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Industrial Policy for a Green Economy

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Industrial Policy for a Green Economy

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Written by Johannes Schwarzer

Executive Summary

Industrial policy, defined as a set of policies that selectively favours the development of certain industries over others, runs counter to the concept of a market economy and is hence a controversial topic in economic theory. Nonetheless, governments around the world with economies at various stages of development continue to use such policies in order to proactively influence their countries' economic development. In recent years, environmental considerations have increasingly shaped policy debates, and green industries are being supported through industrial policies that target the development of industries with relatively less harmful effects on the environment.

Economic justifications for industrial policy

While in principle market forces should guide the process of determining the optimal productive structure of an economy, the general case for government intervention in economics comes into play when markets are either distorted or incomplete. The following examples illustrate the most common rationales for government support to industry.

Marshallian and Inter-Industry Externalities

The presence of localized, industry-level externalities leads to formation of industry clusters, which benefit from synergies such as knowledge spillover among firms, labor pooling, or input-output linkages, where upstream firms provide inputs for downstream firms, taking advantage of low transportation costs. These benefits automatically increase with the size of the sector, which in turn necessarily becomes more productive. Until the industry cluster has reached a critical size, it will be unprofitable, producing at inefficiently low productivity and unable to compete on international markets. Temporary government support to the "infant" industry may help it take off and eventually become competitive. Such spillovers may also arise between different, complementary industries.

Coordination Failures

Coordination failures come about because many projects require simultaneous investments in order to be viable. If these investments are made by independent agents, there is little guarantee that each agent, acting in its own self-interest, would choose to invest, leading to a suboptimal equilibrium.

Self-Discovery and Diversification

Economic development and structural transformation go hand in hand with the "discovery" of economic activities that are new to a country. Therefore, entrepreneurs entering such activities contribute disproportionally to a country's self-discovery of its industrial capabilities, because an entrepreneur's success signals the profitability of a new sector. This can generate significant economy-wide demonstration effects (positive spillovers) and emulation by new entrants, which diminishes the ability of the initial investor to appropriate her benefits. As the entrepreneur would have to privately bear the costs in case of failure, an economy might end up with a suboptimal number of pioneer entrepreneurs and fail to diversify.

Credit market imperfections

Financial markets do not always possess sufficient information to accurately assess the risks involved in the financing of new industry projects, and financial intermediaries may hence fail to grasp profitable opportunities, making government intervention necessary.

Learning by doing

Technical change and productivity improvements may be a function of the very activity of production. Therefore, an infant industry might become profitable only after some time of operating under protection, in order to gain the necessary experience for enhancing competitiveness.

Environmental Externalities

Markets usually fail to adequately price the environmental effects of economic activity, and this can lead to economically viable but socially undesirable economic activity. The government has an important role to play in "levelling the playing field" for green industries, aligning private returns more closely with social returns.

Traditional Industrial Policy

Throughout the 19th and beginning of the 20th century, targeted government intervention in trade and industry has been widespread during the catch-up phase of all currently developed countries, including the United Kingdom, Germany and the United States. The main policy tools were tariffs and other trade restrictions to protect domestic industries from foreign competition. As the emergence of modern government institutions endowed governments with a larger toolbox for industrial policy, countries gradually expanded their support schemes from protection toward more active support. Latecomers to industrialization during the second half of the 20th century, notably in Latin America and Asia, all used very similar policy instruments, such as tariffs, quotas, import licensing, foreign exchange rationing and various forms of subsidies to substitute imports with domestic production—a strategy that came to be known as *import substitution industrialization*. Apart from favourable credit concessions by development banks, domestic firms also benefited from various forms of fiscal incentives such as tax breaks, duty drawbacks on imports, accelerated depreciation on capital equipment and direct subsidies.

Best practices

The literature on industrial policies is large, but faces common challenges in evaluating the impact on countries' performances. Nevertheless, a number of empirical regularities allow to distil some best practices.

Industrial Policies Should Be Only a Subset of a Broader Industrial Agenda

The successful deployment of industrial policies requires a sound enabling policy framework that is conducive to improving the business climate and economic competitiveness more generally. A number of complementary policies are needed to overcome potential bottlenecks, such as education policies to increase relevant skills in the domestic workforce, R&D support, or provision of adequate infrastructure.

Protectionism Can Work, but Design Is Crucial

Protectionism is a thorny policy issue, with many pitfalls that may actually contribute to crippling domestic industries. There is evidence that import protection, for example, may be a viable tool for industry promotion, assuming that trading partners do not retaliate. This assumption is, however, highly unlikely in today's international economic reality, as such measures will necessarily conflict with foreign interests. Even then, the evidence seems to suggest that protection needs to be focused on consumption goods rather than intermediate input goods. Further, a distinction needs to be made between homogeneous and differentiated goods, as there is greater potential in differentiated goods for developing niche industries.

Because of two major findings, the next two best practices must be considered together. These findings are that successfully industrializing countries have complemented protection with active domestic industry support, and that governments have historically been unable to design adequate sectoral protection patterns.

Industry Support Should Be Provided in a Transparent Way that Maintains Competition and Is Incentive Compatible

All forms of industry support are fraught with the threat of special interest capture, so steps must be taken to ensure transparent criteria for selecting support recipients. Not only is picking winners inherently difficult for governments, who have less knowledge concerning firm-specific characteristics than, for example, managers, it also encourages wasteful use of resources by incumbents and discourages the entry of more innovative new firms. Hence, industry support should not discriminate among firms within the promoted industry. In this context, the ability of governments to withdraw support in case of underperformance is equally important. Sunset clauses that link government support to performance criteria have been instrumental in ensuring that government aid to industry acts as an incentive for productivity in successfully industrializing Asian countries. The advantage of basing such performance criteria on export data has the double advantage of ensuring that firms are exposed to the dynamics of the international market and providing a reliable indicator of industry success.

The evidence concerning foreign direct investment is particularly clear on the need for well-defined policy objectives. Attracting foreign direct investment in downstream sectors appears to stimulate upstream domestic industry, whereas active policies are needed to ensure horizontal spillovers for domestic industries operating in the same sector. Here, the challenge is to achieve an adequate balance between offering an attractive investment framework for foreign investors and setting the right incentives for technology and knowledge transfers. While local-content requirements, subcontracting and joint ventures have been used extensively in China, it remains unclear whether countries with smaller markets can impose such regulations on multinationals without affecting their investment decisions. In any case, the literature agrees on the importance of fostering a country's absorptive capacity as a key determinant for technology transfer, necessitating, for example, active policies to develop an aptly skilled domestic workforce.

Close Collaboration Between Governments and Industry to Optimize Information Flow

In order to design adequate support schemes, policy makers need to be clear about which market failures need to be addressed. The answer to this question involves the identification of industries with potential for positive spillovers, inter-industry and input-output linkages, perceived bottlenecks to coordinate investments, the nature of financial constraints and credit market imperfections. A defining feature of successful industrial policy has thus been regular knowledge exchange between high-level government and industry representatives to ensure the continued relevance

and effectiveness of industrial support. This process implies clear objective-setting, monitoring, and progress and impact evaluations, as well as capacity building for government bureaucrats. Given the complexity of the domestic economic tissue and its countless connections to the outside world through, for example, global value chains, industrial policy-making necessarily operates under high levels of uncertainty and will often involve trial and error.

Strengthening Government Capacity to Avoid Government Failure

Government capacity to correctly anticipate trends and effectively withdraw support once it is no longer necessary calls for a highly competent bureaucracy, with highly skilled people taking key roles and accordingly competitive pay, which also helps insulate officials from corruption.

Targets of Industrial Policy Are Country-Specific

Economists have long argued for countries to upgrade their industrial structure according to their comparative advantage. However, a few successful countries have demonstrated that industrial policies may contribute to a substantial shift in what countries are best at producing. While there is still considerable disagreement on which sectors offer the greatest return on industrial policy, recent research offers (sometimes competing) avenues of identifying them. While government policy should certainly be informed by those studies, it should also be clear that there is currently no blueprint that fits across all countries. Hence, picking winning sectors should occur through careful examination of both the literature and strategies identified through country-specific government-industry collaboration.

Green Industrial Policy

With increased evidence for the detrimental effects of conventional economic activity on the environment, policy-makers around the world have been looking for ways to stimulate more environmentally friendly growth paths for their economies. And with green industries booming in recent years, governments are largely resorting to green industrial policies to foster their domestic development and carving out a competitive edge for their countries. Therefore, green industries are essentially infant industries, with all the characteristics of conventional infant industries and subject to the same opportunities and challenges of promoting them. However, given the inability of markets to price environmental externalities, green industries are, to a much larger extent, driven by policies that support the market through the stimulation of both demand and supply. While a first-best policy would need to price the externalities at hand, there are various reasons why countries are not able to do so. Hence, green industrial policies are used as a (second-best) alternative.

This peculiar function makes green industrial policy distinct from traditional industrial policy in at least three ways:

First, the scale of government intervention required is much larger in green industries, which fundamentally rely on government policy to build their markets. The size of future markets for green industries is largely determined by future government policy. For example, the less stringent future emissions ceilings are, the less profitable current investments will be. Industries that are reluctant to undertake green R&D or adopt green technologies can therefore be nudged into undertaking such investments through green industrial policies. At the same time, future government policy is a function of current investments, as the practicality of future carbon taxes, for example, depends on the future availability of alternative fuels, which in turn depends on current investments.

Second, depending on the nature of the market failure, industrial policies might be required for a much longer period of time. If the market failure is permanent and cannot, for whatever reason, be addressed by market-based policies, industrial policies would equally need to persist to ensure a level playing field.

Third, the absence of a competitive market makes performance-based evaluation of green industrial policy much harder in practice. The immaturity of the sector globally and uncoordinated industrial policies worldwide contribute to various distortions, which would, for example, render export data as indicators of a program's success less useful than they proved to be in successfully industrializing Asian nations.

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1.0 Introduction

A central empirical finding of the discipline of development economics is that the beginning of sustained economic growth is associated with a structural transformation of the economy. As countries grow richer, one observes a concomitant diversification of the productive structure away from agriculture toward non-traditional sectors such as manufacturing and, later, services. This process of industrialization took off with the Industrial Revolution, which started in Britain during the 19th century but was far from universal and was largely confined to a few Western European states and former British colonies, such as Australia and the United States (Maddison, 1995). While a number of countries, notably in Asia, have been able to catch up with Western economies through accelerated industrialization, a large majority of countries have failed to do so, leading to an unprecedented divergence in per capita income levels across countries (Pritchett, 1997). Meanwhile, total growth of manufacturing was phenomenal, with world steel production, for example, growing by a factor of six between 1950 and 2000 (Worldsteel (2009) as cited in UNEP (2012b)). It has only been since 1995 that a certain reversal of patterns has been observed and manufacturing has become a major driver of economic growth in developing countries, nearly doubling their GDP, while manufacturing value added has declined in certain industrial economies (UNEP, 2012b).

By promoting job creation and economic growth, industrialization has enormous potential to transform societies, raising living standards and narrowing the gap between rich and poor within as well as among countries. Nevertheless, modern industry is facing a whole range of relatively new challenges. Traditional economic growth has been associated with excessive environmental pressures such as resource depletion and ecosystem degradation. Today, industry alone accounts for approximately one-third of global final energy use and almost 40 per cent of total energy-related carbon dioxide emissions (International Energy Agency, 2009). Modern economic growth needs to be decoupled from production of environmental pressures, severing the link between economic goods and environmental "bads" (UNIDO, 2011). But the quest for greener industries (such as through greater resource efficiency) is far from being a purely environmental one and is in fact a core driver of economic competitiveness and sustainable growth (Smith, Hargroves & von Weizsäcker, 2012). Reducing the ecological footprint of industry has thus become an integral part of sustainable economic development, and promotion of green industry promises to strike a balance between traditional considerations of industrial development and efforts to reduce the environmental impact of such development.

While there appears to be widespread consensus among both policy-makers and researchers on the necessity for countries to develop sound industrial sectors, much disagreement remains on the adequate means to do so. Neoclassical economic theory puts much faith in the workings of a free market and views government departures from "policy neutrality" to be warranted only when attempting to rectify market failures. But even though contemporary development theory centres on the pervasiveness of such market imperfections in developing countries, economists are generally skeptical of governments' abilities to address those properly (Rodrik, 2009). Nevertheless, following great disappointment with the results of laissez-faire policies, as exemplified by what Williamson (1990) crystallized as the "Washington Consensus," industrial policy has recently made a spectacular return to the public scene (Rodrik, 2010). And as concern grows about the adverse effects of climate change, which Stern (2008, p. 1) famously described as the result of "the biggest market failure the world has ever seen," the aspiration for getting industrial policy right has gained new momentum and urgency.

This paper reviews successes and failures of both traditional and more recent green industrial policy in order to distil lessons learned on what works and what doesn't. We will adopt a strictly national welfare perspective, while at times hinting at frictions that might occur when international interests are at stake. For the purpose of this paper, we will define industrial policy very broadly as a set of policies that selectively favours the development of certain industries over others. In the case of green industrial policy, this definition extends to those industries with a relatively less harmful effect on the environment. We will provide a more detailed discussion of green industries in chapter 4.

We will begin by providing an overview of economic arguments for industrial policies, embedding the concept of market failures in the broader context of industrial development and economic growth. The third part of the paper then proceeds with a rough classification of industrial policies and summarizes their use in a historical context, before reviewing the literature on their effectiveness and distilling a few best practices. Chapter 4 then turns to a more detailed look at the emergence of green industries and provides a summary and initial assessment of policies used to favour the emergence of those industries. Chapter 5 recapitulates the main findings and concludes with a brief outlook.

2.0 Economic Justifications for Industrial Policy

Nobel Prize–winning economist Paul Samuelson was once asked whether he could name one proposition in the social sciences that is both true and non-trivial. "Ricardo's theory of comparative advantage," he replied (Samuelson, 1995, p. 22). The concept of comparative advantage was first articulated nearly 200 years ago by David Ricardo (1817) and represents one of the most influential ideas in international economics (see, e.g., Costinot & Donaldson (2012) and Eaton & Kortum (2012)). The central proposition of the basic Ricardian model (and indeed most of its more recent extensions) is that factors of production specialize in different economic activities based on their relative productivity differences. In his original example, Portuguese workers were relatively better at producing wine than cloth compared with English workers. Hence, Portugal had a comparative advantage in the production of wine. David Ricardo was able to show mathematically that Portugal would be better off by specializing in the production of wine and using its export proceeds to purchase cloth from England instead of producing both goods by itself. Conversely, England was more efficient than Portugal in the production of both goods (it had an absolute advantage in the production of both goods), but would still gain from specializing in the production of cloth only and trading it for Portuguese wine. In a more contemporary setting, observers often argue that many developing countries have a comparative advantage in the agricultural sector, due notably to low labour costs. Accordingly, these countries would do best by specializing in agricultural goods and exchanging them for goods from other sectors such as, say, industrial goods on the world market.

The conviction that countries would gain from comparative advantage–driven trade has been a major engine behind post–World War II trade liberalization initiatives, whether they were multilateral under the auspices of the General Agreement on Tariffs and Trade or the World Trade Organization, regional, or even unilateral (Kowalski, 2011). For the optimal pattern of Ricardian production specialization is achieved by market forces and requires openness to trade and competitive pressures to reap the ensuing benefits in terms of country welfare. Any substantive attempt to alter the production structure, such as through active government industrial policy, would reduce these gains or even render them negative.

While in Ricardo's time it seemed reasonable to confer Britain the status of having a comparative advantage in the production of cloth, it would be very hard to make that same case today. Obviously production patterns change over time, and a country's comparative advantage in one sector today does not preclude the possibility of having a comparative advantage in another tomorrow. The thought that comparative advantage may be endogenous to growth has led a number of economists to develop the notion of latent, or dynamic comparative advantage (see, e.g., Krugman, 1987; Grossman & Helpman, 1993; Redding, 1999; Lin, 2012).

Not all goods are alike in terms of their consequences for economic performance, and specializing in some sectors may be more beneficial to economic growth than specializing in others (Hausmann, Hwang & Rodrik, 2007). If developing countries with a comparative advantage in the agricultural sector were to specialize as David Ricardo would have advised them to do, it is questionable whether they would achieve the degree of structural transformation associated with economic development. Recent empirical research emphasizes that countries' ability to achieve structural change toward more productive sectors is indeed a main driver of economic growth in several countries in Africa, Asia and Latin America (McMillan & Rodrik, 2011).

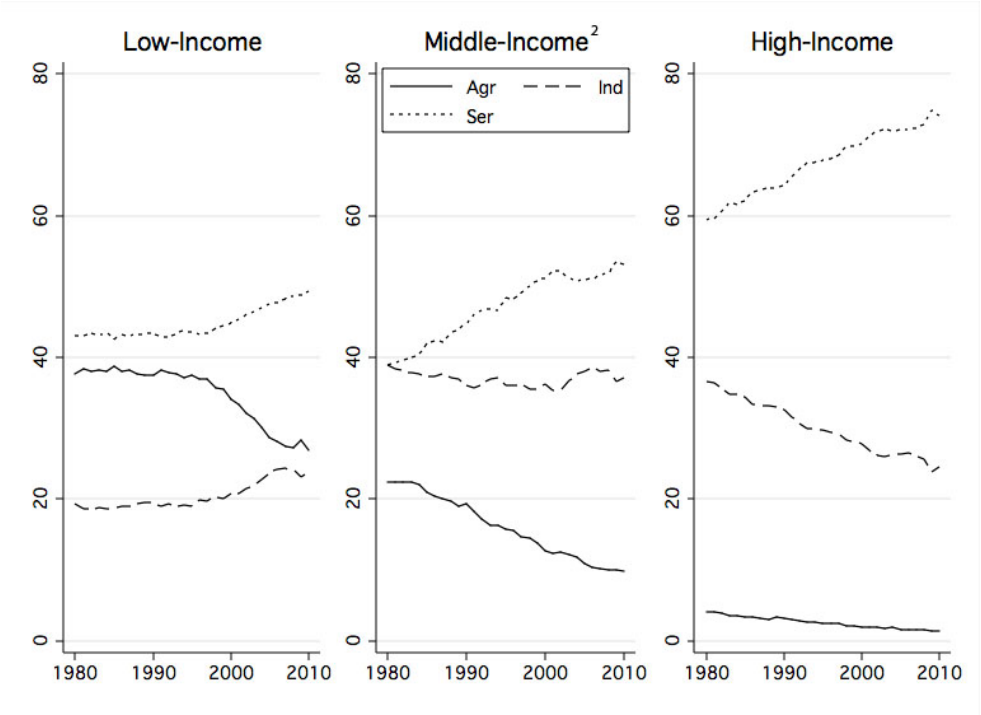

FIGURE 1. RELATIVE IMPORTANCE OF ECONOMIC SECTORS[1] BY INCOME LEVEL

Percentage of GDP. Data source: World Development Indicators, World Bank.
[1] Industry: manufacturing, mining and construction; services: personal, professional and public-sector services and utilities.
[2] The World Bank defines middle-income economies as those with per capita GNI in 2003 between $766 and $9,385 measured with average exchange rates over the past two years.

