a comprehensive overview of the market failures and other elements justifying intervention.
- *The choice of industrial policy instruments.* A new taxonomy allows identifying the channels through which instruments operate and potential complementarities. To that effect, in addition to keeping with the traditional distinction between horizontal and targeted policies, the taxonomy follows the neo-Schumpeterian growth literature in distinguishing between demand-pull instruments and two types of supply-push instruments: those that improve firm performance ("within" instruments) and those that affect industry dynamics and productivity enhancing resource reallocation ("between" or framework instruments).

While the paper purposefully adopts a broad scope towards industrial policy, it emphasises two key elements. First, productivity and economic growth are considered the main metrics against which industrial policy objectives are assessed, giving technology and innovation policies a key role in the proposed framework. With that respect, the proposed framework builds on the large body of previous OECD work on science, technology and innovation (STI) policy interventions. Second, addressing societal challenges has become a key justification for industrial policy, placing mission-oriented strategies at the centre of policymaking. Even though the related evidence remains scarce, this type of intervention is increasingly analysed in OECD work, e.g. the role of industrial policies for achieving decarbonisation (Anderson et al., 2021[10]; OECD, 2021[11]), for fostering the contribution of the private sector to the achievement of the Sustainable Development Goals (SDGs) (OECD, 2021[12]) or for stimulating the development of green hydrogen (Cammeraat, Dechezleprêtre and Lalanne, 2022[13]). The paper also acknowledges the multidimensional nature of performance.

Leveraging the proposed framework and based on the available evidence on the effectiveness of industrial policy instruments reviewed in (Criscuolo et al., 2022[1]), this paper provides four main policy messages:

- **Complementarities between policy instruments justify the use of industrial strategies**. The available evidence supports the effectiveness of several categories of policy instruments such as firm-level investment incentives, instruments favouring the access to inputs (e.g. skills, knowledge, infrastructure) and appropriate framework conditions (e.g. sound competition, well-functioning capital

markets). For the instruments to be effective and to maximise their effectiveness, however, good policy design is crucial. In addition, the framework developed in this paper sheds light on the complementarity between investment incentives, instruments supporting access to inputs and framework conditions, thereby rationalising the use of policy packages, or strategies, to reach industrial policy objectives.

- **Targeted industrial strategies can direct technological change and growth**. Governments having a strong role to play in tackling societal challenges, in particular climate change, this may explain and justify the renewal of targeted industrial strategies, such as mission-oriented and technology-focused strategies. Targeted instruments can usefully complement horizontal policies within a strategy to achieve a given objective. However, it is important to be aware of well-identified pitfalls of targeted interventions, whose governance model should be built so that young competitors are not excluded, specifying objectives rather than means, scheduling assessments and evaluations and building in exit options.
- **Demand side instruments can contribute to transformative industrial change.** These instruments, which affect the demand for products through either their price, availability or public demand, become more and more common, in particular in transformative mission-oriented strategies. The underlying rationale is the creation of demand in order to support scaling-up and improving efficiency through, e.g., learning by doing. In the context of targeted industrial strategies, demand side policies are particularly interesting as they may be less distortive than targeted supply-side policies. For instance, they are more likely to affect indirectly all the relevant firms, irrespective of their size, age or connections with the administration. The evidence supports the effectiveness of these instruments, although the optimal policy mix between demand and supply side instruments remains an open question.
- **Governments need to put a strong emphasis on evaluation and regular re-assessment of targeted policies**. While the evidence on the effectiveness of targeted interventions is limited and mixed so far, digital technologies have the potential to improve the effectiveness of these interventions, in particular by making evaluation cheaper and more timely.

The paper proceeds as follows. Section 2 presents the proposed conceptual framework. Section 3 lays out the new taxonomy of industrial policy instruments. Section 4 describes industrial strategies and their rationale in detail. Section 5 summarises the main policy messages from the analysis. Finally, Annex A describes two examples of industrial strategies – green and artificial intelligence (AI) strategies – in selected countries and regions to illustrate how real-world strategies fit into the conceptual framework developed in this paper.

Box 1. Long-standing debates on targeted industrial policy

Traditional targeted industrial policy: for or against?

The debate around targeted industrial policies has been rather polarised.

- Supporters of targeted industrial policies have stressed success stories – see, e.g., Mazzucato (2013[3]). The American post-WWII technology policy, including the experiences of the Defense Advanced Research Projects Agency (DARPA), the Apollo program and more generally the research programs funded by the

Department of Defense are usually deemed successful as they led to inventions, such as the internet, the GPS, drones, and several other breakthroughs following a model that has been extensively discussed – see, e.g., Alic, Banscomb and Brooks (1992[14]). Recently, supporters of targeted government interventions have also pointed to particular areas such as climate change mitigation, the green transformation and societal challenges, where "mission-oriented" industrial policies can direct innovation and help overcome uncertainty, lack of markets and the need for demonstration projects – see Section 4. .

- Sceptics have warned about ex-post glorification of the role of government and pointed to numerous drawbacks of targeted industrial policies – see for instance Lincicome (2021[4]). These can be summarised along three main issues. First, governments might not be the most knowledgeable when choosing the "best" project to support. Second, support might be subject to capture and firms might focus on lobbying and rent-seeking rather than on productive activities, which is particularly problematic when the opportunity cost of public funds is high. Third, critics have pointed to potential crowding out effects of public investment that might discourage private investment rather than complement and encourage it.

While economists acknowledge that the existence of market failures justify targeted policies in theory, they are generally sceptical about the efficiency of interventions to improve the production system of advanced economies in practice, given unsuccessful past experiences (Romer, 1993[15]; Lerner, 2009[16]; Tagliapietra and Veugelers, 2020[6]) – some even doubt that the benefits of interventions overcome their costs (Pack and Saggi, 2006[17]). When it comes to the successes of industrial policy in Asian countries in the 1960s and the 1970s, when the so-called Asian Tigers successfully caught up with the global productivity frontier, the debate focused on (i) the absence of compelling evidence that these policies caused or harmed growth in these countries, because of the difficulty to design a counterfactual scenario and (ii) the validity of this experience for developed economies, whose goal is to push the technological frontier whereas these countries were trying to catch up.

Finally, ongoing discussions point to potential difficulties to align targeted industrial policies and competition policy – see, e.g., OECD (2020[18]). In particular, state aid might end up favouring some firms over others, supporting inefficient or failing firms and lead to the survival of zombie firms, thereby slowing down productivity-enhancing reallocation and reducing the level playing field.

Recent developments: economic, technological and societal needs

Nevertheless, many economists are reconsidering the role of targeted policies (Rodrik, 2008[19]; Mazzucato, 2018[20]; Bloom, Van Reenen and Williams, 2019[21]), despite the current lack of a framework for governments to identify the right interventions and investments. There are three main reasons for this reconsideration.

- First, there is an increasing focus on market imperfections. Targeted policies are usually thought as unduly discriminating between firms based on their activity. However, in a second-best world (i.e., a world where some markets are imperfect), they may be justified and introducing a policy distortion may actually be welfare enhancing. This argument appears in the public and economic debate under several forms:

  - According to some economists, the global financial crisis revealed an inefficient sectoral allocation (Philippon and Reshef, 2012[22]; Gopinath et al., 2017[23]), justifying interventions to favour reallocations (Warwick, 2013[8]). This argument is in fact similar to the one that underpinned industrial policy of the Asian tigers in the 1960s and 1970s, where the main objective was to overcome the lock-in on a low-growth and low-productivity path by the expansion of heavy industries.
  - In some cases, governments have resorted to industrial policies to compensate sectors or firms for the potential loss of competitiveness resulting from foreign policies, including tax, trade and FDI policies, that are perceived as unfair (European Political Strategy Centre, 2019[24]; Enderlein et al., 2019[25]; Franco-German Manifesto, 2019[2]; ITIF, 2020[26]; Werner, 2018[27]).

- Second, the technological opportunities and societal challenges facing most advanced and developing economies are evolving rapidly. Several aspects of this multi-faceted structural change suggest that there may be a need for more targeted industrial policies:
  - The world is increasingly facing global societal challenges that necessitate both a public impetus/guidance and a large-scale private investment to be addressed (climate change, demographics, growing inequality, cybersecurity, etc.). Such challenges existed in the past (tertiarisation of the economy, energy security, etc.) and already prompted debates about the respective roles of the public and the private sectors (in medical research for instance) but several observers consider that the breadth of these global questions has increased over the past decades – see Section 4. on mission-oriented strategies.
  - Some new technological developments (e.g. big data and artificial intelligence) are considered as a new general purpose technology (GPT) and are expected to become pervasive in the economy. As for societal challenges, breakthroughs in these GPTs, which potentially have positive spillovers on a wide range of sectors, become more likely with a public impetus. From a public policy perspective, they may also need new rules, new governance frameworks and cross-sectoral cooperation (see Annex A on AI strategies).
  - The development of the digital economy and the growth of network externalities in some sectors gave rise to winner-takes-most dynamics, especially in sectors characterised by the rise of platform business models. Some even argue that the phenomenon exceeds the digital economy and is linked to the rise of top firms' tacit knowledge or to a slowdown in technology diffusion (Andrews, Criscuolo and Gal, 2019[28]). Governments have expressed a willingness to invest early in new technologies to secure a global leading position, for instance by building national or regional champions (Franco-German Manifesto, 2019[2]) and to promote technology diffusion to improve the productivity of laggard sectors and firms. More generally, securing positions in high mark-up/high value-added stages of global value chains is also mentioned as an objective of targeted industrial policies (European Political Strategy Centre, 2019[24]).

  - Recent advances in data collection, storage and analytics (notably machine learning) may decrease the cost for governments to design and implement targeted policies, for instance by improving the identification of innovative firms and of the latest technological advances.

- Third, the secular decline in output and productivity growth and the accompanying increase in productivity dispersion and wage inequality (Berlingieri, Blanchenay and Criscuolo, 2017[29]; OECD, 2021[30]) put a special emphasis on the role of industrial policies for social outcomes. Industrial policies are often praised for reducing geographical or income inequalities or counteracting wage polarisation (Rodrik and Sabel, 2019[31]).

The COVID-19 crisis has reinforced these three arguments, and uncovered potential new market imperfections. In particular, short-run and long-lasting disruptions in global value chains have prompted the emergence of economic resilience and strategic autonomy as new objectives of industrial policy (see section 2.).

2. Conceptual framework

2.1. Industrial policy definition

To provide a coherent framework for conceptualising industrial policy interventions, this paper starts by defining industrial policies and delimiting their scope.

No single, clear-cut definition has emerged from previous attempts at considering industrial policy within a coherent framework – see Warwick (2013[8]) for an inventory of the definitions used in the literature. Therefore, the scope of instruments that industrial policy is deemed to encompass varies across authors, policymakers and countries, which unduly obfuscates the debate.

