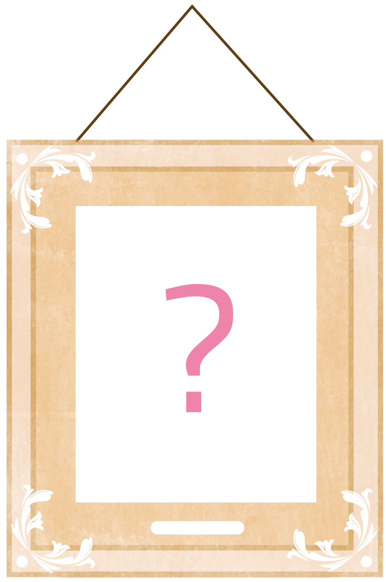

HOW

to account for macro - economic framework conditions in designing eco - innovation policy?

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Outlook 11

How to account for macro-economic framework conditions in designing eco-innovation policy?

By Claudio Baccianti

Highlights

- Macroeconomic framework conditions determine the strength of the eco-innovation response to policy intervention;

- Eco-innovation and indicators of environmental performance in Europe show signs of a slowdown during the last years of weak economic growth;

- The design of eco-innovation policies should account for structural and cyclical framework conditions by maximizing the level of integration with core economic policy areas, i.e. fiscal and competition.

1 INTRODUCTION

Eco-innovation has gained prominence in environmental policy worldwide. While regulation is key to elicit changes in behaviour, eco-innovation opens a wide range of new opportunities for business and society in the transition towards a sustainable economy. Green innovationeases the cost of achieving environmental policy goals in growing economies, where rising income and living standards put increasing pressure on the environment through pollution and the depletion of natural resources. Eco-innovation, as defined in Kemp and Pearson (2007), is "the production, assimilation or exploitation of a product, production process, service or management or business methods that is novel to the firm [or organization] and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives".

Macroeconomic framework conditions (MFCs), which include a variety of market and institutional conditions, deeply affect the stages of production, assimilation and exploitation of eco-innovations in a country. For instance, markets are often characterized by barriers to entry and mismatches between the demand and supply of labour skills. Innovative entrepreneurial activities benefit from high-quality institutions, as they provide the rule of law and a system that rewards talent, achievement and effort. Under poor framework conditions, technological and non-technological solutions do not achieve their full potential, even if the social costs associated to environmental degradation are properly internalized through regulation.To put it differently, MFCs determine the responsiveness of eco-innovation to policy intervention.

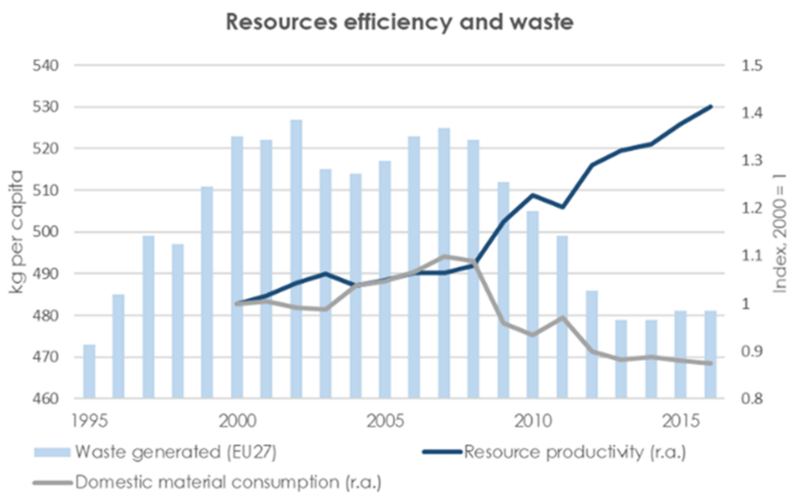
Eco-innovation is the engine of environmental performance in the long-run. The EU has made progress in the last two decades but indicators of eco-innovation inputs and outputs show signs of a slowdown after 2011. Tackling issues related to structural and cyclical MFCs is essential to move forward with the transformative change that is necessary to reach the current environmental and societal goals set at the European and global level, i.e. the United Nations' Sustainable Development Goals.