While in principle market forces should guide the process of determining the optimal productive structures of an economy, there are a number of sound theoretical reasons why this might not in fact be the case.

In economics, the general case for government intervention comes into play when markets are either distorted or incomplete. A market distortion can occur due to the presence of an externality, a situation in which the price fails to signal the true cost or benefit of a good or a service. But markets can also be distorted in cases of excessive market power, which arises, for example, in the presence of a monopoly when there are increasing returns to production scale. An incomplete market typically arises in situations of uncertainty, such as, notably, in the financial and insurance sector, and refers to a situation in which the set of possible outcomes is higher than the set of contingent claims. In the presence of such market failures, a competitive market equilibrium fails to deliver a socially optimal outcome, and the state then has a role in helping achieve this optimum.

While all economic justifications for industrial policy fall under this broad categorization of market failure in one way or another, we will review a few more specific arguments in greater detail.

Marshallian and Inter-Industry Externalities

A classic case for government intervention occurs in the presence of Marshallian externalities (Krugman, 1991; Marshall, 1920). These localized, industry-level externalities result in formation of industry clusters, which benefit from synergies such as knowledge spillovers among firms, labor pooling, or input-output linkages where upstream

firms provide inputs for downstream firms, taking advantage of low transportation costs (Harrison & Rodríguez-Clare, 2009). Empirical work has found great support for the existence of such externalities (Rosenthal & Strange, 2004). A classic example of such agglomeration economics is Silicon Valley, but such clusters are also found elsewhere: Qiaotou, Wenzhou and Yanbu are all relatively small regions in China that, respectively, account for 60 per cent of world button production, produce 95 per cent of the world's cigarette lighters, and dominate global underwear production (Lyn & Rodriquez-Clare, 2011).

The associated spillovers automatically increase with the size of the sector, which in turn necessarily becomes more productive. This idea aligns well with the aforementioned notion of dynamic comparative advantage, in the sense that the development of a country's comparative advantage in a given sector is conditional on the successful formation of such an industry cluster. A developing country might have such a dynamic comparative advantage in a certain industry, but be denied its development due to the prior existence of well-established clusters elsewhere (the so-called infant-industry argument for industrial policy). Until the industry cluster reaches a critical size, it will be unprofitable, producing at inefficiently low rates and unable to compete on international markets. Temporary government support to the industry may help it take off and eventually become competitive.

Spillovers need not be localized within industries only. Instead, there may be aggregate externalities that benefit a whole range of industries, when realized in a certain sector or industry (Stiglitz & Greenwald, 2006). Certain sectors may provide key inputs for others; one could think of the energy sector or infrastructure more generally. Underdevelopment of this key sector would have detrimental effects on a whole range of related sectors. Private firms underinvest, as they do not account for the greater social benefit of their actions, and again government intervention could theoretically rectify the ensuing market failure.

Of course, both cases necessitate careful examination of the underlying causes of the underperformance in order to choose the right instrument for government support. For example, subsidizing an ailing key industry will not make it profitable if the reason for its underperformance is a coordination failure between industries.

Coordination Failures

Coordination failures come about when a project requires simultaneous investments in order to be viable; if these investments are made by independent agents there is little guarantee that, acting in their own self-interest, each agent would choose to invest, leading to a suboptimal equilibrium (Pack & Saggi, 2006). Murphy, Shleifer and Vishny (1988, p. 28) argue that "a program that encourages industrialization in many sectors simultaneously can substantially boost income and welfare even when investment in any one sector appears unprofitable." As this type of pecuniary externality makes different firms' and industries' profits interdependent, it calls for a coordinated investment strategy that goes beyond piecemeal targeting of certain firms or sectors. Moreover, it requires careful examination of a country's input-output linkages in order to decide on an appropriate and effective aid scheme, ensuring that implicit subsidies flow across sectors crucial to simultaneous industrialization.

Self-Discovery and Diversification

Market failures are endemic to economic development, as structural transformation of the economy requires producing new goods with new technology (Rodrik, 2008a). Countries might not know their comparative advantage, in that it is impossible to know the counterfactual cost structures of industries that do not yet exist (Hausmann & Rodrik, 2003).

Effectively exploring those cost structures, an entrepreneur attempting to produce and market a new product will necessarily face a lot of uncertainty as to the success of her endeavour. Even production processes that have extensively and successfully been tested elsewhere will require local adaptation (Evenson & Westphal, 1995). There may be strong economy-wide demonstration effects, in that the successful implementation of an entrepreneur's business signals the profitability of the new business and encourages other entrepreneurs to emulate the incumbent. But while a successful pioneer entrepreneur's success has such positive externalities on others, she would have to privately bear the costs in case of failure. And in case of a successful market entry, she would not be able to fully appropriate the benefits of her investment, as her competitors would enter the market as well. She might thus decide against the investment, as she won't be able to share the costs if her project fails. Taken together, the result is that a suboptimal number of pioneer entrepreneurs would be willing to take on such risks and the country would be unable to exploit its full potential for diversifying its economy.

This line of reasoning draws heavily from the literature on firm strategy and departs substantially from the neoclassical assumption of passive price-taking firms. It recognizes that successful firms create and maintain barriers to entry and rents associated with them, effectively exploiting their competitive advantage (Porter, 1990).

Credit Market Imperfection

Baldwin (1969) provided an incisive criticism of the infant-industry argument, pointing out that if future returns outweighed initial losses, capital markets would provide the necessary financing for domestic industry projects, enabling the creation of successful industry clusters without the need for government intervention. His assumption was that financial markets would possess sufficient information to accurately assess the risks involved in financing new industry projects, and financial intermediaries would grasp profitable opportunities, making government intervention unnecessary. However, deficiencies in the financial sector have been all too frequent in recent history and have cast doubts on the validity of the assumption of omniscient financial intermediaries (Pack & Saggi, 2006). Indeed, Banerjee and Duflo (2005) summarize a wide range of studies that show huge variation in interest rates paid by different borrowers in developing countries and conclude that these can be explained only by credit-market imperfections (Rodrik, 2009). While the pervasiveness of credit-market imperfection does provide a rationale for industrial policy, it also means that any selective economic policies would have to simultaneously address the weakness of the financial sector along with that of manufacturing or other services (Pack & Saggi, 2006).

Learning by Doing

The idea that firms or industries learn by doing relates to the aforementioned notion of dynamic comparative advantage, but does not restrict the latter to the formation of industry clusters. The earliest theoretical formulation of the learning-by-doing hypothesis goes back to Arrow (1962), who hypothesized "that technical change in general can be ascribed to experience, that it is the very activity of production which gives rise to problems for which favorable responses are selected over time" (p. 156). The acquisition of knowledge is hence central to the development of a firm's or an industry's dynamic comparative advantage. More recently, the concept has been extended to "learning by exporting" as a justification for export promotion, aided by the advent of new intra-industry models of international trade, as pioneered by Melitz (2003) (Fernandes & Isgut, 2007).

Environmental Externalities

Environmental externalities present the textbook case of a market failure and are likely to become a major driver of industrial policy worldwide (Altenburg, 2009). According to the United Nations *Glossary of Environment Statistics*, environmental externalities "refer to the economic concept of uncompensated environmental effects of production and consumption that affect consumer utility and enterprise cost outside the market mechanism" (United Nations Statistics Division, 1997). Markets fail to adequately price environmental effects, and this failure can lead to economically viable but socially undesirable economic activity. Investors will tend to overinvest in sectors where the social cost of an investment is greater than the cost accruing to the investor alone (for example, an investment in a coal-fired power plant). Likewise, investors will underinvest where the social return is higher than the private return (such as clean energy investments). In both cases, the government has an important role in levelling the playing field for green industries, aligning private returns more closely with social returns by using a set of policy tools discussed in greater detail in chapter 4.

The distinctive feature of environmental externalities is their scope: they can be localized and occur within a limited geographic area, but may as well be global in nature, depending on which market failure one looks at. Sir Nicholas Stern (2008), author of the influential *Stern Review on the Economics of Climate Change*, famously described climate change as the result of "the biggest market failure the world has ever seen" (p. 1). The failure of markets to put a price on greenhouse gas emissions has led to an unsustainable mode of industry that is fuelling global warming.

Climate change proves to be particularly challenging for industrial policy. On the one hand, industrial policy is of great importance for climate change *adaptation*: a vibrant industrial sector is vital in absorbing excess labour that rapid urbanization is causing in many developing countries. This role of industry is expected to become more pronounced in the near future, as adverse effects of climate change are predicted to produce many "climate refugees" unable to sustain their livelihoods in agriculture. In this sense, climate change calls for an acceleration of *traditional* industrial policy, in order to speed up industrialization and structural change in developing countries. On the other hand, industrial policy is vital for climate change *mitigation*, i.e. actively promoting reduction of economy-wide anthropogenic greenhouse gas emissions. It is this particular function that calls for a novel *green* industrial policy that balances traditional considerations of industrial development and efforts to reduce its environmental impact.

Hence, green industrial policy is to a large extent motivated by the same considerations that apply to traditional industrial policy. However, its usefulness as a government tool is warranted by a few additional considerations that are otherwise absent or less compelling (Karp & Stevenson, 2012):

First, governments face a *commitment problem*, as the size of future markets facing green industries is largely determined by future government policy. For example, the less stringent future emissions ceilings are, the less profitable current investments will be. Industries that are reluctant to undertake green research and development (R&D) or adopt green technologies can therefore be nudged into undertaking such investments through green industrial policies.

Second, future government policy is *endogenous* in that it is a function of current investments. As Karp and Stevenson (2012) point out, the practicality of future carbon taxes, for example, depends on the future availability of alternative fuels, which in turn depends on current investments.

Third, when externalities are transnational or even global in scope (such as climate change), global welfare considerations of green industrial policy will outweigh purely national ones. The inability of national governments to appropriate such international benefits calls for greater coordination of international policy.

3.0 *Traditional Industrial Policy*

While establishing a theoretical case for industrial policy is not very difficult, the question of what instruments best serve different purposes is more involved.

Industrial Policy Instruments

The industrial policy literature usually distinguishes between functional (horizontal) and selective (vertical) policies (Lall, 1997; Pack & Westphal, 1986). The former denotes policies that are not directed toward specific activities, and are, rather, geared toward improving the economic environment more generally. The latter denotes more targeted policies, such as industry tariffs, subsidies or tax breaks. Economists usually favour functional policies over selective ones, as the risk of introducing market distortions grows with the selectivity of a policy. Functional policies are more "market friendly" in that they leave it up to market forces to allocate productive activity among actors. While theoretically attractive, this distinction is very difficult to make in practice, and even the broadest functional policy will favour certain sectors and discriminate against others.

Rodrik (2009) illustrates this problem with the example of exchange rate policy: while an undervalued exchange rate can help stimulate exports in the broadest sense, it necessarily discriminates against the non-tradable sector. Therefore, a more informative classification of policy instruments could be based on the degree of government intervention. With a multitude of possible policy instruments at a government's disposal, we reproduce an aggregate classification as adopted by Altenburg (2009) in Figure 2.

<table>
<tr><td colspan="6">LOW → HIGH</td></tr>
<tr><td>Strict non-intervention in markets</td><td>Market-enhancing policies</td><td>Reactive support</td><td colspan="2">Non-targeted proactive support</td><td>Targeted proactive support</td></tr>
<tr><td rowspan="3">Privatization of public enterprises

Reduction and equalization of remaining trade barriers

Labour market deregulation

Simplification of firm entry and exit</td><td rowspan="3">Anti-trust policies

Provision of business information systems

Demand-side subsidies for the development of private service markets (voucher systems, etc.)</td><td rowspan="3">Troubleshooting for investors in response to private sector demand</td><td colspan="2">General export promotion

Incentives for R&D and innovation

Entrepreneurship development

Promotion of resource efficiency</td><td colspan="2">Promotion of specific activities or technologies (leather industry, solar energy, etc.), clusters or value chains: dedicated laboratories, skills-development centres, etc.</td></tr>
<tr><td colspan="2"></td><td>Strengthening existing activities</td><td>Stimulating new activities</td></tr>
<tr><td>Experimental design, performance-based, services delivered by public providers after competitive bidding → Top-down selection, services delivered by public providers</td><td colspan="2">Experimental design, performance-based, services delivered by public providers after competitive bidding; transparent criteria for selection → Top-down selection, services delivered by public providers; discretionary case-by-case deals</td></tr>
</table>

FIGURE 2. POLICY MEASURED BY DEGREE OF GOVERNMENT INVOLVEMENT

Adapted with permission from Altenburg (2009).

Comparative History

Industrial policy has a long tradition in economic history and has been employed by countries in various stages of development. Targeted government intervention in trade and industry has been widely adopted during the catch-up phase of some currently developed countries (Chang, 2002; Landes, 2003; Reinert, 1994).

Early Industrialization

The earliest systematic overview is widely believed to have been written by List (1885), who is also one of the earliest proponents of the infant-industry argument for industrial development. List's book reviews a plethora of industrial policies in the Western world, tracing them up to his time of writing and assessing their importance for industrialization in the 19th century. List (1885) argues that the development and survival of the manufacturing sector in Britain, which is conventionally depicted as the laissez-faire nation par excellence, has fundamentally relied on "a system of restrictions, privileges and encouragements" to shield it from competition from relatively more advanced industries in countries such as Belgium, Switzerland or the Netherlands. There is also evidence for the existence of industry clusters à la Marshall (Chapter 3), for example the 19th-century gun-making cluster in Birmingham described by Stigler (1951).

List believed that free trade would be beneficial once modern sectors were established and able to compete, or for trade between nations at similar stages of development. Chang (2002) makes this point more generally, illustrating how both Britain in the mid-19th century and the United States in the mid-20th century owed their industrial supremacy to nationalistic use of heavy protectionism but became the most ardent defenders of free trade once their industrial bases had sufficiently matured.[1]

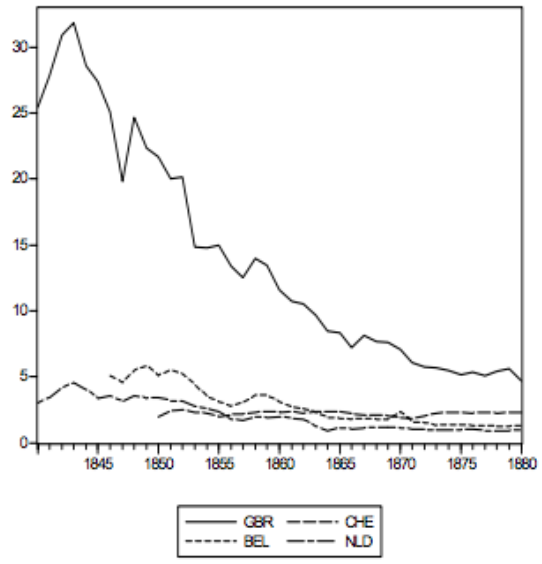

FIGURE 3. PROTECTION IN BRITAIN, SWITZERLAND, BELGIUM AND THE NETHERLANDS

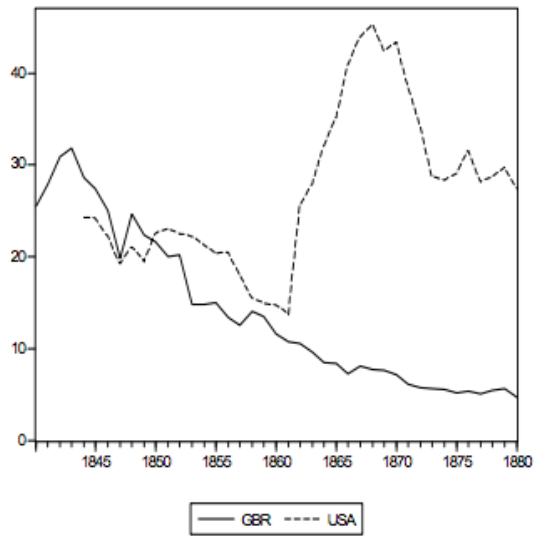

FIGURE 4. PROTECTION IN BRITAIN AND THE UNITED STATES

Reprinted with permission from Accominotti & Flandreau (2008). Protection measure is calculated as ratio of customs revenue over total imports.

[1] Conventional accounts converge on the mid–19th century as the beginning of British-led trade liberalization and the end of the Second World War in 1945 as the beginning of US-led trade liberalization.

Figures 3 and 4 illustrate how Britain moved toward greater liberalization only in the second half of the 19th century, while the same period also witnessed a substantial increase of protection levels in the United States with the outbreak of the Civil War. The United States did not make a substantial shift toward more liberal policies until the mid-20th century. The aggressive use of infant-industry policies to achieve rapid industrialization in the United States led the eminent economic historian Paul Bairoch to call the nation the "mother country and bastion of modern protectionism" (Bairoch, 1993, p. 30).

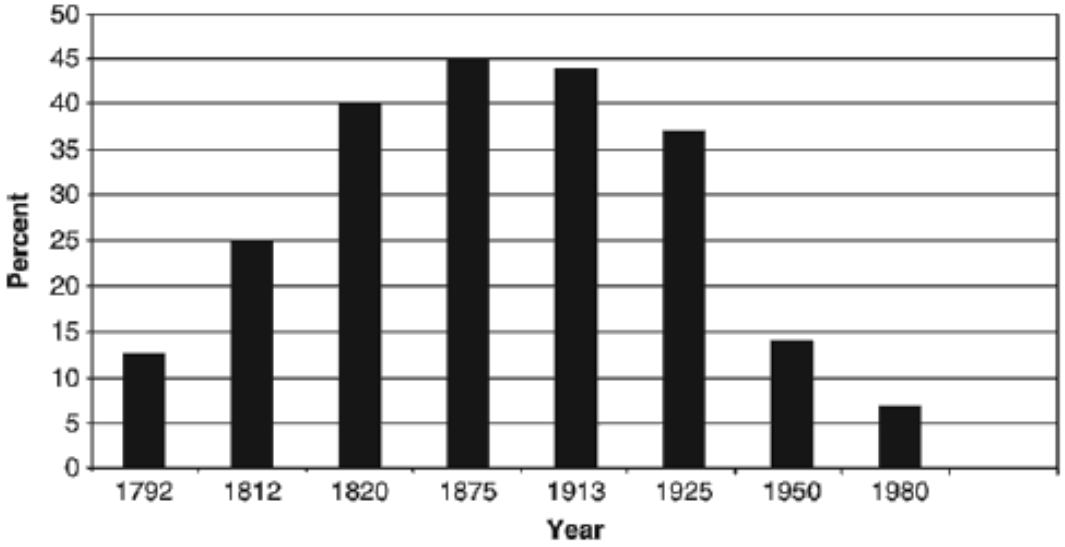

FIGURE 5. INDUSTRIAL TARIFFS IN THE UNITED STATES

Reprinted with permission from Akyüz (2009).

Smaller countries such as Belgium, the Netherlands or Switzerland had lower levels of protection, arguably because they were already closer to the technology frontier and thus did not need to protect their already mature and competitive industries from foreign competition (Chang, 2002).

