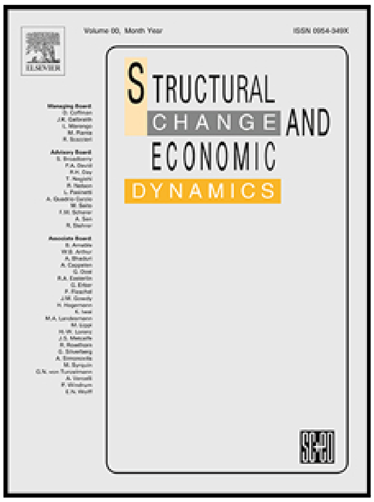
Journal Pre-proof



Selective industrial policy and 'sustainable' structural change. Discussing the political economy of sectoral priorities in the US

Marco R. Di Tommaso , Mattia Tassinari , Elisa Barbieri , Marco Marozzi

PII: S0954-349X(19)30528-4
DOI: https://doi.org/10.1016/j.strueco.2020.05.005
Reference: STRECO 938

To appear in: *Structural Change and Economic Dynamics*

Received date: 12 December 2019
Revised date: 11 May 2020
Accepted date: 13 May 2020

Please cite this article as: Marco R. Di Tommaso , Mattia Tassinari , Elisa Barbieri , Marco Marozzi , Selective industrial policy and 'sustainable' structural change. Discussing the political economy of sectoral priorities in the US, *Structural Change and Economic Dynamics* (2020), doi: https://doi.org/10.1016/j.strueco.2020.05.005

HIGHLIGHTS

- Conceptualization of the notion of ‘sustainable’ structural change
- Proposal for a methodology to mitigate government failures
- Construction of two composite indicators measuring economic and green performances
- Application to the analysis of the US manufacturing system

Selective industrial policy and 'sustainable' structural change. Discussing the political economy of sectoral priorities in the US

Marco R. Di Tommaso*, Mattia Tassinari*°, Elisa Barbieri[§], Marco Marozzi[+]

** Department of Economics and Management, University of Ferrara, Ferrara, Italy*
[§] *Department of Economics, Ca' Foscari University of Venice, Venice, Italy*
[+] *Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, Venice, Italy*
°Corresponding author, email address: tssmtt@unife.it

ABSTRACT

With the 2008 economic crisis–and again with the outbreak of the coronavirus emergency in 2020–industrial policy has explicitly reappeared in the political agenda of many countries and regions. A common feature has been the demand and the adoption of selective policies aimed at promoting specific targets of the economy, such as particular industries, technologies, companies, or territories. Nevertheless, the theoretical framework adopted to legitimize and implement public action in this field has not evolved much in the last two decades: it appears weak, too vague, and often anachronistic, increasing the risk of substantial 'government failures'. By focusing on the US manufacturing system, this paper contributes to the political economy stream of the industrial policy literature by proposing new methods to make government intervention more effective, efficient, and oriented towards a sustainable structural change, as defined in the paper.

Keywords: industrial policy; sustainable structural change; manufacturing targeting; policymaking; composite indicator; United States.

JEL classifications: L50, L60, O14.

1. Introduction[1]

Industrial policy has often been associated with government interventions regarding production dynamics to promote, via structural change, economic growth and broader development objectives.[2] It could be argued that industrial policy is primarily about promoting and governing structural change. This is what we learn from the historical experiences of the most established industrialized countries and, more recently, from planning and policy practices promoted in many fast-growing emerging economies.[3] Industrial policy has been demanded and promoted to combat severe and unexpected shocks (as in the case of the 2008 economic crisis and the coronavirus emergency of 2020). More generally, industrial policy has been used to govern complex processes of structural change in an attempt to reach a number of different economic and societal goals, namely, growth, competitiveness, productivity, and innovation, as well as employment, territorial and social rebalancing, environmental sustainability and economic and political independence from other countries. In this context, public intervention has often been characterized by the adoption of selective industrial policies aimed at supporting and promoting specific targets of the economic system, including particular sectors, technologies, companies, or territories (Lall and Teubal, 1998).

In the past and in the present, in established, highly industrialized countries and in new emerging economies, selective industrial policies have always been a quite diffused intervention for the promotion of economies and societal structural change. In recent years, the beginning of the 2008 global recession and the rise of new emerging industrial powers seem to have made even more explicit the long-term tendency at the international level to implement selective industrial policies.[4] Selective interventions have clearly continued to be implemented in several emerging economies in an attempt to foster economic development through long-term structural change programmes. China is one of the most obvious examples, where specific key and emerging industries are selected by the government as strategic targets of five-year industrial plans (Petti, 2012; Petti et al., 2017; Yang and Stoltenberg, 2014; Lv and Spigarelli, 2016; Di Tommaso et al., 2013; Barbieri et al., 2019a; Di Tommaso et al, 2020a). Similar examples can also be found looking at public interventions in Vietnam (Ohno 2009; Masina, 2012; Di Tommaso and Angelino, 2015), Thailand (Natsuda and Thoburn 2013; Pollio and Rubini, 2015), South Korea (Cardinale, 2019; Tassinari et al, 2019) and many other newly industrialized countries. However, a selective approach has also characterized Western economies. In particular, despite political rhetoric, the United States has massively adopted selective industrial policies for promoting the growth and competitiveness of its national industries (Block 2008; Mazzucato, 2013; Di Tommaso and Schweitzer, 2013; Di Tommaso et al., 2017, 2019, 2020b; Tassinari, 2019).[5]

[1] We would like to express our gratitude to the editor and anonymous reviewers for having provided very useful inputs and insights, contributing to significantly improving the paper.

[2] For an overview of the broad literature on the objectives of industrial policy see, e.g., Chang (1994), Chang et al. (2013); Cimoli et al. (2009); Stiglitz and Lin (2013); Bianchi et al. (2011); Di Tommaso and Schweitzer (2013).

[3] See, e.g., Chang (2002); Cimoli et al. (2009); Di Tommaso et al (2013); Stiglitz and Lin (2013); Barbieri et al. (2019a, 2019b); Tassinari (2019).

[4] See Stiglitz and Lin (2013); Rodrik (2010); OECD (2011); World Bank (2011); Mazzucato (2013); Pianta (2014, 2015); Aghion et al. (2011); Bianchi et al. (2011); Wade (2012); Chang et al. (2013); O'Sullivan et al. (2013); Warwick (2013); Di Tommaso et al. (2017).

[5] For example, through the American Recovery and Reinvestment Act of 2009 (ARRA), a stimulus package worth $780 billion, the Obama administration financed specific sectors such as green industries, the automotive

At any rate, despite the evident diffusion of industrial policy practices all around the world, the theoretical framework adopted to implement and foster public action appears inaccurate, increasing the risk of substantial failures. In other words, while several 'real-world' economic and social issues seem to continue to call for interventions, industrial policy–especially the selective sort–risks being extremely ineffective and inefficient due to quite a long list of unsolved problems regarding government failures (Krueger, 1990; Le Grand, 1991; Chang, 1994, 2011; Buigues and Sekkat, 2009; Di Tommaso and Schweitzer, 2013; Schuck, 2014). The literature on government failures is wide, but for the purpose of this paper, it is useful at least to recall some crucial areas of potential failures. As extensively discussed by the political economy literature, intervening governments risk being driven by particular interests and rent-seekers' pressures, promoting the interests of the actors with the loudest 'voice', instead of the more general interest of society as a whole (Hirschman, 1970).[6] Furthermore, even assuming that the public is genuinely interested in promoting collective goals, the potential government inability to overcome important information asymmetries and to properly identify targets and tools promoting those goals could be another source of failures.

With respect to this view, the paper proposes the adoption in decision-making processes of a methodology that aims, on the one hand, to encourage public discussion on what objectives should be taken into account by the government. On the other hand, once political goals and related variables have been discussed and chosen (i.e., 'public interest' has been identified in concrete terms), the methodology allows us to highlight in a transparent way the relevant goals at stake, the potential trade-offs between them, and the targets (e.g., industries) that better promote those goals, mitigating information problems concerning connections between targets and goals of industrial policy. Specifically, by focusing on the analysis of the US manufacturing system, the methodology we propose is based on the construction of different composite indicators to rank and categorize potential industrial policy targets (in our case, US industries) according to their capacity to pursue different policy goals (in our case, economic and environmental goals). We suggest that the proposed methodology could make industrial policy more effective, efficient, and, in general, oriented towards a *sustainable structural change*, namely, a structural change that takes into account potential causes of failure from a plurality of perspectives, such as the ecological, economic and social perspectives (see the next section, in particular). In this context, this paper wishes to further contribute to the political economy debate and its specialized literature by challenging the perspective that government policies are 'destined' to fail. While government failures have often been presented as unsolvable and equally severe in all countries, discouraging (at least at the theoretical level) the adoption of industrial policies, this article argues that it is possible to find solutions to potential government failures.

The remainder of the paper is organized as follows. The next section enters the details of the debate on government failures and the necessity for new methods and practices to improve the efficiency and effectiveness of policymaking. Section 3 describes the main rationales associated with the selection of a particular target of industrial policy. Section 4 focuses

industry, nanotechnologies, broadband, the health industry, and the financial sector (Di Tommaso and Schweitzer, 2013; Di Tommaso and Tassinari, 2014). More recently, the Trump administration has implemented a new wave of selective interventions with the aim of protecting a number of industries from foreign competition, including machineries, steel and aluminium and automotive (Di Tommaso et al., 2019).

[6] Specifically, on the relationship between industrial structure and political outcomes, see Ferguson (1995) and Ferguson et al. (2018).

specifically on energy efficiency policies in the United States. Sections 5 and 6 present the methodology and its application, respectively. Section 7 concludes the paper.

2. The debate on government failures

2.1 Traditional sources of government failures

The literature on government failures has highlighted typical circumstances and practices that could affect the efficiency and effectiveness of government policies. In this context, the debate refers to two main kinds of problems.

First, according to this literature, the definition of policy goals could suffer from external and internal pressures, which can lead the government to promote particular interests and, diverge from pursuing the more general interest of the community (Di Tommaso et al 2017). This is an often-discussed issue in the political economy literature (see, e.g., Krueger, 1990; Le Grand, 1991; Chang, 1994; Di Tommaso and Schweitzer, 2013). On the one hand, the government could be potentially vulnerable to external pressures coming from the most influential groups of society or rent-seekers, which exercise their influence or capacity to express their voice to attract resources from the public budget (see, e.g., Hirschman, 1970; Cardinale, 2017; Scazzieri et al., 2015). On the other hand, politicians or bureaucrats could themselves be potential internal sources of government failures. They could not be different from other types of economic actors in pursuing their own personal interests by seeking prestige, greater positional power, higher salaries, or office perks, even when it implies acting to the disadvantage of the social output (Di Tommaso and Schweitzer, 2013, p. 36). In these cases, external or internal pressures and systems of incentives could lead to favour ‘particular’ interests instead of the ‘public one’. Of course, the notion of ‘public interest’ itself is problematic. Any government intervention, including industrial policy, might favour some industries or societal groups over others. The notion of ‘public interest’ normally involves compromises between different–often diverging–interests, whereby someone could always be unhappy with changes (or *status quo* persistence). Beyond the dilemma of defining public interest from a theoretical point of view, there is also an issue of ‘representation’ and ‘voice’ of the partial interests included in the public one. The choice of favouring some groups over others could be a conscious one coherent with a specific definition of public interest or could be the result of some form of underrepresentation of partial interests.

Among the most common failures identified in the literature, there is, in fact, the risk of implementing interventions for supporting companies, sectors or territories just because they are able to better organize their lobbing activity or to offer greater political consensus in the time of elections. This dynamic could lead to offering public support to those who do not need it, just because they can better express the demand for intervention, denying, on the other side, support for promising initiatives. In this case, a government risks exclusively supporting the strongest and best organized interests, while the promotion of collective interests could also require full consideration (and even anticipation) of latent demands from new and emerging interests. In this context, the traditional argument against public intervention accuses industrial policy of abandoning the principle of market efficiency in allocating economic resources by ‘picking the winners’ or ‘saving the losers’ without an alternative, transparent and rigorous framework to lead to the success of public action in promoting general interests (see, e.g., The Economist, 2010). This issue deserves special attention and cannot be overlooked in the current debate on industrial policies. It becomes important from the perspective that any partial interest of society has the chance to be considered in the decision-making process, and the choice concerning the objectives effectively pursued by the government (e.g., the weight attached to different political goals) as well as the priority targets that better promote those goals should be accurately discussed.