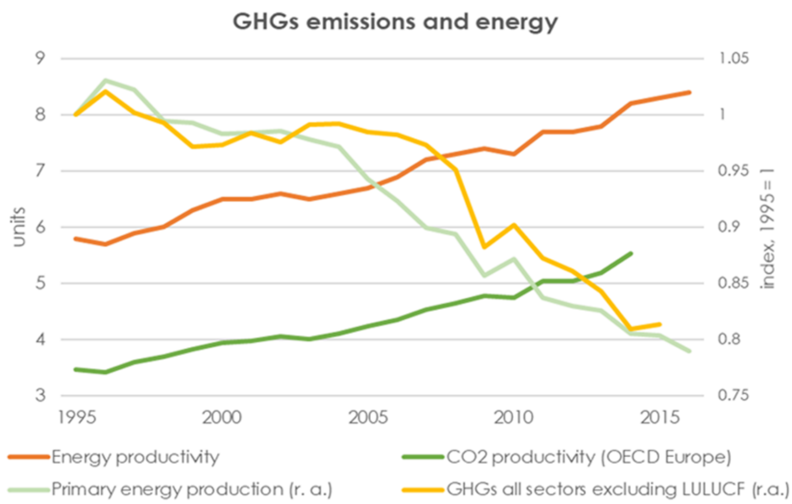
2 MACROECONOMIC FRAMEWORK CONDITIONS AND ECO-INNOVATION

2.1 Eco-innovation: background

The economy of the European Union has made significant progress on environmental sustainability.The productivity of carbon emissionsand the efficiency of resource and energy use steadily increased (Figure 1a and 1b). The generation of one unit of Gross Domestic Product (GDP) has produced a decreasing amount of greenhouse gases emissions and consumption of natural resources over time.In the last decade, the European economy experienced strong decoupling with respect to these environmental variables. While the GDP in the area of the 28 member states grew by 10.3% in real terms between 2005 and 2015, according to Eurostat, the total amounts of greenhouse gas emissions, energy production, municipal waste generation and domestic material consumption declined. The achievement was partly made possible by the economic conditions after 2009, characterized by a severe economic recession followed byweak GDP growth in most European countries. Therefore, the fundamentals behind this trend call for a cautious optimism. The pressures on the environment are likely torise again if growth picks up and the resource and pollution productivity do not keep the pace.

Figures 1a and 1b. Main environmental indicators for the EU28

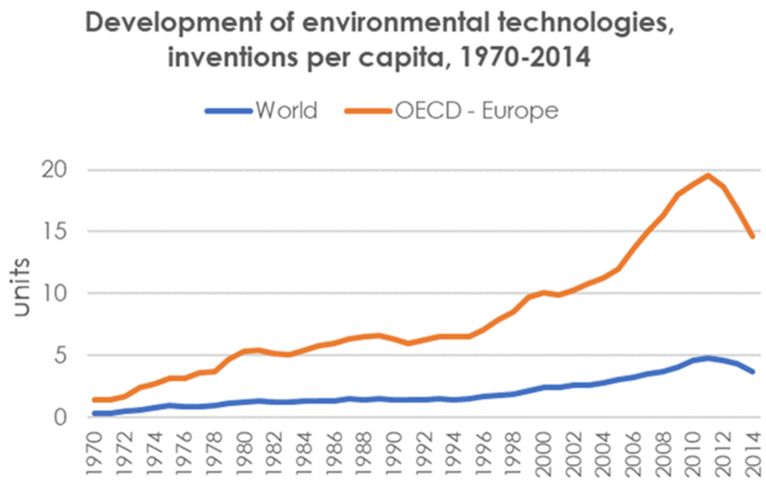


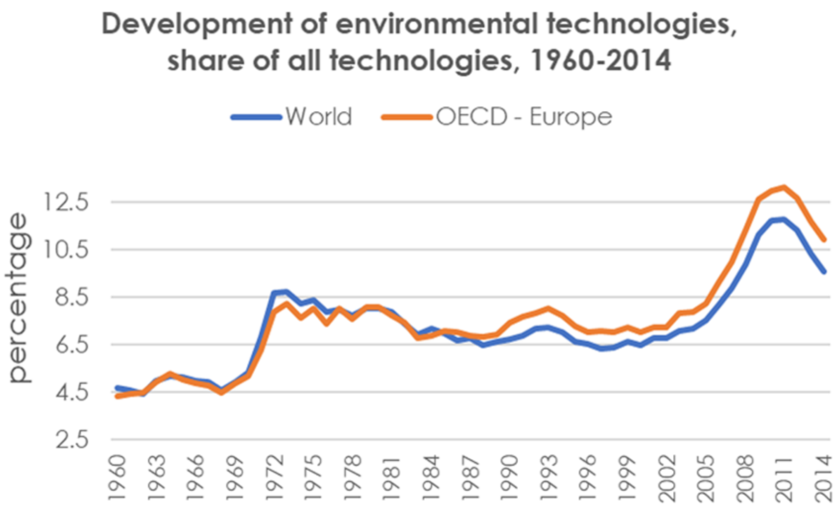


Sources: Eurostat and OECD. Abbreviation: GHGs: Greenhouse Gases, r.a.: right axis. Energy productivity is expressed in Euro per kilogram of oil equivalent and CO2 productivity in US dollars per kilogram.