Indeed, trade relations during the first half of the 19th century were marked by heavy use of tariffs and other trade restrictions as tools of industrial policy (Clemens & Williamson, 2001; O'Rourke, 2000). While they were not the only tools used, it must be recognized that governments were generally subject to much greater restrictions in choosing their policy instruments, as compared with modern standards. Tools of government intervention were quite limited up to the 20th century, as many modern government institutions did not yet exist. Government budgets were small by modern standards, because tax bases were generally narrow.[2] Central banking did not develop fully until the early 20th century. Banks were little regulated by the state, which made directed credit programs similar to those undertaken by Asian countries later in the 20th century impossible to maintain on a similarly large scale. Of course, resorting to tariffs is an obvious option for governments seeking to support their domestic industries. One notable exception from this trend is Japan, which did not gain autonomy over its tariffs until 1911, due to a series of unequal treaties signed with Western powers. But even here the government took an active lead in modernization, for example using targeted subsidized lending through state-controlled banks or setting up pilot plants in certain industrial sectors, generating demonstration effects much in the same sense of promoting self-discovery described in the previous chapter.

[2] Small government budgets and narrow tax bases are still a feature of many developing countries, a point to which we will return later.

More generally, state institutions, including laws and regulations in the 19th century, were substantially different from those we know in modern times. While it is still instructive to look at how Western countries industrialized in the 19th century, we must bear in mind that it was a time in which modern national states were still in the making.[3] The first passports were issued later that century, suffrage was far from universal and male if anything, limited liability was a privilege rather than a right, and labour markets relied extensively on child labour (Chang, 2002). But the bottom line remains that states were indeed actively involved in the development and modernization of their industries, notably manufacturing.

Industrial Policy After World War II: State-Led Industrialization

Perhaps the best opportunity to study industrial policies in a more modern context is provided by the success and failure of certain states to achieve high growth and rapid industrialization after World War II, and notably after political independence for many of them. The immediate years after the Second World War were characterized by immense government efforts to restore technological capacity, especially in the context of the Marshall Plan in Europe, but also in Japan. Economic reconstruction was achieved with a considerable degree of direct state resource allocation, multiple exchange rates, quantitative import and foreign exchange controls, foreign direct investment, and royalties for technology licensing (Noland & Pack, 2002). These interventions were largely defensive in nature and were designed to rebuild what had been functioning before. But as the technology gap with the United States widened over the years, governments more actively pursued development in high-technology sectors. Using a variety of tools that included subsidies for R&D, preferential procurement by public agencies, and the promotion of mergers, the United Kingdom and France were the most active proponents of such activist government roles in Europe (Owen, 2012). Japan displayed effective rates of protection of over 10 per cent in almost all manufacturing sectors until 1975, while maintaining strict regulation of inward foreign investment and technology transfer, preferential tax treatment, and access to capital, as well as various subsidies, in an effort to promote growth in high-technology sectors (Noland & Pack, 2002).

From a development perspective, however, it is probably most telling to analyze the various policies that were employed by latecomers to industrialization, notably in Asia and Latin America.[4] A striking first observation is that policies in all countries have been very similar. All countries have used similar policy instruments, such as tariffs, quotas, import licensing, foreign exchange rationing and various forms of subsidies to substitute imports with domestic production, a strategy that came to be known as import substitution industrialization (Shapiro, 2007). Meanwhile, governments took the role of identifying and targeting the development of priority sectors. Again, these sectors have generally been the same across countries with activist governments.

We will now briefly review those policies before turning to a detailed assessment.

Protection and Trade Policy

Standard economic theory views the use of trade policy to support domestic industry very critically. We have seen how the principle of comparative advantage requires free trade among nations to determine efficient global production patterns. We have also seen how this efficient outcome rests on the assumption of perfectly functioning competitive

[3] A more extensive overview of industrial policies before the Second World War is provided in Cimoli et al. (2009).

[4] The countries whose policies have served as the object of most research on the topic have been Argentina, Brazil, Chile, China, India, Indonesia, South Korea, Malaysia, Mexico, Taiwan, Thailand and Turkey. However, most of the policies described have also been employed in various other countries, including in Africa.

markets. In the presence of market distortions as described in the previous chapter, the theory of targeting implies that policies need to be aimed at the source of the distortion that is to be addressed, and hence direct production subsidies, for example, would be usually more efficient to tackle issues pertaining to stimulating domestic production in a given industry (Bhagwati & Ramaswami, 1963).[5] Tariffs drive a wedge between domestic and international prices and therefore alter the incentive structure that import-competing domestic firms face, effectively shielding them from international competition. On the one hand, welfare losses arise due to the fact that consumers will face higher prices on protected goods, reducing their purchasing power. On the other hand, domestic firms operating under such protective environments lack incentives to increase productivity as long as tariff protection is not linked to some performance indicator. Disproportionally high rents accrue to protected domestic firms, as their domestically sold products fetch higher tariff-induced prices than would prevail under a free trade scenario.

Nevertheless, trade protection for purposes of import substitution industrialization, in the form of tariffs and quantitative restrictions such as quotas, was widespread in the early decades after the Second World War. Trade protection in the framework of import substitution industrialization strategies was an important tool all over Latin America, designed to alter the prevailing specialization structure toward more technology-intensive activities (Peres & Primi, 2009). Average nominal tariffs typically exceeded 100 per cent until the late 1970s. Industrial policies in Latin America were generally inward-looking, promoting the substitution of imports through domestic production, but often lacked an explicit effort aimed at increasing exports or firm productivity. The failure to improve export performance led to a gradual deterioration of countries' trade balances and contributed to balance-of-payment imbalances, and many Latin American countries began accumulating foreign debt in the mid-1960s (Di Maio, 2008), resulting in the debt crisis and "lost decade" of the 1980s.

Rapidly industrializing Asian countries also employed trade policies to foster industrial development. Taiwan and China maintained high levels of protection, with more than 40 per cent of imports receiving nominal protection in excess of 30 per cent by 1980. Indonesia, Malaysia and Thailand also had unusually high rates of protection until the 1980s (World Bank, 1993). Korea maintained protection through a mix of tariff and non-tariff barriers, even when it became clear that protected sectors were successful as measured by export performance. In general, an explicit outward orientation in the design of industrial policies was a major feature of all East Asian Tiger states—a feature completely lacking in Latin American states (except, to a lesser extent, in Brazil).

This outward orientation manifested itself in various provisions to promote exports. Domestic support and protection in Asia was generally conditioned on the fulfillment of certain export targets, defined at sectoral, product and firm level. The advantage of this approach was that export data could be used as a reliable indicator to assess whether domestic industry was indeed improving in terms of international competitiveness. South Korea held monthly meetings between top government officials and leading exporters to work out the details of export targets, and successful firms could count on more favourable tax treatment (Noland & Pack, 2002). If a firm failed to increase its foreign sales and meet its export targets, this was seen as evidence that the firm was not doing enough to improve productivity, and support would eventually be withdrawn. Taiwan adopted similar measures in an effort to minimize the inefficiencies associated with trade protectionism. Domestic sales were increasingly subject to price controls, forcing firms to reduce prices in the local market and effectively narrowing the wedge created by tariff protection and aligning domestic prices more closely with international ones (Noland & Pack, 2002). At the same time, exporting firms were offered preferential tax treatment in the form of various tax rebate schemes and duty drawbacks, as well as access to credit on favourable terms (Di Maio, 2008).

[5] In practice, however, governments are often constrained by budgets.

While this system of sticks and carrots was completely lacking in Latin America, Asian states took great care to institutionalize their export orientation through measures such as setting up trade-promotion centres, staffed with highly skilled bureaucrats, that helped small and medium enterprises make contact with foreign buyers and enter new markets (Di Maio, 2008). Special economic zones were another such instrument, being "demarcated geographical areas within a country's national boundaries where the rules of business are different—generally more liberal—from those that prevail in the national territory" (Farole, 2010, p. 2). After the success of such zones became evident in South Korea and Taiwan, they quickly spread to Malaysia, Indonesia, Thailand and China, and eventually all over the world.

Incentives

Active government support to domestic industry beyond trade protection has been an important additional component of industrial policies in developing countries. The decades after the end of World War II were marked by substantial involvement of the public sector in domestic investments, notably in infrastructure and industry. Public investments as a share of gross domestic investments in the period from 1960 to 1964 ranged from a high 58 per cent in Mexico to a low 25 per cent in Brazil, being the main driver in total capital formation at that time (Amsden, 2004). Public and private investments alike relied heavily on long-term capital supply provided by national development banks, whose objectives were to facilitate the creation and growth of the domestic manufacturing industry through facilitated credit concessions (Di Maio, 2008). The share of such development banks in total manufacturing investments remained often well above 10 per cent up to the 1990s (Amsden, 2004). Loans were made to strategic projects on a preferential basis and carried below-market and negative real interest rates. While specific activities of national development banks varied across countries, "winning" sectors eligible for support were picked on the basis of similar considerations and criteria (Di Maio, 2008):

- The presence of large backward and forward linkages in a recipient industry, so as to stimulate upstream and downstream industries as well.
- High market potential.
- High technology intensity, favouring technology adoption and transfer.
- High added value.

Di Maio (2008) also observes a consistent trend in recipient sectors across countries: while the 1950s saw most funding activity in labour-intensive and heavy industries such as basic metals, food products and textiles, the 1970s focus of national development bank funding was in more capital-intensive sectors such as chemicals, machinery and transportation equipment. Asian countries mostly shifted focus during the 1980s toward more technology-intensive sectors.

Apart from favourable credit concessions by development banks, domestic firms also benefitted from various forms of fiscal incentives such as tax breaks, duty drawbacks on imports, accelerated depreciation on capital equipment and direct subsidies. But throughout, countries usually made such support conditional on the fulfillment of certain performance criteria. We will briefly review the two most common policy goals that were sought, namely exports and local content use.

Increasing *exports* was a policy goal in itself in many countries, and we have already seen in the previous section how Asian countries tied their support to certain export-related performance criteria. Exports not only provide a country with foreign currency, but also stand as testimony to a healthy industry, able to compete in international markets. Conditional support such as provision of subsidized long-term capital based on export targets was widespread in Asian Tiger countries, but could also be found in, for example, India and Turkey.

Firms were also often required to use *locally produced* content in their production processes. This requirement was most widespread in the automobile sector, as this particular sector is especially interconnected with other industries, providing for a large array of backward and forward linkages. Local content rules were to ensure the build-up of national firms, enhancing their technological capabilities by substituting often technology-intensive imports with domestic production. The premise was that local content rules squeezed assemblers' profit margins, which gave them an incentive to train their local parts suppliers, whose greater efficiency would reduce their overall costs (Amsden, 2004). At the same time, localized production would help ease balance-of-payments constraints by saving on foreign exchange, much in the sense of the rationale for import substitution industrialization.

Innovation and Technology Policies

Import substitution and national support schemes for domestic firms and industry all aimed at increasing domestic technological capabilities to some extent, but were in themselves insufficient to substantially decrease reliance on foreign technology over time. Countries worldwide, and especially in Latin America and Asia, made attempts at offering additional support mechanisms for firms to first adopt and then develop new technology as they matured industrially.

Acknowledging the need to socialize risks associated with R&D, many governments set out to undertake the bulk of R&D in publicly owned firms and research institutions. Specific public institutions exclusively dedicated to advancing science were set up as national research councils after World War II. These institutions' stated goals were multiple, including provision of funding for technological development, coordination of R&D programs, diffusing technological information and administering property rights systems (Di Maio, 2008). National development plans increasingly contained science and technology programs, coordinating, steering and prioritizing R&D activities and thereby explicitly targeting domestic technological knowledge accumulation (Amsden, 2004).

During the import substitution industrialization years, more than 80 per cent of science and technology spending was publicly funded in Latin America (Katz, 2000). But government commitment to supporting technological upgrading and innovation was even greater in the Asian Tiger states. In Korea, imports of technology were strongly subsidized (Lall, 2004): transfer costs for patent rights and technology import fees were tax deductible, income from technology consulting was tax-exempt and foreign engineers were exempt from paying income tax. The Korean government also offered tax-exempt Technology Development Reserve funds, which firms had to use in a specified time span. The Korea Technology Development Corporation provided technology finance, and the government gave grants and long-term low-interest loans to participants in "national projects." While Korea was certainly the most ardent driver of domestic technological knowledge accumulation, similar policies were employed in other countries as well, such as Taiwan and Singapore.

As industrialization proceeded and domestic firms progressively entered technologically more demanding fields such as informatics, semiconductors and telecommunications, governments increasingly took the role of pioneers and venture capitalists (Di Maio, 2008). While designing careful policies to attract foreign direct investments in relevant sectors,

governments set up science parks and technology clusters to harness agglomeration synergies. Public enterprises were essential market actors in technologically advanced sectors in which private firms failed to succeed, generating important demonstration effects that the private sector could ultimately benefit from. Government procurement has been essential in creating demand for high-quality domestic products, notably in the defence sector.

Finally, the emphasis on attracting foreign direct investment (FDI) for technological knowledge accumulation varied quite substantially across countries. Amsden (2004) distinguishes two major groups of countries by their approach to FDI. On the one hand, *independentists* such as Korea, Taiwan, China and India advocated minimal reliance on FDI and multinational corporations, stressing the importance of strengthening domestic firms and skill formation. In a way, heavy use of industrial policies as described above served to substitute for FDI and multinationals, creating national champions. The other group is referred to as *integrationists* and comprises Argentina, Brazil, Chile, Indonesia, Malaysia, Mexico, Thailand and Turkey. Countries of this group relied on spillover effects from MNC activity or FDI for technology transfer. Supporting policies to ensure that such transfer would indeed happen comprised local sourcing and subcontracting, local content rules and various obligations to foreign firms and investors to actively transfer technological know-how to domestic actors (Di Maio, 2008).

Complementary Policies and Framework Conditions

Having reviewed the main industrial policies that are usually considered as such, we now turn to complementary and longer-term policies that governments of catching-up countries have enacted over the years. Education is an important such policy that is a priori outside of the scope of immediate industrial policy, but it certainly pertains to industry in important ways. As countries move up the technology ladder and knowledge is used more efficiently, human resource capabilities have to follow suit. The provision of education has a long tradition of government involvement, owing to the fact that investments in human skills are by definition long term and carry externalities for society that cannot usually be appropriated by purely market-driven sources. Good education makes for good citizens, but also good employees.

Education is of course multi-faceted and is difficult to measure appropriately. Formal enrolment in educational institutions is only a rough indicator for countries' educational levels, as much learning occurs on the job or through other experience. A very basic indicator that is relevant especially for least industrialized countries is the rate of illiteracy. All developing and industrializing countries have made much progress in minimizing rates of illiteracy and creating opportunities for school enrolment. Starting from higher levels of illiteracy than in Latin America after World War II, East Asian states still achieved significant reductions in illiteracy at a much faster pace. Primary enrolment today is universal in all now-industrialized nations. Secondary enrolment nears 100 per cent in Korea and Taiwan, making it comparable to developed nations, but lags, sometimes significantly, behind in other Asian states and Latin America (Lall, 2004).

Tertiary enrolment has followed a similar path, but offers interesting insights in its composition across countries. Those countries that achieved the highest degrees of industrialization are also those with an outspoken concentration of tertiary students in technical and engineering degrees. Rather than a sheer coincidence, this concentration has been the outcome of active policies that provided the necessary infrastructure and legislation (Hanushek & Woessmann, 2008). Investment in technical tertiary education has followed increased demand from industry, but cannot solely be explained by demand factors, as many Korean and Taiwanese graduates in the 1960s and 1970s emigrated to find better employment opportunities (Pack, 2010). Hence, it must be seen as a supply-side complement to industrial

policy, which became necessary as countries' industry moved into higher-technology sectors, demanding more relevant and sophisticated skills of its labour force.

Another set of policies that is often viewed as external to industrial policy is exchange rate management. Rodrik (2008b) shows that there has been a strong relationship between the level of the real exchange rate and economic growth. Economic growth, especially in Korea, Taiwan and now China, has been preceded and accompanied by a rise in the undervaluation index for their currencies (Rodrik, 2008b). Undervaluation of a country favours exports over imports and is hence consistent with an outward development strategy promoting exports. Ironically, many Latin American countries had difficulty in maintaining undervaluation or at least close alignment of their nominal exchange rates with the real exchange rate. While this made imports of critical inputs cheaper, it defeated the import substitution industrialization strategy and, coupled with poor export performance, led to foreign exchange shortages.

Assessment: Does Industrial Policy Work?

We have made a theoretical case for industrial policy, and we have sketched the major policies undertaken by countries worldwide, pointing to the fact that industrial policy in its various forms has been ubiquitous. However, when it comes to measuring the success of industrial policy, opinions differ sharply. In a recent authoritative literature survey, Harrison and Rodríguez-Clare (2009) review hundreds of empirical studies on this topic from recent decades, and are unable to give a clear answer to the (admittedly very broad) question of whether industrial policy works or not. There are several reasons why this is the case, and it is important to bear some of them in mind.

First, as is the case with all empirical policy assessments, it is impossible to accurately predict how things would have gone in the absence of the policy in question. Economists refer to this problem as the absence of a counterfactual situation. Hence, even if econometric techniques are used that allow to make a qualified guess about such a counterfactual situation, it is often impossible to precisely isolate a causal effect and to attribute a certain outcome to the policy under examination. For example, if there is a high correlation between two variables—say we observe that subsidies are highest in industries that perform worst—we may not actually uncover a causal relationship. Rather than making subsidies responsible for bad economic performance, there might be confounding factors. An obvious alternative explanation would be to turn things around and to ask whether bad economic performance causes large subsidies. This is precisely what Rodrik (2008a) criticized about studies attempting to estimate the impact of specific policies such as tariffs and subsidies on total factor productivity growth in individual sectors. Rodrik pointed out that the amount of stimulus to industries might be endogenous, increasing with sectoral backwardness, as standard industrial policy rationales would suggest (Rodrik, 2008a).

Second, even if the attribution problems were solved, one could always ask the question of whether a particular policy was an optimal one. An economist would look at the opportunity costs of a policy, meaning the entire set of alternative uses of resources spent for the policy in question. For example, would Korea have been better off stimulating domestic demand through cutting taxes, rather than using tax money to subsidize certain industries? Would Korean government officials have used their time and skills in a more valuable way, had they not been required to supervise and monitor preferential lending agreements conditioned on detailed firm-level performance criteria? Of course, data alone does not give many insights into such considerations.

Third, data collection per se is often very complicated, as countries differ widely with respect to policies on information collection and dissemination, a tendency that gets even more complicated when looking across large time spans.

To researchers' chagrin, the most interesting countries (developing countries) are often those with the poorest data availability and quality.