The second problem often associated with industrial policy intervention refers to the real ability of the government to promote specific goals (see, for example, Chang, 1994). Is the government able to effectively and efficiently promote societal interests? In this field, one of the most quoted problems is the potential lack of capacity in processing information to translate the general objective of promoting the 'public interest' in concrete and specific industrial policy programmes. Decision-making might concretely entail different possible goals, targets and tools and the relations existing among each other (Di Tommaso and Schweitzer, 2013). Thus, policymakers often observe a scenario where society may be interested in simultaneously pursuing different goals, and public action has to confront a variety of objectives at stake. In other words, the proper definition of an industrial policy, from a political economy perspective, requires considering the existence of multiple societal objectives to be promoted and the potential trade-offs among each other. Indeed, any policy inevitably involves compromises between different interests, for example, concerning different trajectories of structural change, which could favour some industries over others. This is the case we make for considering economic and environmental goals at the same time.[7] While industrial policy has traditionally promoted the structural change of economies to foster economic growth or other strategic economic goals, currently, the economic perspective has to be necessarily enlarged by including other meta-economic goals, such as environmental issues (Di Tommaso and Schweitzer, 2013). Moreover, among environmental objectives, one could favour the reduction of carbon emissions, the reduction of plastic production, or other changes, and each will have differential effects on different economic interests. This scenario opens new puzzles for industrial policy, not least because these objectives risk being in conflict with one another, revealing the existence of potential trade-offs (Armaroli and Balzani, 2011). In this framework, as highlighted by decision theory, the final decision of the goal to be promoted should take into account the existence of partial objectives (see, e.g., de Finetti, 1975, p. 645).[8] Nevertheless, even recognizing the necessity to consider partial objectives in view of defining the public interest, the issue of how they should be weighted remains crucial for policymaking. In this regard, the emergence of compromises through discussions between stakeholders about the goals and strategies of industrial policy is inevitable. From this viewpoint, this paper and the methodology it proposes are not about how public interest is defined theoretically (or identified in specific situations) but about how to evaluate different proposals for implementation—once the 'public interest' is identified.

[7] We have chosen these two objectives among the many possible ones, mimicking a situation in which the government has already identified these two goals as a priority. As we explain in Section 4 there is a real tension in the US between these two goals, so we argue that it is a realistic scenario, but other macro-goals could have been identified. This would not change the nature of the methodology.

[8] Specifically, de Finetti argues that a decisional problem involving a variety of objectives is properly addressed considering 'different components or features of judgement, or partial objectives', avoiding 'to immediately fix a global preference relation, that is, a function $f(P)$ directly including a final synthesis of all components of judgement'. Formally, this means 'to introduce, firstly, different functions $f_1(P)$, $f_2(P)$..., $f_n(P)$, and only subsequently [...] to derive the final function $f(P)$, which would obviously be an increasing function of all the $f_h(P)$' (de Finetti, 1975, p. 645).

Furthermore, policymakers are called to select industrial policy targets and tools according to their ability to promote defined goals (Di Tommaso and Schweitzer, 2013). This is another critical issue for industrial policy. For instance, what are the sectors that will be able to respond to the national interest in the future? This is a crucial question of industrial policy, the answer for which is not easy to attain (see, e.g., Lin and Chang, 2009).

2.2 Government failures and 'sustainable' structural change

Along with the two crucial issues mentioned above, industrial policy could also be considered a failure when promoting structural changes that prove to be unsustainable in the long term. In particular, this perspective–though it is rarely emphasized in the literature–in our view deserves special attention. We refer to sustainable structural change as a process of long-term change in the relative proportions between sectors of the economy, which occurs without causing the collapse of the entire socio-economic system, a collapse that could be dramatic and that could arise from a plurality of interconnected dynamics, such as ecological, economic and social dynamics. Indeed, structural change entails adjustment phases of the economic structures (Landesmann and Scazzieri, 1990, 1996; Scazzieri, 2018; Bianchi and Labory, 2019a, 2019b), and it could compromise the proper functioning of the system. For instance, from an ecological standpoint, structural change could generate a scale of production and an exploitation of natural resources whereby ecosystems are unable to regenerate themselves, ending up in collapse (see, e.g., Worm et al., 2006). The ecological standpoint is one of the crucial and most emphasized aspects of the notion of sustainability (see, e.g., Daly 1990; Sauvé et al. 2016; Olawumi and Chan 2018).

However, the sustainability of structural change can also be assessed from an economic perspective. In this context, structural change can be associated with changes in the relative proportions of productive sectors (see, e.g., Cardinale and Scazzieri, 2018). In this process, the sustainability (i.e., *viability*) of structural change is represented by the ability of the system to reproduce itself and produce a surplus, demonstrating the ability to grow. Considering, for example, the economy as represented through input-output tables (namely, as a set of interdependent sectors, where the output of each sector is an input to other sectors), the condition for the viability of structural change is the reproducibility of the inputs used in production and the generation of a surplus. Formally, this constraint is expressed through the Hawkins-Simon conditions (Hawkins and Simon, 1949). While viability conditions can be met with different sectoral proportions resulting from structural change processes, they allow us to identify the 'systemic interest', which is the interest in preserving systemic viability (Cardinale 2017, 2018a; Cardinale and Scazzieri, 2019). According to this notion of systemic interest, 'the pursuit of particular interests must be balanced, within the strategy of each sector, by the "systemic" interest in keeping the economy as a whole viable, for, otherwise, the pursuit of particular interests might be unsustainable' (Cardinale, 2018b, p. 773). In this context, 'sustainability' can be associated with the notion of 'systemic interest', which differs from that of 'public interest'.[9] Systemic interest diverges from collective interest, especially in

[9] Indeed, the notion of 'public interest' entails a specific way to compose interests of individuals or groups, by overcoming the individual standpoints in view of social objectives. This perspective is prevalent when considering, for instance, the idea of public interest assumed by Jeremy Bentham (1823), Friedrich List (1996 [1827]) or, in more recent times, Simon Kuznets (1971), where the interest of a community is associated with the interest of all individuals considered as a whole, seen as potentially in contrast with the interests of some subgroups and individuals (Cardinale and Scazzieri, 2019, p. 82-83). However, this definition opens the question of how individual or group interests are composed, given that the 'public interest' is compatible with situations where the interests of some individuals or groups are satisfied to the detriment of others.

considering the *multiple* ways (e.g., the different sectoral proportions) in which diverse interests can be aligned with systemic conditions of mutual compatibility, based on the fact that ‘each sector has a particular interest in its own survival and expansion, as well as a “systemic” interest in the preservation of the system to which it belongs, which is itself necessary for its survival’ (Cardinale, 2015, p. 203).

Finally, structural change could also be assessed with reference to its impact on society. It can be argued that the social component of structural change can occupy a decisive role in conditioning the development trajectory of economic systems. In particular, while structural change can occur within a range of changes that are made possible by given economic structures, to understand the specific path of change out of those that are possible, it is necessary to consider the social context, which determines the actual actions carried out within those economic structures (Cardinale and Scazzieri, 2018; Cardinale, 2018a; Lee and Shin, 2018). From a political economy perspective, within a range of transformations that could be economically feasible, not all of them could be socially viable because they could be ‘disrespectful’ of the composition of the social interests and powers at stake. Indeed, as argued by Bianchi (2017), relationships within a social organization are ‘relations of power’, so that while some groups push for a change, others resist, creating the social conditions for structural change (or the lack thereof). In this conflicting context, social sustainability refers to structural change that occurs by preserving the integrity of the social system, namely by acknowledging and governing possible fractures and divergences of interests that could make the system inoperative with respect to the goals of any of its members (i.e., in case of particularly severe or violent social instability).

Overall, considering the different interconnected perspectives of sustainability involved in structural change (i.e., ecological, economic, and social), the government can be understood, by virtue of its political nature, as the institution in charge of governing structural changes (by promoting or preventing them), making sure that they are not the cause of the long-term collapse of the socio-economic system. From this perspective, industrial policy–like economic policy in general–is not merely a technical tool for achieving given objectives. Rather, it can decisively influence the trajectory of economic and social development of the system, seeking a virtuous balance between the partial interests of a society (i.e., between territories, sectors, classes, generations, etc.), which is constantly challenged by the dynamics of structural change (Di Tommaso and Tassinari, 2017). Accordingly, government failures can also be seen as those circumstances in which the government is unable to consider and mitigate potential (ecological, economic and social) threats to the sustainability of the process of structural change.

All the potential sources of government failures described above depict a complex scenario for industrial policy, which risks being ineffective and inefficient in promoting sustainable societal goals. In this context, industrial policy still suffers from the lack of a general framework to be used to guide policymaking in properly defining and implementing public interventions (Monga 2012, 160). In other words, the effectiveness and efficiency of industrial policy are also bound to the ability to find new techniques and methodologies of analysis that are useful in the policymaking process. By focusing specifically on the economic and environmental perspective, this paper moves, albeit as a first step, in this direction.

3. The debate on *targeting*: the economic and environmental perspective.

Analysing the theoretical debate on ‘targeting’ (namely, the selection of particular sectors or other entities as targets for industrial policy), it is immediately clear that this is a rather controversial issue in the economic literature. As a matter of fact, the proper choice of particular targets depends first and foremost on the *goals* to be pursued through the promotion of that specific target (Di Tommaso and Schweitzer, 2013), and this implies the need to discuss and find a general agreement about the political priorities to be promoted (Di Tommaso et al., 2017). In this complex scenario, the debate on 'targeting' has often associated industrial policy with the goal of fostering *economic* growth. From this perspective, industrial policy targets have been commonly identified with industries that show the best chances to compete in international markets and systematically reach a new large-scale demand for consumption (see, e.g., Malerba, 2002; Bianchi and Labory, 2006; Bogliacino and Pianta, 2010; Lin, 2010, 2012). In this case, 'targeting' focuses on the more dynamic industries, characterized by high capital content, a high value-added growth rate, high profits and export performance (Di Tommaso et al., 2017).[10] However, even considering these criteria, the uncertainty connected to the future competitiveness and economic performance of different targets remains one of the most critical issues in defining an industrial policy (see, e.g., Lin and Chang, 2009). Dealing with this interesting topic, Lin (2012) argues that the government should promote the structural adjustment of the economy by supporting industries with *latent* comparative advantages as a key factor for a successful industrial policy. However, in this context, how it is possible to identify industries with latent comparative advantage remains a crucial question for industrial policy. Indeed, as stated by Wade (2012), '[Lin] has been reluctant to identify criteria for distinguishing investments within and without the economy's existing comparative advantage' (Wade, 2012, p. 235).

This already complicated framework becomes even more difficult to consider while at the same time considering different political priorities. Indeed, another kind of literature suggests that industrial policy targets can (or should) be defined as going beyond purely economic criteria, which refer to the doings and beings of a society as a whole. A wide range of interesting literature has tried to evaluate countries' processes of development and change from perspectives that go beyond the traditional variables of growth and economic performance (see, e.g., Sen, 1983, 1999; Arndt, 1987; Hirschman, 1981; Ingham, 1993; UNDP, 1990). From this perspective, sectors are considered different because they might have different capacities to foster paths of change consistent with the notions of *human development and capability expansion* (UNDP, 1990). Frequently quoted examples in this framework are green industries as well as health industries and educational and cultural sectors. These 'merit industries' reflect a model of development that is widely accepted in the political debate of several countries and within international institutions (UNDP, 1990), even if it is still scarcely applied in practice. From this point of view, a particular sector is different from others not just because of its potential to produce economic growth but also because it can influence people's quality of life by offering specific merit goods.

For the focus of this work, it is useful to highlight how the issue of environmental sustainability calls fully into question the debate on industrial policy targets.