Eco-innovation shows signs of a slowdown in Europe and worldwide. When the European Commission evaluated the 2004 Environmental Technologies Action Plan and launched the Eco-Innovation Action Plan in 2011, the rate of eco-innovation was considered "insufficient" (European Commission 2011). According to the latest statistics, innovation on environmental technologies and their diffusion did not accelerate since then. Patent data show a sudden slowdown in the development of new environmental technologies in the period 2011-2014 (Figure 2). The number of inventions with environment-related applications had grown steadily in Europe and in the rest of the world after 1990. Global research activity on eco-innovation has experienced a strong acceleration in the period 2000-2011, almost doubling the share of environmental innovations on all inventions. The recent slowdown reverted the trend towards long-run averages (indicators measure flows of innovations each year), which suggests recent policy initiatives delivered only a temporary boost to eco-innovation. While technology diffusion can still deliver important sustainability improvements, the deceleration in the development of new environmental technologies endangers the current decoupling trends.

Figure 2a and 2b. Environmental innovation in the OECD Europe region and the World

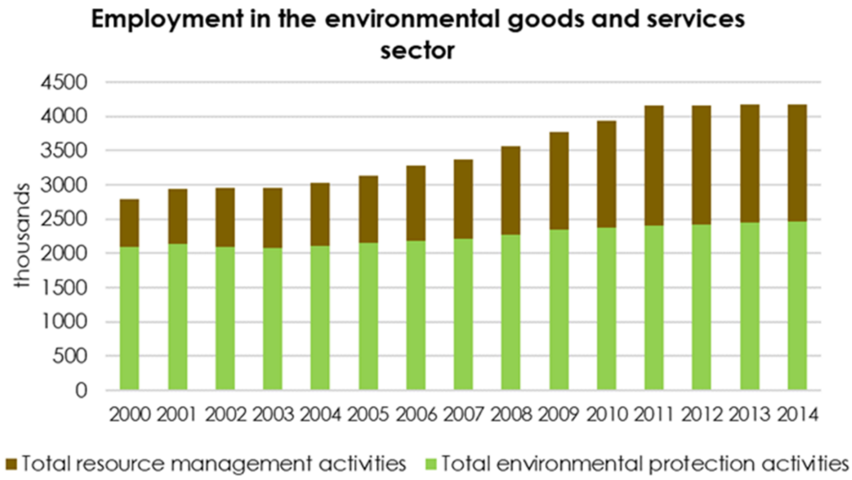


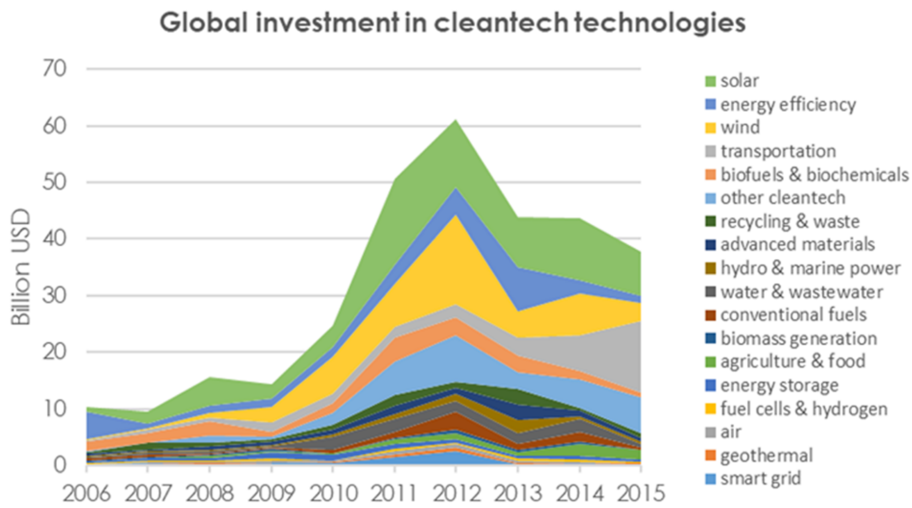


The indicators are constructed using patent data across a wide range of environment-related technological domains, including environmental management, water-related adaptation, and climate change mitigation technologies. Indicators only include higher-value inventions, i.e. with patent family size equal or larger than 2.Data source: OECD.Abbreviation: r.a. = right axis.

According to data constructed by the European Commission and displayed in Figure 3a[1], global investment on firms producing a broad variety of environmental technologies (which includes venture capital investment) has peaked around 2012. Data on the environmental goods and service sector provide insights on the dynamics of output and employment in a narrow set of environment-related activities, mostly specialized in pollution abatement and resource management[2]. The sector has expanded rapidly in the EU28 area between 2004 and 2011 and created more than 1 million jobsduring that period, largely in resource management activities (Figure 3b). Growth has stalled since 2011, which can be explained by the effects the economic crisis had on private and public spending. Nevertheless, the EU and its member states have intensified the policy effort in the areas of eco-innovation and circular economy in recent years, which is a prerequisite for further improving the environmental performance of the region.

Figure 3a and 3b. Global investment in clean technologies and employment in the environmental goods and services sector





Source: European Commission Cleantech Group (3a) and Eurostat (3b).