Fourth, and probably most importantly, it is often unclear what the benchmark should be when measuring the success of a certain policy. Often there is no clear goal associated with a specific policy measure. Does the evaluating researcher look at economy-wide indicators? In this case, should she look at GDP growth per capita or a measure of structural transformation? Should she look at indices of diversification of exports, its share in total value added, or measures of technological upgrading of domestic industry? Then again, some policies may be motivated by sectoral considerations. For example, India might be interested in promoting its information and communications technology sector. In this case, would a researcher measure whether the value added in information and communications technology has increased overall, or whether its growth has been higher than in other sectors? How to determine what level or growth rate of value added should be used as a threshold for qualifying as a success?

Economists tend to converge on two criteria that could theoretically provide for a decent cost-benefit evaluation of sectoral industrial policies, namely the Mill-Bastable test. The first part of the test was formulated by Mill (1848) and requires that protected sectors or firms ultimately become viable, even when protection is withdrawn. The second part of the test comes from Bastable (1904) and requires that the cumulative net benefits provided by the protected industry exceed the cumulative costs of protection. Empirical applications of this test are very rare, due to the fact that a strict application requires data on a level of detail that is usually beyond availability. Moreover, a thorough assessment of cumulative costs and benefits would imply a correct monetary valuation of externalities involved, as many industrial policy rationales build on the presence of these. For example, how would one accurately value the dynamic learning effects of a protected industry and its potential spillovers on other industries? Clearly, this task is very daunting, and while the test does provide for a reasonable analytical framework, its literal application remains elusive for the most part.

Owing to widely available trade data, trade policy is by far the most researched component of industrial policy. Therefore, we will restrict our analysis to trade-related industrial policy instruments.

Trade Protectionism

Assuming that there is no retaliation, trade restrictions such as tariffs and quotas can theoretically enhance welfare for the restriction-imposing country if the protected infant industry offers scope for learning and agglomeration spillovers (Melitz, 2005). Clemens and Williamson (2001) and O'Rourke (2000) find a strong positive correlation between import tariffs and economic growth across countries during the late 19th century, hypothesizing that protection allowed countries to accelerate the growth of what were then emerging sectors (industry), characterized by the type of learning effects and Marshallian externalities noted earlier. However, this type of association could not be upheld for more recent times. Reviewing nearly 200 empirical studies on the link between openness to trade and growth, Harrison and Rodríguez-Clare (2009) conclude that studies using trade volumes as a measure of openness (measured as the share of trade in GDP) generally find a positive relationship between changes in openness and growth, making a strong case for overall trade-friendly policies. However, studies that use tariffs as a measure of openness generally find inconclusive or negative effects of average tariffs on growth. Then again, looking at tariff averages might not be very revealing altogether. Lehmann and O'Rourke (2008) look at the pattern of protection during the 19th century and refine earlier findings, noting that agricultural tariffs were negatively correlated with growth, whereas the reverse was true for industrial tariffs.

More recently, Nunn and Trefler (2010) found strong evidence that the correlation of tariff structure across industries with those industries' respective required skill levels had long-term growth-enhancing effects. That is, if a country's tariff lines are designed such that higher tariffs coincide with goods that necessitate greater skill in their production, long-term GDP growth rates will be higher. They find that at least 25 per cent of the correlation between long-term growth and the skill bias in tariffs corresponds to a causal effect. Decomposing their analysis into high-skill and low-skill sectors, their analysis reveals the differential impact of tariffs on each sector: while tariffs in high-skill sectors are associated with sector growth, tariffs in low-skill sectors are associated with negative sectoral growth, somewhat echoing Lehmann and O'Rourke's (2008) findings with 19th-century data. Overall this analysis suggests that careful sectoral targeting (skill-intensive sectors) can have significant growth-enhancing effects beyond the targeted sector, revealing the presence of inter-industry externalities in high-skill sectors.

Similarly, Estevadeordal and Taylor (2008) find that tariffs on intermediate and capital goods affect growth more negatively than tariffs on consumption goods. This finding is consistent with mainstream economic theory, stressing that firms' access to cheaper imported inputs is vital for keeping production costs low, increasing their competitiveness on international markets. Blonigen (2013) made a similar finding more recently, analyzing industrial policies from 1975 to 2000 in the steel sectors of 21 countries. This study finds strong evidence that import protection policies and export subsidies have had significantly negative effects on the export performance of downstream sectors. Both are tools that will raise domestic prices for steel, raising production costs for domestic users in other sectors.

The fact that studies looking at average tariffs find mostly weak or even negative associations with overall growth implies that countries have used tariffs in very inefficient, even detrimental ways. Indeed, existing evidence suggests that protection is usually motivated by revenue generation, to protect special interests or for other political reasons, rather than for sound industrial policy purposes (Gawande, Krishna & Olarreaga, 2009). The highest tariff protections, as well as other targeted forms of support such as capital subsidies, have frequently been granted to declining sectors, even in countries that are often considered as industrial policy success stories, including Japan (Beason & Weinstein, 1996) and Korea (Lee, 1996).

The failure of Latin American import substitution industrialization strategy to foster emergence of competitive industries is in large part ascribed to the lack of firms' access to cheap foreign input goods, due to inefficient protection patterns. The policies adopted by successfully industrializing Asian countries were designed much more carefully:

> "Most [rapidly industrializing Asian countries] began industrialization with a protectionist orientation and have gradually moved toward increasingly free trade. Along the way they often tapped some of the efficiency generating benefits of international competition through mixed trade regimes: they granted exporters duty-free imports of capital and intermediate goods while continuing to protect consumer goods. Export prices were set in the international market and were often substantially less than current marginal or average costs. Losses on export production offset profits in the protected market, while competition in the international market ensured that the firm would not suffer from loss of cost discipline." (World Bank, 1993, p. 295)

Hence, while there certainly appears to be scope for using trade protectionism as an instrument for successful IP, governments generally seem to have had great difficulty applying it optimally. Furthermore, governments today are bound by a much tighter set of trade rules as embodied in the World Trade Organization (WTO), significantly restricting the scope of their discretion in setting up trade barriers. Consequently, it is not surprising that much of the current debate on trade-related IP is nowadays focused on trade promotion policies.

Trade Promotion

Besides the demonstrated empirical regularity that openness (measured as the sum of imports and exports over GDP) is associated with economic growth, there is increasing evidence that causality runs from trade to growth (see, for example, Brückner & Lederman, 2012). And with the decline of traditional barriers to market access throughout the world, supply-side constraints are now seen as the main obstacle that developing countries face in taking advantage of new opportunities in international markets (Cadot, Fernandes, Gourdon & Mattoo, 2011). The focus on export promotion is also aided by the advent of a new strand of international trade literature that focuses on firm behavior, whereas prior international trade theory has tended to focus on country-level aggregates. Improved data availability has recently allowed researchers to examine firm behavior more closely, providing a deeper understanding of how international trade works. It is useful to discuss a few of these new findings pertaining to IP at this point.

Export Duration

The number of exporting firms is typically very small compared with a country's total number of firms. This finding dates back to Bernard, Jensen and Lawrence (1995), who examined U.S. manufacturing firms, but it has subsequently been confirmed for other countries in a number of other studies (see, for example, Eaton, Kortum & Kramarz, 2008, or Mayer & Ottaviano, 2008, for an overview). Moreover, total export value is typically concentrated in a few large, established firms. There is large turnover of firms entering into and exiting from exporting activity. The export status of newly entering firms is usually very short lived (see, for example, Eaton, Eslava, Kugler & Tybout, 2007, and Besedes & Prusa, 2006a). But if they manage to survive the first few years in the export market, new exporters quickly grow and soon make up a substantial share of total export expansion (Eaton et al., 2007, and confirmed for African exporters in Cadot et al., 2011), suggesting that improving trade duration could be an important driver of increasing export shares, making such improvements a promising target for export-promotion policies in developing countries (Cadot et al., 2011). This seems to make sense, as there appear to be structural differences in trade duration among countries and export sectors.

Besedes and Prusa (2011) show that developing countries are often unable to deepen and maintain their trade relationships. Exports from industrialized countries typically last longer than exports from developing countries, owing notably to the relatively long lifespan of machinery exports. Besedes and Prusa (2006b) generalize this result, finding that the hazard rate (the probability of "dying," in terms of the trade spell) is 23 per cent larger for homogeneous goods than for differentiated ones. On a firm level, Görg, Hanley and Strobl (2008) and Iacovone and Javorcik (2010) find evidence for greater export survival for products close to firms' core competencies. Indeed, evidence seems to suggest that excessive costs associated with exporting are a major factor inhibiting firms' success. The costs can be of administrative nature, including, for example, the ease of doing business in a country (Fugazza & Molina, 2009). But such costs can also be informational in nature.

Cadot et al. (2011) find strong evidence for positive national spillover effects (information network externalities) due to the existence of other firms exporting the same product to the same destination. These effects may have a variety of causes, the most obvious being that one would expect established business relations with the export market to make it easier for new firms to market their products. On the one hand, it should be easier for an entrant to identify potential customers. On the other hand, customers already doing business with a country's exporter can rely on experience with a country's products, which arguably builds up trust. Using a panel of 460 British manufacturing firms, Kneller and Pisu

(2007) find that the frequency of firms indicating such issues as barriers to exporting declines with the experience of firms in export markets. As we will see later, governments can take an active role in reducing these additional costs associated with exporting, facilitating firms' entry and survival in exporting activity.

Productivity Gains

Another case for export promotion drawing from the literature on firms in international trade is that competitive pressures raise average industry productivity, sorting out less productive firms and encouraging entry and survival of high-productivity firms (see, for example, Pavcnik, 2000, or Tybout, 2003). These competitive pressures need not necessarily be due to trade liberalization; in fact, Aghion, Dewatripont, Du, Harrison and Legros (2011) show that industrial policies such as subsidies and tax holidays—but also tariffs—can yield productivity gains and thus have a net positive impact, as long as competition within the targeted sector is preserved or increased. An adequate design of such "competition-friendly" industrial policy would, for example, entail that subsidies be given to all firms within a sector, avoiding picking winners. However, trade-friendly policies appear to have benefits that go beyond reducing the risk of political capture as described above: lowering tariffs on input goods is associated with large productivity gains in firms (see, for example, Goldberg, Khandelwal, Pavcnik & Topalova, 2010, or Amiti & Konings, 2007). These benefits support the notion that trade can be a vehicle for international R&D spillovers, in that countries importing intermediate and capital goods can benefit from R&D done in the exporting country (Harrison & Rodríguez-Clare, 2009).

Input tariffs affect productivity through a number of potential channels, including learning about foreign technology, expansion in the variety of intermediate inputs available to production, and availability of higher-quality intermediate inputs (Bernard, Jensen, Redding & Schott, 2011). Moreover, exporters in both developing (Alvarez & López, 2005) *and* developed (Bernard, Jensen, Redding & Schott, 2007) countries are typically more capital- and skill-intensive than non-exporters. This finding is difficult to square with "old" trade theory, which stresses comparative advantage as a determinant of trade flows and predicts such differences among countries, rather than within them. From an export-promotion point of view, it would be interesting to know in which way causality runs. If exporting firms learn by doing, there would be a clear case for export promotion. And indeed, a few studies do confirm differential productivity growth between exporters and non-exporters, notably in developing countries (see Van Biesebroeck, 2003, and De Loecker, 2007). Bustos (2011) finds evidence in Argentinian firm-level data that entry into exporting induces firms to upgrade their technologies, and Van Biesebroeck (2003) finds similar effects on sub-Saharan African manufacturing firms. From a development perspective, the most important finding is probably that learning from exporting is most likely in technologically backward countries and among less productive firms (Harrison & Rodríguez-Clare, 2009).

Export Promotion Policies

Export promotion policies in general involve all measures and programs aimed at assisting current and potential exporters in penetrating foreign markets, as well as export subsidies, reduced tax rates on exporting firms' earnings, favourable insurance rates, advantageous financial conditions, or variations in the exchange rates (Belloc & Di Maio, 2012). As it is impossible to review them in their entirety, we will briefly review the empirical evidence for a few key instruments of export promotion.

Export subsidies can come in many disguises, including direct export subsidies, duty drawback schemes that offer a refund of duties paid on imported inputs that are incorporated in exports, and tax preferences for exporting firms.

Such policies have been credited with contributing to the export success of rapidly industrializing Asian countries, complementing tariff protection with a necessary vent for output (Noland & Pack, 2003). More recent evidence on their use shows mixed results: while direct export subsidies rarely pass a cost-benefit analysis, duty drawbacks and tax exemptions have slightly more positive effects, especially for small and medium enterprises (Belloc & Di Maio, 2012).

Theoretically, as Harrison and Rodríguez-Clare (2009) have pointed out, the advantage of export subsidies over tariffs is threefold. First, export subsidies tend to ensure that firms are subject to the discipline of the international market, forcing them to become more productive. But the same should be true for firms selling in the domestic market, as long as there are no trade restrictions present that would distort domestic prices. Rapidly industrializing Asian countries have often used export subsidies in conjunction with protection of the domestic market. This has allowed them to offset losses in international markets with "superprofits" on the protected domestic market, while competition in the international market ensures that the firm does not suffer from loss of cost discipline (World Bank, 1993). It seems that the creation of such a "vacuum environment" has been crucial for the take-off of these firms, a condition that usually only technological leaders enjoy through patent protection (Dosi, 1988). In this context, Shapiro (2007) highlights that there has been a fundamental change in the understanding of the importance of "rents": "The acknowledgement that rents are at the heart of technological change and not simply politically derived is ubiquitous in the theoretical and empirical literature that focuses on the microfoundations of development" (Shapiro, 2007, p. 10). These views closely relate to the "self-discovery" market failure we described earlier, stressing that the ability to appropriate such rents is a precondition for pioneers to undertake risky investments in underdeveloped areas.

Second, export subsidies effectively limit the scope of support to exporters, which are the most productive firms. Yet there is in principle no reason why only the most productive firms should be supported, unless there are important barriers that prevent low-productivity firms from becoming high-productivity firms. In this case, an optimal policy should target removal of those barriers. A number of non-trade-related but complementary factors have been found to inhibit firm productivity growth, including rigid labour markets, underdeveloped infrastructure and barriers to firm entry (Chang, Kaltani & Loayza, 2005).

Third, domestic markets may be too small to allow the protected industry to reap the full extent of Marshallian externalities, and thus export subsidies may help increase an industry's market share. But Harrison and Rodríguez-Clare (2009) argue that rather than sheer size, sophistication of domestic demand is more important, as this will be the criterion upon which success in foreign markets will depend. The label "export quality" is often used as an indicator for product sophistication in developing countries. Hence the export orientation of infant industries will help develop a certain degree of product sophistication that would be hard to acquire by selling to the domestic market only. Nevertheless, export subsidies today are tightly regulated by the WTO and are permissible only for least developed countries and countries with a per capita GDP below US$1,000.

Special economic zones (SEZs) are another instrument that has proven successful in Asian states and has been emulated worldwide over the years. But a comprehensive review is still missing, and, apart from success stories in China and Mauritius, anecdotal evidence and country studies are inconclusive about the optimal conditions for the success of SEZs in terms of increasing countries' exports and economic growth. In particular, SEZs seem to remain relatively secluded from other areas in a country, preventing technology transfer and knowledge spillovers (Belloc & Di Maio, 2012). Interestingly, Amsden (2004) argues that the success of SEZs in Asian states lay elsewhere. There, SEZs came in the form of export-processing zones or free trade enclaves, enabling participating firms to acquire their imported

inputs duty-free in exchange for an obligation to export all their output. These special economic zones did not directly create either backward or forward linkages with domestic industry, nor did they substantially facilitate technology transfer in an immediate way. But they managed to create employment, and rising wages ultimately helped create a domestic market for other manufactures.

Finally, *export promotion agencies* are becoming more and more popular across the world. In fact, the number of export promotion agencies has increased by a factor of three over the last 20 years (Lederman, Olarreaga & Payton., 2010). Generally, it does appear that export promotion agencies have a positive effect on countries' exports. Kang (2011) argues that the activities of the Korean Trade Promotion Corporation have been critical to the country's export development. He estimates that each increase of 10 per cent in the budget of its overseas offices leads to increased Korean exports on a magnitude of 2.45 to 6.34 per cent. Using a larger set of data from several countries, Lederman et al. (2010) estimate a $40 increase in exports for each $1 of export promotion by the median export promotion agency.

Volpe Martincus, Estevadeordal, Gallo and Luna (2010) find evidence that the presence of offices of export promotion agencies abroad favours an increase in the number of differentiated goods being exported, whereas a larger number of diplomatic representations in the importer countries seems to be associated with exports of a larger number of homogeneous goods. Lastly, Volpe Martincus and Carballo (2010) confirm these effects and show that export promotion benefits accrue asymmetrically to smaller firms that are suspected to suffer from more severe informational impediments. Also, small firms contribute a disproportionate share of major innovations. In line with the findings on learning-by-doing and learning-by-exporting, small firms' contribution to innovation has been found to be greatest in immature industries (Acs & Audretsch, 1990). Moreover, young firms are the main driver of job creation (Davis et al., 2008), providing an additional rationale for targeting support towards these businesses.

Foreign Direct Investment

Policies to attract FDI have been widespread in both developed and developing countries. Governments have usually sought to attract such investments by tilting incentives toward foreign investors, such as by offering tax holidays, tariff exemptions or subsidies for infrastructure. Empirical evidence generally confirms a link between FDI and sectoral growth, but again it is very difficult to draw conclusions concerning the direction of causality: while FDI might induce growth of a certain sector, promising growth prospects of a sector might also induce FDI inflow (Harrison & Rodríguez-Clare, 2009). Rather than looking at whether FDI promotes sectoral or economy-wide growth, most pertinent research has therefore focused on whether FDI increases firm productivity, be it within or across industries. Here, most researchers have found that firms with foreign equity participation display higher output, higher output per worker, or higher levels of total factor productivity, making a strong case for policies promoting joint ventures, as exemplified by China (Harrison & Rodríguez-Clare, 2009).

Using econometric techniques that rule out the possibility that foreign firms tend to acquire the most productive domestic enterprises, studies have been able to conclude that, indeed, foreign equity infusion does confer productivity benefits to domestic firms (see, for example, Matthias & Javorcik, 2009). However, there is little evidence for the existence of *horizontal spillovers*, the extent to which foreign ownership benefits indigenous firms in the same industry. Developing countries often seek to attract FDI in order to facilitate technology transfer to domestic firms operating in the same sector, hoping to encourage the development of indigenous firms. Foreign investors usually lack incentives to actively engage in technology transfer with their own domestic competitors. And unlike China and Korea earlier,

many developing countries today may not have enough leverage to force such transfers (through copying designs, engaging in reverse engineering, etc.) without risking a massive exodus of foreign firms (Altenburg, 2009). Hence, incentives and tax breaks to multinational investors could end up crowding out domestic firms and transferring rents from domestic taxpayers to foreign investors (Pack & Saggi, 2006).

On the other hand, there is ample empirical backing for the conjecture that FDI might be beneficial to domestic firms through *vertical spillovers*, that is, positive externalities stemming from the relationship of foreign enterprises with domestic suppliers and customers (Harrison & Rodríguez-Clare, 2009). Evidence on forward spillovers—the supply of inputs embodying new technologies or processes—is scant. However, the existence of backward spillover effects—productivity gains in foreign firms' domestic suppliers—has been confirmed in various studies for a number of countries (see, for example, Gorodnichenko, Svejnar & Terrell, 2007, and Javorcik, 2004).