On the one hand, energy and ecological problems require the identification of alternative energy sources to address energy scarcity and the environmental impact of non-renewable energy sources (i.e., fossil fuels). This choice opens up a debate mainly based on the assessment of which alternative energy sources are strategic for the long-run development of a national state (Armaroli and Balzani, 2011; Delucchi and Jacobson, 2011; Setti and Balzani, 2011; Smil, 2008). In this case, the relevance of different energy sources can be evaluated on the basis of economic criteria (such as the capacity of energy cost containment of and, more

[10] See also Krugman (1987); Michalski (1991); Soete (1991); Stevens (1991); Teece (1991); Yoshitomi (1991).

generally, the efficiency of the production system as a whole). However, it can also be evaluated using reasons that go beyond the economic sphere, such as geopolitical ones (linked to the ability to reduce energy dependence from abroad) and ecological ones, related to the reduction of environmental impact (Armaroli and Balzani, 2011). In this framework, the promotion of some particular energy sources (rather than others) inevitably takes the form of support for specific economic sectors, which become the targets of industrial policies.

On the other hand (and this is the specific perspective adopted in this paper), in addition to the identification of alternative energy sources, the goal of environmental sustainability suggests the need for policies to generally reduce energy consumption and its polluting impact (Armaroli and Balzani, 2011; Frey, 2014). From this standpoint, policymaking could be interested in categorizing specific targets according to their energy efficiency performance and selecting some of them as priority recipients of specific policies. For example, the government could be interested in incentivizing the adoption of energy-saving technologies in industries with very low environmental performance or rewarding targets with the best results, encouraging innovation and the adaptation of sustainable productive processes. Additionally, this context suggests further reasons for 'targeting' in industrial policy in view of specific issues and goals.

Without a robust analytical framework, industrial policy risks being extremely inefficient and ineffective. Moreover, the lack of rigor and transparency in industrial policy practices could have the consequence of leaving substantially 'unchecked' the discretionary power of the policymaker in defining industrial policy goals and targets, which, at best, remain mainly bound to the vision of enlightened politicians. In other words, through this article, we want to suggest that industrial policy needs a methodological framework able to foster, in a rigorous and transparent way, the political debate about goals and targets of industrial policies.

4. Energy efficiency policies in the US: an overview.

The issues of 'targeting' and the complexity of considering a wide range of goals in defining industrial policies find clear evidence looking at the promotion of energy efficiency policies in the US. Initially, environmental issues started to occupy an important position in the international political debate during the 1990s. International meetings to discuss problems related to sustainable development began in Rio de Janeiro in 1992 with the 'Earth Summit', which resulted in a first agreement on the United Nations Framework Convention on Climate Change (UNFCCC). Following the entry into force of the Convention (on 21 March 1994), several Conferences of the Parties (COP) were held, with the purpose of defining the details of the adoption of specific Protocols to address climate change. In 1997, in the context of the third Conference of the Parties (COP3), the Kyoto Protocol was defined. The treaty provided for the obligation of industrialized countries to reduce emissions of polluting elements by no less than 5% compared to emissions in 1990, which was considered as the base year. The ratification phase of the protocol was particularly difficult in the context of the different COPs. Many countries struggled to sign the agreement because of the constraints that this imposed on the national level and the related political interests at stake.[11]

[11] The emission constraints imposed on countries by the protocol were not the same for all economies. The signatory states were divided into three groups: the countries of the Annex I (the industrialized countries), the countries of Annex II (the industrialized countries that pay for the costs of the developing countries) and the developing countries. Each group faced different obligations. For example, countries in the Annex I had to reduce their emissions and if they did not succeed, they would have to buy emission credits. By contrast, developing countries did not have immediate restrictions. For example, India and China, which ratified the

In the United States, which in 2001 accounted for 36.2% of world carbon dioxide emissions, accession to the protocol was particularly affected by the dynamics of national politics. President Bill Clinton (encouraged by Vice President Al Gore) signed the protocol during the last months of his mandate, but shortly after the election of George W. Bush, the United States withdrew from the Kyoto Protocol.

Nevertheless, despite the domestic difficulties in adopting international environmental agreements policies responding to energy efficiency problems started to be gradually reinforced. American energy efficiency policies have been generally implemented through a number of actions aimed at reducing the total national consumption of energy by adopting energy-efficient technologies and practices. These actions have targeted a large number of sectors and markets for energy efficiency, involving many end-uses, intermediaries, and consumers (individuals, organizations, and businesses). For example, public measures have been established to adopt mandatory energy codes for new houses and commercial buildings and energy efficiency standards for cars and light trucks, appliances, equipment, and electronic lighting ballasts and to regulate the utility sector.[12]

The focus of our analysis is on policies targeting industrial sectors and their productive processes. From this point of view, the industrial sector (which accounts for approximately 22% of total U.S. primary energy consumption), experienced a decline in energy usage of 38% over the 1980–2013 period.[13] Some of this change in usage is partly a result of structural shifts in the industrial sector. However, the increasing performance in industrial energy efficiency can also be attributed to the implementation of policies encouraging the adoption of new energy-saving technologies and practices.[14] These energy efficiency policies in the industrial sector include (1) financial and nonfinancial incentives (such as loans and grants for industries to upgrade equipment or expedited permitting programmes); (2) technical assistance programmes (such as energy audits, which help industries identify and implement energy-efficiency programmes); and (3) research and development programmes (Doris et al., 2009). The US federal government generally implements all three types of policies.

First, incentives in the industrial sector help industries to reduce the cost of adopting energy-saving technologies and also pursue the goal of fostering the development of new industries and technologies in an emerging market, encouraging a sustainable structural change of the economy. These incentives included, for instance, tax credits and loan guarantee programmes specifically directed at the industrial sector, such as the *Manufacturers' Energy Efficient Appliance Credit*[15] and the *DOE Loan Guarantee Program*. Such incentives are flexible enough to be applied to a broad number of subsectors (Doris et al., 2009).

Second, technical assistance programmes help industries to reduce energy consumption while maintaining their competitiveness through improved efficiencies. Through energy

---

protocol, were not required to reduce their carbon dioxide emissions because they were not among the major sources of greenhouse gas emissions during the industrialization period, which is believed to be causing today's climate change.

[12] See: '4 Energy Efficiency'. National Academy of Sciences, National Academy of Engineering, and National Research Council. 2009. America's Energy Future: Technology and Transformation. Washington, DC: The National Academies Press. doi: 10.17226/12091.

[13] See EIA (2015), https://www.eia.gov/totalenergy/data/monthly/pdf/flow/css_2015_energy.pdf

[14] Energy saving technologies include, for instance, technologies for combining heat and power (CHP, also referred to as cogeneration), better motor systems (Nadel et al. 2002), wider application of energy control systems in industrial processes (Rogers 2014), and improved energy management (Nadel et al., 2015).

[15] See: https://www.irs.gov/businesses/corporations/manufacturers-energy-efficient-appliance-credit

audits and information campaigns, industrial energy-efficiency programmes foster the adoption of technologies that increase efficiency at the plant level.[16]

Finally, the DOE implemented a number of R&D programmes across many sectors (buildings, transportation, manufacturing, and power) through the Energy Policy Act of 2005, the Energy Independence and Security Act of 2007, and the American Recovery and Reinvestment Act (ARRA) of 2009. These constitute an important role for energy efficiency policies and for the sustainable structural change of the US economy. Indeed, the energy sector and green industries had a central position in the policy regarding science and technology during the Obama administration. In this framework, for instance, in 2009, the DOE sponsored $90 million (not including ARRA funding) in R&D for the industrial sector, with an overall objective of 20% reductions in energy intensity from 1990 levels in energy-intensive industries by 2020 (Doris et al., 2009). In this case, specific research funding targeted energy conversion and utilization (such as in gasification technologies, high-efficiency boilers, waste recovery heat exchangers, and cogeneration), energy-intensive and high carbon dioxide-emitting processes, resource recovery and utilization (i.e., through reductions in material use, improved materials recycling, improved use of wastes and by-products, and identifying new markets for recovered materials). Furthermore, approximately $90 billion were invested by the Administration in R&D activities and incentives in industrial sectors through the ARRA, involving numerous industries, including renewable energies (solar, wind, and geothermal), plug-in hybrid vehicles, electric vehicles and the infrastructure necessary for their operation, and plants producing batteries and components for electric vehicles. Another 300 million dollars was invested through the General Services Administration for purchasing energy efficient vehicles produced in America (Di Tommaso and Schweitzer 2013; Di Tommaso et al., 2019, 2020b). An additional $400 million was spent for the establishment of the Advanced Research Projects Agency-Energy (ARPA-E), in charge of carrying out scientific research in the field of advanced energy technologies (ERP, 2010). To reduce the national consumption of electrical energy, the government promoted the construction of a modern *smart grid*. The investment in this area has been $4 billion. The ARRA also provided a tax credit from $500 to $1,500 in 2010 for the renovation of private homes in line with energy efficiency standards (Di Tommaso and Schweitzer 2013; Di Tommaso et al., 2019, 2020b).

Even with these actions, the politics of the green economy and industrial policy in the US still remain extremely complex today. The impact that public decision-making in the field of environmental policy has on investment decisions in particular sectors and technologies, on the cost structure of companies and on the structural adjustment of the US economy is enormous. These considerations explain why President Trump declared the US withdrawal from the Paris Climate Agreement of 2015, which the Obama administration had signed. In this context, the Trump administration's environmental policy firmly contrasts with the commitment of the Obama administration in this field. In this context, just a few months after his election, the Trump administration launched the 'Energy Independence' policy. The impact of this executive order could be disruptive. First, it aims to eradicate the Clean Power

[16] In this context the main programs are: the *Department of Energy Industrial Assessment Centers* (IAC) program (implemented through a collaboration among stakeholders from the federal government, universities, and industry); the EPA's Center for Corporate Climate Leadership (that serves as a resource centre for all organizations looking to expand their work in the area of greenhouse gas measurement and management); and the *Industries in Focus program* (that offers tailored services on best practices and innovative energy saving ideas for industry). See: https://www.energystar.gov/buildings/facility-owners-and-managers/industrial-plants/measure-track-and-benchmark/energy-star-energy-0

Plan launched in 2015 by the Obama administration to promote clean energy production.[17] In this framework, the consequence of the Trump administration's executive order is that the U.S. Environmental Protection Agency (EPA) will change the rules on greenhouse gas emissions, not only for existing power plants but also for those to be built. The Obama administration's rules made it virtually impossible to build new coal-fired power plants because they required every new plant to have a system (which was very expensive and only recently developed) to store carbon dioxide underground. The Trump administration's EPA has essentially rewritten these rules by softening its terms. Another prescription that the Trump administration might erase in light of the Energy Independence policy is the reduction of methane losses in the atmosphere during mining and refining of oil and natural gas: the Obama administration had decided to reduce them by 40% by 2025, compared with 2012 levels. Furthermore, the Trump administration's executive order would revise current estimations of the social cost of emissions: under the new laws, EPA could lower these estimates, for example, by considering only the emissions damages to the United States and not to the whole planet.[18] Finally, one of the few measures contained in the Trump administration's executive order that could have an immediate effect is the elimination of the Obama administration's moratorium on federal land-use concessions for coal mining, established to prevent new mines from being too easy to build.[19]

This overview further shows how the scenario for a sustainable structural change in the US is inherently a political economy issue and that any industrial policy programme must be envisioned with this perspective in mind. The lack of transparency about the policy goals and weak analytical process to support policymaking can lead to dramatic government failures in this field.

5. Methods

From the abovementioned perspective, this paper aims to propose new practices that can improve the efficiency and effectiveness of industrial policy. In particular, by focusing on the analysis of the US manufacturing system, the work proposes a methodology for mapping the economic and environmental performance of these sectors to improve the process of identifying industrial policy targets. From a methodological point of view, the analysis is carried out by using composite indicators.

Composite indicators are commonly utilized by social scientists with the aim of comparing social units such as cities and nations with respect to multiple dimensions of social life. They are very familiar in country performance comparisons in globalization, competitiveness, education, health, human rights, ecological footprint, corruption, technology achievement, social cohesion and trust in public institutions (OECD 2008, Munda et al. 2009, Marozzi 2012). In this paper, we apply the notion of a *composite indicator* to elaborate a methodology to map the economic and environmental performance of the sectors.

