2 An innovation-driven industrial policy for Europe

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1 Introduction

With the stated objective of both curbing in ation and ghting global warming, the American administration has enacted the so-called In ation Reduction Act (IRA). is law gives the green light to a considerable increase in public spending of $737 billion over ten years, including $369 billion in tax credits and subsidies.

e protectionist consequences of the IRA are fairly obvious. In particular, it provides for a subsidy of up to $7500 for any American consumer who purchases an electric car assembled in the United States, and that has batteries relying on at least 40 percent US input components. It also o ers generous tax exemptions to any producer of solar panels that chooses to operate on American soil, and it heavily subsidises green research and development activities that are being carried out in the United States. Consequently, some companies have decided to freeze projects elsewhere and relocate to the US.

e IRA penalises not only European producers of electric cars, such as BMW or Fiat, but also European rms that operate already in the US but which rely on production chains partly located in other countries.

How can Europe react to the IRA and preserve its competitiveness worldwide? How can it stop and hopefully reverse the declining trend in its industrial production and exports? How can it avoid being leapfrogged by China and becoming an innovation laggard? European industrial policy is part of the answer, provided it is adequately designed and nanced.

2 The case for industrial policy

In the years following the Second World War, national industrial champions were at the forefront of industrial policy in many developed countries. In France, this pro-champion policy was a pillar of the reconstruction of the economy and of the thirty years of post-war growth. In the United States, it played a decisive role in particular for the defence, aeronautics and aerospace industries in pursuit of supremacy over the Soviet Union. At the same time, the World Bank, under the direction of Robert McNamara, supported trade protection and import substitution in developing countries, to allow them to nurture their infant industries.

e infant industry doctrine can be summarised as follows (List, 1841). Consider a developing country with two sectors of activity: a large agricultural sector and a nascent domestic manufacturing sector.

is country wishes to develop its manufacturing sector because of the resulting positive technological externalities on the economy as a whole. Manufacturing, however, entails high initial xed costs that will decrease over time thanks to experience and learning-by-doing. Total and immediate liberalisation of international trade would lead this country to import manufactured products from developed countries, where they are initially cheaper to produce. is in turn would lead to less local manufacturing activity, less learning-by-doing, and thus less technological progress and domestic growth. To avoid these repercussions, proponents of the infant industry argument endorse temporary protectionist policies, such as provisional tari barriers, so that infant industries can grow and catch up to the technological frontier.

Over time, industrial policy fell out of favour. Little by little, economists became aware of the problems it creates in practice. First, it favours existing large domestic rms – the national champions – thus limiting or distorting competition. But we know that product market competition is key for innovation and productivity growth: more competition induces rms to innovate more intensely in order to surpass their rivals (Aghion , 2005). Second, governments are not great

at picking winners, that is, choosing which rms they should support

in combustion engine technology in the past will tend to innovate in combustion engine technology in the future because of path dependency (Aghion , 2016). Imposing a carbon tax or subsidising green innovation makes it less costly to adopt a new technology and redirects the innovation activities of car manufacturers to electric engines. is example shows that governments have a role to play, not only in stimulating innovation in general, but also by directing innovation through targeted interventions.

Another argument has to do with problems of coordination. Bolton and Farrell (1990), and Rob (1991), suggested that government action can help resolve coordination problems, thereby enabling or accelerating entry into strategic sectors where the initial xed costs of entry are high. Consider a new potential market for which entry is costly and where future pro ts are uncertain and depend on information (such as the level of consumer demand) that cannot be known until the market is active. No single rm wants to be the rst to pay the xed costs of entry. Every rm prefers to let other rms bear the xed costs rst, and then to bene t from the information they generate, without bearing the risk and cost of acquiring this information. In other words, the absence of state intervention leads to the free-rider phenomenon, which results in delay or even an impasse in creating the market. To solve this problem, the state can subsidise the rst entrant, which encourages other rms to follow its example.

is coordination argument explains the success of state intervention in the aeronautics industry (Boeing, Airbus), where xed costs are high and demand is uncertain. It also explains the success of the US Defense Advanced Research Projects Agency (DARPA), established in 1958 to facilitate the transition from basic research to applied research and marketing for breakthrough innovations ('tough technologies'), where this transition entails substantial xed costs and requires coordinated e orts by various economic actors (Azoulay , 2019). We discuss DARPA in more detail below.