In this paper, industrial policy encompasses all types of instruments that intend to structurally improve the performance of the domestic business sector. By this definition, it includes business support measures, such as STI and entrepreneurship policies. Industrial policy does not necessarily focus on manufacturing, but concerns the whole private sector.

Such a purposefully broad definition encompasses a vast set of policies (including those implemented without being explicitly labelled "industrial policy"), thereby providing policy makers with a comprehensive framework to discuss policy interventions aimed at improving the performance of the business sector. It is worth noting that, by this definition, governments have always implemented industrial policies to some extent. Importantly, the objective of industrial policy (i.e., the performance of the business sector) is multidimensional – see below.

Industrial policy, given its focus on structural performance, needs to go hand in hand with competition policy, tax policy and trade and investment policy, and general business framework policies.

Macroeconomic policies, i.e. fiscal, monetary and macro-prudential policies, do not fall within the present scope of industrial policies because they address the business cycle, not the structural performance of the business sector. However, it is important to bear in mind that they indirectly contribute to the resilience and productivity of the business sector. More generally, many other policy areas can have an indirect impact on the performance of the business sector but are excluded from the scope of this paper to keep it tractable, e.g., social, education, housing and health policies.

2.2. Horizontal and targeted policies

There is a standard distinction between horizontal and targeted (or "vertical") industrial policies. Horizontal policies are available to all firms, irrespective of their activity, technology or location, e.g. R&D tax credits of fiscal incentives to support the green transformation of businesses. On the contrary, targeted policies are restricted to a subset of eligible firms based on their activity, their technology or location, e.g., public procurement for specific products; or place-based policies.[3]

This is an 'ex-ante' definition of horizontality. Even if eligibility to horizontal policies is not restricted to specific sectors or technologies, they might disproportionally benefit a small number of sectors or firms. For instance, R&D tax credits mostly concern R&D-intensive sectors or, depending on their design, larger firms and tax-paying incumbents. Second, according to the definition adopted in this paper, size-contingent policies are also considered horizontal measures (Box 3).

2.3. Policy instruments and industrial strategies

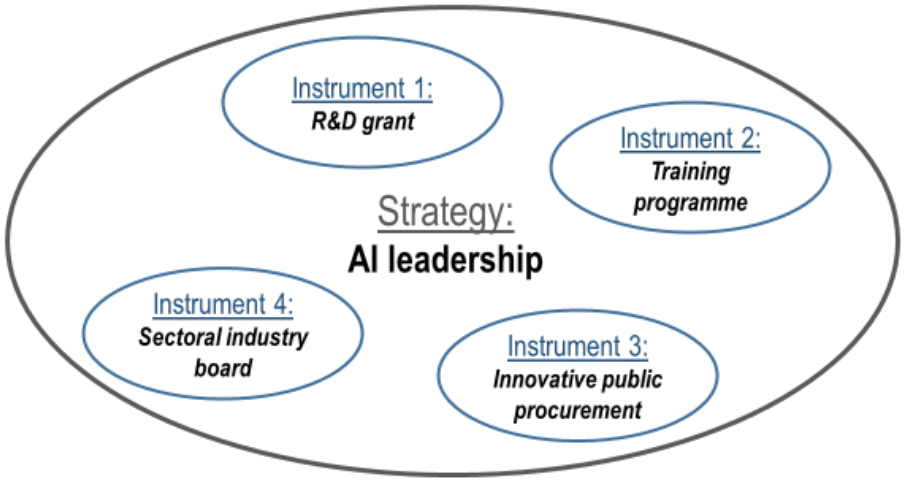
This paper distinguishes policy instruments from industrial strategies.

A policy instrument is defined as a tool used by policymakers to affect performance outcomes in the business sector in order to achieve a pre-defined objective. Examples of policy instruments include R&D grants, training programs, public procurement or sectoral industry boards. In this paper, instruments are categorised along two dimensions:

- *The target of the intervention*, referring to the standard distinction between horizontal and targeted policy;
- *The channel through which it operates*, distinguishing "between", "within", "demand" and "governance" instruments (defined in Section 3. below).

Industrial strategies are defined as a consistent and articulated group of policy instruments designed in order to reach specific policy objectives. For example, an artificial intelligence (AI) leadership strategy can combine R&D grants, training programmes, innovative public procurement and sectoral industry boards (Figure 2). The diversity of policy instruments found in industrial strategies is the main reason for resorting to a broad definition of industrial policy.[4] Strategies are categorised in Section 4. below.

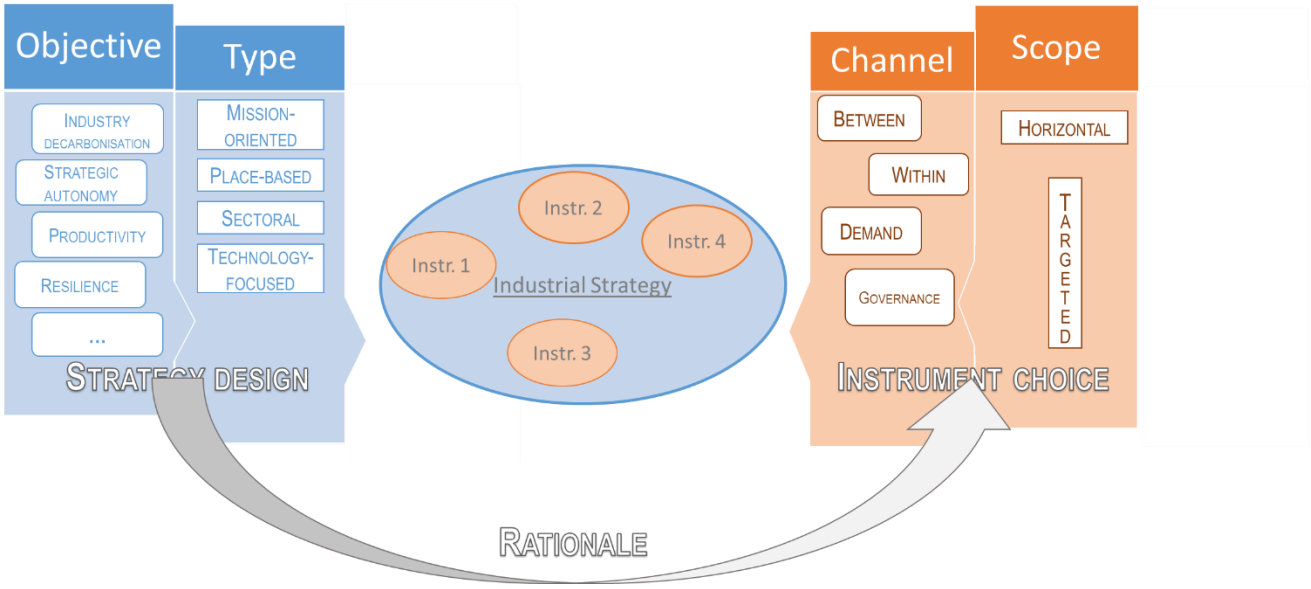
Figure 2. Policy instruments and industrial strategies



Note: This is a fictitious example. See the OECD AI observatory for a list of national strategies and policies (https://oecd.ai/en/dashboards).
Source: Authors.

Within this framework, the formulation of industrial policy rests on the combination of instrument choice and strategy design (Figure 3). A strategy is designed in order to achieve a predefined objective and instruments with specific targets and channels are chosen and bundled. Keeping with the previous example of AI leadership, a technology-focused strategy can be designed resting on a bundle of instruments including horizontal "within" instruments like R&D grants and training programmes, targeted demand instruments such as public procurement for innovative AI-related products and governance instruments like tech industry boards.

Figure 3. The formulation of industrial policy



Source: OECD.

2.4. Industrial strategy objectives

Traditional objectives of industrial strategies comprise **innovation, productivity and economic growth**. Industrial policies have also long been used to pursue social objectives, such as smoothing transition costs or fostering economic activity and employment in disadvantaged areas. In recent years, renewed government interventions pursued goals well beyond traditional ones, e.g., the green transition (Anderson et al., 2021[10]); the SDGs (OECD, 2021[12]); and issues related to resilience or strategic autonomy exposed by the COVID-19 crisis.

Industrial policy interventions to promote innovation find one of their main rationales in the non-appropriability of the full return on private investment in knowledge creation by firms. Interventions are therefore welfare-improving, since the existence of knowledge spillovers implies that social returns to investment are higher than private returns.

Promoting technology adoption is increasingly considered as an important policy objective, given the mounting evidence pointing to a breakdown in technology diffusion and its role in the productivity slowdown of the last decades – see Berlingieri et al. (2020[32]). Indeed, productivity growth can be obtained either by pushing the domestic productivity frontier or by improving the productivity of non-frontier firms. The former solution corresponds to an innovation objective, whereas the latter rather corresponds to the diffusion of innovations, including organisational and managerial ones.

Competitiveness is sometimes considered as a traditional objective of industrial policy. Differently from productivity, competitiveness is a measure of relative costs across countries. While innovation, productivity or technology adoption have a positive impact on competitiveness, affecting competitiveness through other channels (including by subsidising the production of a sector) bears the risk of hurting other countries in a zero (or even negative) sum game at the global level. Macroeconomic policy is typically seen as a common alternative to foster competitiveness.

Industrial policies may also target the **inclusiveness** of economic development through targeting firms in disadvantaged areas, employing minority and disadvantaged workers

and/or entrepreneurs in specific population groups (Iammarino, Rodríguez-Pose and Storper, 2020[33]; OECD, 2019[34]). In some instances, targeted industrial policies may be a way to provide economic opportunities to these groups. This objective is not necessarily unrelated to efficiency, with lower access to "good jobs" having social costs and negative externalities (Autor, Dorn and Hanson, 2019[35]; Rodrik and Sabel, 2019[31]; Bartik, 2020[36])[5] , notably by increasing political polarisation (Autor et al., 2020[37]). Relatedly, improving productivity through diffusion can also contribute to inclusiveness by reducing wage inequalities, as low-productivity firms typically pay lower wages (Berlingieri, Calligaris and Criscuolo, 2018[38]).

Green industrial policies consist in re-directing technological innovation and deployment away from dirty production processes and towards low-carbon technologies to achieve decarbonisation goals – see, e.g., Anderson et al. (2021[10]). As this type of objective necessitates overcoming a complex set of market failures, it also requires a strategy that includes complementary policies (e.g., skills), enabling framework conditions and stakeholder co-ordination at the local, national and international levels (Tagliapietra and Veugelers, 2020[6]; Anderson et al., 2021[10]; Matsumoto et al., 2019[39]).