A general procedure to compute composite indicators is reported in Marozzi (2015). Here, we consider a modification of this procedure based on three steps:

1. normalization of the original data
2. weighting of the normalized data

[17] The Clean Power Plan has been under a legal review process at the U.S. Court of Appeals for the District of Columbia, after many industrial groups and 27 states had filed a lawsuit against the measure.
[18] www.ilpost.it/2017/03/29/trump-clima
[19] www.focus.it/ambiente/ecologia

3. aggregation of the weighted normalized data

Let X_{jk}, j=1,…,J, k=1,…,K denote the value of variable X_k for sector j. Suppose that $X_1,\ldots,X_K$ are related to a complex variable that cannot be directly measured. Therefore, we combine $X_1,\ldots,X_K$ to assess the underlying complex variable. In the first step of the procedure, the original data are normalized as follows:

$$\beta(X_{jk}) = \frac{X_{jk} - \min_j(X_{jk}, j=1,\ldots,J) + 1/J}{\max_j(X_{jk}, j=1,\ldots,J) - \min_j(X_{jk}, j=1,\ldots,J) + 2/J},$$

corresponding to well-known linear scaling in the min-max range. Note that to avoid $\beta(X_{jk})$ values equal to 0 or 1, which may cause computational inconsistencies in the aggregation step, correction factors $1/J$ and $2/J$ are added to the numerator and denominator, respectively. Normalization is necessary before weighting and aggregation steps because $X_1,\ldots,X_K$ generally have different scales and dispersions.

In the second step of the procedure, the normalized data are weighted according to a certain weighting scheme c to reflect possible different degrees of importance for the variables. In the third step of the procedure, the weighted normalized data are aggregated according to a certain aggregation rule δ_d as follows:

$$_{dc}\delta\left(\beta(X_{jk}), {}_c w_k, k=1,\ldots,K\right) = {}_{dc}\psi_j, \quad c=1,\ldots,C,\ d=1,\ldots,D$$

where δ_d denotes the aggregation rule and $_c w_k$ is the weight assigned to the k-th normalized variable. In particular, we consider the following four aggregation rules:

- d=1, Additive rule

$$_{1c}\delta\left(\beta(X_{jk}), {}_c w_k, k=1,\ldots,K\right) = \sum_{k=1}^{K} \beta(X_{jk})\, {}_c w_k = {}_{1c}\psi_j;$$

- d=2, Fisher rule

$$_{2c}\delta\left(\beta(X_{jk}), {}_c w_k, k=1,\ldots,K\right) = -\sum_{k=1}^{K} \log\left(1-\beta(X_{jk})\right) {}_c w_k = {}_{2c}\psi_j;$$

- d=3, Logistic rule

$$_{3c}\delta\left(\beta(X_{jk}), {}_c w_k, k=1,\ldots,K\right) = \sum_{k=1}^{K} \log\left(\frac{\beta(X_{jk})}{1-\beta(X_{jk})}\right) {}_c w_k = {}_{3c}\psi_j \;;$$

- d=4, Liptak rule

$$_{4c}\delta\left(\beta(X_{jk}), {}_c w_k, k=1,\ldots,K\right) = \sum_{k=1}^{K} \Phi^{-1}\left(\beta(X_{jk})\right) {}_c w_k = {}_{4c}\psi_j \,.$$

where Φ^{-1} denotes the quantile function of a standard normal distribution. The composite indicator can be used to rank the J sectors by simultaneously considering $X_1,\ldots,X_K$.

Subjective decisions are made on which aggregation method and weighting scheme selections will be used to design composite indicators. Each selection of (c, d) has its pros and cons and leads to a different composite indicator and then potentially to a different ranking of sectors. As emphasized by OECD (2008), the robustness of a composite indicator ranking against its design should be assessed. A very useful method to address this problem is *uncertainty analysis*, as shown by Saisana et al. (2005), Marozzi (2015), Luzzati and Gucciardi (2015), and Di Tommaso et al. (2017).

Uncertainty analysis is a Monte Carlo simulation-based procedure applied to the formula defining the composite indicator. The sources of uncertainty in the composite indicator are aggregation and weighting. The aim of uncertainty analysis is to test whether the ranking of sectors according to the composite indicator is robust or volatile with respect to the design of the index. More precisely, the aggregation source of uncertainty is modelled by scalar input factor U_1, and the weighting source of uncertainty is modelled by vectoral input factor U_2. According to general practice, uniform distributions are assigned to the input factors (Saisana et al. 2005, Marozzi 2015). These distributions are sampled, i.e., aggregation and weighting are varied simultaneously to assess their effects on the composite indicator.

Let ε denote a continuous random variable uniformly distributed in the [0,1] interval. For input factor U_1, the general disposal rule is as follows:

$$U_1 = \begin{cases} 1 & \text{ie select } {}_1\delta \text{ if } \varepsilon \in [0, 1/4) \\ 2 & \text{ie select } {}_2\delta \text{ if } \varepsilon \in [1/4, 1/2) \\ 3 & \text{ie select } {}_3\delta \text{ if } \varepsilon \in [1/2, 3/4) \\ 4 & \text{ie select } {}_4\delta \text{ if } \varepsilon \in [3/4, 1] \end{cases}$$

Input factor $U_2=(U_{21}\ldots,U_{2K})$ is the vector of raw weights. We assign to each raw weight a continuous uniform distribution in the interval $[1,p]$ with $p>1$ so that the maximum theoretical weight cannot exceed p times the minimum theoretical weight. The raw weights are then rescaled as follows:

$$w_k = \frac{U_{2k}}{\sum_{k=1}^{K} U_{2k}}, k = 1,\ldots, K$$

so that the usual restrictions on weights apply: $w_k \geq 0$, $\forall k=1\ldots,K$ and $\sum_{k=1}^{K} w_k = 1$. The rationale for assigning different weights to the variables is to reflect different importance as well as different perceptions of policymakers towards them.

L combinations of the two sources of uncertainty are generated by sampling the uncertainty input space L times. Each combination corresponds to a different composite indicator, ${}_l\psi=({}_l\psi_j, j=1,\ldots,J)$, and then to a different ranking ${}_lR=({}_lR_j, j=1\ldots,J)$ of the J sectors. An estimate of the uncertainty distribution of the rank of sector j is obtained by considering all L combinations of input factors and computing the corresponding rank. The median of the resulting vector of ranks for sector j ${}_jR=({}_lR_j, l=1\ldots,L)$ is a summary measure of sector j rank uncertainty distribution, and the interval defined by the 5th and 95th percentiles of the rank distribution reflects its robustness with respect to the design of the composite indicator. A narrow uncertainty interval for sector *j* means that its ranking is robust because it slightly depends on the selection of a particular aggregation method and a particular set of weights. Conversely, a wide interval means that the sector *j* ranking is volatile because it markedly depends on the particular design of the composite indicator.

In this work, we apply the methodology described above to develop two different composite indicators to assess the economic and environmental performance of 18 American manufacturing industries.[20] Data were collected by the United States Census Bureau (US Department of Commerce) and by the Manufacturing Energy Consumption Survey (MECS) conducted by the US Energy Information Administration (EIA). Manufacturing industries are classified according to the classification of productive sectors of the 2012 North American Industry Classification System (NAICS).

The first composite indicator (the *Economic Performance Index*, or EPI) provides a ranking of the US industries based on their different economic performance. The index is calculated for the years 1998, 2002, 2006, 2010, 2014, and 2015. It is composed of five different variables to evaluate the economic performance of these industries[21]:

1. *VA as % of GDP*: the sector value added as a percentage of the total national GDP in 2012. This variable aims to consider the weight of the industry in the economy.
2. *VA/Full-time equivalent employees*: the sector productivity of labour. It shows the intrinsic capacities of a sector to produce economic wealth, regardless of the total volume of sector production (thus differentiating it from the previous three variables).
3. *Net export/Full-time equivalent employees*: the value of net exports per employee. This variable is used as a proxy to evaluate sector performance in international markets.
4. *Investment in private fixed assets*: the total value of investment in private fixed assets. It aims to measure the overall capital intensity of the industry.

[20] The choice of focusing on manufacturing sectors derives from the peculiar role that these industries play in economic growth dynamic. Indeed, as shown by the economic literature, characteristics such as high productivity of labour, dynamic economies of scale, rapid technological change and innovation, and positive externalities towards other sectors, make manufacturing industries extremely important as engines of economic growth (see amongst others Tregenna 2009, 2014; Bianchi and Labory 2011; Chang et al. 2013; Andreoni and Scazzieri 2014). The choice to limit our study to manufacturing industries also presents the methodological advantage of testing our exercise on a more homogeneous group of sectors.

[21] The choice of variables (and the weight to be assigned to each variable) is an arbitrary decision in studies using composite indicators, manifesting itself as ‘a source of contention’ (see, e.g., OECD, 2008, p. 31). As emphasized by the Joint Research Centre of the European Commission (Saisana and Tarantola, 2002) and the United Nations Economic Commission for Europe (UNECE, 2019), there is often a compromise between scientific accuracy and information availability, making reliability and timeliness of available data central in selecting variables. There is no fully objective way of selecting the variables defining the composite indicator (Saisana and Tarantola, 2002, p. 8), and it is central to assuring that composite indicator design is transparent: this is the aim of the uncertainty analysis performed in Subsection 6.1. Following these considerations, in this paper we have chosen the economic and environmental perspectives (as defined by the selected variables), in order to apply the proposed methodology to an illustrative case-study, discussing potential targets for industrial policy. It would be in principle possible to assess the importance of the variables behind a composite indicator and to select the most important ones, obtaining a simplified composite indicator. However, there are many methods in the literature and no agreement on which one is the best (Marozzi, 2016). Moreover, in these methods the selection of variables is merely statistical, ignoring the possible economic or political significance that these variables might carry.

5. *Investment in private fixed assets/full-time equivalent employees*: the value of investment in private fixed assets per employee. It aims to measure capital intensity per employee and the propensity of private businesses to invest in the sector.

The second indicator (the *Greening Performance Index*, or GPI) assesses the sector's environmental performance. As specified in the previous sections of the paper, our focus is on the productive processes characterizing the industries, and the environmental performance is evaluated according to the degree of adoption of energy-saving technologies by the sectors. The GPI is calculated for the years 1998, 2002, 2006, and 2010 (which is the last year currently available for the chosen variables). It is composed of seven variables to assess the greening performance of industries:

1. *Percentage of Establishments Using Computer Control of Processes or Major Energy-Using Equipment*. This refers to a process automation or automation system (PAS) that is used to automatically control a process through a network to interconnected sensors, controllers, operator terminals and actuators. PAS is the lowest level of automation. Process automation involves using computer technology and software engineering to help power plants and factories operate more efficiently and safely.
2. *Percentage of Establishments Using Waste Heat Recovery*. A waste heat recovery unit (WHRU) is an energy recovery heat exchanger that recovers heat from hot streams with potential high energy content, such as hot flue gases from a diesel generator or steam from cooling towers or even wastewater from different cooling processes, such as steel cooling.
3. *Percentage of Establishments Using Adjustable-Speed Motors*. Adjustable speed drive (ASD) or variable-speed drive (VSD) describes equipment used to control the speed of machinery. Many industrial processes, such as assembly lines, must operate at different speeds for different products. Where process conditions demand the adjustment of flow from a pump or fan, varying the speed of the drive may save energy compared with other techniques for flow control.
4. *Percentage of Establishments Using Cogeneration Technologies*. The cogeneration system uses a heat engine or power station to generate electricity and useful heat at the same time.
5. *Percentage of Establishments Employing a Full-Time Energy Manager*. A full-time energy manager is a person whose major function is to direct or plan energy strategies relating to energy use and energy-efficient technology within the establishment.
6. *Percentage of Establishments Participating in One or More General Energy-Management Activities*. General energy-management activities include energy audit or assessment; electricity load control; power factor correction or improvement; standby generation programme; equipment installation or retrofit for the primary purpose of using a different energy source; special rate schedule; interval metering; equipment installation or retrofit for the primary purpose of improving energy efficiency affecting.
7. *Capability to Switch from Natural Gas to Alternative Energy Sources*: the ability of the sector to switch from natural gas to alternative energy sources (in terms of percentage of switchable energy on total consumption). 'Alternative energy sources' consist of those energy sources that could have been substituted for natural gas. It measures the flexibility of the sectors in substituting for the use of natural gas in productive activities.

The next section presents the results of the application of the two indexes to the case of the United States.