Figure 4. The role of eco-innovation

Why do we need eco-innovation?Environmental R&D and the diffusion of clean and resource-efficient technologies increases the cost of environmental policy. Standard technologies, mainstream business structures and the organization of local and global value chains are still largely environmentally unsustainable. Without innovation, there is little room for taxes and regulation to lower pollution and resource depletion without deteriorating living standards. For instance, under the current state of technology, switching completely from fossil fuels to low-carbon energy sources is expensive and the rise in electricity and fuel prices (or taxes financing subsidy schemes) would weigh on economic activity and shrink households purchasing power. Voluntary behavioural changes by consumers and producers alone, i.e. reducing food waste and the use of packaging or driving less, are unable to completely address the existing environmental challenges. Instead, environmental innovation generates new modes of production and consumption that are more resource-efficient and less polluting, while providing the same – or even better – quality compared to the technologies they replace.

Investment in environmental R&D and the adoption of environment-related technologies is suboptimal without policy intervention (Fischer and Newell 2008). Because of market failures related to environmental degradation, to the use of natural resources and to knowledge creation, firms have few incentives to reduce their environmental footprint from the point of view of society. Without regulation, innovation that delivers both economic and environmental gains can arise, but it exists alongside other types of innovation that are neutral or even detrimental for the environment. For instance, carbon dioxide emissionsper unit of energy used in the world (per unit of oil equivalent energy use) has declined steadily[3] since 1960 even without direct policy intervention on climate change mitigation. However, market-driven innovation was insufficient to preventtotal carbon emissions from increasing by a factor of three during the same period of time. A comprehensive and stable environmental policy framework istherefore necessary to realign public and private incentives and to foster the technological transition towards a sustainable economy (Horbachet al 2012).

Even if environmental taxes and regulation are in place to give the right signals to innovators, eco-innovation effort and performance may still be suboptimal, as markets for knowledge and technologies are characterized by market failures. Positive spillovers in the development of new ideas make it difficult for entrepreneurs to fully appropriate the results of innovation and free markets tend to underinvest in R&D on any technology. This market failure is not specific to environmental technologies and it should be addressed in the framework ofbroad innovation policy. Therefore, it does not justify policy measures that favour green technologies over the alternatives, e.g. tax exemptions on electric vehicles (Fischer 2009).

Lock-in effects in innovation provide one argument in favour of innovation policies that explicitly discriminate technologies according to their environmental impact (Acemoglu et al. 2012a). If innovators are profit-driven and rather short-sighted, they will tend to direct their effort towards the most advanced and widespreadsystems and technologies, which are often the least environmental-friendly. In the context of climate policy, Acemoglu et al. (2012a; 2016) show that subsidizing clean innovation alongside carbon pricing is the policy option that delivers the highest social welfare. Very strict environmental regulation may well phase out unsustainable production and consumption modes, but at a higher welfare cost compared to a policy mix that integrates innovation subsidies to taxes and command-and-control measures.

Moreover, entry barriers are also more severe in some key markets for green innovation, i.e. electricity sector (OECD 2011). Government support to green technologies and the phasing out of harmful subsidies (e.g. for fossil fuels) are two building blocks of green growth policies.

Environmental policy has the potential to foster the transition to a green economy, but it is not sufficient to achieve it. The development and diffusion of eco-innovations take place in a complex economic system composed of a variety of markets and institutions. The full potential of eco-innovation is not realized if the system lacks the right framework conditions. Market barriers and weak socio-economic governance systems slow down the technological and organizational changes that are essential to achieve poverty reduction and shared prosperity in a sustainable way. Radical innovations are less likely to arise in adverse conditions and, even if they do, it is more challenging for them to succeed and become established. Having the right framework conditions is essential to make technological progress do its job: easing the welfare cost of environmental policy. The better these conditions are, the stronger and faster innovation, technology adoption and organizational changes will be.

2.2 The role of macroeconomic framework conditions

MFCs are specific characteristics of markets and institutions that create a stimulating or inhibiting environment for eco-innovation.The adjective macroeconomic refers to the fact that these conditions are faced by all societal and economic actors in the economy and are not industry-specific. The OECD (2010a) and OECD (2015a) offer a detailed discussion of MFCs for innovation in general. They share close similarities with the framework conditions that are relevant for eco-innovation. Figure 5 provides an overview, dividing MFCs into broad areas.

Market barriers and institutional weaknesses influence eco-innovationin different ways. Investment in environmental R&D only thrives under specific circumstances. Innovators are unwilling or unable to engage in risky projects if the destination market is highly concentrated, planning is disrupted by frequent changes in the regulatory framework, the cost related to failure is high and the access to frontier knowledge, skills and technologies is costly. Similarly, the assimilation of frontier technologies and best practices may require external financing and skills that are unavailable within the firm. If skills, i.e. specialized skills related to eco-innovation, are scarce and credit availability is constrained, some firms might be unable to exploit frontier technologies to boost their economic outcomes while complying with environmental regulation.