More generally, industrial policies can also aim at the attainment of the **SDGs**. Industrial policies can promote sustainability in the private sector beyond environmental transition by, e.g., ensuring better health, well-being and education, reducing inequalities, eliminating poverty or promoting gender equality. Beyond regulations and taxes, industrial policy can also incentivise firms to become more sustainable but also accompany the growth of the sectors and companies that provide solutions to overcome these challenges – see OECD (2021[12]). This objective does not necessarily conflict with others such as innovation, productivity and growth or economic resilience (OECD, 2021[12]).

The ongoing COVID-19 crisis is placing **resilience** on par with other objectives at the forefront of the policy debate, making it a key objective of policy interventions – see e.g. OECD (2020[40]). There is little consensus on policy instruments meant to promote resilience or even on a definition of the concept of resilience.[6] This calls for more work on integrating the concept of resilience in industrial policy work. The working definition of resilience tentatively adopted in this paper is the capacity to limit welfare loss when facing a shock, either by limiting its impact or by rapidly recovering from it. Resilience is critical for the stability and inclusiveness of economic growth and improvements in living standards. In particular, resilience enables the economy to withstand, adapt and rebound quickly from shocks as diverse as natural disasters, financial crises, health emergencies, cyberattacks, terrorism, warfare or price swings in international commodity markets (OECD, 2020[40]; OECD, 2020[41]).[7]

Resilience can be assessed at the macroeconomic, sectoral and firm level. Therefore, firm-level resilience can be an objective of firms' organisation and management practices. Public policies can have a role to play if firm-level resilience has externalities or if macroeconomic or sectoral resilience requires coordination or reallocation across firms, for instance to safeguard the network of inter-firm and worker-firm relationships, to promote cybersecurity or to maintain stockpiles of essential goods – see also DesJardine, Bansal and Yang (2019[42]); Jüttner and Maklan (2011[43]); Aiginger (2009[44]); Caldera Sánchez, Rasmussen and Röhn (2015[45]); Hynes, Lees and Müller (2020[46]).

Even though resilience and productivity may go hand in hand (OECD, 2020[47]), tensions can arise between the two objectives, as resilience may emerge from features that efficiency wants to reduce. Resilience comes from the ability to adjust products, processes, supply chains and employment regimes flexibly in response to a shock and, thus, may rely on diversification, inventories and redundancy. Efficiency implies specialisation, sourcing and scaling up to spread fixed costs over larger quantities.

Finally, **strategic autonomy** is increasingly seen as an important industrial policy objective (Ding and Dafoe, 2021[48]; European Political Strategy Centre, 2019[24]; Franco-German Manifesto, 2019[2]). In the COVID-19 context, some countries faced shortages of essential products in the early stages of the pandemic, e.g., of facemasks (OECD, 2020[49]), and the recovery challenges the organisation of global value chains in key sectors (e.g. semiconductors). Beyond essential goods and services, strategic autonomy also covers technology and sometimes constitutes an explicit rationale for supporting the domestic development of key technologies, as well as for pre-empting acquisitions of domestic firms by heavily subsidised foreign firms.

The strategic autonomy concept is increasingly used to identify sectors or value chains deemed to require special support, because of both productivity and resilience (European Commission, 2021[50]), even though it is rarely well defined. Ding and Dafoe (2021[48]) define a strategic asset as being important (economic or military significance), prone to externalities and national in scope (the externalities occur at a national level; on the contrary, for instance, externalities of fundamental research in medicine diffuse easily to other countries). They define three types of 'externalities' in the strategic sense (not necessarily in an economic sense): (i) cumulative nature, when an asset features economies of scale or any type of significant advantage for incumbents, such that it cannot be produced easily in the short run without previous experience, (ii) infrastructure, when several other activities rely on this asset (e.g. broadband network, banking sector) and (iii) dependence, which corresponds to goods or services whose supply is concentrated and at risk of disruption. However, this definition has not been operationalised yet.

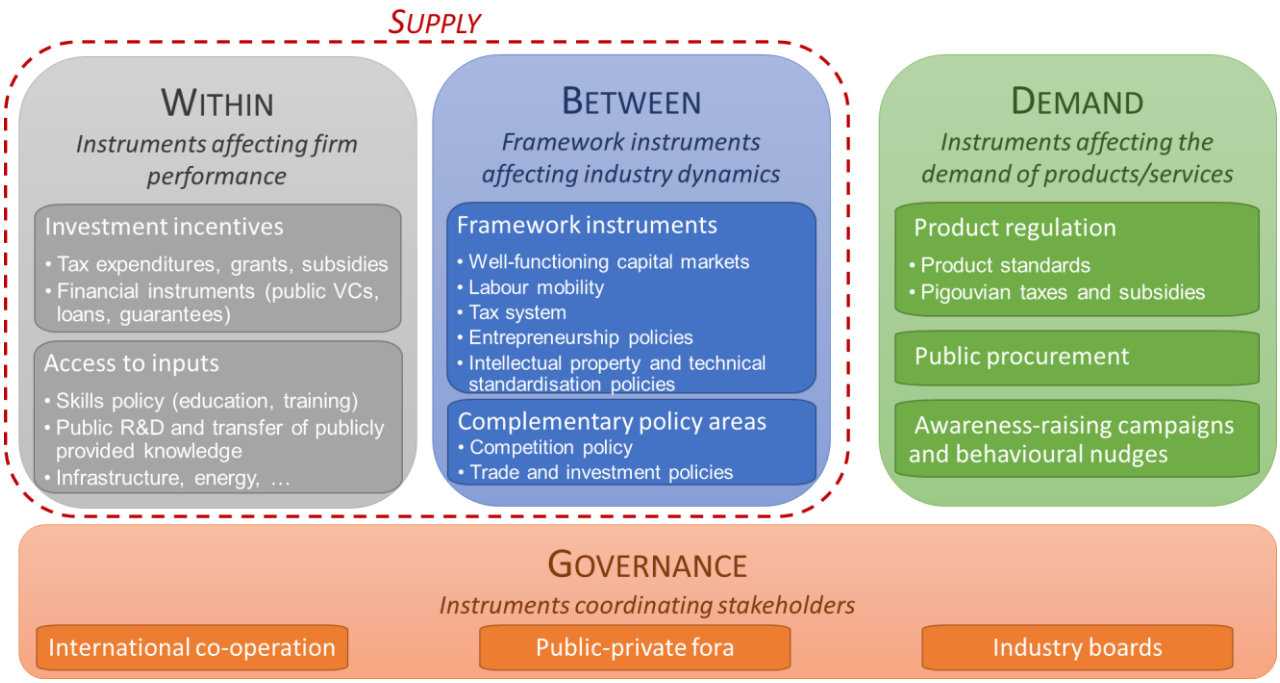
Importantly, the objectives described above are not mutually exclusive and synergies exist across the different policy instruments. For instance, green industrial policies often require innovation support in order to make a business case for low-carbon technologies, which may result in improved competitiveness.

3. Policy instruments

3.1. Distinguishing instruments

This section introduces a new taxonomy of industrial policy instruments (Figure 4), which allows (i) uncovering the rationale and the channels through which different instruments operate and (ii) underlining possible complementarities between different types of instruments. The new taxonomy is designed to serve as a conceptual backbone of industrial policy analysis. It is also used as a tool to organise the evidence on industrial policy instruments, as summarised in Criscuolo et al. (2022[1]). Existing taxonomies typically classify policy instruments according to either the corresponding input factors, the technology-readiness level (TRL), the target group or the instruments' objective and associated goals (Warwick, 2013[8]; O'Sullivan et al., 2013[51]; Steinmueller, 2010[52]; EC/OECD, 2019[53]; Edler et al., 2016[54]; UNCTAD, 2018[55]; WTO, 2020[56]).

Figure 4. Taxonomy of policy instruments



Note: Examples based on main channel through which policy instruments work.
Source: Authors.

This new taxonomy builds upon two essential distinctions to achieve the desired type of analysis.

First, it borrows from the mainstream split between supply-side instruments and demand-oriented instruments (Edler et al., 2016[54]). Supply-side instruments affect domestic production decisions, regardless of where consumption takes place, while demand-side instruments affect domestic consumption decisions, regardless of where production takes place.

Second, among supply-side instruments, the taxonomy further distinguishes those that affect efficiency within firms from those that affect the allocation of production factors between firms, in the same spirit as in the productivity literature (Olley and Pakes, 1996[57]; Syverson, 2011[58]; Bartelsman and Doms, 2000[59]). This allows capturing any interaction between different instruments.

Distinguishing "between" instruments from "within" instruments is a key novelty in thinking about industrial policy. In doing so, the new taxonomy explicitly accounts for Schumpeterian dynamics and the fact that productivity growth partly comes from creative destruction, in particular the reallocation of production factors from less to more productive firms with a superior technology or better innovation capacity (Aghion and Howitt, 1992[60]). Empirical work has confirmed that such reallocation between firms is a major growth channel (Haltiwanger, Jarmin and Miranda, 2013[61]; Bravo-Biosca, 2016[62]).

The "between/within" distinction also helps thinking about resilience. Indeed, sectoral resilience can be achieved through two channels: increasing firm-level resilience and improving the ability to swiftly mobilise and (re)allocate resources across firms. The former can be fostered through "within" instruments; the latter mostly through "between" instruments promoting business dynamics.

In addition to demand- and supply-side instruments, governance is regarded as a necessary enabler of successful policy interventions – see Box 2. Therefore, as depicted in Figure 4, "governance" instruments complement the three main categories of industrial policy interventions. Their role is to coordinate stakeholders in the business sector, the public sector and research institutions, e.g. industrial actors, governments or universities, at the subnational, national and international levels. Moreover, the ongoing COVID-19 crisis highlighted the importance of international co-operation and reinforced the importance of sound multi-level governance at the national level.

Many policy instruments can be either horizontal or targeted. Yet, while "within" instruments typically feature in both types of policies, "between" instruments are more likely horizontal. Demand-side instruments are more likely targeted, in particular as part of transformative industrial strategies that aim to promote sustainable production and consumption simultaneously (Altenburg and Rodrik, 2017[63]; OECD, 2021[12]).

Box 2. The governance of industrial policies

Like in other policy areas, good governance and transparency settings promote the success and inclusiveness of industrial policies. Such governance settings rest on three pillars:

- **Design**: whole-of-government approach involving all levels of government, academia, the private sector and civil society;
- **Implementation**: by professional agencies;
- **Evaluation**: built in ex-ante.

Recent OECD work reviewed the governance mechanisms of 13 national and supranational STI initiatives and identified several critical dimensions leading to successful initiatives (Paic and Viros, 2019[64]). These include a commitment at the highest level of government to signal priorities to all stakeholders; the implication of all stakeholders to promote knowledge and innovation absorption; a "mission orientation" to increase societal impact; the coherence of specific intermediary objectives to promote

complementarities and prevent unintended effects; a systematic evaluation and monitoring to make adjustment or termination possible; the flexibility in setting priorities to be able to respond to rapid technological change; and the streamlining of existing programs to optimise the use of resources.