3 Governing industrial policy

Once we recognise that industrial policy can be useful, how can we determine in which sectors the state should intervene? Policymakers should first address economic and social priorities including fighting climate change and developing renewable energies, health, and defence. After that, they should focus on sectors that use highly skilled labour or have a high degree of competition. Thus, a study analysing international microeconomic data showed that public investments targeting skill-intensive sectors are more effective in stimulating productivity growth (Nunn and Trefler, 2010). Similarly, a study based on Chinese data showed that targeting more competitive sectors helps stimulate productivity growth (Aghion , 2015).

The question then arises of the governance of industrial policy and sectoral state aid. A priority is for industrial policy to be competition-friendly. Thus, Aghion (2015) showed that sectoral aid stimulates productivity growth more when it is not concentrated on a single

re nancing from the ECB. ese loans thus enabled banks to obtain additional liquidity. Firms that are most likely to repay their debt have a rating of 1. ey are followed by the rms rated 2, then 3, then 4, then 5, with decreasing probabilities of repaying their debt. A rating of P means the rm is close to bankruptcy. Before February 2012, commercial banks could use only loans to rms rated better than 4 as collateral for re nancing from the ECB. e ACC programme extended eligibility to rms rated 4.

What happened after implementation of the ACC programme? e rst consequence was that loans to rms rated 4 increased relative to loans to rms with a rating worse than 4, in particular those one step below, at 5+. e second consequence was that the productivity growth of rms rated 4 increased. In other words, relaxing credit constraints on these rms allowed them to invest, in particular in innovation. But this positive e ect was o set by a reallocation e ect: the implementation of the ACC programme reduced the fraction of rms rated 4 that exited the market, and the biggest impact was on the lowest-performing rms in terms of initial productivity. In other words, the ACC programme impeded the replacement of the lowest-performing rms rated 4 by new, potentially higher-performing rms.

e existence of a reallocation e ect pointed out by the above-mentioned studies suggests that any public policy to subsidise rms should take into account the impact of the policy not only on existing rms, but also on potential new entrants to the sector.

Next, sectoral state aid should be regularly reassessed to avoid the perpetuation of programmes that prove ine ective. Co- nancing by state and private investors, such as development banks, can facilitate the establishment of adequate exit mechanisms.

Overall, industrial policy is not a ‘yes or no’ issue; the question is rather to redesign the governance of industrial policy to make it more compatible with competition and, more generally, with innovation-led growth.

4 The DARPA model

e so-called DARPA model is a successful attempt at reconciling industrial policy with competition and entry. DARPA is a research agency within the US Department of Defense, responsible for innovations with military applications. e history of DARPA's success demonstrates that a well-managed industrial policy can successfully foster rather than inhibit innovation. DARPA was created after the United States lost a battle in the space race against the Soviet Union: in October 1957, the Soviet satellite Sputnik became the rst arti cial satellite to orbit the earth. is event had a huge international impact. It substantiated the advance of the Soviet space programme and stunned the American public. Lyndon B. Johnson, then a senator, wrote of "

(Johnson, 1971). Within ve months, in February 1958, even before the creation of NASA, President Eisenhower established DARPA as America's primary tool in the military race and the space race against the Soviet Union.