The entrepreneurial ecosystem plays a crucial role in the long-term dynamics of eco-innovation. The probability of success for new firms entering markets with innovative products and solutions is sensitive to the MFCs in the country (Van Roy and Nepelski 2016). Markets for environmental and energy goods and services are often characterized by high entry costs and market dominance by incumbents, which pose challenges to potential entrants, i.e. highcapital needs. The conditions for entrepreneurship, in particular in the stages of experimentation and scaling up, are affected by regulation, i.e. bankruptcy laws, and greatly benefit from the presence of well-developed venture capital markets. Postemployment covenants such as the non-compete agreement between an employer and a former employee is an example of a norm that impedes talented individuals in commercializing new ideas (Gilson 1999, Marx and Fleming 2012). Moreover, trade openness is important for new firms to optimize costs through frontier production technologies and global value chains, turning an idea into a competitive product. Access to large markets, i.e. exports, allows successful innovators to expand rapidly and exploit economies of scale.

The level of intellectual propertyprotection is another important factor fortechnological progress. A well-defined international framework for Intellectual Property Rights (IPRs) and the enforcement of these rights are often listed as key conditions for innovation (OECD 2011, 2015a). Eco-innovation is highly dependent on the overall rate of innovation and patenting is common in industries developing environmental technologies. However, empirical evidence on the relationship between the stringency of patent protection and the rate of innovation and diffusion is mixed (Lerner 2009, Boldrin and Levine 2013). While IPRs safeguard innovators from imitators, strong protectiondoes not necessarily lead to higher innovative activity (other than filing patents) and higher industry-level or economy-wide productivity growth (Boldrin and Levine 2013).

Consumer choices are also an important factor that influences the diffusion of environmental-friendly solutions. Preferences and education determine the response of households not only to "soft measures" such as green labelling and certifications, but also to taxes and regulation. In countries where consumers have stronger preference for private over public transportation and for large vehicles, preferencespose an obstacle to the diffusion of light vehicles with high fuel efficiency and car sharing schemes.

(Next page) Figure 5. Macroeconomic Framework Conditions

Source: Adapted from OECD (2013, 2015a)

Area	Conditions
Institutional framework and macroeconomic policies	The rule of law protects innovators from the discretionary exercise of power by the government. Predictability of the intervention by public authorities, together with transparency and accountability, are important conditions for investors to undertake the riskiestprojects. Frequent changes in legislation, often the result of unstable political systems, introduce additional uncertainty surrounding the investmentreturns and have a negative impact on the level of investment and innovation activity. Moreover, stable macroeconomic policies lower uncertainty related to inflation, business cycle fluctuations and even disruptions in financial markets. Financial stability ensures the smooth provision of financing to eco-innovation opportunities and expansionary monetary policies support all types of investment, including those improving the environmental performance, through cheaper and more accessible financing.
Competition and entrepreneur-friendly regulation	Pro-competitive market regulation stimulates innovation and the development of new products in markets that are characterized by high concentration. Low barriers to entry make it easier for innovative entrants to reach consumersand test potentially revolutionary technologies, products and systems.Administrative costs and red tape may add a disproportionate burden to small and young firms. IPRs provide incentives for innovation but strong patent protection creates entry barriers. Regulation, i.e. bankruptcy laws, should not penalize failures and discourage risk-taking behaviour, but instead facilitate experimentation.
Tax policy	The design of the tax system affects innovation, entrepreneurship and the inflow of high-skill foreign workers. Parts of the tax code may be in conflict with environmental goals, e.g. fossil fuel subsidies and favourable tax treatment of company cars for personal purposes (OECD 2015b).
Infrastructures	Innovation needs physical and intangible infrastructures to thrive. Broadband and other digital networks are the backbone of the digitalization process, which has direct resource-saving impact and enables innovation through new platforms.
Human capital	Human capital is complementary to innovation and technology adoption. A skilled workforce is able to develop new ideas and to deal with the complexities related to product management. Innovations do not diffuse through the economy when firms lack the necessary absorptive capacity. Human capital is also a success factor for entrepreneurship. Education makes the acceptance of new technologies easier by consumers and skilled users provide valuable feedback to producers. Skill gaps and mismatches are particularly severe in eco-innovation, as the required knowledge and competences are highly specialized.
Innovation systems	Not only the quality of higher education institutions is important for the innovation performance of a country. The collaboration between industries and universities, i.e. connecting basic and applied research, fosters the transfer of knowledge and skills to the entrepreneurial ecosystem and promotes the culture of innovation.
Financing	A financial system that offers a broad range of financing instruments to innovators, in particular start-ups and SMEs, is key to turn ideas into market applications and to scale up production. Seed and early stage ventures are dependent on special capital markets for higher-risk and less liquid investment, i.e. venture capital markets. Entrepreneurs that engage in the innovative activity may lack the skills or experience to develop business plans and to sell their ideas to investors.
Internationalization	Open markets of goods and services. Reduced trade barriers to import and export merchandise, which expands profit opportunities and favours the access to frontier technologies. International labour mobility to recruit and collaborate with talents from other countries. Cooperation in R&D across countries fosters international knowledge transfers.