In addition, public-private coordination fora are key for targeted policies, as they help alleviate the coordination failure that justify sectoral and mission-oriented interventions (Larrue, 2021[5]). Such fora are meant to both promote the efficient transfer of publicly-produced knowledge and help government gather information on the technical issues at play.

In October 2019, the OECD organised a workshop on "Reorienting STI and industrial policies to tackle societal challenges". Policy makers involved in mission-oriented STI policies shared their experience of the challenges and opportunities associated with such initiatives, from research to innovation and industrial and commercial deployment. The talks perfectly illustrated the recent inflections of industrial policies: whether at the level of the European Union (Horizon Europe), in Germany (New HT Strategy 2025), in the Netherlands (Top Sectors) or in the United Kingdom (UK Industrial Strategy), industrial policies increasingly follow a "mission-oriented" approach, which often transcend the boundaries of industrial sectors – see Section 4. . The discussion suggested that the governance settings of these policies seek to maintain a healthy competitive business environment in which new entrants have as much latitude to participate as established players.

Finally, Larrue (2021[5]) recently explored the design, funding and implementation of mission-oriented innovation policies to address societal challenges. This work mapped the practices of such systemic initiatives with regards to i) how they engage a wide range of stakeholders in the mission definition; ii) how they coordinate public and private actors beyond disciplinary, sectoral and policy silos around the common mission; iii) how they integrate and implement different policy and regulatory instruments in consistent schemes or programmes to achieve the mission.

3.2. Within instruments

"Within" instruments can be split into two subcategories (left box in Figure 4).

In the first sub-category, "within" instruments affect incentives for business investment through sharing either the costs or the risks with the public sector. In particular, knowledge externalities result in insufficient incentives for firms to invest in risky projects: firms under-invest because they only get a share of the total return on their investment (Bloom, Van Reenen and Williams, 2019[21]; OECD, 2015[65]). This market failure can justify the use of instruments such as R&D tax credits, grants or subsidies, of which the aim is to share the costs of investments between public and private stakeholders (Hall, Mairesse and Mohnen, 2010[66]). Beyond knowledge externalities, asymmetric information makes risk assessment difficult for third party investors, including financial institutions, which may hinder the financing of risky investments. This justifies the use of instruments that transfer part of the risk from the business sector to the public sector (loans, guarantees, public venture capital).

In the second subcategory, "within" instruments affect firm performance through the provision of efficiency-improving inputs. To carry out innovative and risky investment, firms need to access specific inputs, in particular skills and knowledge. The externalities and market failures that plague the markets for skills and knowledge justify the intervention

of the public sector. Regarding skills, interventions include public support to investment in specific skills required by the business sector, vocational and on-the-job training. Regarding research, interventions are increasingly coupled with schemes facilitating the absorption of research outcomes by the business sector or incentivise mobility between universities and public research institutes on the one hand and businesses on the other hand or collaboration between these different actors in the innovation ecosystem. Moreover, continuous access to inputs such as energy and infrastructure (including broadband, 5G, ...) is crucial and a factor of resilience.

'Within' instruments from these two subcategories do not only affect innovation at the frontier but also promote technology diffusion by improving the absorptive capacities of firms, for instance by supporting related investments, improving firms' management practices or by addressing skill shortages and skills mismatch (Calvino and Criscuolo, 2022[67]; Calvino et al., 2022[68]).

3.3. Between instruments

Among "between" instruments (middle box in Figure 4), one can distinguish

- Framework instruments, which affect the reallocation of production factors (capital and labour) towards the most productive uses, allow efficient entry of new ventures or provide a framework to balance the benefits of innovation diffusion with the incentives to innovate through intellectual property and standardisation policies;
- Complementary policy areas, which aim to ensure a fair competition between firms (in particular incumbents and challengers or domestic and foreign firms).

Product market regulations (PMR) play a key role with respect to factors' allocation, as they condition firms' entry, exit, scale up and scale down. Pro-competitive PMR enable innovative firms to bring new products to the market and expand. While tax expenditures constitute a privileged channel for investments incentives, tax systems also have major effects on the user cost of capital and therefore on the allocation of capital across firms, both internationally and domestically.

Note that, by allowing entrants and small firms to compete and eventually challenge large incumbents, framework instruments can have an indirect positive effect on both challengers' and incumbents' incentives to innovate or adopt frontier technologies and organisational practices, thereby fostering within-firm performance.[8]

Box 3. Entrepreneurship and SME policies

Start-ups and small and medium enterprises (SMEs) are an important target of industrial policy interventions in OECD countries (OECD, 2019[69]). Although size- and age-dependent by definition, entrepreneurship and SME policies are horizontal in essence, as they aim at improving the entire business environment for any entrepreneur to innovate, grow and create value added. Moreover, SMEs are the predominant form of business and employment across OECD countries, so that SME policies affect the overwhelming majority of firms.

Two main reasons underlie the importance of entrepreneurship and SME policies for policymakers:

- Start-ups and young firms contribute disproportionately to private sector job creation in OECD countries (Criscuolo, Gal and Menon, 2016[70]). Moreover, fast-growing young firms are more likely to recruit workers from disadvantaged

or marginalised groups, thereby contributing to sharing productivity gains with larger segments of the population (Coad et al., 2014[71]).

- The entry and growth of new firms to replace old, unproductive ones is the engine of efficiency-enhancing reallocation and a major driver of aggregate productivity growth (Decker et al., 2017[72]). Moreover, start-ups are often seen as vehicles of radical innovation and, thus, of reallocation and productivity growth (Acemoglu et al., 2018[73]). SMEs can also contribute to innovation and productivity growth thanks to their relatively simple organisational structure, which enables them to be agile and responsive to the market.

The rationale for supporting start-ups and SMEs stems from the disproportionally high fixed operating costs they bear due to administrative processes, as well as credit market imperfections and other information asymmetries. Generally, entrepreneurship and SME policies can be welfare improving to the extent that both government failures and labour, capital and technology market failures are more likely to affect start-ups and SMEs than large incumbents (Calvino, Criscuolo and Menon, 2016[74]).

These elements suggest that "between" instruments are especially relevant for fostering start-ups and SMEs (see Figure 4). Among "within" instruments, those that promote risk sharing also help address start-ups' and SMEs' structural disadvantages.

Across OECD countries, SMEs represent on average more than 90 % of the business population and are therefore a very heterogeneous group: policies should take this into account (OECD, 2020[75]; OECD, 2020[76]). For example, age is an important dimension of this heterogeneity. Indeed, young, rather than small, firms account for the bulk of job creation (Criscuolo, Gal and Menon, 2016[70]; Haltiwanger, Jarmin and Miranda, 2013[61]). Moreover, size-contingent policies need to avoid creating disincentives to scale up and grow, as they may distort the allocation of inputs and be detrimental to aggregate productivity (Garicano, Lelarge and Van Reenen, 2016[77]; Aghion, Bergeaud and Van Reenen, 2021[78]; Ando, 2021[79]).

Finally, age and size criteria should take into account the economic boundaries of a firm rather than relying on a strictly legal definition, in order to avoid creating loopholes due to ownership linkages.

3.4. Demand instruments

The third category contains demand-oriented instruments (at the right of Figure 4), which apply to domestic consumption (including intermediate consumption), regardless of where production takes place. They influence the demand for products and services, either through diminishing their price or availability or through increased public demand. The distinction between supply- and demand-side instruments is sometimes referred to as the "supply-push" vs "demand-pull" dichotomy in the innovation literature, although their exact definitions may vary across publications.

Carbon pricing is a typical example of Pigouvian taxes, and as such a demand-side instrument. However, in practice, carbon pricing concerns only domestic emissions and treats differently domestic and foreign production, thereby potentially affecting competitiveness. Recent discussions on Carbon Border Adjustment Mechanisms (CBAM) aim to address the adverse competitiveness effects (as well as the associated carbon leakages) and would bring carbon pricing closer to a pure demand-side instrument.

Most demand-oriented instruments are not primarily targeting firm's productivity and innovation and rather focus on consumer safety (e.g. product standards[9]) or follow behavioural objectives.

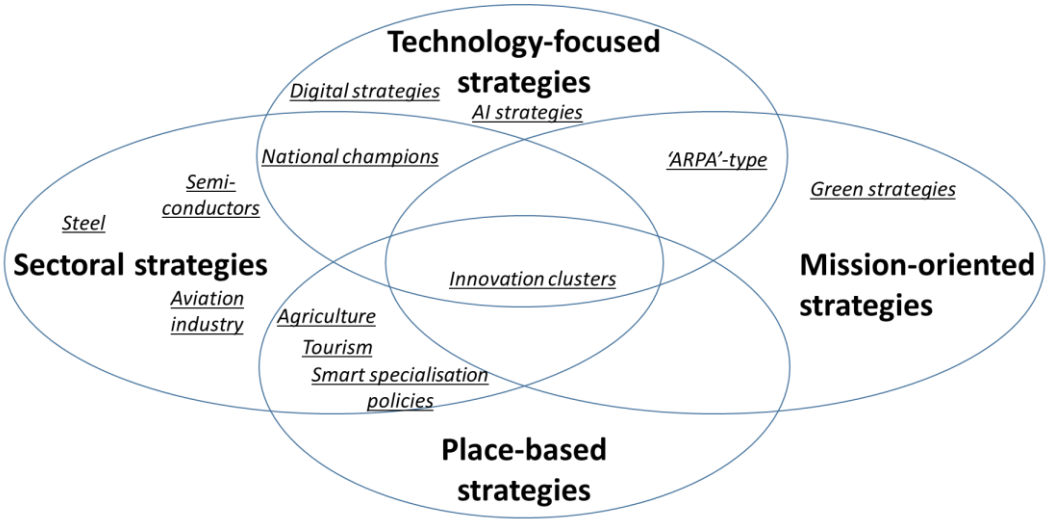
Public procurement instruments are popular in incentivising innovation, for instance by reducing market size risk or helping "demonstrate" a new product with public clients before uptake by the private sector.

Finally, some demand-side instruments have an explicit industrial policy rationale, even though their effect on domestic producers is less direct. At first glance, demand-oriented instruments should have symmetric effects for domestic and foreign producers. For instance, a tightening of regulatory standards in a given country should force both types of producers to adapt to the new standards, and have the same effect on the incentives to innovate. However, this type of instrument may favour domestic producers disproportionally, either because of the purposeful design of regulatory standards (e.g. local content requirements) or because they can become familiar with the new regulation and implement it at a lower cost. More generally, the local nature of innovation and the fundamental uncertainty on the demand might give some rationale for demand-oriented instruments.