These findings rationalize industrial policy that sets local content requirements, requiring foreign firms to source a certain percentage of their inputs from local suppliers. Sutton (2004) explains the mechanism by which local content requirements have helped suppliers in India and China:

> "From the early 90s onwards, a wave of multinational firms entered both markets. In both countries, these entrants were required to achieve a high level of domestic content within a specified period (typically, 70 percent within 3 years). For at least some of the new entrants, this was seen as an unreasonable target, as domestic suppliers could not meet the price and quality requirements of the carmakers. Achieving the 70 percent target required the car makers to switch rapidly from a reliance on imported components to sourcing from local vendors; and this in turn gave the car makers a strong incentive to work closely with (first-tier) suppliers, to ensure that quality standards were met, within an acceptable price." (p. 1)

But while the imposition of such criteria might actually have positive benefits, it may as well scare off investors in the first place. Such concerns could be avoided, for example through subsidizing domestic inputs instead (Harrison & Rodríguez-Clare, 2009).

Notwithstanding these findings, many developing countries have not been able to reap such gains from FDI, as FDI has often been directed to extractive natural resource sectors that have only few linkages with the rest of the economy (Belloc & Di Maio, 2012). In general, FDI policies seem to have been the most successful when they were part of a broader industrial policy strategy, including efforts at improving the supply of skilled workers in targeted industries, improving regulation and infrastructure and export promotion (Harrison & Rodríguez-Clare, 2009).

Industrial Policy Targets

We have up to now reviewed and assessed a number of more-or-less successful industrial policies in the hopes of giving a broad overview of instruments used, and we have stressed a few factors that do or do not contribute to their success. However, on a more general level, we have not really discussed *what* industries countries' industrial policies should target. Keeping in mind the goal of achieving structural transformation of the economy to achieve long-term growth, have any lessons been learned on how radical industrial promotion away from the current structure really can be? For example, having noticed that the automobile sector appears to have many backward linkages with various suppliers, does this mean that all countries should start developing automobile industries? Obviously, countries have differential capacities regarding what they are good at producing, which is exactly why we see so much international

trade. While a thorough discussion that would do justice to the complexity of this topic is beyond the scope of this paper, we will briefly present the main ideas around this debate, building on the notion of comparative advantage as discussed in the introduction to Chapter 2.

The term *comparative advantage* as used in economic theory is essentially an analytical device. Comparative advantage arises from between-country productivity differences, which are not directly observable (Costinot, 2009). Moreover, the sources of productivity differences vary, and they include a disparate set of factors such as human and physical capital, natural resources, institutional quality, capital-to-labour ratios, financial market development, and labour market characteristics (Kowalski, 2011). Outcome-based measures of comparative advantage such as Balassa's (1965) index of revealed comparative advantage based on trade shares suffer from various real-world market distortions and thus have to be viewed with caution. Nevertheless, comparative advantage remains probably the most powerful benchmark in assessing trade flows and hence global production patterns.

This being said, industrial policy faces a certain dilemma: on the one hand, moving away from current comparative advantage is the very *raison d'être* of industrial policy. On the other hand, one would expect the success of a country's industrial policy to diminish the further it strays from its comparative advantage. This view seems to have recently been adopted by the World Bank, and it is worth pausing a moment to have a closer look at what motivates this finding. An earlier study by former World Bank Chief Economist Justin Yifu Lin and a colleague (Lin & Liu, 2004) serves as the basis for his recent book *New Structural Economics: A Framework for Rethinking Development and Policy* (Lin, 2012). The book makes a strong case for government involvement in the industrialization process, but advocates for industrial policy to be consistent with a country's comparative advantage as determined by its current endowment structure. Lin views economic growth as a constant process of technological upgrading, but emphasizes that such upgrading—which can be facilitated by the state—needs to be consistent with comparative advantage. While empirical studies generally struggle with finding indicators that appropriately measure and summarize countries' often disparate sets of industrial policies, Lin and Liu (2004) find an elegant—albeit certainly imperfect—way to circumvent such measurement issues. They construct the following technology choice indicator (TCI), where subscripts *i* and *t* indicate that each observation is per country *i* and per year *t*:

$$TCI_{i,t} = \frac{\text{share of manufacturing in GDP}_{i,t}}{\text{share of labour in manufacturing}_{i,t}}$$

The lower a country's comparative advantage in capital-intensive manufacturing activities, the more support domestic firms will need in order to be viable. Hence, the numerator will increase with government support to manufacturing firms. An increase in the share of manufacturing alone would not in itself be an indicator of industrial policy, but could simply indicate a structural transformation of a country regardless of whether the government has intervened or not. The authors claim that what makes the TCI an appropriate indicator for intensity of industrial policy that *defies* comparative advantage is the presence of the denominator: directed investments in priority manufacturing sectors are expected to be more capital intensive than would *otherwise* be the case and hence absorb less labour than would occur if the labour absorption were a result of purely market forces. That is, the pace of hiring in the sector will not keep up with the pace of capital injections as supported by governments. Hence, a country that actively pursues a comparative advantage–defying industrial policy strategy will have a relatively higher TCI, resulting from an increasing numerator and a relatively decreasing denominator.

Using the TCI index in various regressions, Lin and Liu (2004) go on to test several hypotheses and find that countries with high TCI levels generally have slow long-term economic growth, unequal income distributions and significant market distortions as well as bad economic and political institutions. Therefore, the central theme of Lin (2012) and recent World Bank research more generally is not to reject industrial policy per se, but to caution countries not to stray too far away from where their comparative advantage lies. A useful guide for policy-makers to identify where exactly their country's comparative advantage lies is provided in the same volume. The "Framework for Growth Identification and Facilitation" basically suggests determining which of a country's industries are worth promoting by drawing up a list of tradable goods that have been produced over the last 20 years in countries with similar endowment structures and twice the country's own per capita GDP.

Nevertheless, a number of scholars have criticized this approach to industrial policy, pointing out that the very purpose of industrial policy is to move away from a country's current comparative advantage and calling for more radical industrial policy (see, for example, Chang, 2002; Mattoo & Subramanian, 2009; or Singh, 2011). Justin Lin's focus on the importance of countries' endowment structures assumes that countries with similar endowment structures will have similar technology-industry structures, implying similar levels of GDP per capita. Singh (2011) points out that many Asian countries successfully moved into industries in which they clearly did not have a comparative advantage at that time. For example, Japan and then Korea started producing steel when their per capita income was only 2.5 per cent that of the United States.

A wider strand of industrial policy literature relates countries' export or production baskets to their levels of GDP. Hausmann et al. (2007) developed a measure of sophistication of a country's exports, evaluating each good according to the GDP per capita associated with each exporter of that good worldwide. The authors then calculated, using the export mixes of different countries, an implied level of GDP and compared it with the actual GDP per capita. They found that a number of countries have export baskets that substantially overpredict their actual GDP per capita. Using this technique in a case study on China, Rodrik (2006) identifies a large gap between implied and actual GDP and ascribes it to dirigiste government industrial policy that is directing the economy toward higher export sophistication, as the gap would be too large to have occurred naturally.

A third recent strand of literature might offer an alternative to the traditional comparative advantage–centered approach. Hidalgo, Klinger, Barabási and Hausmann (2007) introduce the idea of the global *product space*, which illustrates the extent to which certain products are connected to other products. As products are interconnected, countries that produce more "complex" products with more linkages tend to have more possibilities to also produce "nearby" products, allowing them to move up the industrial structure with greater ease. Calculating the proximity between products based on the likelihoods of various product pairs actually being produced as evidenced by trade data has the advantage of not having to rely on a priori assessments of countries' business environments and product relatedness. According to Hidalgo et al. (2007), their measure of proximity is "based on the idea that if two goods are related, because they require similar institutions, infrastructure, physical factors, technology, or some combination thereof, then they will tend to be produced in tandem, whereas highly dissimilar goods are less likely to be produced together" (p. 2).

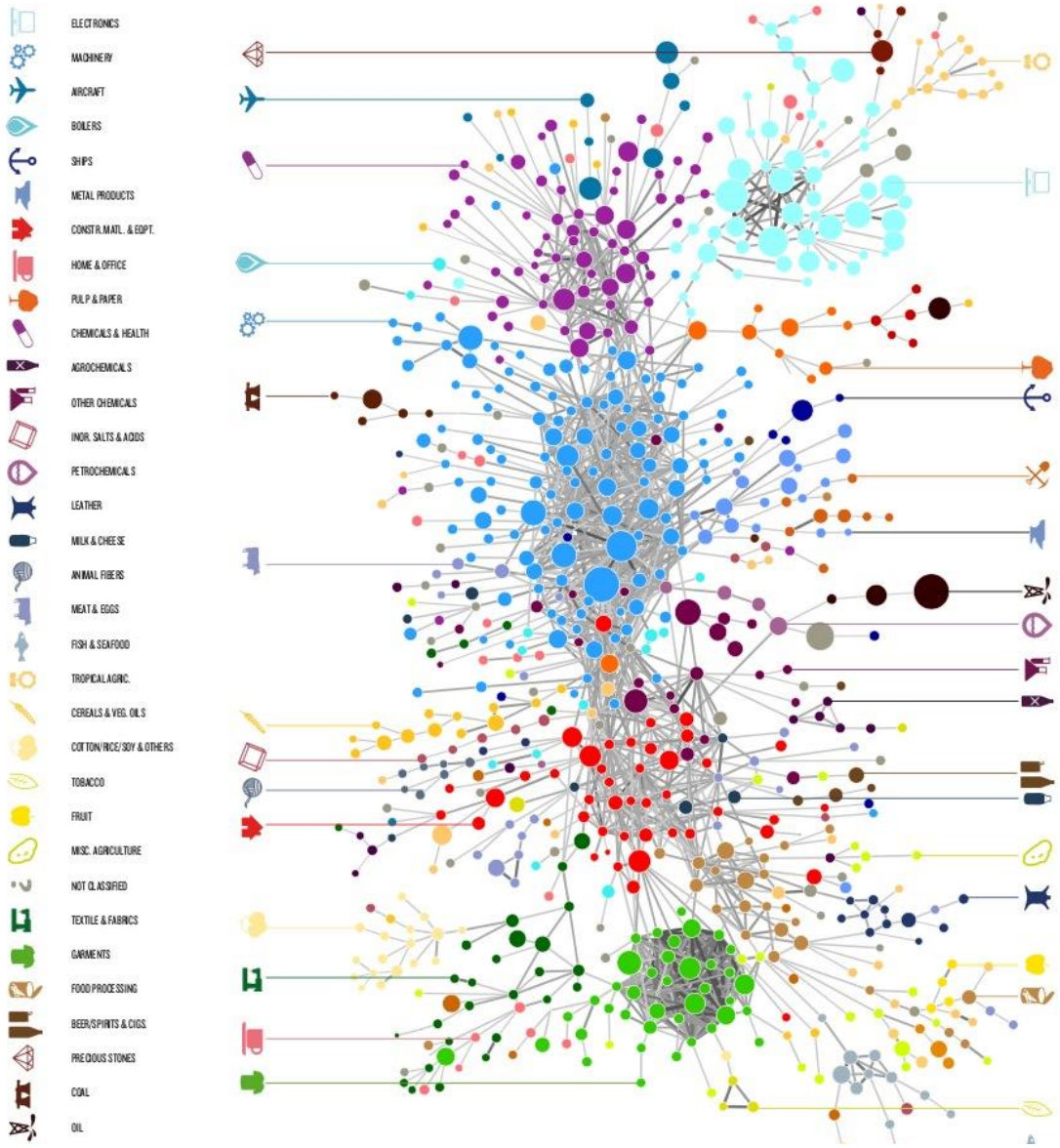

FIGURE 6. THE GLOBAL PRODUCT SPACE

Reprinted with permission from Hausmann et al. (2011).

Hidalgo et al. (2007) find evidence that some countries have indeed hit a dead end, specializing in sectors that are relatively secluded from other products in the global product space. Other, more connected countries have historically been able to gradually upgrade their economies. Their research has enormous implications for industrial policy, in that it might help to identify promising sectors with higher growth prospects from government intervention, for example through overcoming coordination problems. Such strategic government policy may help countries accelerate their structural upgrading, or even jump to higher production structures.

A more comprehensive overview of the latest research on determining promising targets of industrial policy can be found in Reis and Farole (2012).

Best Practice

The literature reviewed so far suggests the following best practices for optimizing the benefits of industrial policy.

Industrial policies should be only a subset of a broader industrial agenda. The successful deployment of industrial policies requires a sound enabling policy framework that is conducive to improving the business climate and economic competitiveness more generally. A number of complementary policies are needed to overcome potential bottlenecks. These include education policies to increase the supply of relevant skills within the domestic workforce, R&D support and provision of adequate infrastructure. A sound macroeconomic environment, including a competitive exchange rate regime, has also been found to be an important driver for industry growth. Broader industrial agendas also help to lock in commitments in that they create incentives for consistent policies over successive administrations with sometimes conflicting policy objectives (Devlin & Moguillansky, 2012).

Protectionism can work, but design is crucial. Protectionism is a thorny policy issue, with many pitfalls that may actually contribute to the crippling of domestic industries. For example, we found evidence that import protection may be a viable tool for industry promotion, assuming that there is no retaliation from trading partners. This assumption is, however, highly unlikely to hold true in today's international economic reality, as such measures will necessarily be in conflict with foreign interests. Even then, the evidence seems to suggest that protection needs to be focused on consumption goods, rather than intermediate input goods. Further, a distinction needs to be made between homogeneous and differentiated goods, indicating that there is greater potential in developing niche industries in differentiated goods.

Two major findings necessitate the complementary consideration of the next two best practices, namely that successfully industrializing countries have complemented protection with active domestic industry support and that governments have historically been unable to design adequate sectoral protection patterns.

Industry support should be provided in a transparent way that maintains competition and is incentive compatible. As all forms of industry support are fraught with the threat of capture by special interest, steps must be taken to ensure transparent selection criteria. Not only is picking winners inherently difficult for governments, who have less knowledge of firm-specific characteristics than, for example, managers, it also encourages wasteful use of resources by incumbents and discourages entry by more innovative new firms. Hence, industry support should not discriminate among firms within the promoted industry. In this context, the ability of governments to withdraw support in case of underperformance is equally important. Sunset clauses that link government support to performance criteria have been instrumental in ensuring incentive compatibility of government aid to industry in successfully industrializing Asian countries. Basing such performance criteria on export data has the double advantage of ensuring that firms are exposed to the dynamics of the international market and providing a reliable indicator of industry success.

Temporary support for "sunset" industries may be a necessary step to make a broader structural reform package politically feasible and to ease the transition for affected workers. In such cases, the temporary aspect of the support scheme needs to be communicated clearly, and complementary policies should encourage the retraining of workers to acquire the new skill sets required for an emerging industry.

The evidence concerning FDI is particularly clear on the need for well-defined policy objectives. Attracting FDI in downstream sectors appears to stimulate upstream domestic industry, whereas active policies are needed to ensure horizontal spillovers for domestic industries operating in the same sector. Here, the challenge is to achieve an adequate balance between offering an attractive investment framework for foreign investors and setting the right incentives for technology and knowledge transfers. While local content requirements, subcontracting and joint ventures have been used extensively in China, it remains unclear whether countries with smaller markets can impose such regulation on multinationals without affecting their investment decisions. In any case, the literature agrees on the importance of fostering a country's absorptive capacity as a key determinant for technology transfer, necessitating, for example, active policies to develop an aptly skilled domestic workforce.

Close collaboration between governments and industry can optimize information flow. In order to design adequate support schemes, policy-makers need to have extensive knowledge about which market failures need to be addressed. Answering this question involves identifying industries with potential for positive spillovers, inter-industry and input-output linkages, perceived bottlenecks to coordination of investments, the nature of financial constraints and credit market imperfections. A defining feature of successful industrial policy has thus been regular knowledge exchange between high-level government and industry representatives to ensure the continued relevance and effectiveness of industrial support. This process implies clear objective setting, monitoring, progress and impact evaluations, as well as capacity building for government bureaucrats. Given the complexity of the domestic economic tissue and its countless connections to the outside world, for example through global value chains, industrial policy making necessarily operates under high levels of uncertainty and will often be trial and error.

Strengthening government capacity can help avoid government failure. Government capacity to correctly anticipate trends and effectively withdraw support once it is no longer necessary calls for a highly competent bureaucracy with highly skilled people taking key roles, and accordingly competitive pay, which also helps insulate officials from corruption.

Targets of industrial policy are country-specific. Economists have long argued for countries to upgrade their industrial structure according to their comparative advantage. However, a few successful countries have demonstrated that industrial policies may contribute to a substantial shift in what those countries are best at producing. While there is still considerable disagreement on which sectors offer the greatest return on industrial policy, a number of recent research offers avenues of identifying these, though some of those avenues compete. While government policy should certainly be informed by these studies, it should also be clear that there is currently no blueprint that fits across all countries. Hence picking winning sectors should be the result of careful examination of both the literature and strategies identified through country-specific government-industry collaboration.

4.0 Green Industrial Policy

Our analysis has up to now focused on what may be called the conventional economic paradigm, which is largely confined to the purely economic realm and makes few explicit efforts to integrate external social or environmental considerations.

In the absence of market failures, supply and demand are efficiently balanced through price signals. And while there has been steadily increasing demand for finite resources such as water, energy (mostly fossil-based) and various materials, a combination of technological improvements and the discovery of new, low-cost sources of supply has been able to sustain economic growth while keeping resource prices flat throughout the last century (Dobbs et al., 2011). Nevertheless, resource prices have soared in the last decade, reaching record levels in recent years.

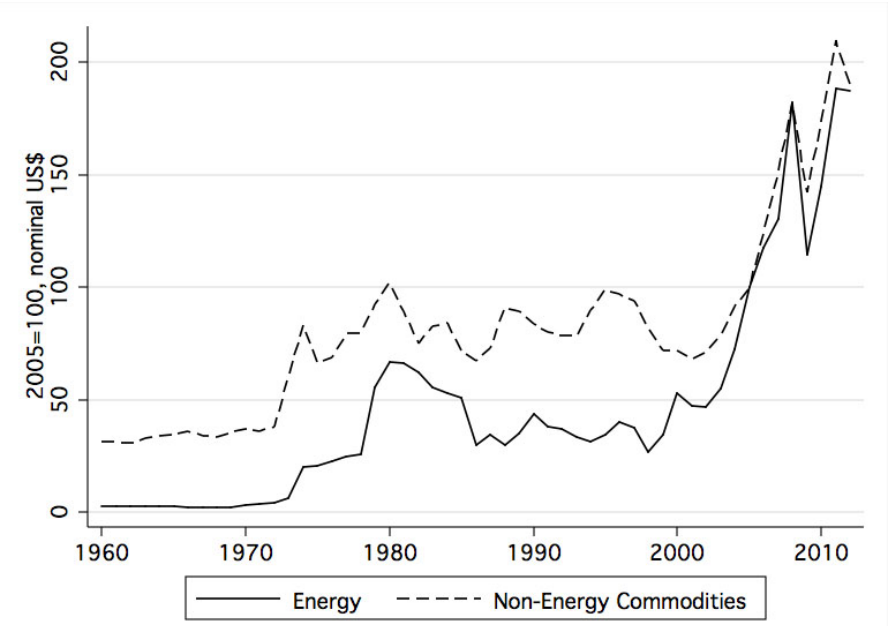

FIGURE 7. COMMODITY PRICES HAVE INCREASED SHARPLY SINCE 2000

Data source: GEM Commodities, World Bank Group.