3 MACROECONOMIC FRAMEWORK CONDITIONS AND THE DESIGN OF ECO-INNOVATION POLICIES

MFCs are necessary for eco-innovation to thrive and the systemic sustainability transformation to advance fast through the uptake of technological and non-technological innovations. The design and implementation of eco-innovation policies that account for weaknesses, bottlenecks and market failures in the economic system are more effective in pushing the sustainability transition forward.

It is of paramount importance to adopt a systemic perspective that integrates eco-innovation policies into a sound broad strategy for innovation. Productivity growth of emissions, energy and materials relies on quite specific knowledge and skills and it largely benefits from spill-overs originated in basic research and general-purpose innovation, e.g. ICT and biotechnologies.Moreover, it is more challenging for eco-innovation policy to address missing framework conditions if it is excluded from the core national economic strategies. The European Commission has integrated the funding for the development of environmental innovation into general research framework programmes, i.e. Horizon 2020 and LIFE, and supports the diffusion of eco-innovation through its regional policy, i.e. the European Structural and Investment Funds, with special focus on SMEs.

Figure 6. Eco-innovation policies

The set of policies that are available to support eco-innovation is broad and it includes a variety of instruments, e.g. taxes, information campaigns and public procurement. Policy measures are of the following types:

- **Regulatory instruments:** bans and restrictions, compulsory standards on environmental performance (for product and processes), extended producer's responsibility, codes, intellectual property rights, monitoring of labelling and certifications, public procurement.

- **Economic instruments:** environmental taxation, tax-based incentives (i.e. deductions and credits), market-based instruments (e.g. tradable permits), feed-in-tariffs, harmful subsidies removal.

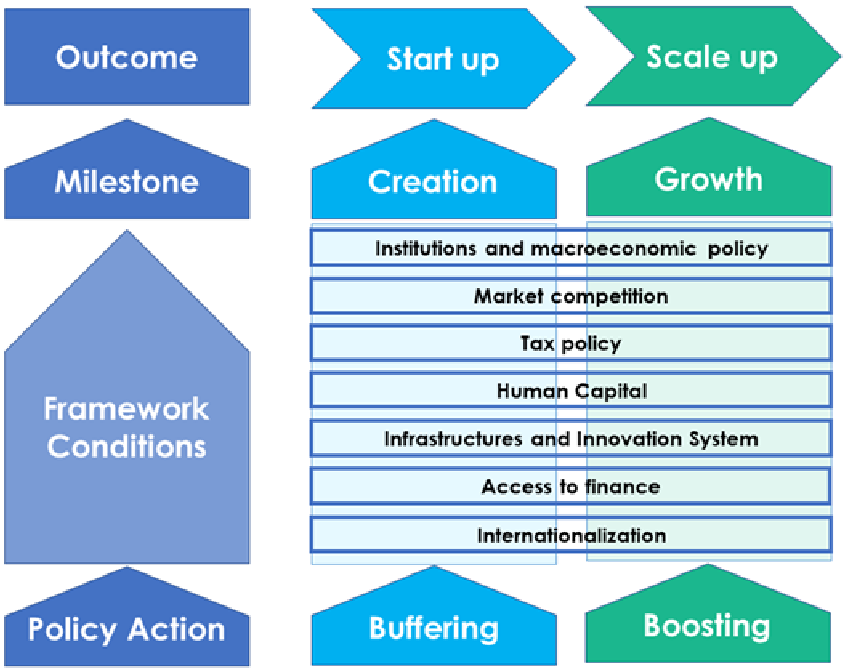
- **Research and investment funding programmes:** public funding (i.e. grants) to public and private R&D activities or to investment in firms' technology adoption, investment in public infrastructures, project loans for the private sector, support to equity financing needs of young companies and SMEs.

- **Knowledge transfers, capacity building and information campaigns**: business advisory services and professional training programmes, support to networking activities related to innovation, technology platforms and forums, international research cooperation programmes, information campaigns.

The policy framework for eco-innovation must work in the direction of removing market barriers that discourage and impair new firms in commercializing innovative ideas. Direct policy intervention can support the creation and growth of firms, focusing on two key outcomes of an entrepreneurial project: start-ups and scale-up companies. As shown in Figure 7, start-up firms represent the very early stage of a business and set the milestone of creation of a new firm. Once the firm survives the phase of experimentation and has established a revenue stream, it reaches the phase of growth and business development. Buffering policies target start-ups with measures that alleviate the resource constraints that pose a threat to the survival of the firm in the early phase. Examples are seed-stage access to finance, low-cost office space, training and consulting services, cutting red tape and tax deductions. Boosting policies focus instead on scale-up firms, encouraging their expansion by supporting their organizational capacity for growth (Van Roy and Nepelski 2016). The effectiveness of both types of policy depends on the broad set of MFCs that shape the entrepreneurial and research environment in the country.