4. Industrial strategies

Countries are increasingly adopting industrial strategies focused on subsets of the economy they deem to deserve support. Several ways of defining the relevant subset of firms co-exist. This paper distinguishes four types of selection criteria: sectoral, mission-oriented, technology-focused and place-based strategies. This section describes these different types of targeted industrial strategies (see Figure 5) and their economic rationale (summarised in Table 1).[10] It starts from the standard sectoral orientation and then elaborates on mission-oriented and technology-focused strategies. It also briefly describes place-based strategies, which have been extensively reviewed elsewhere.[11] Moreover, Annex A describes two examples of industrial strategies (green and AI strategies) in a subset of countries or regions (European Union, People's Republic of China (hereafter "China"), United States, United Kingdom, Japan and Germany).

Figure 5. Types of industrial strategies



Note: Stylised representation; real-world strategies often borrow characteristics from several categories.
Source: Authors.

Table 1. Industrial strategies and their rationale

	Sectoral	Mission-oriented	Technology-focused	Place-based
Learning-by-doing	✓		✓✓	
External economies of scale	✓			
Informational externalities	✓		✓✓	
Competition creation	✓			
Upstream sectors in value chains	✓		✓✓	
Coordination failures	✓	✓✓	✓	
Societal benefits		✓✓		
Acceptability of public investment		✓		
Regulatory uncertainty or Imperfect commitment		✓		
Marshallian externalities				✓

Notes: ✓ means relevant; ✓✓ means especially relevant.
Source: Authors.

4.1. Types of strategies

4.1.1. Sectoral strategies

Sectoral strategies are the oldest and simplest type of targeted industrial strategy. Firms are eligible based on their activity. Sectoral strategies either target a sector or a group of interlinked sectors, for instance an industrial eco-system – see European Commission (2021[80]).

Sectoral strategies primarily aim at increasing innovation and productivity growth. The recent focuses on strategic autonomy and resilience could also trigger a new wave of sectoral strategies. Sectoral strategies can also aim at inclusiveness, by targeting sectors that concentrate low- or middle-wage workers or that are expected to decline rapidly with significant social consequences.

While the rationale underlying this type of intervention was first discussed decades ago, new arguments are emerging in the recent literature. Most are based on the existence of different types of spillovers described below (in addition to standard knowledge spillovers) to justify sharing the costs or the risks of investments.

Learning-by-doing

Under the learning-by-doing argument (also referred to as the infant industry argument in the trade literature), sectoral productivity increases with experience, of which cumulated production volume is a proxy, based on the idea that firms discover and improve processes over time.

The literature has questioned the validity of this hypothesis, arguing that the government's valuation of expected payoffs should not be better than the private sector's, as both take future productivity gains into account (Baldwin, 1969[81]). However, the combination of learning-by-doing with spillovers (external learning-by-doing) or imperfections in the capital markets resulting in a wedge between the public and private valuation of investments theoretically restores the validity of the argument (Pack and Saggi, 2006[17]; Melitz, 2005[82]).

However, the empirical evidence is mixed. On the one side, supporters of this rationale argue that the experience of industrial policies in the Asian countries gives credit to the infant industries narrative. On the other side, counterfactual studies supporting this assertion are scarce and give contrasting results (Criscuolo et al., 2022[1]).

Finally, the learning-by-doing rationale justifies temporary public support only. The timing and design of the phasing out of support is key in ensuring efficiency. Once the domestic industry has climbed the learning curve, it is supposed to be able to compete on the global scale. However, some argue that this type of support creates moral hazard, as the incentive to become competitive is weak if firms continue receiving support otherwise.

External economies of scale

External economies of scale imply that firm productivity increases with sector size (as opposed to firm size), usually at the national level and sometimes beyond, creating a wedge between the public and private returns to investment. Hence, subsidising the sector to increase its size can improve the efficiency of the economy (Chipman, 1970[83]).

This rationale can be seen as a static version of the learning-by-doing argument. With learning-by-doing, productivity increases with the cumulated output of an industry, while with external economies of scale it increases with current output. As in the previous discussion, in theory, internal returns to scale do not distort the firm's decisions and do not call for a public subsidy[12].

The empirical evidence is insufficient to identify the sectors that are subject to external economies of scale. Bartelme et al. (2019[84]) find evidence of external economies of scale in all 2-digit sectors, but they are limited, and the gains from an optimal industrial policy (i.e., internalising the external economies of scale) are small. This paper has however the merit to set out a method for the estimation of the external economies of scale at the industry level. Pons-Benaiges (2017[85]) finds similar results and shows that the post-WWII Japanese industrial policy is positively correlated with the external returns to scale.

Informational externalities

Through experimentation, early investors reveal sector-specific information that allows subsequent investors to better assess the risk-return profile of the investments (Pack and Saggi, 2006[17]). In this respect, followers benefit from the risk having been taken by first entrants, which should therefore be supported.

This argument is close to the learning-by-doing one, as it is also about early investors improving the risk-return profile. Whereas with learning-by-doing the first entrants increase the expected pay-off of an investment, with informational externalities they are reducing the risk or the uncertainty of this investment.

Competition creation

In industries with barriers to entry (e.g. large fixed costs, network effects, regulatory obstacles or incumbency advantages), private incentives to enter may be insufficient. In such a case, monopoly situations are likely to arise, with a detrimental effect on competition. The support to entering firms can be welfare improving by creating competition and increasing of consumer surplus.

This argument has usually been put forward for situations in which the monopolist is a foreign firm and the domestic government wants to create a national champion. While the creation of Airbus is the most famous example of a successful policy in this context, the argument is also often made regarding the digital platforms.

However, welfare analysis should take into account the negative externalities abroad. In particular, the creation of a national champion duplicates fixed costs at the global level and may lower the overall efficiency of the industry (Neven, Seabright and Grossman, 1995[86]).

Upstream sectors

In value chains, the productivity of upstream sectors has an impact on the performance of downstream sectors, which may call for government support (Liu, 2019[87]). Upstream services can be particularly important for the productivity of downstream manufacturing industries.[13]

However, it is unclear why upstream sectors would underinvest in productivity improvements, or how gains are shared through the value chains, both with downstream sectors and between domestic and foreign clients.

With home bias in trade and externalities within value chains, it may still be rational to target some interventions on these upstream sectors. Liu (2019[87]) shows that South Korea supported upstream sectors in the 1970s (e.g. heavy and chemical manufacturing) and China is doing the same today.

Moreover, the COVID-19 crisis exposed the potential of shocks to directly impair the functioning of some sectors absent relevant and timely policy responses (e.g., the airline industry or the non-essential retail sector), which can in turn indirectly affect the rest of the economy (e.g., indirect impact of airline industry on tourism) – see, e.g., OECD (2020[88]). If a sector-wide disruption were to jeopardise the viability of parts of the economy, it would cause tremendous negative externalities to society as a whole in the long run.[14] Therefore, the benefits of publicly supporting sectoral resilience could outweigh its costs and thus become an objective of sectoral policies.

However, the optimal level of public support for resilience enhancement is unknown, as it involves different aspects and timelines.[15] In particular, the optimal cost sharing between the public and private sectors remains an open question. Even if resilience can give rise to social externalities, firms also directly benefit from their own resilience and thus have intrinsic incentives to invest in this direction. Firms, however, can face moral hazard and have little incentives to invest in resilience against some types of shocks, for instance disastrous shocks that will anyway require public support.

Coordination failures

Some projects may require several (compatible) simultaneous investments. For instance, complex products may need a vast network of suppliers (need of horizontal coordination), or products may go through a number of outsourced production steps through value-chains (need of a vertical coordination).

If coordination fails, governments should step in through exchanges of information and cooperation between the stakeholders. They can resort to industry boards, but also standardisation initiatives or improvements of the intellectual property system.

These remedies may emerge spontaneously from professional organisations (Romer, 1993[15]), or the public sector can play an active role, as a third party or a stakeholder, to make this public-private coordination happen (e.g.‘21-platforms’ in Norway, various sectoral strategic committees in Japan).

4.1.2. Mission-oriented strategies

Larrue (2021[5]) defines a mission-oriented innovation policy as a “co-ordinated package of research and innovation policy and regulatory measures tailored specifically to address

well-defined objectives related to a societal challenge, in a defined timeframe. These measures possibly span different stages of the innovation cycle from research to demonstration and market deployment, mix supply-push and demand-pull instruments, and cut across various policy fields, sectors and disciplines." Even though this definition is designed for innovation policies, it is straightforward to extend it to industrial policies more generally.

As it is clear from the definition, the missions pursued by this type of policy are not only about tackling 'grand challenges', such as for instance addressing climate change, but are also translated into concrete and measurable objectives and targets to be met in a defined timeframe. They range from green strategies (see Annex A for a description of green strategies in selected countries and regions), in which emission targets or resource efficiency objectives apply to a vast range of industries through several policy instruments (see below), to more targeted interventions, such as the ones in 'ARPA'-type[16] challenges (Azoulay et al., 2019[89]), the fight against some public health issues or 'moonshots'[17]. The European Commission (2018[90]) distinguishes between well-defined narrow missions (accelerators) and broad missions addressing complex multi-faceted challenges (transformers) - see also Wittmann et al. (2020[91]).

Mission-oriented strategies are becoming increasingly popular to address societal challenges, including the green transition and more generally the SDGs (OECD, 2021[12]).[18] By improving sustainability, mission-oriented strategies can also be understood as contributing to the long-run resilience of industry. Moreover, as innovation and technology diffusion are usually key levers to overcome these challenges (Popp, Newell and Jaffe, 2010[92]; Anderson et al., 2021[10]), they can become objectives in themselves.

Mission-oriented policies differ from other types of strategies in that they are 'transformation-oriented' (Weber and Rohracher, 2012[93]), i.e. they address the direction of innovation rather than its level and need coordination across policy domains and across stakeholders (consumers, government, research institutions, etc.). They therefore include, alongside investment incentives, several policy instruments in the demand-side and governance categories (see the green strategies described in Annex A).

One important question regarding these strategies is whether they are superior to a combination of pure demand-side instruments to address the spillovers linked to the challenge and horizontal policy instruments to foster innovation.

Four rationales can justify the use of mission-oriented policies:

- Social benefits. In addition to the traditional knowledge spillovers, mission-oriented innovation yields social benefits that are inherently linked to the issue that they are aimed at tackling, be it national security or sustainable growth (Rodrik, 2014[94]). Along this line, mission-oriented policies do not aim at fixing market failures linked to innovation (Mazzucato, 2018[20]; Foray, Mowery and Nelson, 2012[95]; Ergas, 1987[96]). Indeed, the literature on mission-oriented policies often claims that these strategies do not only support economic growth, but also its direction. In other terms, there are paths in economic growth that are preferable to others because they provide a higher level of well-being in the long term (Wanzenböck et al., 2019[97]). In a Schumpeterian framework where firms innovate to create new markets, mission-oriented industrial policies can incentivise or catalyse firms to search in selected directions (Cantner and Vannuccini, 2018[98]). Some of the COVID-19 crisis recovery plan were designed following more or less explicitly a mission-oriented policy approach (e.g., the Korean New Deal or NextGeneration EU) so as to more proactively foster sustainable development in the long-run.