DARPA still exists, and its novel model has been studied in detail (Azoulay , 2019). In areas such as defence and space exploration, it is di cult to make the transition from basic research to implementation and marketing. is can be represented by an S curve. e beginning of the curve represents the origin of a concept to which not much development e ort has been devoted because the returns on such e orts are low. e median part of the curve corresponds to the take-o phase: returns on development e orts are higher, enabling the technology to advance more quickly. Lastly, the phase of maturity implies diminishing returns to development e orts and slower improvements to the technology. Because the initial phase requires substantial e orts, the anticipated social gains from future exploitation must be considerable in order for the project to generate interest and be eligible for DARPA funding. Accordingly, DARPA projects have three characteristics: they are midway between basic and applied

research; it is possible to organise research toward a precise objective; and the existence of coordination problems makes large-scale funding and testing of the technology di cult without public intervention.

is model of scienti c development enabled the United States to catch up steadily with the Soviet Union in the space race. Even though in the initial years after DARPA was created the USSR had a series of successes, thanks to an equally ambitious space programme (for example, the rst animal in space in 1957, the rst man and rst woman in space in 1961 and 1963, respectively, and rst unmanned lunar landing in 1966), the United States ultimately won the race in 1969, when it rst landed humans on the moon. Today, DARPA's annual budget is over $3 billion, and it funds over one hundred programmes. DARPA has played a decisive role in the development of high-risk projects with high social value, such as the internet, originally called Arpanet (at the time DARPA had been renamed ARPA), and GPS.

e DARPA model is particularly interesting because it combines a top-down approach with a bottom-up approach[4]. On the top-down side, the Department of Defense funds the programmes, selects the programme heads and hires them for a three- to ve-year period. On the bottom-up side, the programme heads, who come from academia or the private sector, or who are investors, have full latitude to de ne and manage their programmes. ey can freely organise partnerships between start-ups, university labs and large industrial rms, and they enjoy great exibility in recruiting collaborators.

And most importantly, programme heads elicit new competing projects. A good example is BARDA (the Biomedical Advanced Research and Development Authority), which is the equivalent of DARPA for

several competing vaccine projects, including BioNTech and Oxford-AstraZeneca, which were initiated outside the US.

5 The case for European DARPAs

Having to compete with the US and China, both of which are promoting very assertive industrial and innovation policies, why not create European DARPAs? A rst reason for creating European DARPAs is to enable Europe to assume greater responsibility for its own defence. A more fundamental motive is that Europe faces major technological challenges, in particular in the energy and environment, digital and healthcare sectors. e projects of these European DARPAs would be funded directly from participating nations' governmental budgets, and also from borrowing by the European Union as a whole.

Most importantly, as it is already the case for the funding of basic research by the European Research Council (ERC), the selection of projects by these European DARPAs should escape the ((principle, according to which each member state expects to receive, in monetary returns, at least as much as it contributes. Project selection by European DARPAs should also avoid member states' obsession with veto rights. Some EU countries have expressed the fear that European DARPAs would systematically favour larger EU members at the expense of the smaller. Here again, governance is the adequate response and there are at least two models one can build upon. First, BARDA during the COVID-19 crisis: it included labs located outside the US when selecting which vaccines to push for mass production; in particular it took BioNTech and Oxford-AstraZeneca. Second, the European Research Council and its international jury panels: excellence, not nationality, is the primary criterion for selecting those research projects that receive ERC funding.

Who should take part in these European DARPAs? Our preference would be for an open 'coalition of the willing', with the possibility for the United Kingdom to also join, given their academic and industrial expertise in defence, health and energy.

be granted an entry ticket to invest more and better in education, innovation and energy transition.

- : rather than for- bidding any kind of sectoral state aid , an - approach should be adopted and sectoral aid should be tolerated as long as it does not result in a decline in product market competition or in obstacles preventing the entry of new innovative rms.
- : Europe's investment capacity should be enhanced using EU borrowing, to fund new – and properly governed – European DARPAs aimed at making Europe more competitive in the world economy.

Without any accommodation of the rules and any evolution in the underlying doctrine, Europe runs the risk of an irreversible decline.

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