While supporting young and small firms is important for eco-innovation, R&D activities are dominated by large and established firms (Figure 8). In most countries, business R&D expenditures of companies, with more than 500 employees, contribute disproportionately to private R&D. In countries like Germany and Japan, their share is higher than 80 percent. In principle, eco-innovation policy design should balance liberalization measures with research support schemes targeting market failures also affecting large firms. Large companies nevertheless already benefit disproportionately from R&D tax credits, as they perform most of R&D activities. OECD (2010b) documents that, for the case of Spain over the period 2000-2005, large firms captured a share of the tax credit disbursement that far outweighs their share of total net corporate tax payable.

Figure 7. Policy framework for the support of firm creation and growth



Adapted from Van Roy and Nepelski (2016)

Figure 8. Business R&D expenditures (BERD) of firms with more than 50 and 500 employees, shares of total expenditures in the country in 2013

Source: OECD

The list of framework conditions is long and the political and fiscal cost of a comprehensive intervention may be excessive. In this case, one possible strategy is to adopt a stepwise approach and prioritize a few critical areas in the short-medium term. The identification of the critical areas is, to a large extent, the process of reviewing the country performance in each area (i.e. financing conditions, skill gaps), possibly using other countries as a benchmark (e.g. the most innovative). The measure of country performance for each framework area should ideally be weighted according to how sensitive eco-innovation is to the specific framework conditions. However, convincing empirical evidence on the quantitative effect of country-level framework conditions on eco-innovation is quite scarce[4].

All stages of policymaking need to take into account key strengths and vulnerabilities originating from MFCs. The agenda setting should prioritize the most critical areas for the country and mobilize stakeholders to turn general guidelines and international best-practices into a policy formulation that will deliver long-lasting improvements. In countries with weak institutions, the implementation phase is particularly critical. Legislation loopholes and weak law enforcement have the potential to jeopardize the policy effectiveness. A final evaluation allows to better understand how much MFCs have influenced the policy outcome.

The analysis of MFCs for innovation generally limits the attention to structural factors that persistently affect the country performance relative to other peers. Cyclical conditions may be as important for the design of eco-innovation policies, in particular economic instruments and funding programmes. Recessions are usually associated with tighter financing conditions and with weak aggregate demand that negatively impact investment in eco-innovation. Moreover, the cost of reducing ecological footprints change over the business cycle and the political support for environmental policy may be reduced during economic downturns, as firms and households shift priorities towards jobs and economic growth and may desire looser regulation and lower taxes to foster a recovery.

There are reasons to adjust environmental taxation and eco-innovation support programmes over business and commodity cycles to meet the policy goals while ensuring growth-friendly conditions.

Countercyclical fiscal policy: Even if a country has well-developed financial markets, e.g. venture capital investment is high as a percentage of GDP, financing conditions are tight during recessions and financial crises. While the opportunity cost of innovation activities is lower during economic downturns than during expansions - the Schumpeterian argument - financial constraints pose serious challenges to innovators in raising capital to fund new projects. Using French firm-level data, Aghion et al. (2012b) find an important role for credit constraints in determining the procyclicality of private R&D spending. In order to smooth innovation effort over time, policy makers might decide to strength government-sponsored R&D programmes in the area of eco-innovation during economic downturns. This type of intervention has occurred within broader counter-cyclical fiscal policies. The American Recovery and Reinvestment Act, a stimulus package passed by the US Congress in 2009, included more than $90 billion to support R&D and technology deploymentof clean energy and other environmental innovations.

Choice between quantity and price instruments: The presence of business cycles adds one criterion to the choice between environmental taxation and quantity-based measures, i.e. regulation. Recent theoretical studies[5] have investigated the performance of different instruments in achieving environmental targets under economic uncertainty. Compared to an emission tax, a cap on emissions delivers the desired outcome with the lowest volatility of macroeconomic variables. Nevertheless, taxation is still superior in welfare terms as it is compatible with a more flexible allocation of resources. Fischer and Springborn (2011) find that (aggregate) emission intensity targetsprovide advantages compared to taxes and quantity constraints. Intensity targets are investment-friendly as they allow more emissions during economic expansions. The environmental goal can be achieved with a higher capital stock and no additional volatility.

Revenue-neutral eco-innovation support schemes: Business cycles are also relevant for the design of revenue-neutral policy packages that finance eco-innovation support schemes through environmental taxation (or similar economic instruments). One example is the use of auctioning revenues of emission trading schemes as a source of funding for environmental innovation subsidies or climate finance. Economic downturns and periods of stagnation depress the price of permits as the subdued economic activity generates less pollution emissions. The design of eco-innovation support programs that are financed through environmental taxation should therefore account for the volatility in tax revenues over the business cycles.