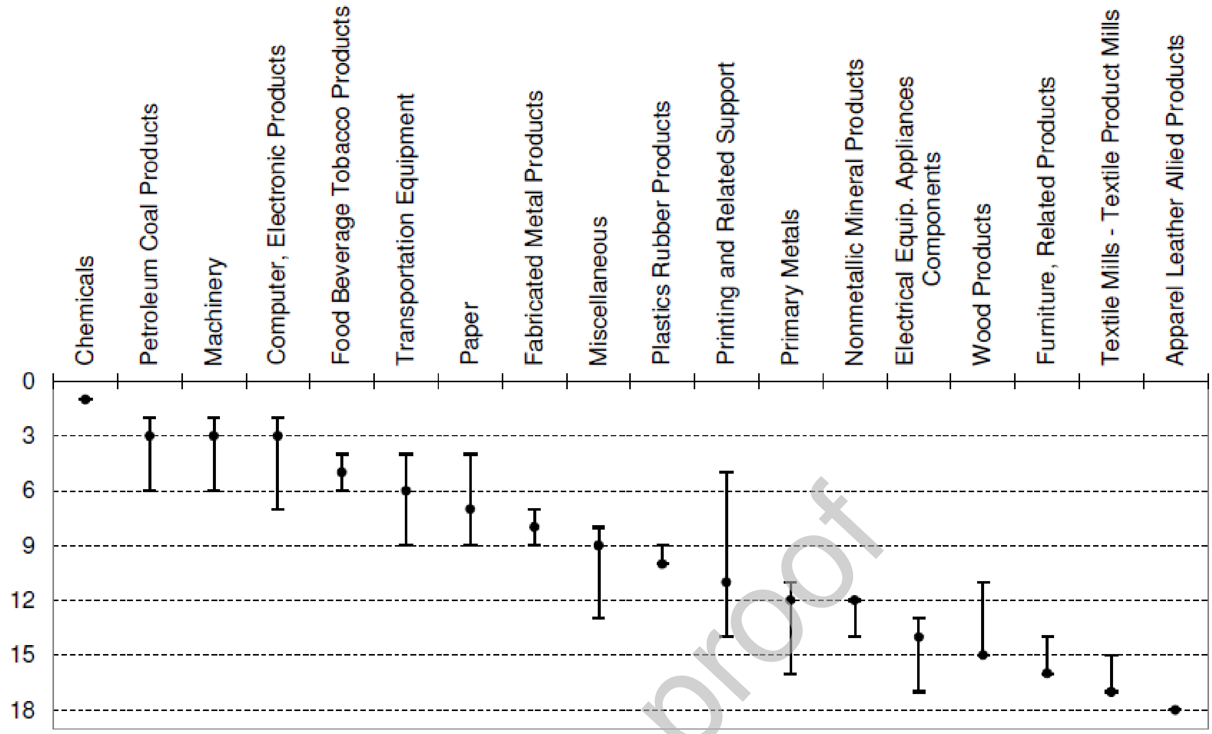
6. Results

6.1 Assessing the robustness of the ranking trough uncertainty analysis (UA)

The uncertainty analysis (UA) methodology described above has been used to assess the robustness of the ranking for the two indicators for each year considered. The *uncertainty analysis* was computed considering 50,000 different combinations of combining functions and variable weighting schemes in the composite indicator equation. The result of the UA is a distribution of values of the composite indicator for each sector. Accordingly, the position of each sector in the ranking is not given by a single value but by a distribution of values corresponding to a large number of different groupings from combining functions and variable weighting schemes in the index equation, graphically represented as the rank (position) uncertainty interval. The wider the band is, the higher the influence of the index computing choices (i.e., 0.5 selection of combining function and of the weights assigned to the variables) on the ranking are. In other words, the wider the bands are, the higher the possibility is of manipulating the ranking by changing the equation of the index and the weights assigned to the variables. The final ranking is built on the basis of the median rank for each sector, which is represented in the graph by the dot, whereas the band goes from the 5^{th} to the 95^{th} percentile of the rank uncertainty distribution. Sector 1 is the best and sector 18 is the worst for performance.

By performing the uncertainty analysis for the two indicators for each year considered, we find that the rankings are generally very robust since the bands representing the level of uncertainty are generally very short. Below, we report the results of UA for the two indicators for 2010. Appendix A shows the details of the percentage frequency distribution of each sector rank resulting from our uncertainty analysis.

Figure 1. Result of the Uncertainty Analysis for the Economic Performance Index

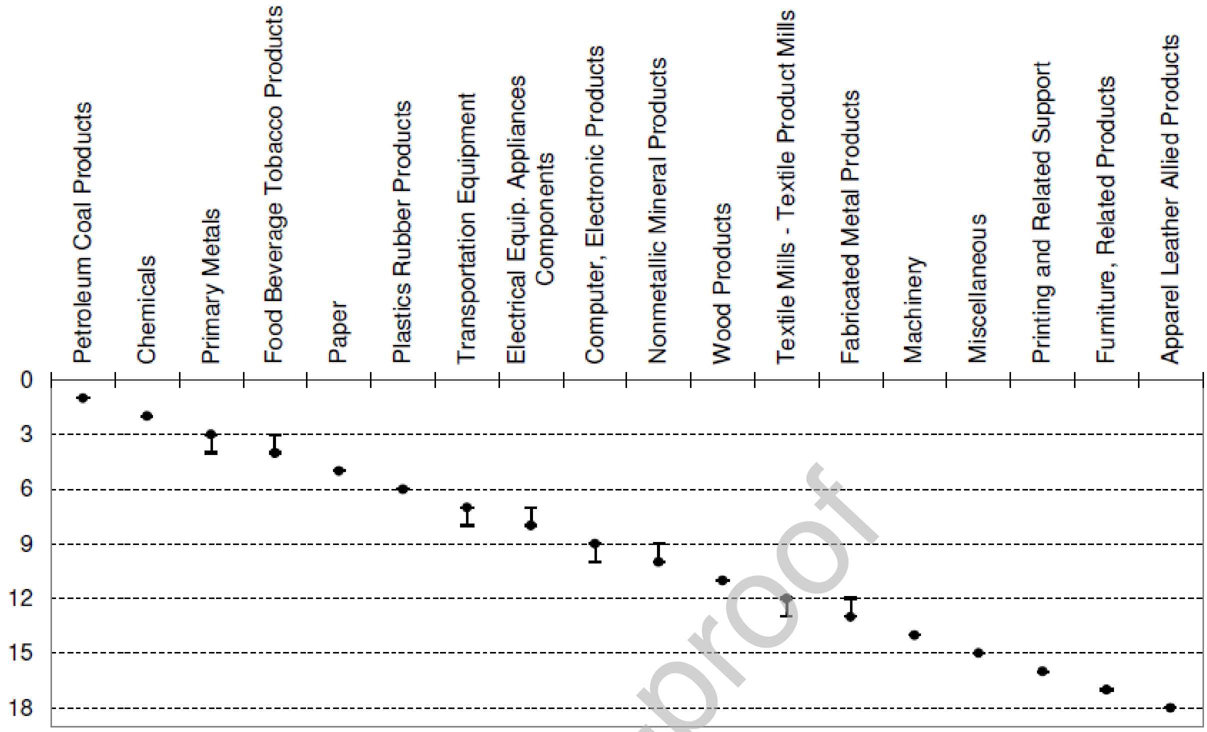


Source: Author's calculations.

The uncertainty analysis applied to the *economic performance index* shows that the ranking of industries is sufficiently robust. In fact, the bands generally tend to be narrow. As can be noted, industries near the head and tail of the ranking have generally narrower bands, and the results tend to be more robust for these sectors. In certain cases, the median is located at the extremity of the band because its value coincides with the maximum or minimum of the range. This is another indication of the robustness of the median ranking. In particular, the ranking for the *economic performance index* shows a different economic performance of the sectors. For the US economy, the industries with the best economic performance are chemical products; petroleum and coal products; machinery computer and electronic products; and food, beverage and tobacco products. In contrast, the industries that achieved the lowest economic performance are apparel and leather allied products; textile; furniture; wood products, and electrical equipment and appliances components. As a preliminary result, the EPI provides information on the industrial structure of the American economy that is potentially useful in the process of defining industrial policy targets.

Figure 2 shows the result of the uncertainty analysis for the *Greening Performance Index*.

Figure 2. Result of the Uncertainty Analysis for the Greening Performance Index



Source: Author's calculations.

The 2010 ranking for the Greening Performance Index (GPI) appears particularly robust since the bands obtained by applying the uncertainty analysis are very short. The results in terms of ranking of the industries analysed indicate that the GPI presents some similarities with the economic performance index (EPI). (We further discuss the similarities and differences between the two rankings in the next section). Indeed, among the best greening performance industries, we find petroleum and coal products; chemical products; food, beverage and tobacco products, which are in the first five positions for their economic performance. In addition, primary metals and paper reached good greening performances (at the third and fifth positions, respectively). These best greening performance sectors are those that have mostly adopted energy-saving technologies in their productive processes. In contrast, apparel and leather allied products; furniture; printing and related support sector; miscellaneous; and machinery are the industries characterized by the lowest greening performance. In reading these results, we specify that the GPI tends to capture just the ability of the sectors to invest in energy-efficient productive processes. This means, for example, that the Greening Performance Index (GPI) overlooks considerations on the environmental impact of the sector product's final use. In our specific case, for instance, the petroleum and coal industry has achieved good greening performance since it mostly adopted energy-saving technologies compared to the other sectors; of course, this does not mean that the *use* of petroleum and coal products is environmentally friendly.

6.2 Discussion on potential targets for industrial policy

By simultaneously evaluating the results provided by the two indexes presented above, it is possible to derive important information on the characteristics of the potential targets of industrial policies. As a first step of this analysis, we assessed the degree of correlation among the two indexes (see Figure 3).

Table 1. Degree of correlation between EPI and GPI over time (1998, 2002, 2006, 2010)

Year	Coefficient R
1998	0,305
2002	0,333
2006	0,330
2010	0,549

Source: Author's calculations.

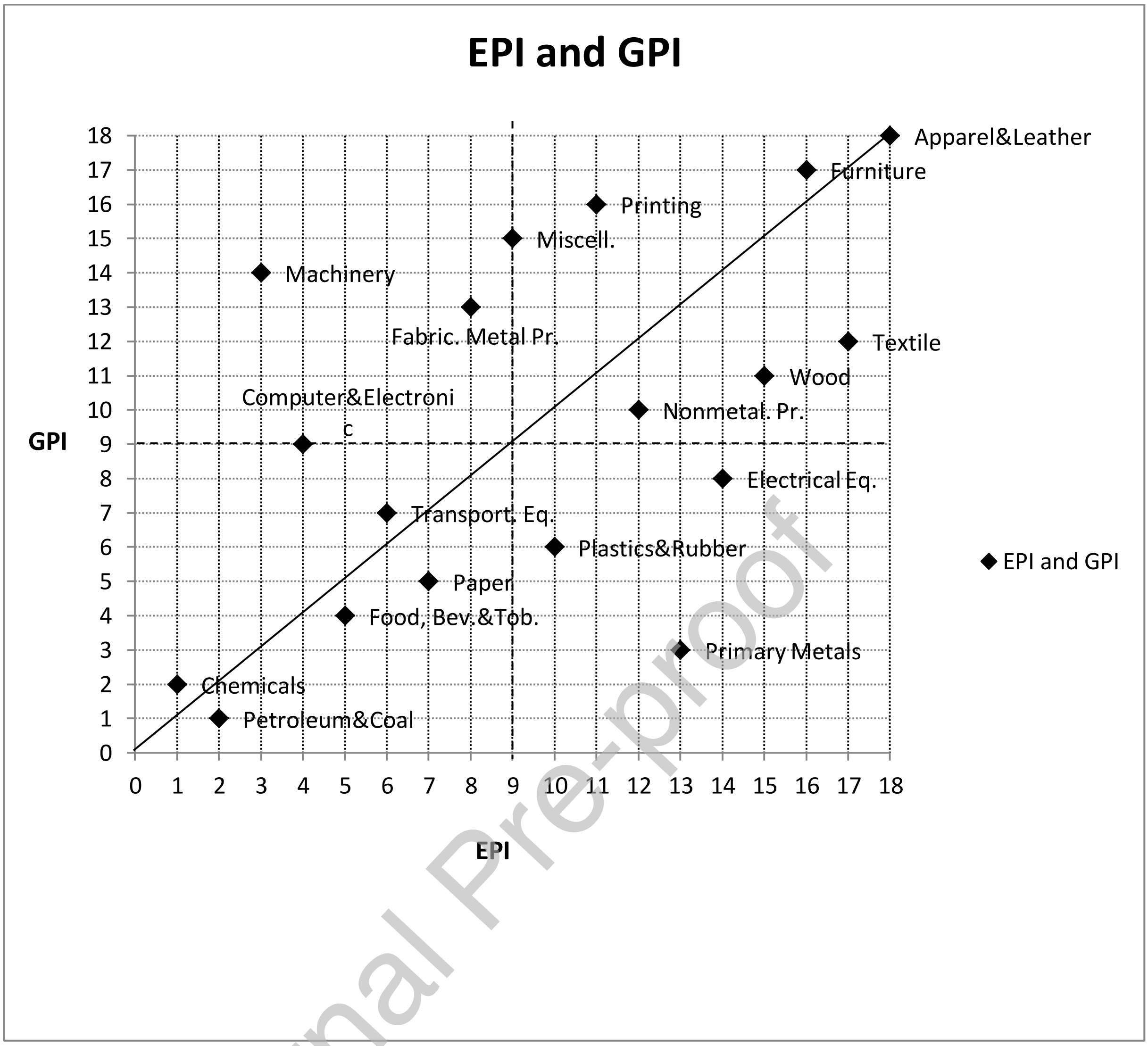
The analysis of correlation between the two indexes, performed by using the Spearman correlation coefficient (here, it is equivalent to the Pearson correlation coefficient R), shows that correlations between indicators maintain approximately the same value over time. In particular, the Greening Performance Index (GPI) is positively correlated with the Economic Performance Index (EPI) (even if the level of correlation is not high). The correlation coefficients range from 0.305 to 0.579 over time. This could mean that industries with higher economic performance (that, according to the construction of the EPI, tend to coincide with capital intensive industries) are more inclined to invest in energy-saving technologies.