- Coordination failures (see above) may be particularly severe when a mission requires simultaneous investments occurring in different industries (Altenburg and Rodrik, 2017[63]), which is likely to be the case when dealing with societal challenges, for instance the promotion of a thriving circular economy (OECD, 2020[99]).
- Acceptability of public investment. Bloom, Van Reenen and Williams (2019[21]) provide a political economy argument in favour of such mission-oriented policies. They argue that, by articulating a political vision around expenditures, mission-oriented narratives can make it more acceptable to invest additional resources in new technologies. By putting forward bold inspirational goals, mission-oriented policies are conducive to higher and wider stakeholder engagement, including citizens. In the same vein, they can facilitate the pooling of resources of different ministries, enabling more ambitious and complex projects, and the reduction of unnecessary overlaps between their respective actions in the same areas.
- Regulatory uncertainty / imperfect commitment. Firms' investment decisions rely on their discounted benefits over a long time span. If regulatory uncertainty casts doubt on the ability to recover the costs of the investment, it may hamper innovation (Popp, Newell and Jaffe, 2010[92]). For instance, in low-carbon transition strategies, governments need to set a clear carbon price trajectory for the private sector to invest in low-carbon productive capital – see Anderson et al. (2021[10]). However, their commitment to the carbon price trajectory can be perceived as imperfect, as governments can still renege on their promises, or be overturned by elections. In such case, targeted industrial policy may be needed, on top of the traditional demand-side policy (Harstad, 2020[100]).

4.1.3. Technology-focused strategies

Technology-focused strategies mainly aim at fostering innovation, diffusion and, ultimately, productivity. Technologies that have applications in several sectors and can be considered as General Purpose Technologies (GPTs), following the work of Bresnahan and Trajtenberg (1995[101]), attract special attention from many countries.

Like mission-oriented policies, technology-focused policies are by nature multi-sectoral, but may also include targeted interventions on the sector producing the good or the service embodying the GPT (see Annex A for a description of AI strategies in selected countries and regions). Two types of arguments are usually put forward when designing technology-focused policies:

- External learning-by-doing or informational externalities (discussed above) may be particularly severe on new technologies with wide-ranging applications, including follow-on innovations (Dolfsma and Seo, 2013[102]), which are not covered by intellectual property rights. For instance, the 'Nascent S-curve' (see for instance Azoulay et al. (2019[89]), frequently cited as an element of the ARPA model, incorporates this idea of a large first-mover disadvantage in emerging fields or technologies where the inflection point is likely to be close, but a lot of uncertainty remains.
- Upstream sectors. The argument developed above applies to sectors producing the goods or services incorporating the GPT.

4.1.4. Place-based strategies

Place-based strategies mainly aim at affecting the regional distribution of economic activity, thereby addressing inclusiveness, fairness and/or equality objectives. They sometimes aim at increasing productivity and economic growth by supporting the specialisation of regions in some sectors and technologies in which they have a comparative advantage (innovation cluster policies, e.g., Smart Specialisation Strategy in the European Union).

The rationale for place-based policies largely stems from the Marshallian externalities (economies of scale in the production of specific intermediate goods, in the specialisation of the local labour market, and the existence of local knowledge spillovers).

Place-based policies are the object of a large literature and are not at the core of this report. For this reason, the evidence on the efficiency of place-based policies is not detailed here, and interested readers may refer to Neumark and Simpson (2015[103]) and OECD (2015[65])[19].

Cluster policies bring together research institutions, large firms, start-ups and SMEs to create innovation clusters that leverage localised knowledge spillovers and at the same time achieve the necessary critical size to be connected to the global knowledge pipeline (Feldman and Kogler, 2010[104]). They usually include policy instruments of the "within" category (e.g. tax incentives, R&D grants and risk-sharing instruments, knowledge transfer from public research) and governance arrangements to co-ordinate public and private stakeholders. Examples of such an approach, based on the local comparative advantage in some innovative sectors, can be found in Canada (Innovation Superclusters Initiative[20] - 2018), the United States (Manufacturing USA[21] – 2012) and many European countries (e.g., go-Cluster, Spitzencluster and Zukunftcluster initiatives in Germany; Pôles de compétitivité in France).

While past innovation cluster policies were found to be little effective (Uyarra and Ramlogan, 2016[105]), the new wave of cluster policies may be different (Ben Hassine and Mathieu, 2020[106]; Bartik, 2020[36]; Mar and Massard, 2021[107]). Yet, many programs are too recent to be evaluated and results may strongly depend on the design, governance, technology and local economic conditions (Grashof, 2021[108]).

4.2. Strategy overlap

The different types of strategies may in some instances overlap. Mission-oriented strategies are likely to include technology-focused or sectoral policies. For instance, green technologies appear to have some GPT components (Barbieri, Marzucchi and Rizzo, 2020[109]; Nomaler and Verspagen, 2019[110]). Technology-focused strategies may also include sectoral or mission-oriented policies. For instance, some actions of AI strategies are motivated by the will to preserve human rights and democratic values (OECD, 2019[111]).

In fact, technology-focused strategies can be viewed as solution-led pathways whereas mission-oriented strategies are rather problem-led pathways (Wanzenböck et al., 2019[97]). They underline that many strategies are in fact hybrid, in the sense that they integrate both technology-focused and mission-oriented elements. While keeping this limit in mind, this categorisation of policy orientations remains useful to explicit the underlying rationale of strategies.

Place based-policies can also be sectoral, mission-oriented or technology-focused policies, as soon as Marshallian externalities are expected to take place at the sectoral or at the technology level.

5. Policy recommendations

The previous sections of this paper have discussed the definition and scope of industrial policy and laid out a framework to analyse industrial policy interventions based on the distinction between objectives, strategies and instruments. Armed with that framework and leveraging the extensive literature review in Criscuolo et al. (2022[1]), this final section identifies four main policy messages.

5.1. Complementarities between policy instruments justify the use of industrial strategies

The combination of the results from the literature review on the effectiveness of industrial policy instruments (Criscuolo et al., 2022[1]) with the taxonomy developed in this paper underlines the importance of designing industrial policy strategies that include several instrument types, such as investment incentives, access to inputs and framework conditions. This mirrors the co-existence of multiple market failures linked to knowledge spillovers, financial markets, labour markets, myopia, uncertainty, etc. (OECD, 2021[11]).

The existing evidence stresses the effectiveness of each category of policy instruments and the importance of policy design:

- Investment incentives have been extensively studied and evaluated. For instance, there is now rich evidence that well-designed R&D tax credits and subsidies are effective in stimulating R&D and innovation. Although the impact is less clear cut regarding non-R&D investment incentives, targeted incentives and financial instruments (such as public loans, public guarantees and government venture capital), the body of evidence is growing and will allow uncovering the strength and weaknesses of these interventions.
- "Access to inputs" instruments, such as skill and transfer policies, are shown to be crucial enablers of innovation and productivity growth (Criscuolo et al., 2022[1]).
- Framework policies, notably competition and trade policies, are complementary to industrial policy and are key in enabling the most productive firms to grow. These instruments directly affect the allocation of resources and their reallocation between firms, which is one of the main drivers of productivity growth and structural change.

The framework developed in this paper sheds light on the complementarity between those three categories of instruments.

- **Complementarity between investment incentives and access to inputs**. "Access to inputs" instruments, such as skill and transfer policies, enhance the effectiveness of investment incentives and contribute to increasing the absorptive capacities of the least productive firms, thereby fostering technological diffusion.[22]
- **Complementarity between instruments affecting firm performance ("within") and instruments affecting industry dynamics ("between").** Framework instruments enable firms' exit, allow the most productive firms to grow and contribute to translating firm-level successes into macroeconomic impact. In particular, there is a large body of evidence showing that competition policy is an efficient instrument to reallocate resources toward the more productive firms and,

indirectly, incentivise firms to innovate. More generally, business dynamics is a key lever of structural change.

5.2. Targeted industrial strategies can direct technological change and growth, but should be handled with care

While the market failures justifying sectoral or place-based strategies have been extensively discussed during the previous decades, this paper provides a comprehensive review of the justifications for mission-oriented and technology-focused strategies. The former primarily rests on the specific spill-overs stemming from the social benefits of the mission, but can also be justified by particularly severe coordination failures and the legitimacy provided by the challenge or the general-interest dimension of the mission. The latter, particularly when it comes to General Purpose Technologies (GPT), can be justified by external learning-by-doing and informational externalities for nascent technologies, as well as their upstream nature.

While there are clear rationales in favour of targeted industrial strategies, the lack of conclusive evidence on the effectiveness of targeted industrial policy instruments (see the companion paper) and the pitfalls of targeted industrial policies (Box 4) call for prudence. In particular, when designing targeted strategies, it is important to:

- **Ensure that horizontal policies are not sufficient to reach the objectives of the strategy**. More generally, horizontal policy instruments can usefully complement targeted policy instruments within a strategy to achieve a given objective. For instance, to limit negative general equilibrium effects, strategies need to include instruments favouring access to inputs (both at the targeted and horizontal levels). It can be particularly useful to ensure that the necessary skills can be provided in sufficient quantities.
- **Make explicit the rationale behind the strategy and ensure that policymakers can rely on the relevant technical and business knowledge**. Governments having a strong role to play in tackling societal challenges, asymmetry of information could be limited for mission-oriented strategies. As targeted industrial policies are very demanding on information, and since the choice of the selected projects is of paramount importance, this may explain, and justify, the increasing appeal of mission-oriented strategies (Rodrik, 2014[94]; Aiginger, 2014[112]);
- **Pay particular attention to the governance of the strategy** to limit the risk of capture and attenuate information asymmetries (Paic and Viros, 2019[64]; Romer, 1993[15]; Warwick, 2013[8]). Otherwise, targeted strategies may hinder competition and therefore innovation. In particular, it is necessary to:
    - favour their inclusiveness, notably by ensuring that young firms are solicited to participate and that, to the extent possible, the specifications are technology-neutral and do not discriminate between domestic and foreign firms;
    - plan at inception scheduled assessments and evaluations;
    - allow for failure, and plan a regular refit of the instruments and the strategy. It is even more important when risks or 'wickedness' are high, in particular for broad mission-oriented policies (Cantner and Vannuccini, 2018[98]; Wanzenböck et al., 2019[97]). Removing or retargeting industrial policy instruments brings important political economy challenges.