The extraordinary rise of commodity prices has been accompanied by heightened price volatility, significantly impacting investment decisions by adding uncertainty over future developments. This trend can be attributed to a number of developments, none of which is likely to subside in the near future. Rapidly rising global population and phenomenal growth in emerging economies are stimulating global demand at an unprecedented scale. Technological innovation cannot keep up with the speed of increase of consumption in emerging markets, that is, the first mechanism for keeping resource prices at bay during the 20th century is currently impaired. At the same time, the second mechanism is not working either, effectively magnifying the price effect of the former. With a given amount of resources, unabated extraction cannot go on forever. Increasing scarcity requires increasingly intrusive and hence costly extraction methods to discover new sources of resource supply. Therefore, supply lags behind demand and cannot easily adjust to shifts, such as during recessions, and this increases prices and their volatility.

More fundamentally, resource prices rarely reflect their true economic value. In a purely market-driven economy, this is due to the presence of substantial market failures due to the inability of private actors to internalize environmental externalities, as described in chapter 1. The negligence of the conventional economic paradigm to account for these has resulted in price signals that have encouraged irresponsible resource management that allows excessive use of resources. Resource depletion and degradation of ecosystems are threatening the very foundation of the economy and are often irreversible. The absence of a carbon price has resulted in human-induced climatic change, whose catastrophic effects are increasingly being felt throughout the world.

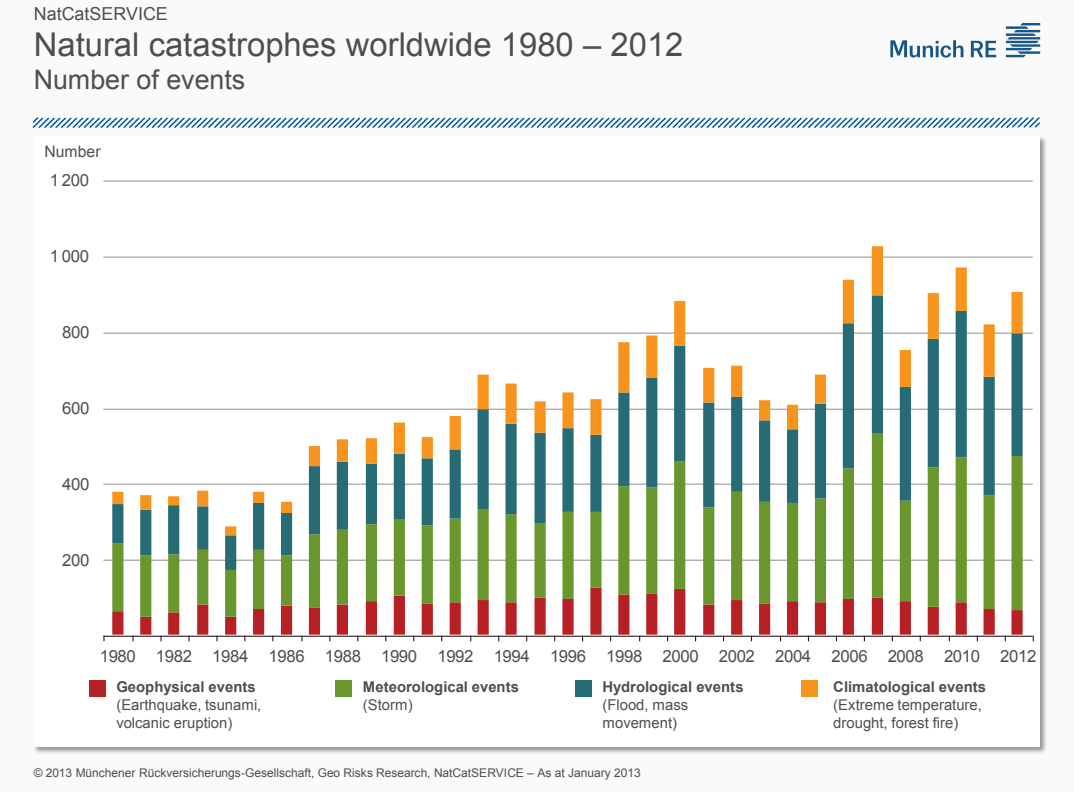

FIGURE 8. NUMBER OF CATASTROPHES WORLDWIDE, 1980 TO 2012

The number of disruptive natural events has risen over the past three decades. Reprinted with permission from Munich RE (2013).

Apart from market failures, government policies have contributed to the misalignment of prices with their true value, setting the wrong incentives. Subsidies for agriculture, water consumption and fossil fuels have been pervasive throughout the second half of the last century and are currently estimated at a global level of up to US$1.1 trillion annually (Dobbs et al., 2011).

With this background, it is not surprising that calls for a paradigm shift have gained considerable momentum in recent years. The "green economy" is at the centre of this new public debate. While there is no universally agreed definition of what the term really involves, there appears to be consensus on the need for a green economy to be consistent with the earlier notion of *sustainable* development, reflecting a holistic approach to development that strives for intergenerational

justice in terms of economic, social and environmental well-being. The United Nations Environment Programme defines a green economy as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities." The fact that economic growth, even measured imperfectly by GDP, has historically been associated with rising economic and social well-being has led to the emergence of the term *green growth*, which "is about making growth processes resource-efficient, cleaner and more resilient without necessarily slowing them" (Hallegatte, Heal, Fay & Treguer, 2012, p. 2). An exceptional amount of research within the last few years has offered substantial grounds to believe that "green growth" is indeed not an oxymoron, and that there are important synergies to be exploited.[6] And the proven failure of markets alone to take advantage of such synergies calls for increased government effort to provide a policy framework that is conducive to optimized market behavior.

Therefore, pursuing green growth is in principle consistent with the use of traditional industrial policies for development, when motivated by considerations laid out in our previous analysis, and subject to the same limitations. But green growth requires the emergence and strengthening of green industries in order to harness synergies in terms of economic, social and environmental benefits. This adds yet another layer of complexity to industrial policy, warranting the use of the distinctive term *green industrial policy*.

The following section will briefly review the concept of green industries with an eye toward rationalizing the use of supporting policies.

Green Industries

It is analytically convenient to distinguish between the *greening of* (existing) industries and the stimulation and creation of *green* industries, as suggested by UNIDO (2011). However, we will see that in fact the two overlap and interact a great deal, as exemplified by the renewable energy sector, which we will briefly highlight as well.

The Greening of Industry

The *greening* of industry refers to the constant improvement of environmental performance of *all* industry, regardless of sector, size or location.

Most obviously, the greening of industries can be pursued through promoting greater resource efficiency. Resource inputs are a cost to industry and can account for up to 65 per cent of costs in the food and beverage sectors and 70 to 80 per cent in the steel sector (Manyika et al., 2012). Energy costs alone can make up 30 per cent of total value added in industries such as basic metals, paper and pulp, mineral products, rubber and plastics, and chemicals (Manyika et al., 2012). Such economic considerations have already contributed to increased resource efficiency over the last decades, as evidenced in declining material intensity.

[6] An overview of these publications by major international organizations can be found at http://www.greengrowthknowledge.org/Pages/Reports.aspx.

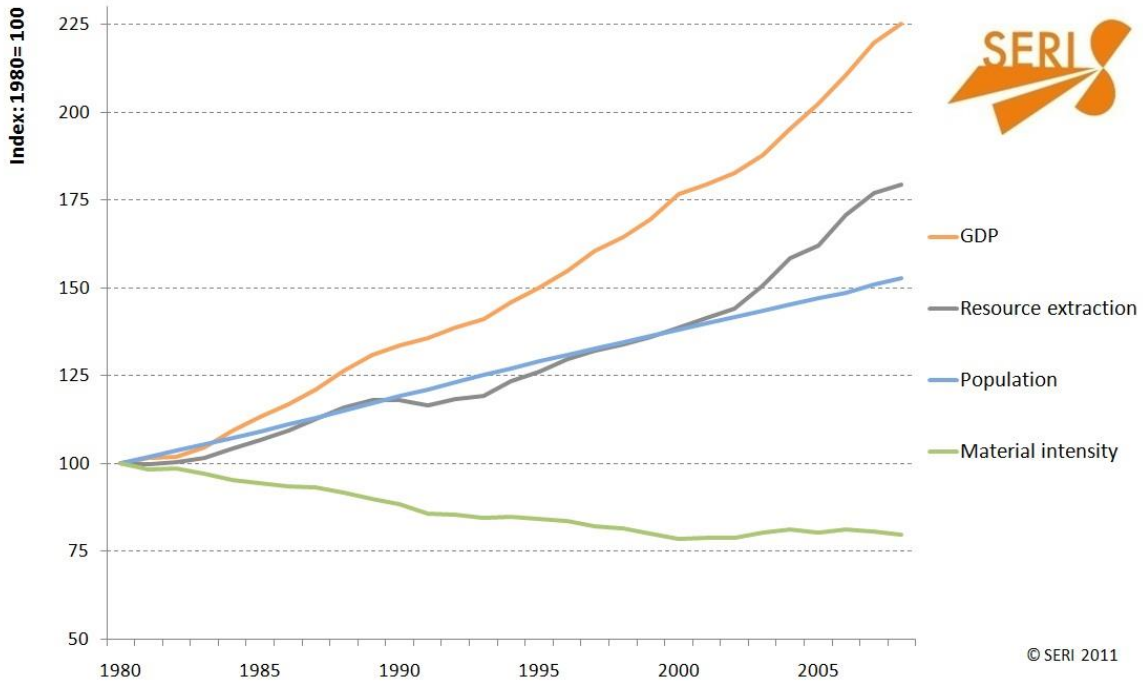

FIGURE 9. DECOUPLING GDP AND RESOURCE USE

Reprinted with permission from Sustainable Europe Research Institute (2012).

This development has helped the global economy achieve a certain degree of *relative decoupling*, meaning that the rate of GDP growth has been higher than the rate of resource extraction. However, sustained growth will ultimately necessitate an *absolute* decoupling, requiring resource extraction to stabilize at some sustainable level. At the same time, awareness of the cost of industry-induced air, water and soil pollution has become increasingly obvious. Apart from greenhouse gases, industrial facilities often release hazardous pollutants into the air, water and soil, with sometimes drastic consequences for human health and safety, as well as for ecosystems. Health costs from mostly air pollution in the United States are estimated to amount to between 0.7 and 2.8 per cent of GDP (UNEP, 2012b). Such health concerns also have very tangible effects on firms: Hanna and Oliva (2011) find that even small reductions in air and water pollution in Mexico City have had a large positive impact on labour supply. A study by Zivin and Neidell (2011) lends robust empirical support to the notion that reductions in pollution can have positive effects on economic growth, finding that slight decreases in ozone concentrations in the United States have caused significant gains in labour productivity.

In view of these challenges, industry is increasingly pressed to adopt cleaner production by reducing the amount of energy and materials used in the production process and considering environmental impacts throughout product life cycles. Of course, the potential to capitalize on opportunities from the greening of industries varies widely across countries and particular industries, depending on stages of development and countries' endowment structures. Also, there are several stages to the greening of industries, which can range from simple pollution control through end-of-pipe solutions via closed-loop production systems that minimize the use of virgin material, up to industrial ecology, which harnesses synergies within integrated production systems such as in eco-industrial parks (UNIDO, 2011).

Greater resource efficiency on a national level is quite consistently associated with high-income countries (Dittrich et al., 2012), pointing to low-hanging fruits to be harvested by developing countries, through, for example, increased technology transfer and adoption. However, it is not clear to what extent this difference in resource efficiency is due to the relocation of polluting industries to industrializing countries as those countries leapfrog into industrial production, while structural change implies that high-income countries move increasingly into less polluting service activities. The most recent findings do shed some light on this question, indicating that only 30 per cent of reductions in energy intensity are due to structural change, and the remainder is due to energy-efficiency improvements (GEA, 2012). On a global level, development historically implied an inverse-U pattern of carbon dioxide emissions per unit of income, as illustrated in Figure 10.

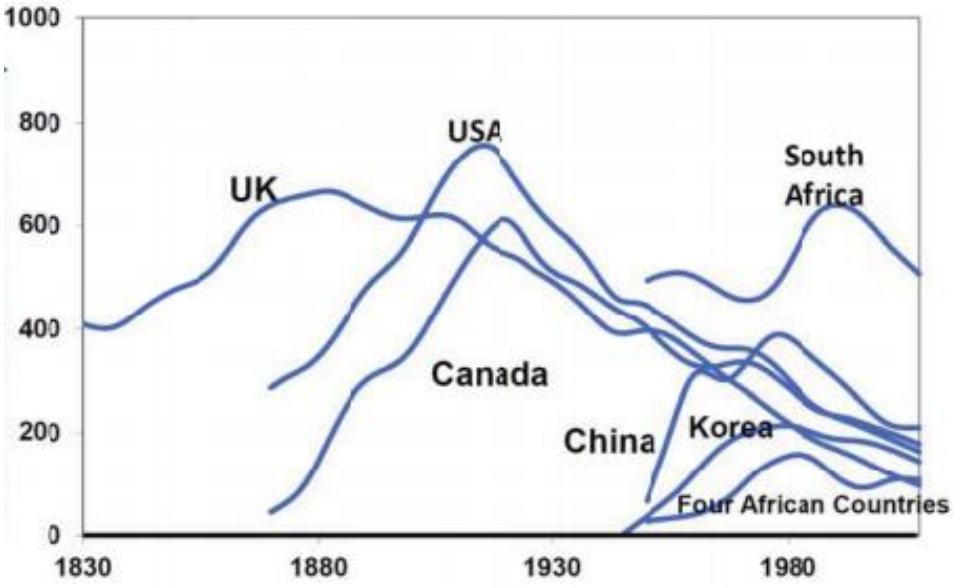

FIGURE 10. CARBON DIOXIDE EMISSIONS PER UNIT OF INCOME FOR SELECTED COUNTRIES

Tons of carbon dioxide emitted per US$1 million over time. Reprinted with permission from Collier and Venables (2012).

Nevertheless, it would be premature to conclude that developing countries seeking to industrialize should emulate the "pollute now and clean up later" strategy of high-income countries. In fact, there are a number of good economic reasons why this should not be the case.

First, resource scarcity, price volatility and ever-tighter environmental regulation are here to stay. Many businesses in developing countries continue to use obsolete and inefficient technologies and fail to adopt proper management systems (UNIDO, 2010). In the five most energy-intensive sectors (cement, iron and steel, pulp and paper, aluminum, chemicals and petrochemicals), significant opportunities exist in improved energy management, fuel switching, recycling, and carbon capture and storage to capture process emissions (World Economic Forum, 2013). Moreover, a number of developing countries have generous endowments of renewable energy sources that are currently underexploited. For example, a growing number of developing economies use renewable energy solutions as viable cost-efficient options for rural development (REN21, 2012). According to the International Energy Agency (2011), oil-importing developing

economies today face prices in excess of US$100 a barrel, while OECD countries faced an average oil price of US$22 at a comparable stage of development (in 2010 dollars). Hence, development today takes place in a radically different economic environment.

Many developing countries' exports are also heavily concentrated in a few commodities, making them particularly vulnerable to price volatility shocks. Diversification and greening of exports can help reduce the exposure to such shocks, making industry more resilient. Moreover, certain components of greening industry are typically very labour-intensive. For example, the recuperation of materials embodied in finished products often involves laborious extraction practices, which can be a source of significant labour opportunities (UNEP, 2012b). Cheap labour is increasingly becoming a source of comparative advantage for developing countries, as emerging giants and traditional hubs of low-cost labour manufacturing such as India and China have experienced rising wages over the last years (Manyika et al., 2012).

Finally, in the past few years, OECD countries have introduced environmental legislation that has had substantial impact on developing country exports. As this trend is likely to continue in the future, countries that do not adapt their production structures might indeed lose existing market shares. Beyond regulatory requirements, the ability to adapt to shifting consumer preferences in these countries can even be an important source of competitive advantage (Manyika et al., 2012).

Second, it may well be more cost-effective to design green industrialization at an early stage, instead of cleaning up later (see Acemoglu, Aghion, Bursztyn & Hemous, 2012, or Hallegatte et al., 2012). Much of the success of green industry is preconditioned on adequate infrastructure, which developing countries are going to build over the coming years. Developed economies have sunk capital in irreversible investments in often-outdated power supply, transport networks and urban structures, which confers a latecomer advantage to developing countries that could profit from new technologies at an earlier stage (Collier & Venables, 2012). Indeed, emerging economies have significantly improved their material productivity (measured as GDP per material consumption) since 1985, at faster rates than global averages (Dittrich, Giljum, Polzin, Lutter & Bringezu, 2011).

Third, disregard for the environmental impacts of industrialization overlooks their irreversible nature. For example, while desertification can be countered to some extent by replanting trees, its effects in terms of shrinking biodiversity and tourism industry potential are permanent (Hallegatte et al., 2012).

Green Industry

Green industry, as distinguished from greening of industry, involves stimulating the development and creation of industries that provide environmental goods and services (UNIDO, 2011). Green industry is a varied and growing sector that transcends conventional sectoral boundaries and comprises elements from both manufacturing and services. It includes, for example, companies that manufacture and install renewable energy equipment and develop and manufacture clean technologies, but also companies active in material recovery, recycling, waste treatment and management, as well as environmental and energy consultants (UNIDO, 2011). Hence, green industry is obviously an essential part of the greening of industries, as it provides many of the related services and equipment.

To date there is no consensus on the exact definition of "environmental goods and services." The OECD defined the environmental goods and services industry to include "activities which produce goods and services to measure,

prevent, limit, minimise or correct environmental damage to water, air and soil and problems related to waste, noise and ecosystems." Being a relatively new sector, the market for green goods is very dynamic, and any attempt to classify such products in lists faces a variety of challenges, such as the addition of new products and obsolence of older ones. Analyses based on trade data face the additional problem that product classifications are harmonized internationally only up to a relatively high degree of aggregation (the Harmonized System 6-digit level). Nevertheless, Dutz and Sharma (2012) recently found a few interesting global characteristics about the sector.

First, frontier innovation in green technology is highly concentrated in high-income countries. Looking at patent data, Dutz and Sharma (2012) find that the large majority of patents in green technologies has been granted to high-income countries. Japan, Germany and the United States accounted for 60 per cent of total green innovations worldwide between 2000 and 2005. China, in tenth place, is the only emerging country in the top ten high-quality innovation countries and, together with eight other emerging economies, accounts for 80 per cent of all such patents granted to developing countries. While patents are certainly an imperfect measure, these findings still strongly suggest that high-income countries have a comparative advantage in frontier innovation green products. However, highly innovative segments of green industry account for only a very small share of employment in high-income economies (Manyika et al., 2012).