However, the analysis of the degree of correlation offers just a general overview of the relation between the economic and environmental performance of industries by simultaneously considering all sectors. In reality, the existence of possible inconsistencies between the economic and greening performance of industries could suggest different kinds of policies for sectors with different characteristics. In other words, the relationship between the economic and greening performance of the sectors deserves to be further explored to address the potential trade-off between the economic and environmental goals of industrial policies. This kind of problem must be addressed through methodologies able to identify, through a 'case by case' approach, the existence of such a trade-off to implement selective industrial policies that are differentiated and calibrated on the specific characteristics of the target.[22]

Following this intuition, Figure 4 simultaneously displays the two rankings. This chart is a useful tool for mapping different industrial sector performances and discussing policy implications.

Figure 3. Mapping industrial sectors - Economic and Greening Indexes

[22] In addition to the problem of potential trade-offs, the issue of the interdependencies between different industries is a relevant topic that currently is not taken into account in our analysis, but that certainly deserve to be explored in the future. Indeed, considering linkages between different activities seems to be a promising way to identify relevant industries of an economy, as well as to assess how intervention on each industry will have effects on other industries. For instance, sectors with strong upstream connections, which buy inputs from many other industries, are capable of influencing overall economic production by stimulating demand for the related industries. On the other hand, sectors with downstream connections can improve the offer by selling output to other sectors, and therefore develop overall consumption (see, e.g., Hirschman, 1958; Cella, 1984; Cardinale, 2017; Scazzieri et al., 2015).



Source: Author's calculations.

In the horizontal axis, the sectors are sorted according to the growing economic performance (from the best – 1 – to the worst – 18 –), whereas the vertical axis maps the greening performance as a function of the economic performance. The more the greening performance moves away from the bisector, the greater the divergence between this performance and the economic performance; therefore, the trade-off between economic and environmental objectives is potentially greater. According to this framework, the diagram can be divided into four quadrants, which identify four different types of industrial policy targets potentially treated in different ways by the policymaker. The quadrant at the top left of the diagram includes the sectors with high economic performance but low environmental performance. One can hypothesize, for example, that for this group of sectors, the intervention of industrial policy should pursue the objective of improving the environmental performance of the industries. The opposite case is represented by the low right quadrant: sectors with low economic performance but high environmental performance. For these sectors, policy goals, for instance, could focus on improving economic performance. The quadrants on the bisector represent the sectors for which the trade-off between economic and environmental performance is less evident. Specifically, the sectors of the quadrant at the top right could be the target of policies aimed at both improving economic and environmental performance. In contrast, the lower quadrant on the left contains sectors that may not need any policy intervention, as they are characterized by high economic and environmental performance. We recall here that the good performances of sectors such as petroleum and coal depend upon the indicator we use, which captures improvements in the production processes, and not in the impact of the final goods produced or in the renewability of resources.

Beyond the specific results of our analysis on the US case, which should be considered only as an illustrative example, these results allow us to present a methodology that, appropriately adapted to the objectives to be studied, can help different policy stakeholders to discuss and define goals and targets of industrial policies in a more rigorous and transparent manner by making the relation between them explicit. Specifically, the methodology aims to improve the policymaking process in two ways. First, since industrial policy implemented with weak (or unobservable) justifications could run the risk of responding to partial interests (e.g., of influential lobbies or self-interested politicians and bureaucrats), we suggest that policymakers' choice about the promotion of specific targets (such as industries, companies, territories, and so on) should be based on transparent and communicable motivations. Indeed, requiring policymakers' reasons for industrial policy to be explicit increases the control of society on public action and potentially limits 'unvirtuous' behaviours, creating incentives to operate for the more general interest of the community (see, for example, Bird, 2005). In this direction, the methodology we applied makes different political priorities explicit (e.g., economic and environmental) and highlights their connections with specific targets of intervention. In other words, the methodology, if applied, offers to the policymaker the opportunity to justify industrial policy decisions (i.e., in terms of promotion of particular targets instead of others) in a rigorous and transparent way, showing the explicit connection between a particular target and its capacity to promote specific societal goals. This transparency in policymaking potentially has the effect of discouraging and reducing 'regulatory capture' phenomena from (internal and external) 'rent-seekers' by revealing whether the selection of particular targets and the implementation of particular policies are justifiable or not with respect to the identified societal goals.

Second, the proposed methodology aims to improve the ability of the government to process information useful to decision-making. In this context, the methodology provides useful information on the performance of the different targets (e.g., industries) with respect to multiple objectives (e.g., economic and environmental). Specifically, the methodology categorizes the potential targets of intervention in different groups based on the combination of the performances realized with respect to different goals. In this framework, in addition to information on the existence or absence of potential trade-offs, the analysis reveals how different targets express a different capacity to achieve certain policy objectives. This constitutes useful information for policymakers to discuss and decide on which targets deserve to be promoted (and through which policy tools) in view of fostering sustainable structural change. In this way, the methodology is useful to provide rigorous information for the implementation of selective industrial policies, differentiated on the specific characteristics of the targets. Under this perspective, the illustrative results of the analysis (i.e., the diagram in Figure 4) can also be intended as a *modus operandi* that can be used by governments to share their views on priorities, goals and targets both within and outside the public administration. Certainly, there are limitations, especially in those sectors at the technological frontier, because of the structural uncertainty characterizing new industries and innovations (Nelson and Winter, 1982; Foster, 1997; Cardinale, 2019). This uncertainty can imply even more difficulties for policymakers in justifying their selective choices.

Nevertheless, we argue that competing policy choices should always be specified and discussed, as should be the reasons (albeit unstable) to follow one policy option or another. Indeed, this *modus operandi* appears useful to promote risk sharing and/or to mitigate potential government failures due, for example, to the lack of information or opportunistic behaviours (Bird, 2005). In doing so and if the discussion is genuinely open (i.e., in a participatory setting) a potential arena is created for different stakeholders to raise their voice. In this context, effective public policy management choices might offer important answers to the kind of government failures we are discussing. There are no one-for-all solutions, and in diverse institutional settings, different policy governance and management mechanisms could be envisioned to guarantee an effective participatory process in which distinct stakeholders have a real voice. Ideas and solutions on this matter can come from studying the different (past and present) government practice experiences in Europe (with reference, for example, to how the governance of national and regional innovation agencies can be organized), in the US (with reference, for example, to the role of industrial lobbying) and in quite different institutional contexts, such as China or South Korea (with reference, for example, to the process of defining ‘strategic industries’).[23]

7. Final remarks.

This paper is grounded in the debate on selective industrial policy and *sustainable* structural change, as defined in this paper. Despite the massive use of selective industrial policy to promote processes of structural change, this paper has recalled the risk that public actions could be affected by government failures, especially in the absence of a widespread theoretical debate on the possible corrections to such failures. On the one hand, government action risks being led and captured by pressures from partial interests and rent-seekers. On the other hand, important information asymmetries must be overcome to identify targets and tools that better promote specific economic and societal objectives. Building up these well-known issues, we have discussed the importance of promoting structural changes that are sustainable from a plurality of viewpoints, including ecological, economic and social changes. In this vein, we have considered industrial policy as a powerful tool for governing structural changes, with the goal of containing the risk of dramatic collapses. In view of that, government failures have also been considered circumstances in which public action is unable to acknowledge and mitigate the potential (ecological, economic and social) threats to system sustainability that could characterize the process of structural change. All these considerations point to the need to invest in analytical tools and theoretical frameworks able to recognize the political economy of industrial policy, with different interests at stake from various societal groups that can be translated into specific industrial policy goals and later into specific industrial policy targets.

With this in mind, this paper has intended to contribute to the literature and to the theoretical debate by proposing a methodology to improve the efficiency and effectiveness of industrial policy. Specifically, by focusing on the analysis of the US manufacturing system, the methodology we have proposed ranks US manufacturing industries as potential industrial

[23] For further details on how different governance and management policy mechanisms might work in different institutional settings, see, for example, Diez (2001); Dür and Mateo (2012); Yadav (2008); Barbieri et al (2019a); Tassinari et al. (2019); Holburn, G., and Spiller, P. (2002); Kamberelis and Dimitriadis (2000).

policy targets according to their capacity to pursue economic and environmental goals. This analysis has been carried out through the construction of two different composite indicators that are useful to assess many sectors' economic and environmental performances. In addition, we have applied an uncertainty analysis methodology to the construction of the composite indicators to test the robustness of the rankings. In this way, it has been possible to understand whether and to what extent the rankings are volatile or fail to capture the phenomenon that the indicator is meant to measure. Finally, the results of the two rankings have been simultaneously considered by mapping in a single diagram the economic and environmental performance of the industries. From a political economy perspective, such a diagram should be intended as an important exemplifying outcome for discussing, deciding and motivating (inside and outside the public administration) the choice on *targets* and *tools* of industrial policy when multiple *goals* are at stake. In this context, the main strength of the proposed methodology is the ability to highlight the political priorities and their connections with IP targets. This enables, in our view, transparency and rigour in industrial policymaking, which can in turn contribute to mitigating potential government failures. On the one hand, the clear specification of the political priorities by the policymakers and their connection with the intervention targets could increase the control of public action by the community and discourage 'unvirtuous' behaviours of regulatory capture, incentivising policymakers to operate for the more general interest of society. On the other hand, the methodology offers reliable information on how different targets express a different capacity to achieve certain policy objectives, contributing to overcoming potential information asymmetries affecting policymaking processes. Of course, we are aware that the analytical exercise proposed herein is simplified in a context of two 'competing' goals and that it could be improved to simultaneously capture a higher number of goals. In this framework, we wish to further underline that, within the practice of identifying proper IP goals, targets and tools, the adoption of the proposed methodology might be interpreted as a *modus operandi* rather than a mere tool, and in this sense, it can offer a chance to make the debate on political priorities more explicit and transparent.

References

Aghion, P., Boulanger, J. and Cohen, E. 2011. Rethinking Industrial Policy, Bruegel Policy Brief, no. 4.

Andreoni, A., and R. Scazzieri. 2014. 'Triggers of Change: Structural Trajectories and Production Dynamics.' Cambridge Journal of Economics 38 (6): 1391-1408

Armaroli, N. and Balzani, V. 2011. Towards an electricity-powered world, Energy & Environmental Science, vol. 4, no. 9, 3193-3222

Arndt, H. W. 1987. Economic Development: The History of an Idea, Chicago: University of Chicago Press

Barbieri E., Di Tommaso M.R., Tassinari M., Marozzi M. (2019a), Selective Industrial Policies in China: Investigating the Choice of Pillar Industries, International Journal of Emerging Markets, DOI(10.1108/IJoEM-02-2018-0105)

Barbieri, E., Di Tommaso, M.R., Pollio, C., Rubini, L. (2019b), Industrial Policy in China: The Planned Growth of Specialised Towns in Guangdong Province, Cambridge Journal of Regions, Economy and Society, DOI:10.1093/cjres/rsz012

Bentham, J. (1823 [1789]) An Introduction to the Principles of Morals and Legislation, London, Pickering.