Fluctuations in commodity prices: Large fluctuations in commodity prices, i.e. crude oil, natural gas, metals and lumber, have strong effects on the consumption of energy and natural resources. Eco-innovation policies that are designed in periods of high prices should consider downside risks related to a change in the price regime. Subsidies on electric vehicles that are fixed when a barrel of crude oil costs $100, might not be as effective when the energy commodity is exchanged at $40. Internal combustion engine vehicles become relatively less expensive than electric vehicles, as their operating (fuel) costs decline, and public subsidies maybe revised upwards to meet the original target in the diffusion of low-carbon transport vehicles.

4 INSIGHTS FOR POLICY DESIGN

Eco-innovation is particularly sensitive to MFCs because it leverages on a set of specific skills and is largely dependent on markets, such as the one for electricity and water services, that are characterized by entry barriers and other conditions that discourage innovation. There are a large spillovers to be exploited, as the development and uptake of environmental innovation benefits from the technological change occurring in major scientific areas such as biotechnologies and information and communication technologies. Moreover, eco-innovation policies that have the ambition to be transformative and to foster systemic solutions are more exposed to weaknesses ineconomy-wide MFCs. The right set of MFCs, making a competition-friendly and highly knowledge-intensive economic environment, may foster the development, marketing and diffusion of radical innovations.

The design of eco-innovation policies can account for structural and cyclical framework conditions by maximizing the level of integration with the set of general economic policies. Within a broad innovation policy strategy, eco-innovation policy should borrow from measures that are intended to promote product market competition, experimentation and entrepreneurship, to strengthen labour skills through investment in university education and vocational training (with emphasis on STEM subjects) and to improve the access to finance and foreign knowledge and technologies. Increasing the absorptive capacity of the economy has also the effects to accelerate the adoption of cutting-edge technologies and best practices and to equip workers with the skills required by the transition to a sustainable economy. In fact, employment in the most energy and resource intensive activities faces the risk of displacement. These workers may lack the human capital that is necessary to capture new job opportunities created in the framework of the circular economy and the energy transition.

The choice of instruments and intensity of policy intervention should account for economic uncertainty, i.e. business cycles, and be open for revisions in response to changes in market conditions, i.e. fluctuations in prices of energy and raw material commodities. An effective policy mix balances the impact on different firm size categories, addressing knowledge spillovers in R&D of large corporations and promoting disruptive innovation through entry of new firms. Demand-side measures are important complementary policies to foster technology diffusion and support the profitability of manufacturers of less mature technologies.

[1] Data downloaded from https://ec.europa.eu/environment/ecoap/indicators/inputs_en

[2] Eurostat defines the environmental goods and services sector as the one including "(i) 'environmental protection' activities, whose main purpose is to prevent, reduce and eliminate pollution and any other degradation of the environment, and (ii) 'resource management' activities, aimed at preserving and maintaining the stock of natural resources and hence their safeguarding against depletion".

[3] See the EN.ATM.CO2E.EG.ZS series in the World Bank World Development Indicators database.

[4] One recent study is Nesta et al. (2014), which finds renewable energy policies to be more effective in boosting patenting on clean technologies in countries with liberalized energy markets.

[5] cf. Fischer and Heutel (2013) for a review.

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ABOUT

The Inno4SD Policy Outlooks series focuses on the horizontal policy issues or transversal topics relevant for public policy supporting innovation for sustainable development. The selected topics are based on questions and issues raised by policy makers and stakeholders active in the Innovation for Sustainable Development (Inno4SD) network.

1. Why should public policy support transformative eco-innovation?

2. How can policies supporting innovation deliver on the sustainable development goals (SDGs)?

3. How to support eco- innovation in trade policy and international trade regimes?

4. Can environmental process standards enable eco- innovation?

5. Can eco- innovation respond to NEXUS challenges?

6. Can public procurement in cities support circular economy?

7. How to measure eco- innovation and assess its impacts?

8. How to build effective policy mixes for eco- innovation?

9. How to ensure the level playing field for eco- innovation, taking into account adverse effects of existing policy measures?

10. How to design and implement science, technology and innovation (STI) roadmaps to foster eco- innovation for sustainable development?

11. How to account for macro- economic framework conditions in designing eco- innovation policy?

12. Can environmental product standards enable eco- innovation?

The content of each document has been peer- reviewed by experts and by the editorial team of the inno4sd network. The views expressed in each Outlook are those of the authors and not necessarily reflect the views of inno4sd or its strategic partners.

Expressions of interest to contribute to the series are welcomed; please send us your proposals at the email/ contact details indicated at in the back cover of this document.

Advancing the state-of-the-art in innovation for global sustainability

The Innovation for Sustainable Development Network (inno4sd.net®) brings together networks dedicated to innovation for sustainable development with the aim of reducing fragmentation and supporting collaboration, whilst engaging policy-makers, research & development, and businesses to achieve the sustainable development goals.

The H2020 Green.eu project and inno4sd® network was coordinated by the Netherlands Organisation for applied Scientific research TNO in the period March 2015-January 2019. As of February 2019 the inno4sd Steering Board oversees the activities and management of the network.

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