Second, environmental goods more broadly constitute a non-trivial and rising share of exports in high-income and Asia-Pacific countries. However, the gap with other regions is much narrower than for patents. The fact that developing countries have not been able to increase exports does not necessarily mean that they are at a comparative disadvantage. Rather, looking at countries' export potential in terms of exported products that are close[7] to green goods, Dutz and Sharma (2012) seem to suggest that there are untapped opportunities. Finally, the third finding states that combined exports of green and close-to-green products represent three to five times the exports of green products alone, suggesting that there is indeed scope for developing countries to move their production into greener sectors.

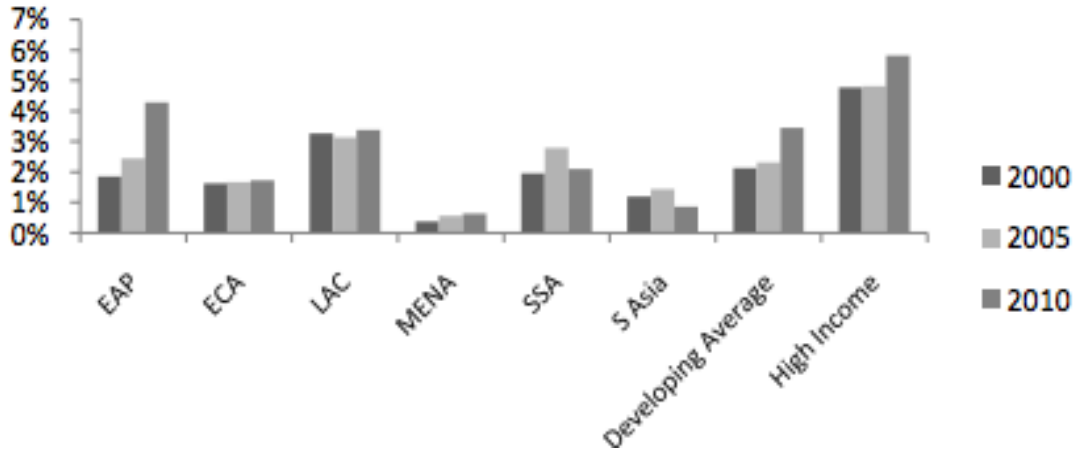

FIGURE 11. EXPORT OF GREEN GOODS AND SERVICES (AS % OF ALL EXPORTS)

Reprinted with permission from Dutz and Sharma (2012).

[7] The term "close" here refers to the proximity of products in the product space, as described in chapter 4.

Renewable Energy

Renewable energy is in many ways central to green growth and is a major component of both the greening of industries (in terms of energy inputs) and the stimulation of green industries (in terms of the renewable energy industry itself). Indeed, the sector has experienced phenomenal growth over the last decade. Global green investments in renewable energy have increased more than sixfold since 2004, amounting to $257 billion in 2011, driving capacity growth notably in solar photovoltaics, concentrating solar thermal power and wind energy (McCrone, 2012). Net investment in renewables capacity was $40 billion higher than in fossil fuel capacity in 2011 (REN21, 2012). While most capacity is currently installed in a few high-income countries, developing countries are becoming more and more important players. In the wake of the financial crisis, investment originating in developing countries did not slow as much as that from OECD countries. Based on current investment growth rates, it seems likely that clean-energy asset finance flows originating in non-OECD countries will exceed those originating in OECD countries for the first time in 2012 (World Economic Forum, 2013).

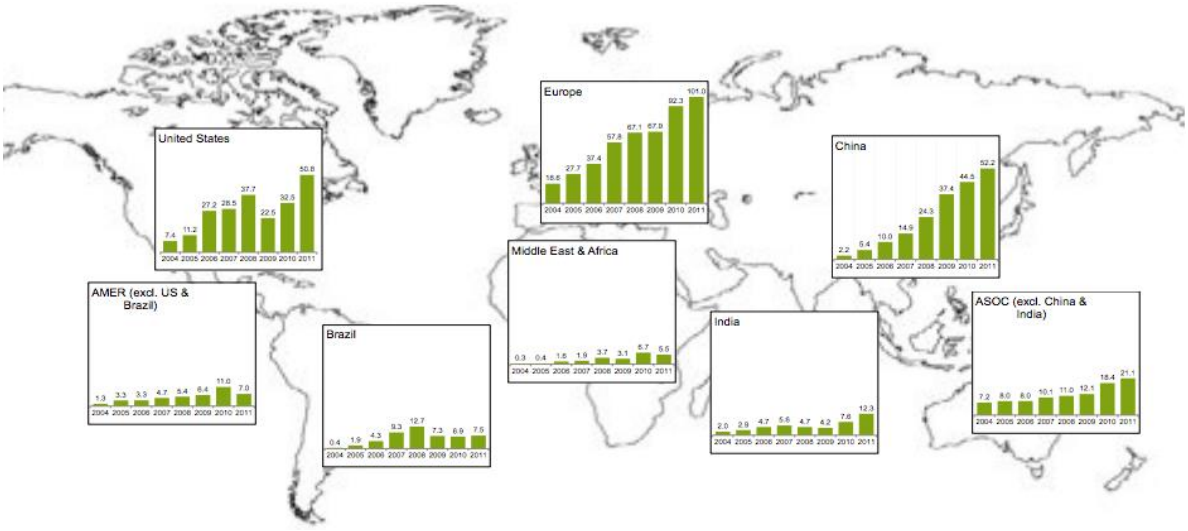

FIGURE 12. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004 TO 2011

In billions of U.S. dollars. New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. Reprinted with permission from McCrone (2012).

Nevertheless, low initial levels of investment mostly explain these very high growth rates. While renewables (excluding large hydro) continue to account for an increasing share of the overall generation capacity added per year (44 per cent in 2011), they still represented only 6 per cent of total power generation worldwide (McCrone, 2012). Considering all end-use sectors—power, heating and cooling, and transport—renewable energy sources have provided roughly 17 per cent of global energy consumption in 2010. However, modern sources of renewable energy, including biofuels, solar, wind, geothermal, modern biomass and even hydropower, account for roughly half this total, while traditional biomass provided the other half (REN21, 2012).

Meanwhile, the renewables sector has made great advances with respect to its competitiveness: the decline in the cost of important technologies is starting to challenge fossil fuel alternatives, even without climate, health and other benefits factored in (McCrone, 2012). The decline in costs has been most spectacular in solar photovoltaic modules, which in early 2012 have been 76 per cent below their level in summer 2008. Similar, but less spectacular declines in costs for renewable energy technology can be observed in other sectors as well. Modern renewables markets and industries have originated in high-income countries, but are continuingly and increasingly expanding to developing countries. China and India play an increasing role both as markets and in manufacturing, and new players are emerging elsewhere in Asia, Latin America, and the Middle East and North Africa region (REN21, 2012).

Green Industrial Policies

We have described how the term "green industries" is both cross-cutting and sectoral at the same time. A central obstacle to the earlier emergence of green industries is the lack of a market, as conventional markets have failed to correctly price externalities. Most prominently, the failure of markets to align the social cost of carbon with its private costs has led to an unsustainable mode of industry that is fuelling global warming. Because of this market failure, green industries are essentially infant industries, driven by policies that support the market through both the stimulation of demand and supply.

From an economic point of view, an optimal policy would consist of correctly pricing the externalities. For example, the first-best policy to control greenhouse gas emissions would be a tax or a cap-and-trade system that ensures that the social cost of carbon would equal the costs of reducing emissions (marginal abatement cost) (Morris, Nivola & Schultze, 2012). Rectifying the market failure would level the playing field for green industries, which then would not need additional government policies to sustain them. However, such market-based policies are currently completely lacking in developing countries and at best insufficient in high-income countries. While the desirability of such policies over the longer term is undoubted, and they are certainly a central element of a green economy, their precipitate introduction could in practice choke existing industries over the short term (especially in developing countries) and hence be incompatible with green growth (United Nations Department of Economic and Social Affairs, 2011).

Thus, in the absence of comprehensive policies that tackle environmental externalities at the source, countries are widely resorting to green industrial policies to spur green growth.

Moreover, green industries are not exempt from those (non-environmental) externalities that many conventional industries are facing either (see chapter 2). There is indeed much reason to believe that non-environmental externalities are even amplified in the case of green industries.

High uncertainty over technological developments and policy-induced market trends expose investors to unmanageable risk, exacerbating credit market imperfections and hampering the provision of much needed green financing (World Economic Forum, 2013). Investment subsidies can help to efficiently spread the risk by transferring it from private investors to taxpayers (Karp & Stevenson, 2012). Technological leadership of high-income countries has favoured the emergence of green industries in those countries, and policies that facilitate and accelerate technology transfer are indeed central to ensuring global technology diffusion. But innovation in green industries is much more specific to local conditions, providing significant opportunities for indigenous innovations: while a state-of-the-art computer chip will be the same whether used in Mexico or Thailand, green technologies require adaptation to local soil, water, air, wind and sun conditions, among others (Dutz & Sharma, 2012). For example, only 1 per cent of Chinese solar

photovoltaic patents are also filed abroad, suggesting they primarily target the specific features of the Chinese market (Popp, 2012). Hence, "self-discovery" in green industries appears to be of greater significance than has been the case in conventional sectors, and this calls for governments to more actively engage in technological research, development, and demonstration, deployment, and diffusion.

Moreover, even if technological capabilities exist, new technology adoption is subject to path-dependency, as industries only sluggishly refrain from applying old production methods (United Nations Department of Economic and Social Affairs, 2011). Addressing knowledge and information gaps through targeted policies can help firms realize cost-efficient technological improvements (GEA, 2012). Promoting green industries can also create first-mover advantages, and learning by doing might yield strategic advantages in the rapidly evolving global market for green industries (Altenburg, 2009). Finally, coordination failures are pervasive, given that current infrastructure has gradually emerged in tandem with conventional industries and is often inadequate for green industries. For example, the development of a market for electric vehicles hinges critically on the availability of recharging stations, with common standards for charging plugs and other technicalities. Likewise, a move toward closed-loop production systems in manufacturing will only be viable if ancillary businesses develop simultaneously, implying the coordinated clustering of industries to optimize resource flows among them (UNEP, 2012b).

Nevertheless, the second-best character of many green industrial policies that is due to the absence of more comprehensive environmental policies illustrates two key differences relative to traditional industrial policies. First, the scale of required government intervention is much larger in green industries, which fundamentally rely on government policy to build their markets. In contrast to the bulk of traditional industrial policies, the focus of green industrial policies is not merely on pushing the supply side. An equally important component of green industrial policy is to create demand: the development of green industries is endogenous to government policies that support them (Karp & Stevenson, 2012). Second, depending on the nature of the market failure at hand, industrial policies might be required for a much longer period. If the market failure is permanent and cannot, for whatever reason, be addressed by market-based policies, industrial policies would be required to equally persist to ensure a level playing field (Dutz & Sharma, 2012). These characteristics substantially complicate analytical first-best industrial policy evaluations based on the Mills-Bastable test (as discussed in the last chapter), part of which requires that industries remain competitive once support is withdrawn.

Green industrial policies are not new but have gained much attention in recent years, as governments throughout the world have attempted to capitalize on the opportunity presented by the 2008/2009 economic crisis to promote a transition to a green recovery (De Serres, Murtin & Nicoletti, 2010). Major governments promised some US$195 billion of "green stimulus" programs, US$141.8 billion of which had been spent by the end of 2011 (McCrone, 2012). According to Dani Rodrik from Harvard University, the investment of tens of billions of U.S. dollars by the United States alone may be the biggest industrial policy effort in history.[8] In what follows, we will present a brief overview of green industrial policies, highlighting emerging findings on the potential and shortcomings of particular measures.

Regulatory and Control Mechanisms

Regulatory and control policies are demand-side policies that impose decisions on business choices and operations, either through technology standards (requiring the use of certain technologies) or performance standards, such as

[8] http://www.economist.com/node/16741043, accessed on January 23, 2013

setting specific environmental targets (De Serres et al., 2010). While completely lacking before the 1960s, such policies have gained increased momentum throughout the world. The initial focus of such policies was purely environmental, regulating emissions and waste in manufacturing industries or reducing the use of toxic substances. More recently, they have become important elements of promoting greater resource efficiency and innovation more generally, for example through energy-efficiency codes for buildings, and air, water and fuel efficiency standards (United Nations Department of Economic and Social Affairs, 2011). For example, the European Commission has currently included more than 30 energy-using product categories in an eco-design regulation that sets minimum energy-efficiency requirements and environmental performance norms based on a life-cycle approach (GEA, 2012).

But industry regulation is also widespread in developing countries. In 2005 China had implemented regulation that provided for the gradual phasing out of inefficient production capacities in iron and steel, cement, power generation, coal mining and others (GEA, 2012). India has effectively regulated the conversion of Delhi's three-wheeler taxis to natural gas, among other policies to reduce urban air pollution (Asian Development Bank, & Asian Development Bank Institute, 2012). Since complying with regulation is usually associated with costs to industries, this trend is counterintuitive. One reason for this widespread adoption of regulatory measures might be a decline in adoption costs for green technologies, stemming from international technology diffusion. Indeed, looking at adoption rates across countries for regulations concerning coal-fired plants, Lovely and Popp (2011) find that countries adopting such regulations at later stages do so at lower levels of per capita GDP than earlier adopters. Another reason might be that it appears that firms often operate at inefficient productivity levels within their efficiency frontiers, in which case environmental regulation might actually increase productivity (De Serres et al., 2010). A number of studies also find empirical backing for longer-term productivity gains, which materialize after initial setbacks (see e.g. Lanoie, Laurent-Lucchetti, Johnstone & Ambec, 2011).

Targeted regulations are usually a subset of and mostly motivated by overarching renewable energy targets. Reviewing the policy landscape for renewables around the world, REN21 (2012) identify 118 countries that had such renewable energy targets in place in 2011, more than half of which are developing countries. Fuel mandates and blending requirements are a major tool underlying policies to support biofuels in 46 countries, and obligations to use renewable energy heat are gaining attention for their potential to encourage growth independent of public financial support (Intergovernmental Panel on Climate Change, 2011).

However, regulatory policies are rarely purely regulatory. One reason is that regulatory or legislative policies usually back economic instruments (UNIDO, 2011). Another reason is that green industrial policies are usually policy mixes. The case of feed-in tariffs (FITs) illustrates this (Table 1). FITs are the major policy tool for promoting renewable power generation and have been in use across 65 countries in early 2012. In general, FITs are considered to be very effective tools and are credited for having successfully driven 64 per cent of global wind and 87 per cent of global photovoltaic capacity (UNEP, 2012a). But regulations and requirements are only part of the design of FITs, as energy providers are usually guaranteed a higher-than-market selling price. As such, purely regulatory policies often have to be complemented with other policies, for example establishing cost-sharing mechanisms between ratepayers and taxpayers, which effectively amount to subsidies.

TABLE 1. FEED-IN TARIFF POLICY ELEMENTS

POLICY ELEMENTS	
Interconnection	The term "feed-in tariff" derives from the fact that early European FITs established rules for how electricity could feed in to the grid. Although many FIT definitions focus on the price paid to the generator, the rules that govern grid interconnection remain a powerful component of many FITs—particularly in countries that are transitioning from monopoly utilities to markets that allow independent power producers to participate. The interconnection regulations contained in FITs can include interconnection guarantees, streamlined or priority interconnection, and special rules for how interconnection costs are allocated and recovered.
Purchasing	FIT policies may require that utilities (or other entities) purchase renewable electricity.
Transmission and distribution	Related to, but distinct from, interconnection and purchasing requirements are requirements that utilities give priority to renewable electricity on the transmission and distribution systems.
Contracting	FIT policies may specify details of the contracts that are to be signed with renewable generators. These include the term of the contract, the extent to which the contract must be simplified and standardized, the contract currency, etc.
Pricing	FIT policies typically specify the price(s) that will be paid to renewable generators. Although pricing methodologies and price levels are the focus of many FIT analyses, it is important to realize that pricing is only one component of FIT policy packages.

Reprinted with permission from UNEP (2012a).

While regulation is a key instrument in establishing a market for green industries, governments appear to frequently have difficulties carefully designing such policies. For example, price-based regulation in the energy sector needs to take into account that demand is generally quite unresponsive to price changes, due to lack of alternatives (Hallegatte et al., 2012). Hence policies must simultaneously support the provision of substitutes. Another major complication appears to be that governments need to balance concerns for the confidence of investors, who face substantial regulatory and policy risks when making decisions, and policy flexibility, in order to avoid distortive and costly policy lock-ins. Regulation needs to keep up with developments in technology, markets and other relevant factors in order to not stifle technological innovation (UNEP, 2012b).

Such problems in the solar photovoltaic market have become clear in recent years, as increased cost-efficiency in the manufacture of solar panels, notably in China, has led to a global glut in supply and increased installations worldwide. Consequently, the costs of FIT programs that usually guarantee a certain fixed price for renewable energy supply over a long period of time have increased significantly, leading several countries to redesign their policies in order to suit them to the novel circumstances. In some cases, FIT schemes were suspended for some time until new legislation was enacted, leaving new investors uncertain for several months over future policy developments. Keeping legislation abreast of market developments is often difficult and requires efficient systems of government as well as highly competent bureaucrats. In general, the literature emphasizes that regulatory policies that have a positive net impact on profitability and productivity need to be focusing on end results rather than means, and be stable and predictable (Dutz & Sharma, 2012).

Environmental Taxes

A well-designed fiscal regime can help tilt market incentives in favour of green industries. By placing a direct cost on environmental damage, taxes and charges both encourage the lowest-cost abatement among polluters and provide incentives for abatement at each unit of pollution. Moreover, they are a source of revenue to governments. Hence economists usually view taxes as economically superior to regulation and control instruments. Environmental taxes and charges are mainly found in high-income countries, and revenues currently account for 2.5 per cent of GDP in OECD countries (of which over 90 per cent come from motor vehicles and fuels) (OECD, 2012b). In other areas, the revenue generation potential of environmental taxes is much less pronounced, but can still be useful. For example, a congestion tax in London has been successful in reducing pollution, while providing funds to invest in public transport (Hallegatte et al., 2012). Reviewing the effect of environmental taxes in several OECD countries on firm innovation, the OECD (2012b) finds that taxes can indeed stimulate the development and diffusion of new technologies, if designed such that they are levied closer to the source of pollution (such as taxes on carbon dioxide emissions rather than on motor vehicles). Such innovations happen across different sizes of firms and in different ways. For example, small and medium enterprises in Sweden that do not engage in R&D have been found to gradually improve production methods through incremental, trial-and-error changes in their production processes (GEA, 2012).