More work is needed on best practices for the design of targeted strategies and the identification of the rights targets. The 'ARPA' model (Advance Research Project Agency

from the US Department of Defence) is usually presented as close to best practices in terms of governance (Azoulay et al., 2019[89]; Rodrik and Sabel, 2019[31]; Larrue, 2021[5]). In particular, these papers put forward the agile organisational structure, the promotion of risk-taking and the capacity of allowing a rapid withdrawal of ailing projects. This governance is based on the role and the talent of the programme managers, whose academic reputation is supposed to limit the asymmetry of information and to reduce the capture risk. It complies with the three principles of embeddedness, discipline and accountability (Rodrik, 2008[19]; Rodrik, 2014[94]). This literature rests on anecdotal evidence or technical assessments (GAO, 2015[113]; Committee on Evaluation of the Advanced Research Projects Agency-Energy (ARPA-E) et al., 2017[114]), but, even though difficult, a quantitative evaluation would be required.

Box 4. The pitfalls of targeted industrial policies

Economists, be they sceptics or supportive of targeted industrial policy, usually point out three main pitfalls in such interventions.

Access to information

The success of a targeted industrial policy relies on the ability of governments to pick the right target. It requires gathering a vast amount of information on the expected returns, risks, spillovers and other market failures for each project[23]. Some argue that this information is not available (be it for the government or for any other actor) and others that it may be easier to access for businesses than for the government. Even if this information could be gathered, technical experts, which are not necessarily available in the public administration, should process it and then compare the different targets, which requires common metrics and/or cross-sectoral experts. This argument is particularly important for economies at the technological frontier with policy projects related to emerging and uncertain technologies, whereas it is looser for countries trying to catch-up this frontier and benefiting from the experience and knowledge of first movers.

Capture and rent-seeking

Ex-ante. Due to the asymmetric information between public and private sectors, there is a risk of competition and lobbying between policy projects for being picked (Romer, 1993[15]), with two consequences. First, resources may be wasted in the lobbying process (Bhagwati, 1982[115]). Second, the outcome of the lobbying game is not necessarily efficient and may favour the most organised projects, precisely the ones that are less affected by coordination failures. The literature is abundant on this issue (Goldberg and Maggi, 1999[116]; Ades and Di Tella, 1997[117]).

This capture effect may be reinforced when picking firms rather than policy projects, be it for grants, VC investments, or even participation in coordination fora. First, the government may be biased in favour of incumbents, which are easier to identify. Second, it may be inclined to pick losers, in a try to smoothen adjustment costs.

Ex-post. The literature questions the ability to stop projects that are ailing (both at the level of the policy and at the firm level[24]). Rodrik (2008[19]) stresses that successful experiences of industrial policy in East Asia relied on both carrots (tax credits and subsidies) and sticks.[25] In contrast, these sticks were lacking in other targeted industrial policy experiences, such as in Latin America during the 1950-1980 period.

General equilibrium effects

By investing in a policy project, one reduces the availability of public funds, of researchers, of capital, etc. These general equilibrium effects reinforce the need for an appropriate selection of the policy projects. But this selection is the most debated issue on targeted policies.

5.3. Demand side instruments can contribute to transformative industrial change

As mission-oriented industrial strategies have the ambition – going beyond innovation and productivity – to transform the industrial structure, they tend to rely significantly on demand side instruments. The latter are based on where consumption takes place, irrespective of the localisation of production. These affect the demand for products, by changing either their price, availability or public demand. The underlying rationale is the creation of demand (where imperfect markets fail to do so) in order to incentivise scaling-up and improving efficiency through, e.g., learning by doing.

In the context of targeted industrial strategies, demand side policies are particularly interesting as they may be less distortive than targeted supply-side policies. For instance, they are more likely to affect indirectly all the relevant firms, irrespective of their size, age or connections with the administration. Renewable electricity purchase tariffs are for instance more likely to be technology neutral (e.g. between wind and solar photovoltaic) than targeted innovation support. The literature review (Criscuolo et al., 2022[1]) also shows that public procurement may also foster innovation in cases where demand emanates from the public sector (e.g. aerospace, defence, infrastructure).

Criscuolo et al. (2022[1]) provides evidence that demand-side policy instruments can efficiently foster innovation, but also that they have important shortcomings. For instance, they have ambiguous impacts on competitiveness, as innovation is not only stimulated for domestic firms, but also abroad (e.g. impact of European subsidies to solar photovoltaic on innovation in Asia). Regulatory standards can provide a short-run regulatory comparative advantage to domestic firms but can entail long-run negative effects on business dynamics.

In conclusion, demand-side and supply-side instruments seem complementary in fostering transformative industrial change (Anderson et al., 2021[10]). The most pressing policy issue regarding demand-pull instruments regards their optimal combination with supply-push instruments, which ultimately depends on the design of both types of instruments. Among the main remaining unknowns is the overall and comprehensive cost-benefit analysis of innovation-oriented public procurement, taking into account industry heterogeneity.

5.4. Governments need to put a strong emphasis on evaluation and regular re-assessments of targeted policies

Despite renewed interest on targeted policies, the available evidence remains scarce and mainly focused on the effect of investment incentives on their beneficiaries (Criscuolo et al., 2022[1]). The lack of transparent, publicly available and easily accessible information on the implementation of industrial policies hinders evaluation.

This is all the more needed as the pitfalls of targeted policy instruments and strategies call for systematic evaluations and cost-benefit analyses. In particular, it is worth asking the following questions:

- What is the causal impact of the targeted policy instruments on the treated firms, by type of instrument?
- What is the impact of the targeted policy instruments on macroeconomic and societal outcomes, such as productivity, employment, GDP, inequalities or welfare? Answering this question needs to uncover the indirect effects of the policy, e.g. on domestic non-treated firms, other domestic agents (government and consumers) and foreign competitors. It is the first step towards a complete cost-benefit analysis, taking into account the spillovers and market failures that many of these instruments are trying to tackle, and the general equilibrium effects.
- What are the complementarities between targeted policy instruments? How to compose an efficient industrial strategy?
- Are targeted industrial policies more efficient than horizontal ones?

Such a complete cost-benefit analysis of targeted industrial strategies is out of reach for the time being but the very limited and mixed evidence on the effectiveness of targeted industrial policies calls for (i) more work on the evaluation of targeted policy instruments and strategies and (ii) caution when implementing targeted strategies.

Recent advances in data collection, storage and analytics (notably machine learning) may lower the cost of policy impact evaluation, thereby improving the efficiency of targeted interventions – see Box 5. While the evidence on the effectiveness of targeted interventions is limited and mixed so far, digital technologies have the potential to improve the effectiveness of these interventions, in particular by making evaluation richer, cheaper and more timely.

Nevertheless, even if frequent re-assessments can contribute to more efficient policy interventions, policy makers have to take into account the need for stability, and should therefore avoid continual policy adjustments.

Box 5. The potential of new data sources and Machine Learning for designing targeted policies

The ongoing technological developments around big data and machine learning (ML) allows:

- New ways to gather and match information on (new) ventures and innovation inputs or outputs;
- New and more efficient methods to treat this information using Machine Learning (ML) techniques.

This revolution has far-reaching consequences for firms (OECD, 2019[118]), industrial organisation and thus affects industrial and innovation policies (OECD, 2018[119]; Varian, 2018[120]). Big data and ML techniques do not only call for revising the policies, they can also be used in the process of policy-making to improve their design and efficiency (Johnstone et al., 2019[121]).

They are already used as a decision-support tool in a growing share of public policies, e.g., justice, medicine, tax auditing – see Ubaldi et al. (2019[122]) or Berryhill et al. (2019[123]). Nevertheless, industrial and innovation policies seem to lag behind.

However, these new methods can affect the design and targeting of industrial and innovation policies at four moments in the policy cycle[26].

- Ex-ante, by improving the collection of data, either by accessing new data sources (e.g., web scraping) or by allowing the matching between databases that

are not designed to be matched (e.g. patent databases do not feature identifiers and are thus uneasy to match with administrative data (Tarasconi and Menon, 2017[124])).

- Ex-ante, using analytical techniques to foster the evidence-based design of policies. Leveraging on usual data sources or on new types of data (and even more promising by combining both), it is possible to better assess the strengths and weaknesses of the innovation system (e.g., landscape of start-ups, of scientific production, demand of skills)[27].
- Ex-interim, by using the data in real-time to foster the effectiveness and efficiency of the policy (e.g., increase of take-up rates by targeting likely eligible firms, evaluation of investment or default rate for public VCs, subsidised loans or guarantee schemes) – see, e.g., Andini et al. (2019[125]).
- Ex-post, by nurturing the evaluation process, allowing for instance to uncover heterogeneous treatment effects, feeding back into the design of the policy.

Machine Learning can bring large benefits in standard horizontal innovation policies, by, for instance, increasing the take-up rates for R&D tax credits or guarantee schemes, or allowing the identification of the firms that are the most reactive to an investment incentive instrument. The main benefits are through the steps 3 and 4 of the policy cycle.

The advantages may even be higher when dealing with targeted industrial policies. It is highly likely that the benefits can stem from the 4 steps of the previous policy cycle. First, this type of policy may benefit from data on new ventures, not yet available from business registers or other administrative data. It may also benefit from information that is not readily available through these data, such as innovativeness, technological field, or the track record of the management team. Second, these data may need to be processed through machine learning techniques. For instance, identifying innovative firms may be thought of as a classification or a clustering problem. In the same vein, machine learning can be used to identify the strengths of an innovative system. Third, the awareness on these policies, because they are restricted to a sub-sample of firms, may be less widespread, resulting in low take-up rates and the need to identify potential non-takers. Machine learning can also inform public agencies on sectoral issues when designing and implementing public procurement programs or risk-sharing policy instruments. Fourth, as for horizontal policies, the evaluation of heterogeneous treatment effects can be carried out with machine learning techniques (Wager and Athey, 2018[126]).

Endnotes

[1] While this paper focuses on developed economies, there is also a renewed interest in industrial policies on the part of developing countries, partly based on the success story of some East Asian countries (Cherif and Hasanov, 2019[7]; UNCTAD, 2018[55]; Rodrik, 2008[19]). In the context of emerging and developing economies, see also, e.g., Maloney and Nayyar (2018[129]) on industrial policy and government capacity, and Milberg, Jiang and Gereffi (2014[130]) on industrial policy and GVCs.

[2] Annex A shows concrete examples on how to link the rationale of the strategy and the choice of the policy instruments.

[3] Note that some authors restrict the definition of industrial policies to targeted interventions, e.g., Pack & Saggi (2006[17]): "*According to us, industrial policy is basically any type of selective intervention or government policy that attempts to alter the sectoral structure of production toward sectors that are expected to offer better prospects for economic growth than would occur in the absence of such intervention, i.e., in the market equilibrium*." See Warwick (2013[8]) for an inventory of the definitions used in the literature.