Bianchi P. and Labory S. (2019a). Industrial Policy for the Manufacturing Revolution: Perspectives on Digital Globalisation, Cheltenham Glos. and Northampton, MA (USA), Edward Elgar Publishing.

Bianchi P. and Labory S. (2019b). Manufacturing regimes and transitional paths: Lessons for industrial policy. Struct. Change Econ. Dynamics 48, 24–31.

Bianchi, P. and Labory, S. 2011. Industrial Policies after the Crisis. Seizing the Future, Cheltenham, E. Elgar

Bianchi, P., and S. Labory (eds). 2006. International Handbook on Industrial Policy. Cheltenham: E. Elgar

Bianchi. (2017). Il cammino e le orme. Industria e politica alle origini dell'Italia contemporanea, Il Mulino, Bologna.

Bird, S. M. 2005. "Performance indicators: good, bad, and ugly." Journal of the Royal Statistical Society: Series A 168 (1): 1–27

Block, F. (2008). Swimming against the current: The Rise of a Hidden Developmental State in the United States. Politics & Society, 36(2), 69–206

Bogliacino, F. and Pianta, M., 2011. Engines of growth. Innovation and productivity in industry groups. Structural Change and Economic Dynamics, 22, 41–53.

Buigues, P. A., and K. Sekkat. 2009. Industrial Policy in Europe, Japan and the USA. Amounts, Mechanisms and Effectiveness. Palgrave Macmillan

Cardinale I., and Scazzieri R., 2018. Explaining structural change: actions and transformations, Structural Change and Economic Dynamics.

Cardinale, I. (2015), 'Towards a structural political economy of resources', in: M. Baranzini, C. Rotondi and R. Scazzieri (eds), Resources, Production and Structural Dynamics, Cambridge University Press, Cambridge, pp. 198-210

Cardinale, I. (2018b). Structural Political Economy. In The Palgrave Handbook of Political Economy, ed. I. Cardinale and R. Scazzieri. London: Palgrave Macmillan.

Cardinale, I. 2017. Sectoral Interests and 'Systemic' Interest: Towards a Structural Political Economy of the Eurozone. In The Political Economy of the Eurozone, ed. I. Cardinale, D. Coffman, and R. Scazzieri, 216–237. Cambridge: Cambridge University Press.

Cardinale, I., & Scazzieri, R. (2019). SUL RITORNO DELL'ECONOMIA POLITICA. Istituto Lombardo - Accademia Di Scienze E Lettere - Rendiconti Di Lettere. https://doi.org/10.4081/let.2016.505

Cardinale, I., (2018a). A bridge over troubled water: a Structural Political Economy of vertical integration. Struct. Change Econ. Dyn. 46 (September), 172–179.

Cardinale, R. (2019), Theory and practice of State intervention: Italy, South Korea and stages of economic development, Structural Change and Economic Dynamics, Volume 4p, pp. 206-216.

Cella, G. 1984. "The Input-Output Measurement of Interindustry Linkages." Oxford Bulletin of Economics and Statistics 46 (1): 73-84

Chang, H.J. (2002) Kicking Away the Ladder: Development Strategy in Historical Perspective, London: Anthem Press.

Chang, H.-J. 1994. The Political Economy of Industrial Policy. New York: St. Martin's Press

Chang, H.-J. 2011. "Industrial Policy: Can We Go Beyond an Unproductive Confrontation?" In Lin, J. Y., and B. Pleskovic (eds). Annual World Bank Conference on Development Economics 2010, Global: Lessons from East Asia and the Global Financial Crisis, Washington DC: World Bank

Chang, H.-J., A. Andreoni, and M. L. Kuan. 2013. International Industrial Policy Experiences and the Lessons for the UK, Policy Report for the London: UK Foresight Future of Manufacturing Project, UK

Government Office of Science.
Cimoli, M., G. Dosi, and J. Stiglitz, eds. 2009. Industrial Policy and Development. The Political Economy of Capabilities Accumulation. Oxford: Oxford University Press.
Daly HE. 1990. Toward some operational principles of sustainable development. Ecological Economics. 2:1-6
de Finetti, Bruno (1975). Due lezioni su "Teoria delle Decisioni". In Accademia Nazionale dei Lincei, Contributi del Centro Linceo Interdisciplinare di scienze matematiche e loro applicazioni, 6: 643-656.
Delucchi, M. A. and Jacobson, M. Z. 2011. Providing all gobal energy with wind, water and solar power, Part two: Reliability, system and transmission costs, and policies, Energy Policy, vol. 39, no. 3, 1170-1190
Di Tommaso M.R, Rubini L., Barbieri E. (2013), Southern China: Industry, Development and Industrial Policy, London and New York, Routledge.
Di Tommaso M.R., Angelino A. (2015), Hanoi tra Washington e Pechino. La crescita industriale vietnamita tra export-led growth e pianificazione selettiva, in "L'industria, Rivista di economia e politica industriale" 3/2015, pp. 351-380, doi: 10.1430/81867
Di Tommaso M.R., Tassinari M. (2017), Industria, Governo, Mercato. Lezioni americane, Il Mulino, Bologna.
Di Tommaso M.R., Tassinari M., Ferrannini A. (2020), Industrial policy and societal goals. A new look at the American case (from Hamilton to Obama and Trump), in Pressman S. (ed.), How Social Forces Impact the Economy, Routledge. ISBN 9780367439002.
Di Tommaso M.R., Tassinari, M., Ferrannini A. (2019b), Industry and government in the long-run: on the true story of the American model, in Bianchi P., Ruiz Duran C., Labory S., (2019), Transforming industrial policy for digital age: production, territories, and structural change, Cheltenham, Edward Elgar Publishing.
Di Tommaso, M. R. and Schweitzer, S. O. 2013. Industrial Policy in America. Breaking the Taboo, Cheltenham, UK and Northampton, MA, USA, Edward Elgar
Di Tommaso, M. R., and Tassinari M. 2014. "Government and Industry in the United States. Past Practices and the Debate on the Present Policies." L'Industria 35 (3): 369–408.
Di Tommaso, M.R. and Tassinari, M., Bonnini S. and Marozzi M. (2017), Industrial Policy and Manufacturing Targeting in the US: New Methodological Tools for Strategic Policy-making, International Review Applied Economics, Vol. 31, no. 5.
Di Tommaso, M.R., Spigarelli, F., Barbieri, E., Rubini, L., (2020a) "The Globalization of China's Health Industry: Industrial Policies. International Networks and Company Choices", Palgrave Mac Millan, London.
Diez, M.A. (2001), The evaluation of regional innovation and cluster policies: towards a participatory approach, European Planning Studies, 9: 905-923
Doris Elizabeth, Cochran Jaquelin, and Vorum Martin (2009), Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government
Dür, A. & Mateo,G. (2012).Who lobbies the European Union? National interest groups in a multilevel polity. Journal of European Public Policy 19(7): 969–987
Ferguson T. (1995). Golden Rule : The Investment Theory of Party Competition and the Logic of Money-Driven Political Systems, Chicago: University of Chicago Press.
Ferguson T., Jorgensen P., & Chen, J. (2018). Industrial Structure and Political Outcomes: The Case of the 2016 US Presidential Election. In Cardinale I. and R. Scazzieri (eds) The Palgrave Handbook of Political Economy, pp. 333–440. London: Palgrave Macmillan.
Foster, J., 1997. The analytical foundations of evolutionary economics: from biological analogy to economic self-organization. Struct. Change Econ. Dyn. 8(4), 427–451.
Frey, M. 2014. La valorizzazione del territorio in una prospettiva green, in Cappellin, R., Marelli, E., Rullani, E. and Sterlacchini, A. (eds), Crescita, investimenti e territorio: il ruolo delle politiche industriali e regionali, Website "Scienze Regionali", eBook 2014.1
Hawkins, D., and H.A. Simon. 1949. Note: Some Conditions of Macroeconomic Stability. Econometrica 17: 245–228.
Hirschman, A. 1958. The Strategy of Economic Development. New Haven and London: Yale University Press.
Hirschman A.O. (1970), Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States, Cambridge, MA, Harvard University Press.
Hirschman, A. O. 1981. Essays in Trepassing: Economics to Politics and Beyond. Cambridge: Cambridge University Press
Holburn, G., and Spiller, P. (2002), 'Interest Group Representation in Administrative Institutions: The Impact of Consumer Advocates and Elected Commissioners on Regulatory Policy in the United States', University of California Energy Institute, mimeo.

Ingham, B. 1993. "The Meaning of Development: Interaction Between 'New' and 'Old' Ideas." World Development 21 (11): 1803-1821
Kamberelis, G., & Dimitriadis, G. (2000). Focus Groups: Strategic Articulations of Pedagogy, Politics, and Inquiry. In: Denzin, N.K., & Lincoln, Y.S. (eds.) Handbook of qualitative research. 2nd ed. Thousand Oaks, CA: SAGE Publications.
Krueger, A. O. 1990. "Government Failures in Development." The Journal of Economic Perspectives 4 (3): 9-23
Krugman, P. 1987. "Strategic Sectors and International Competition." In Robert, S. M. (ed.), *U.S. Trade Policies in a Changing World Economy*, Cambridge: MIT Press
Kuznets, S. (1971) Economic Growth of Nations: Total Output and Production Structure. Cambridge, MA, Belknap Press of Harvard University Press.
Lall S., Teubal M. (1998), 'Market-Stimulating' technology policies in developing countries: a framework with examples from East Asia, in «World Development», 26, 8, pp. 1369-1385.
Landesmann, M., Scazzieri, R., 1990. Specification of structure and economic dynamics. In: Baranzini, M., Scazzieri, R. (Eds.), The Economic Theory of Structure and Change. Cambridge University Press, Cambridge, pp. 95–121.
Landesmann, M., Scazzieri, R., 1996. The production process: description and analysis. In: Landesmann, M., Scazzieri, R. (Eds.), Production and Economic Dynamics. Cambridge University Press, Cambridge, pp. 191–228.
Le Grand J. (1991), The theory of government failure, in «British Journal of Political Science», 21, 4, pp. 423-442.
Lee, K., and Shin H., 2018. Varieties of capitalism and East Asia: Long-term evolution, structural change, and the end of East Asian capitalism. Structural Change and Economic Dynamics.
Lin, J.Y, and H.-J. Chang. 2009. "Should industrial policy in developing countries conform to comparative advantage or defy it? A debate between Justin Lin and Ha-Joon Chang." Development Policy Review 27 (5): 483-58
Lin, J.Y. (ed.) 2012. New Structural Economics. A Framework for Rethinking Development and Policy. Washington: The World Bank
Lin, J.Y. 2010. "Six steps for strategic government intervention." Global Policy 1 (3): 330-1
List, F. (1996 [1827]) Outlines of American Political Economy in Twelve Letters to Charles J. Ingersoll., Wiesbaden, Böttiger.
Luzzati, T., Gucciardi, G. (2015), A non-simplistic approach to composite indicators and rankings: an illustration by comparing the sustainability of the EU Countries, Ecological Economics Vol. 113, no. 5, 25-38.
Lv, P. and Spigarelli, F. (2016), "The determinants of location choice: Chinese foreign direct investments in the European renewable energy sector", International Journal of Emerging Markets, Vol. 11 No. 3, pp. 333-356.
Malerba, F. 2002. "Sectoral System of Innovation and Production", Research Policy 31(2): 247-264
Marozzi M. (2012), Tertiary Student Satisfaction with Socialization: a Statistical Assessment, Quality and Quantity, 46, p. 1271-1278
Marozzi, M. (2016), Construction, Robustness Assessment and Application of an Index of Perceived Level of Socio-economic Threat from Immigrants: A Study of 47 European Countries and Regions, Social Indicators Research, 128, 413–437.
Marozzi, M. 2015. Measuring Trust in European Public Institutions, Social Indicator Research, vol. 123, 879-895
Masina, P. 2012. "Vietnam between developmental state and neoliberalism –the case of the industrial sector."In Developmental Politics in the Neoliberal Era and Beyond: Critical Issues and Comparative Cases, edited by K.S. Chang, B. Fine and L. Weiss. Palgrave: London.
Mazzucato, M. 2013. The Entrepreneurial State. Debunking Public vs. Private Sector Myths. London and New York: Anthem Press.
Michalski, W. 1991. "Support Policies for Strategic Industries: An Introduction to the Main Issues." In OECD, Strategic Industries in a Global Economy: Policy Issues for the 1990s, Paris, CEDEX
Monga, C. 2012. "Growth Identification and Facilitation: The Role of the State in the Dynamics of Structural Change." In Lin, J.Y. (ed.), New Structural Economics. A Framework for Rethinking Development and Policy. Washington: The World Bank
Munda, G., Nardo, M., Saisana, M., & Srebotnjak, T. (2009). Measuring uncertainties in composite indicators of sustainability. International Journal of Environmental Technology and Management, 11, 7–26.
Nadel, S., Elliott R. N., Shepard M., Greenberg S., Katz G., and de Almeida A. 2002. Energy-Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunities. 2nd edition. Washington,