Developing countries are usually hesitant to implement environmental taxes, mainly because they fear the negative impact of such taxes on industry competitiveness, as well as distributional consequences. To date, however, there is no conclusive evidence of such negative competitiveness effects, which might also be due to the fact that even in OECD countries these taxes do not focus on energy-intensive sectors (OECD, 2012b). Nevertheless, as environmental taxes are likely to become more stringent in OECD countries in the near future, there is growing concern over "carbon leakage": the relocation of polluting firms to countries with more lax regulations. In that case, levying more stringent environmental taxes would both weaken the domestic economy and encourage pollution elsewhere, with a possibly negative net impact for environmental protection globally. In that context, it has been proposed that carbon-taxing countries levy import fees on goods manufactured in non-carbon-taxing countries (so called border tax adjustments) to narrow the regulatory gap internationally (Wooders, Cosbey & Stephenson, 2009).

Industry Protection

We have already explored in chapter 3 the link between international trade and technology transfer embodied in traded products. On average, the environmental goods sector appears to be subject to less tariff protection than were infant industries during the catch-up phase of major rapidly industrializing economies after World War II. OECD countries typically apply very low tariffs on manufactured goods in general. The picture is somewhat different for developing countries, where average applied tariffs on environmental goods amount to 10 per cent, which is roughly five times greater than the most-favoured nation rates of the United States, Japan, Canada and the European Union (Golub, Kauffmann & Yeres, 2011).

Let us recall that there is evidence for positive growth effects of tariffs on products from industries whose promotion is likely to have positive national spillover effects. Therefore, import restrictions could be an appropriate tool for countries attempting to promote proficiency in such a sector. For example, China and Brazil maintain high tariffs on solar thermal panels (35 per cent and 20 per cent, respectively). India has achieved almost complete self-sufficiency in the manufacture of wind turbines within less than 10 years, using customs and excise taxes to favour importation of components over complete turbines (Popp, 2012). In general, the wind power manufacturing sector relies less on

trade than on international investment flows, due to the high costs associated with cross-border transport (Kirkegaard, Hanemann & Weischer, 2009). Consequently, protective industrial policy in the sector comes in the form of investment restrictions. For example, the Chinese government has long maintained local content requirements for its state-run wind farms, amounting to an obligation to source at least 70 per cent of the value of equipment to be domestically manufactured. Because of this, foreign investors seeking access to the Chinese wind power market contributed significantly to the development of local expertise in ancillary supplier industries (Carbaugh & Brown, 2012). Following a U.S. challenge, China has recently revoked this program, but in all likelihood with little damage, as China now controls about half of the global wind market.

However, such restrictions run counter to efforts for international technology transfer and adoption, by artificially raising the cost of products and hence discouraging their adoption. This finding applies in particular to the renewable energy industry, which is still facing strong cost-competitiveness challenges, for example with respect to fossil fuel–based energy provision. A number of studies find that removing trade distortions increases adoption of energy-efficient technology and can even substitute for other barriers, such as intellectual property rights (Popp, Newell & Jaffe, 2009). Moreover, the same caveats for using restrictive trade policy in environmental goods applies as in traditional industrial policy sectors, most notably the threat of government failure to appropriately design these policies to suit the country-specific context.

Much research has focused on tariffs on environmental goods, as data on tariffs is easily available. Emerging research focuses instead on the prevalence of non-tariff barriers to trade, which are much harder to trace and most likely much more substantial than tariff barriers, which are under tighter scrutiny within the WTO. Examining imports of certain clean energy technologies in 18 developing countries, the World Bank (2007) estimates that eliminating both tariff and non-tariff barriers would result in increases in trade volumes from 4.6 per cent for clean coal to 63.6 per cent for energy-efficient lighting. Steenblik and Kim (2009) identify the lack of harmonization of technical standards in importing countries as one of the main impediments to increased adoption of imported climate change–mitigation technology.

A lot of research on green industrial policies focuses on China and India. While such research certainly adds value to this new field of activity, it is unclear to what extent one can distil robust generalizations that would also hold for other industrializing nations (Popp, 2012). Both countries offer investors access to huge, dynamic markets and hence have more leverage in negotiating specific obligations, for example for technology transfer. And as small industrializing countries are likely not able to compete in the production of major advanced technologies, analysts suggest that such countries would be better advised to open up to green technology imports and engage in adaptive R&D that is focused on modifying or enhancing technologies to local needs (Copeland, 2011). In fact, this is a strategy that larger nations have employed as well. Kristinsson and Rao (2008) show how India's wind turbine industry needed to adapt existing turbine design in order to generate electricity, as wind speeds in India are lower than in Europe. Similarly, De La Tour, Glachant and Ménière (2011) describe how Chinese photovoltaic manufacturers have adopted production processes by replacing capital with labour, effectively taking advantage of its comparative advantage in labour costs vis-à-vis Western competitors.

The extent to which technology transfer and adoption occur hinges critically on a country's absorptive capacity, which describes a country's ability to do research to understand, implement and adapt technologies that arrive in the country (Popp, 2012). Industrial policies hence need to go beyond the liberalization of key imports to ensure that such positive spillovers happen.

Also, environmental goods are only a fraction of the environmental sector as a whole. Indeed, environmental services account for about 65 per cent of the sector's value added (OECD, 2012a). Moreover, it is often very difficult to distinguish between goods and services in the sector, as both are often closely intertwined. Looking at a range of key greenhouse gas mitigation and adaptation technologies, Steenblik and Grosso (2011) find that the deployment of those technologies is often heavily dependent on the availability of specialized quality services. While developing countries often lack such expertise, project sponsors in developed countries also often prefer to import services when international service providers can meet their needs more effectively. The key modes of delivery of such international services require local commercial presence and the temporary movement of natural persons. Hence, industrial policies targeting technology transfer and adoption need to ensure the complementary free movement of trade in services. Barriers to the latter most likely come in the form of restrictions on international investments (such as foreign equity limits) or impediments to the temporary movement of service-providing natural persons (such as quotas or restrictions on the stay of foreign providers) (Steenblik & Grosso, 2011). Indeed, 80 per cent of the environmental services market is composed of infrastructure environmental services, which require local commercial presence and are hence best delivered through FDI (Golub et al., 2011). Paradoxically, foreign ownership is most limited in exactly those industries, such as transport, electricity, telecommunications and, to a lesser extent, waste management (United Nations Conference on Trade and Development, 2011).

Industry Support

A central question of the traditional industrial policy literature, how to pick winning sectors, persists equally in the area of green industrial policy. While this question is relevant for all kinds of industrial policies, including those described above, the costs of picking "losers" are most visible when government subsidies are involved, as these are ultimately paid by taxpayers.

While there is generally consensus on the need to move toward provision of renewable energy, there is much uncertainty about exactly which sources will provide the world's future energy mix. And even then, it is far from obvious which countries will be the competitive providers of the respective technologies. As mentioned earlier, China and India have both managed to establish a competitive wind power industry within a short time. China has taken the lead in (downstream) solar photovoltaic manufacturing, taking over this role from Germany and the United States, which had to observe major concomitant bankruptcies of former domestic champions. The most publicized example is probably the case of Solyndra, a California-based company making solar panels, which defaulted on a US$535 million, government-guaranteed loan in 2011, as it found it impossible to compete with the surge of Chinese products. This surge was helped by generous subsidies from European governments for solar installations, FITs, and, perhaps more importantly, an effective Chinese industrial policy of industry support that provided manufacturers with a number of advantages such as access to low-cost capital, subsidized electricity rates, free access to land and a shortened permitting process for factories (Carbaugh & Brown, 2012).

After having found Chinese subsidies to be harmful to the U.S.'s domestic solar industry at the WTO, the U.S. government has recently enacted punitive tariffs and countervailing duties of up to 250 per cent on Chinese solar imports.[9] Following complaints from industry, the European Union is currently investigating options along the same lines. From the perspective of global economic efficiency, it is very hard to make a case for punishing another country's use of subsidies, as these simply imply financial transfers from foreign taxpayers to domestic consumers. Moreover, in this particular case, Chinese producers are concentrated in labour-intensive downstream segments of the industry

[9] http://www.forbes.com/sites/benzingainsights/2012/11/09/chinese-solar-panel-makers-face-punitive-tariffs/

supply chain, in which China has a comparative advantage (De La Tour et al., 2011). Industrial countries such as Germany still maintain their dominance in upstream sectors of the industry, such as silicon production, and provide some of the machinery used by Chinese manufacturers (UNEP, 2012b). It is therefore likely that punitive tariffs and countervailing duties will do more harm than good to the imposing country, raising domestic costs and reducing demand for installations and other components of solar systems, which are produced in those countries, ultimately leading to job losses.[10]

A similar case has been a trade dispute between the United States and Brazil in the biofuels sector, where the United States maintained massive subsidies (in form of tax credits) to corn-based ethanol producers and tariffs on biofuel imports to protect its domestic industry. While corn-based ethanol is at a clear cost disadvantage vis-à-vis sugar-based ethanol production as in Brazil, a major line of defence for those subsidies has been that the industry has not reached technological maturity yet. U.S. subsidies to ethanol producers have been estimated at US$6 billion for 2009, while the estimated reduction in fossil fuel use achieved by ethanol substitution could have been achieved simply by maintaining tires inflated throughout the year (Karp & Stevenson, 2012). Meanwhile, total subsidies to the fossil fuel industry—the result of both intentional policies and mismanagement—have been estimated at US$10 billion, annihilating any possible greenhouse gas reductions achieved through promoting the biofuels sector. While both the subsidy and tariff on ethanol were phased out in late 2011, implicit subsidies remain and might even increase through mandatory blending requirements. Therefore, the cost of the program is spread over millions of consumers, taking political pressure to remove it off the government budget while locking in the costs and distortions for the entire economy (UNEP, 2012b).

These two examples illustrate the difficulty countries have with both picking winners and withdrawing support to losers. The key challenge is to identify promising sectors, that is sectors that have the greatest potential for learning by doing and for which targeted support and protection may be warranted, if not crucial. Hence, in the absence of clear priorities in terms of technological potential, and the alignment of this potential with domestic capacities, industrial policy instruments should be designed in a way that is as technology-neutral as possible. For example, FITs can be designed to offer the same premium for any low-carbon electricity, leaving it up to producers to choose the technology they use (UNEP, 2012a). Conversely, industrial policies can be tailored to be more technology-specific in cases where growth potential and economies of scale are more obvious. Arguably, this confers an advantage to developing countries that can inform their technological choices by experiences in countries that have successfully been using the technology in question. We have hinted in chapter 3 at the literature for identifying promising avenues for industrial upgrading, notably the concept of latent comparative advantage and the product space.

Instruments

There are a number of instruments governments can use to incentivize the development of green industries. We have already seen that government interventions should aim to redress the market failures at hand, which can be multiple. Hence, a policy priority should be the removal of existing policy-induced distortions in the economy, as without this, relevant market failures will be harder to identify. In this context, the most obvious measure to level the playing field for green industry is to remove harmful subsidies to polluting sectors of the economy. While aligning market signals more closely with their true values and offering a first step toward incentivizing the emergence of green industries, removal of

[10] http://www.guardian.co.uk/environment/2013/feb/19/solar-panel-duty-chinese-imports?CMP=twt_fd

such subsidies can free up important financial resources for government policy.[11] According to Ellis (2010), a key reason for low energy efficiency in many subsidizing countries is the large distortions in price that result from such subsidies.

Green government procurement is one way for governments to create demand for green products such as clean bus fleets, green lighting solutions and green building design, and is increasingly adopted in both high-income and developing countries. Average government expenditures worldwide are currently almost 60 per cent of GDP[12] and can hence be a major driver for creating green demand and supply. Moreover, they can have demonstration effects in that they can help overcome knowledge and information gaps within countries. Key constraints to green public procurement programs in developing countries have been the lack of a supplier base and higher perceived costs associated with green goods (OECD, 2012a). The latter can be considered unfortunate, as they defy the purpose of green public procurement, which is exactly to offer an outlet for socially desirable products at an early stage of commercial development. Moreover, from a global welfare and climate change perspective, there is no reason to discriminate against foreign suppliers (UNEP, 2012b). However, the mismatch between demand and domestic supply suggests that government can be more strategic in devising industrial policies that combine the development of domestic industries with demand through public procurement.

Another way governments frequently intervene in promoting green industry is through subsidies. While subsidies address financial market failures, the presence of other market failures often requires the simultaneous deployment of complementary measures. The most frequent case inherent in the development of new industries is the presence of coordination failures. For example, a number of studies find that while financial constraints are pervasive in the deployment of renewable energy technologies in developing countries, maintenance and after-sales services are equally important and should be an integral component of project planning (see, for example, Barry, Steyn & Brent, 2011; Brunnschweiler, 2010; D'Agostino, Sovacool & Bambawale, 2011). Similarly, the rapid expansion of solar and wind energy in China was accompanied by uneven development of components of the system, as large wind and solar farms were built far from urban areas. The cost of building grid infrastructure to connect producers and users, as well as the electricity losses arising from transmission distance, led to large unused capacity (Karp & Stevenson, 2012).

Given the peculiarities of green industries, investors face substantial additional policy, regulatory, technology and market risks, making it hard for project owners to attract the necessary funds (Corfee-Morlot et al., 2012). While output-based FITs affect revenue streams and can hence improve the risk-reward calculus of investors, investment subsidies more directly target the cost of capital. They can be direct investment incentives such as capital grants, loan guarantees and low-interest loans, or more implicit in the form of tax incentives such as accelerated depreciation, tax credits, tax exemptions and rebates. Since empirical evidence on the effect of these instruments on the development of green industry is scarce, we will highlight a few conceptual issues that may arise, drawing on insights from the literature on traditional industrial policy as reviewed in chapter 3.

A central result from that literature is that government support should be provided in a way that maintains sectoral competition. Governments typically face two major problems when selectively picking firms eligible for support:

- Firm-level characteristics are hardly observable to government, making it hard to know which firms have the highest potential for productivity improvement.
- Once supported, firms will not necessarily use government resources in the intended manner, leading to suboptimal behaviour.

[11] See, for example, the Global Subsidies Initiative for more resources on the topic: www.iisd.org/gsi/
[12] http://www.heritage.org/index

In the economics literature these problems are known as adverse selection and moral hazard, respectively, arising in situations where there is asymmetric information between a principal (in this case the government) and the agent (in this case the recipient firm).

The following comparison of these instruments in light of these considerations draws heavily on Kalamova, Kaminker and Johnstone (2011). Government grants are used mainly to stimulate commercialization of early-stage technologies and form a major part of green stimulus programs throughout OECD countries. Since grants need not be paid back, the risk of moral hazard is particularly pronounced. On the other hand, making grants available regardless of recipients' asset holdings and project qualities can spread the risk of adverse selection among firms. Such risk is particularly high in the case of loan guarantees, which are promises to banks to pay back loans in case projects fail. While innovative projects with untested technology are necessarily risky, firms whose projects are most likely to fail will tend to be those that seek loan guarantees. The provision of low-interest loans faces similar challenges, as these are often given to firms without a proven track record or using immature technologies that fail to obtain commercial loans on reasonable terms. Low-interest loans can be allocated directly by state-owned development banks (such as the KfW in Germany) or through subsidizing commercial banks. In both cases, loans on preferential terms do provide an incentive to successfully carry out a project, as loans ultimately need to be repaid. But the preferential interest rates involved may actually lead to overinvestment beyond the desirable level.

While tax-based incentives can be more easily tailored toward meeting certain performance criteria, a major drawback is that some potential beneficiaries, such as new entrants, do not pay taxes. If that is the case, it is important to make support conditional on certain performance criteria, such as productivity change over time. But tax-based support does not provide insulation from moral hazard per se. Accelerated depreciation allows for lower effective tax rates in the early years of an investment and can raise the overall net present value of a project. However, the fact that it is not linked to output per se can create inefficiencies. For example, India has long used accelerated depreciation as its main investment incentive, which has led to shoddy construction of wind farms that sometimes sit unused (Karp & Stevenson, 2012). Investment tax credits can magnify such inefficiencies, being based on installed capacity and offering the deduction of a specified percentage of investment from project developers' tax liability, in addition to depreciation allowances. Production tax credits have the same function, but are based on actual production and may hence be more conducive to greater efficiency.

A major drawback of all fiscal incentive schemes is their perceived instability, as they usually rely on government budgets and are subject to regular reviews and political negotiations. For example, the stop-and-go character of the expiration and renewal of tax credits for wind power production in the United States is associated with high volatility in investments.[13]

In general, market-based tests for conditioning support schemes as employed by rapidly industrializing Asian states are more difficult to implement in the case of green industry. A major complication is the absence of a market environment, given the lack of a carbon price and other prevailing environmental externalities. Uncoordinated industrial policies worldwide make it less attractive to use export performance as a reliable benchmark, as exporting per se is less of an indicator of efficiency (see, for example, above on U.S. biofuels, which are also exported to Brazil). These complications call for a more pragmatic way of assessing industrial policies, in terms of trade-offs among various development goals.

[13] See, for example, http://www.ucsusa.org/clean_energy/smart-energy-solutions/increase-renewables/production-tax-credit-for.html

Finally, it is worth briefly pondering the question of whether investment incentive schemes should equally apply to international green investments. Currently, such green investment protectionism is not a major feature of the international policy landscape (except in infrastructure as mentioned above), but there are concerns that the rise of green industrial policies might lead to greater protectionism in the future (OECD, 2011). We saw in chapter 3 how countries have had different stances towards attracting FDI. Regarding the effects of foreign-controlled firms on the national economy, we have found that positive spillovers come mainly in the form of backward linkages, and complementary policies are often needed to ensure that horizontal spillovers take place (for example joint ventures).

Similarly, the emerging literature on green FDI finds that attracting international investments in green industries can provide benefits to the domestic economy. Reviewing a number of cross-sectional econometric and case studies, Golub et al. (2011) find that multinationals are on average both more productive and cleaner than domestic firms and have in some cases even been drivers of stricter environmental regulation in host countries. However, it remains true that technology transfer is not an automatic process, as firms have an interest in maintaining a competitive edge wherever they operate. Nevertheless, rather than restricting foreign access, the literature appears to agree on the need for complementary policies to enhance, notably, a country's absorptive capacity, including (adaptive) R&D support policies, educational policies, technology licensing and strengthening international networks, for example through worker migration (see for example Popp, 2012; UNEP, 2012b).

5.0 Conclusion

The literature surveyed suggests that industrial policy can be an effective tool for industry promotion, if it is done right. We have sought to point out a few best practices that policy-makers ought to consider when designing such policies, cautioning that disregard for certain factors may actually have negative results for industry growth. While the same considerations hold true for green industrial policy, it differs from conventional industrial policy in important aspects. A key challenge lies in the scale of required government intervention. As government support to the sector rises, so does the risk of government failure. Hence, it will be crucial to adequately design, monitor and evaluate policies to ensure that resources are not wasted. At the same time, the immaturity of the sector globally and distortions induced by the lack of international policy coordination make it harder for countries to accurately assess sectoral progress. As industrial policy by definition discriminates against non-targeted sectors of the economy, these complications call for pragmatic ways of assessing policies in terms of trade-offs among various development goals.

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