[4] The present conceptual framework necessarily simplifies the formulation of industrial policy. In particular, some interventions are a combination of instrument types but do not necessarily qualify as a strategy, e.g., the creation of State-Owned Enterprises (SOEs), which combine the use of implicit subsidies, low competition and specific governance by the public sector.

[5] See also the recent American Jobs Plan (https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/).

[6] Different fields use different operational definitions of resilience. For example, regional science thinks of resilience as three necessary, sequential conditions: a shock, a response by stakeholders and a sustainable trajectory of growth, with the two first elements only constituting resistance – see e.g. Sweeney, Mordue and Carey (2020[131]). Another example is the risk management literature, which distinguishes between robustness (ability to function despite a shock) and resilience (ability to return swiftly to normal operating performance after a shock) of supply chains –see e.g. Brandon-Jones et al. (2014[132]). Resilience has also been a long-standing focus of agricultural policy (OECD, 2020[133]).

[7] Gross and Sampat (2020[134]) discuss the lessons learnt from WWII for crisis innovation policy, and how peacetime innovation and industrial policies can help prepare a crisis. They stress the importance of basic science to lay the ground for the swift development of applications and of the design of institutions able to pivot quickly. During a crisis, these institutions should be able to coordinate and diffuse innovation among the relevant stakeholders, be they public or private, military or civilian.

[8] Conversely, within instruments can increase business dynamics by favouring innovation.

[9] Product standards are considered as demand-side instruments since they apply regardless of where production takes place. On the contrary, regulations of production (e.g. health and safety requirements in the workplace, see OECD (2021[12])) apply to the production stage and are 'within instruments'.

[10] As evident from Figure 5, the four types of selection criteria correspond to a stylised representation. Although useful to understand the underpinnings of the industrial strategies design, it abstracts from the complexity of real world strategies, which often borrow characteristics from several categories.

[11] See OECD (2019[135]) and references therein.

[12] Note that for strategic reasons, governments may however choose to subsidise industries with internal returns to scale, if they are at the same time deemed strategically important and national in scope (Ding and Dafoe, 2021[48]).

[13] The OECD TiVA database allows for the identification of upstream sectors.

[14] The European Union's New Industrial Strategy for Europe in part focuses on ecosystems, a dynamic and modular concept that factors in risk and resilience (European Commission, 2021[80]).

[15] See e.g. OECD (2020[136]) on resilience in GVCs during the COVID-19 pandemic.

[16] Advanced Research Projects Agency. It refers to the type of interventions popularised by the DARPA (Defense ARPA) in the US.

[17] See also the Norwegian Government's action plan for green shipping (Larrue, 2021[5]).

[18] About than 9 out of 10 OECD countries have strategies that address societal challenges (Paic and Viros, 2019[64]).

[19] Other references include OECD (2019[135]) and the references therein, as well as (Crescenzi, 2005[137]; Lee and Rodriguez-Pose, 2012[138]; Eder, 2018[139]; Freshwater et al., 2019[140]; McCann, 2019[141]; Iammarino, Rodríguez-Pose and Storper, 2020[33]).

[20] https://www.ic.gc.ca/eic/site/093.nsf/eng/home

[21] https://www.manufacturingusa.com/

[22] Diffusion policies are extensively reviewed in Calvino and Criscuolo (2022[67]).

[23] See Pack and Saggi (2006[17]) for the list of information required.

[24] In the COVID context, see for instance OECD (2020[142]) and Global Forum on Steel Excess Capacity (2020[143]).

[25] In the case of successful East Asian experiences, credits and subsidies were conditioned on export performance, which avoided keeping unproductive firms alive. However, this is now prohibited by WTO rules, except for export credits conforming to the OECD Arrangement on Officially Supported Export Credits.

[26] See for instance Pencheva, Esteve and Mikhaylov (2018[144]).

[27] See for instance the Korean R&D Platform for Investment and Evaluation (R&D PIE). https://oecd-opsi.org/innovations/rd-platform-for-investment-and-evaluation-rd-pie/

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Annex A. Industrial strategies in practice

This annex describes two examples of industrial strategies – green and artificial intelligence (AI) strategies – in a subset of countries or regions (China, European Union, Germany, Japan, United Kingdom and United States). The aim is not to provide an extensive survey of practices, but rather to use some examples to illustrate how real-world strategies fit into the conceptual framework developed in this paper.

Green strategies are a particularly widespread example of mission-oriented strategies: 76% of the strategies addressing societal challenges aim to support a sustainable economy (Paic and Viros, 2019[64]). As part of green strategies, demand-oriented instruments play a particularly central role to make demand more sustainable, while supply-side instruments (e.g. green innovation subsidies) complement the effect of demand-oriented instruments by inducing green technologies. Part of these strategies concerns the manufacturing sector[1], in particular through innovation.

AI strategies[2] are an example of technology-focused strategies. AI is considered by many stakeholders as a GPT (OECD, 2019[118]), but there remains a lot of uncertainty on the technical, ethical and market challenges around this technology.

This annex relies on the following sources:

- Official websites and publications;
- STIP Compass;
- The AI Observatory (oecd.ai).

The rest of this annex lists the types of instruments used in these strategies, explains how their interactions are designed, in particular the interactions between demand-side, framework and other instruments, and describes the governance arrangements, in particular the diversity of stakeholders and the evaluation process.

Green strategies

Over the past few years, a growing number of economies have launched ambitious, long-term green strategies. This subsection relies on the following examples: part of China's 13th Five-Year Plan for Economic and Social Development (2016-2020), the European Green Deal (2019-2024); Germany's Climate Action Programme 2030 (2019); Japan's 2050 Zero Carbon Cities (2019); and 2 out of 4 Grand Challenges set out in the British Industrial Strategy (2019). Each strategy consists of numerous instruments, targeting a large number of climate-related industries, as well as households.

Consistently with the main rationale of mission-oriented strategies, green strategies are first focused on demand-side instruments, whose primary goal is to limit environmental externalities through for instance carbon taxes or green public procurement, and indirectly incentivises firms to go green. Still, on top of demand-side instruments, they include numerous supply-side instruments. The latter provide extra-incentives for firms to invest in green technologies. These strategies also aim at alleviating coordination failures by creating fora for the coordination of the relevant industries and, beyond that, by coordinating expectations among producers and consumers, at the national and international levels.

Specifically, comparing the features of green strategies and instruments yields the following insights:

- Strong goal orientation and uncertainty in technology. Strategies articulate public objectives without knowing the way to reach them, nor guaranteeing their technological/political feasibility (problem-led pathway). Modern green strategies put more emphasis on the objective or its components (e.g., achieving carbon neutrality by 2050, ban sale of gas/diesel vehicles by 2050, public investment into the production and deployment of sustainable alternative transport fuels), rather than on the technologies required to reach them. This is directly linked to the long-term horizon of such strategies, typically up to 30 years, and the huge uncertainty in the technological evolutions at this horizon.
- Demand side instruments play a central role. As the primary role of these strategies is to correct for environmental externalities, demand side instruments, such as product regulation and standards, and Pigouvian taxes and subsidies, are fundamental tools of these strategies.
- Complementary supply-side instruments. As innovation incentives may be insufficient and there may be a need to tackle coordination failures in the production system, green strategies also include supply-side instruments. They are rather considered as complementary instruments, compared to the indispensable role of demand side instruments. Supply-side instruments are used to facilitate and accelerate the technological developments required to meet the goals. In addition, skill policies ensure that the jobs created by green innovation can be filled (Consoli et al., 2016[127]).
- International, national and local coordination fora. As mission-oriented strategies deal with a large number of industries that are supposed to provide complementary inputs to reach the objectives, green strategies also include coordination mechanisms. They do not only coordinate domestic industries on compatible and complementary investments, but also contribute to setting common expectations for stakeholders, including consumers, and include international co-ordination (e.g. IPCC, COPs). A green strategy often includes several sub-strategies, in which many stakeholders are involved (e.g. mainstreaming sustainability in all EU policies, 2050 Zero Carbon Cities in Japan) – see also Matsumoto et al. (2019[39]).
- Governance. Some strategies, such as the Germany Climate Action Programme 2030, embed a legal monitoring and evaluation mechanism by annually defining reduction targets by sector to ensure that the targets are met, but it is not explicit in the other strategies.

AI strategies

Many economies have adopted AI strategies since the late 2010s. This subsection relies on the following examples: China's New Generation Artificial Intelligence Development Plan (2017-2020); the European Strategy for AI (2018); Germany's Artificial Intelligence Strategy (2018); Japan's AI Strategy 2019 (2019); the British AI Sectoral Deal (2018); and the American AI Initiative (2019).

AI strategies cover a large number of instruments but rely in particular on R&D support policies. Complementary to these support measures, governments also try to increase the supply of relevant skills and data infrastructures. They also put in place governance fora to facilitate national and international coordination and standards to foster trust in these technologies and indirectly increase demand.

Specifically, comparing the features of AI strategies and instruments yields the following insights:

- Large public funding for AI R&D. To foster technological developments, governments target a big push for the development of domestic AI expertise, with public funding of both public and private R&D, as well as partnerships.
- Skills policy. Three main types of skills policies are observed: 1) actions to increase the number of AI professionals, including the creation of professional degrees in universities and more welcoming migration policies for skilled workers; 2) actions to increase the number of teachers in this realm; 3) generic education (AI awareness) for students and workers. In practice, governments also adopt regulatory measures, for instance to revise school curricula and visa frameworks.
- Data infrastructure. Storing, sharing and accessing massive amounts of data is one of the main challenge of AI strategies. Coordination, standards, infrastructure, interoperability and sharing functionalities are pivotal for the development and application of AI technologies (OECD, 2019[128]). Valuing data as a strategic asset requires a strong stakeholder coordination with both public and private sector.[3]
- New rules for data and algorithm governance. AI industry development requires setting standards for safety and ethics. A failure in building trust around AI would slow down the diffusion of AI and drastically reduce its benefits for consumers. Hence, AI strategies often include rule making for data and algorithm governance, both at the national and international levels (e.g. the OECD AI principles).
- Governance/evaluation. Given the rapid evolution of AI industry, governments acknowledge the need of enhanced coordination with public and private stakeholders for the development of realistic and impactful AI strategies. Likewise, annual assessments of these strategies are needed, even though in practice they do not specify targets and rely on a communication of their achievements to the public and discretionary readjustments of policy implementation.

Endnotes to Annex A

[1] Industry is responsible for 21 % of the greenhouse gas emissions (IPCC, 2014[146]).

[2] For a more comprehensive review of AI national Policies, see OECD (2020[145]).

[3] http://www.oecd.org/gov/infrastructure-governance/recommendation/