DC: ACEEE. http://aceee.org/ebook/energy-efficient-motor-systems.
Nadel, S., Elliott R.N., and Langer T., June 2015, Energy Efficiency in the United States: 35 Years and Counting, Report E1502
Natsuda K. and Thoburn J. (2013) Industrial policy and the development of the automotive industry in Thailand, Journal of the Asia Pacific Economy, 18:3, 413-437, DOI: 10.1080/13547860.2012.742690
Nelson, R.R., Winter, S.G., 1982. An Evolutionary Theory of Economic Change. Belknap Press, Cambridge, Mass., London.
O'Sullivan, E., Andreoni, A., López-Gómez, C. and Gregory, M. 2013. What is new in the new industrial policy? A manufacturing systems perspective, Oxford Economic Review of economic Policy, vol. 29, no. 2, 232-462
OECD (2008). Handbook on constructing composite indicators. Paris: OECD.
OECD 2011. Towards Green Growth: A Summary for Policy Makers, Paris, OECD
Ohno, K. 2009. "Avoiding the Middle-Income Trap: Renovating Industrial Policy Formation in Vietnam."ASEAN Economic Bulletin 26(1), 25-43.
Olawumi T.O. and Chan D.W.M. (2018), A scientometric review of global research on sustainability and sustainable development, Journal of Cleaner Production, Vol. 183, pp. 231-250
Pasinetti, L.L., 1981. Structural Change and Economic Growth: A Theoretical Essay on the Dynamics of the Wealth of Nations. Cambridge University Press, Cambridge.
Petti, C. 2012. Technological Entrepreneurship in China. How Does It Work? Edward Elgar, Cheltenham, UK and Northampton, MA, USA.
Petti, C., Rubini, L., Podetti, S. (2017). Government Support and R&D Investments Effectiveness in Chinese SMEs: A Complex Relationship. Asian Economic Papers 16(1), pp. 201-226.
Pianta M. (2014), An industrial policy for Europe, Seoul Journal of Economics, 27, 3.
Pianta M. (2015), What is to be produced? The case for Industrial Policy, "Intereconomics – Review of European Economic Policy", Vol 50, N. 3, pp. 139-145
Pollio C., Rubini L. (2015), Le contraddizioni delle politiche industriali selettive. Il caso dell'automotive in Tailandia, in "L'industria, Rivista di economia e politica industriale" 3/2015, pp. 381-402, doi: 10.1430/81868
Rodrik, D. 2010. The Return of Industrial Policy, http://www.project-syndicate.org/commentary/rodrik42/English (last accessed November 2014)
Rogers, E. 2014. The Energy Savings Potential of Smart Manufacturing. Washington, DC: ACEEE. http://aceee.org/sites/default/files/publications/researchreports/ie1403.pdf.
Saisana, M. and Tarantola, S., (2002). State-of-the-art Report on Current Methodologies and Practices for Composite Indicator Development, European Commission, Joint Research Centre, Ispra, Italy, EUR 20408 EN.
Saisana, M., Saltelli, A., & Tarantola, S. (2005). Uncertainty and sensitivity analysis techniques as tools for the quality assessment of composite indicators. Journal of the Royal Statistical Society Series A, 168, 307–323.
Sauvé S., Bernard S., Sloan P. (2016), Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research, Environmental Development, Vol. 17, pp. 48-56
Scazzieri, R., 2018. Structural dynamics and evolutionary change. Struct. Change Econ. Dynamics 46, 52–58.
Scazzieri, R., Baranzini, M. and Rotondi, C. (2015) 'Resources, Scarcities and Rents: Technological Interdependence and the Dynamics of Socio-Economic Structures', in M. Baranzini, C. Rotondi and R. Scazzieri (eds.), Resources, Production and Structural Dynamics, Cambridge, Cambridge University Press, pp. 427-484.
Schuck, P. 2014. Why government fails so often and how it can do better. Princeton: Princeton University Press
Sen, A. K. 1983. "Development ? Which way now?" Economic Journal 93 (372): 745-762
Sen, A. K. 1999. Development as Freedom, New York and Oxford, Oxford University Press
Setti, L. and Balzani, V. 2011. Road Map towards an entigrating management system in Italy, Rendiconti Lincei, vol. 22, no. 1, 55-64
Smil, V. 2008. Energy in Nature and Society, Cambridge, Massachusetts and London, UK, MIT press
Soete, L. 1991. "National Support Policies for Strategic Industries: The International Implications." In OECD, Strategic Industries in a Global Economy: Policy Issues for the 1990s, Paris, CEDEX
Stevens, B. 1991. "Support Policies for Strategic Industries: An Assessment and Some Policy Recommendations." In OECD. Strategic Industries in a Global Economy: Policy Issues for the 1990s. Paris: CEDEX 3.
Stiglitz, J. E. and Lin, J. Y. (eds) 2013. The Industrial Policy Revolution I: The Role of Government Beyond Ideology, New York, Palgrave Macmillan

Tassinari M. (2019), Capitalizing Economic Power in the US. Industrial Strategy in the Neoliberal Era, International Political Economy Series, Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-76648-5_1

Tassinari M., Barbieri E., Morleo G., Di Tommaso M.R. (2019), Targeted Industrial Policy and Government Failures: Insights from the South Korean Experience, International Journal of Emerging Markets, DOI(10.1108/IJoEM-02-2018-0110)

Teece, D. J. 1991. "Support Policies for Strategic Industries: Impact on Home Economies." In OECD, Strategic Industries in a Global Economy: Policy Issues for the 1990s. Paris: CEDEX

The Economist 2010. The global revival of industrial policy, Picking winners, saving losers: Industrial policy is back in fashion. Have governments learned from past failures? 5 August 2010.

Tregenna, F. 2009. "Characterising deindustrialisation: An analysis of changes in manufacturing employment and output internationally." Cambridge Journal of Economics 33 (3): 433-466

Tregenna, F. 2014. "A new theoretical analysis of Deindustrialisation." Cambridge Journal of Economics, vol. 38, no. 6, 1373–1390

UNDP (United Nations Development Program) 1990. Human Development Report 1990. New York and Oxford: Oxford University Press

UNECE (United Nations Economic Commission for Europe) (2019). Guidelines on producing leading, composite and sentiment indicators. Geneva: United Nations.

Wade, R. H. 2012. Return of industrial policy?, International Review of Applied Economics, vol. 26, no. 2, 223-239

Warwick, K. 2013. Beyond Industrial Policy: Emerging Issues and New Trends, in OECD Science, Technology and Industry Policy Papers, no. 2, OECD Publishing, http://dx.doi.org/10.1787/5k4869clw0xp-en

World Bank 2011. Moving to a Green Growth Approach to Development, World Bank.

Worm, B. et al., 2006. Impacts of biodiversity loss on ocean ecosystem services. Science 314, 787-790.

Yadav V. 2008. Business Lobbies and Policymaking in Developing Countries: The Contrasting Cases of India and China. Journal of Public Affairs 8(1-2): 67–82

Yang, X. and Stoltenberg, C.D. (2014), “A review of institutional influence on the rise of made-in-China multinationals”, International Journal of Emerging Markets, Vol. 9 No. 2, pp. 162-180

Yoshitomi, M. 1991. "New Trends of Oligopolistic Competition in the Globalisation of High-Tech Industries: Interactions among Trade, Investment and Government in Strategic Industries." In OECD, Strategic Industries in a Global Economy: Policy Issues for the 1990s. Paris: CEDEX 5.

Credit Author Statement

Marco R. Di Tommaso: Conceptualization; Project administration; Writing - original draft; Writing - review & editing

Mattia Tassinari: Conceptualization; Writing - original draft; Data curation; Writing - review & editing

Elisa Barbieri: Conceptualization; Writing - original draft; Writing - review & editing.

Marco Marozzi: Methodology; Data curation; Writing - original draft; Writing - review & editing

Appendix A

Table A1. Percentage frequency distribution resulting from uncertainty analysis for the Economic Performance Index (2010) - sectors listed according to the median rank.

		Rank																	
Manufactoring sector	Median	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Chemicals	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum Coal Products	3	0	23	53	15	3	4	2	0	0	0	0	0	0	0	0	0	0	0
Machinery	3	0	44	8	19	2	27	0	0	0	0	0	0	0	0	0	0	0	0
Computer, Electronic Products	3	0	33	31	20	3	3	9	0	0	0	0	0	0	0	0	0	0	0
Food Beverage Tobacco Products	5	0	0	4	10	75	10	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	6	0	0	0	28	8	39	1	17	8	0	0	0	0	0	0	0	0	0
Paper	7	0	0	4	6	5	11	46	18	11	0	0	0	0	0	0	0	0	0
Fabricated Metal Products	8	0	0	0	0	0	0	29	53	17	0	0	0	0	0	0	0	0	0
Miscellaneous	9	0	0	0	0	0	0	0	11	41	10	13	0	25	0	0	0	0	0
Plastics Rubber Products	10	0	0	0	0	0	0	0	0	15	85	0	0	0	0	0	0	0	0
Printing and Related Support	11	0	0	0	2	5	6	13	1	9	5	32	7	13	10	0	0	0	0
Nonmetallic Mineral Products	12	0	0	0	0	0	0	0	0	0	0	3	52	35	10	0	0	0	0
Primary Metals	12	0	0	0	0	0	0	0	0	0	0	29	34	11	14	5	6	0	0
Electrical Equip. Appliances Components	14	0	0	0	0	0	0	0	0	0	0	0	5	15	55	0	1	24	0
Wood Products	15	0	0	0	0	0	0	0	0	0	0	23	2	0	0	75	0	0	0
Furniture, Related Products	16	0	0	0	0	0	0	0	0	0	0	0	0	0	12	14	75	0	0
Textile Mills - Textile Product Mills	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	18	76	0
Apparel Leather Allied Products	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100

Source: Author's calculations.

Table A2. Percentage frequency distribution resulting from uncertainty analysis for the Greening Performance Index (2010) - sectors listed according to the median rank.

		Rank																	
Manufacturing sector	Median	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Petroleum Coal Products	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemicals	2	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Primary Metals	3	0	0	93	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food Beverage Tobacco Products	4	0	0	7	93	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paper	5	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Plastics Rubber Products	6	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	7	0	0	0	0	0	0	54	46	0	0	0	0	0	0	0	0	0	0
Electrical Equip. Appliances Components	8	0	0	0	0	0	0	46	54	0	0	0	0	0	0	0	0	0	0
Computer, Electronic Products	9	0	0	0	0	0	0	0	0	63	37	0	0	0	0	0	0	0	0
Nonmetallic Mineral Products	10	0	0	0	0	0	0	0	0	36	63	0	0	0	0	0	0	0	0
Wood Products	11	0	0	0	0	0	0	0	0	0	0	98	2	0	0	0	0	0	0
Textile Mills - Textile Product Mills	12	0	0	0	0	0	0	0	0	0	0	2	52	43	2	0	0	0	0
Fabricated Metal Products	13	0	0	0	0	0	0	0	0	0	0	0	45	55	0	0	0	0	0
Machinery	14	0	0	0	0	0	0	0	0	0	0	0	0	2	98	0	0	0	0
Miscellaneous	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
Printing and Related Support	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	5	0
Furniture, Related Products	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	95	0
Apparel Leather Allied Products	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100

Source: Author's calculations.