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**Article**

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## **Environmental Innovation and Economic Policy: is green fiscal policy sustainable?**

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### **ABSTRACT**

Environmental innovation, which field is larger than the innovation of eco-industries, enjoys recently an impressive development, which is due for a great part to environmental tax and subsidies. Different channels are available to promote environmental innovation, through technological innovation but also through use and attitudes changes, which will be self-enforcing. Many Policy tools are available to promote environmental innovation, regulation, tax and subsidies, cap and trade systems. Their combination leads to disparities in the carbon avoided price while economic theory requires a unique carbon price in order to guide environmental technique choice. The main challenge for economic policy in the coming years will be to promote a sustainable “green” fiscal policy, which has to be both coherent and sustainable with the budget balance. In this condition it should be possible to change the habits and techniques through taxes and subsidies without depressing economic growth.

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## **Introduction**

This paper will assess the problem of the sustainability of the environmental policy in a period of budgetary restrictions and austerity. These environmental policy aims at shifting habit and practice through taxes, and to encourage environmental innovation through subsidies. Both objectives are complementary, but several tools can be used by economic policies to achieve them, with diverse results and effects.

### **1. Environmental Innovation and Economic Policy: Some stylized Facts**

Considered for a long time as belonging to different fields, environmental and innovation economics are by now converging in research works devoted to the economics of global warming, and to the measures required to set up coherent and credible policies leading to a decarbonized growth<sup>2</sup>.

#### **1.1 Is the green innovation machine working?**

Environmental innovation, measured either on R&D spending or on patents, enjoyed recently an impressive development. It is moreover important to point out that environmental innovation field is larger than the innovation of eco-industries, according to the EOCED Report “Measuring Environmental Innovation” (2007) “Eco-innovation is the production, assimilation or exploitation of a product, production process, service, or a managerial tool that is new to the organization that develops or adopts, and which leads, at throughout its lifecycle, to reducing environmental risks, pollution and other negative impacts of resource use (including

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<sup>2</sup> Lot of highly documented reports have been recently published in this field, like the Von Weizacker Factor Five report (2009), the Recipe Report (2010) , the Pro-Inno report (Arundel and alii, 2011), and the EIB Bruegel report (Kolev and alii, 2012)

energy) compared to other relevant alternatives" ( Arundel and Kemp, 1998, Kemp and Pearson, 2007). Though measured in a few studies in report, environmental innovation accounts for more or less half of the overall innovations of firms, as a pioneering paper of R. Veugelers proved (Veugelers, 2012).

Nevertheless, till a recent time the surge of environmental innovation didn't entail a significant decrease in the pressure on environmental resources: as the rise in resource efficiency has a feed back effect on its use, global use of non renewable resources continue to rise, according to the « rebound effect ». This effect has been assessed in various environmental field –energy consumption, water and land use, space heating and lighting. It is a challenge for environmental policy to try to shift it, on a national but also on an international level. From a more general point of view, innovation tends to increase environmental pressure through planned obsolescence, mainly in Information and Telecommunication Technologies (ITC) that are not environment friendly. Not only their production, but also their use requires high use of energy and materials, which are increasing with their development. So another challenge should be to “green” the innovation process, especially in the field of ITC, and it is far from be realized.

## **1.2 Which channel to promote Environmental Innovation and “green growth”?**

So decoupling economic growth and environmental pressure is a rather difficult task to achieve, at a national and international level. While innovation is necessary to achieve this goal, it appears not to be sufficient. It should be accompanied by change in use and habits, which will be self-enforcing in a demand-pulled and technology push process. A typology of Innovation helps to understand this issue, which classifies each environmental Innovation on these two dimensions, user and institutional practices, and change in technologies. It ranks these innovations in four categories: Incremental innovation, social innovations, techno-fixes innovation, and transformative innovations (Arundel, Kanerva, Kemp, (2011). Energy transition requires using the widest range of technology choice according to this typology, but in some case the implementation of

some of these technologies can drive to contradictory results. While some technologies will help to decrease directly environmental pressure and green house gas emissions, others, like the techno-fixes innovations, can lead to rebound effects mainly through the support they give to sustain existing practices. Shale Gas production technologies are a startling example of this kind of energy innovations which will help to continue the use of fossil fuels at a high environmental cost. Carbon Capture and Storage (CCS) technologies are another examples of these techno-fixes innovations. Their massive deployment in developed as in developing countries is expected by the International Energy Agency "Blue Map" to reach its goal of a stabilization of earth warming of 2° in 2050, but it will help to continue the use of fossil fuels. Another issue that have to be addressed in the field of environmental innovation is the question of the timing of the deployment of these technologies: while some are already available without a financial public support, most of them are far from be competitive with the current energy sources. Technological forecasts are expecting that learning curves and technological change will help to shorten this time, but a wide range of uncertainty still remains in this field.

## **2. How to promote a sustainable environmental policy?**

### **2.1 Which Policy Tool to encourage Green Growth?**

Environmental and Innovation Policies are sharing a common feature, which is the existence of externalities, positive for the first, and negative for the second. Environmental Innovation combines these two externalities: while they are benefiting to the whole population, theirs costs are supported by private investors who have few incentives to adopt them, although some public action will help to implement them. This public action has a double role to play: it is necessary to correct the environmental externality, and to boost the innovation in order to improve the knowledge externalities. (Pop, Newell et Jaffe, 2009). For example, in the energy field, if the spontaneous market evolution had lead to a rise in the energy price, which explained for a quarter to an half of the energy efficiency gains, (Newell,R. Jaffe A., Stavins R (1999) , Gillingham K., Newell R. et

Palmer K. (2009)), public action had played a key role in this field. The large observed disparities in the energy efficiency between countries can be explained for a main part by the dramatic disparities existing in taxation and regulatory schemes at the international level. From this point of view global warming figures a fierce challenge: if world climate can be considered as a world public good, the effects of its change are asymmetric in time and space: countries are very differently affected, and at a very variable and farther horizon.

The target devoted to environmental policy influences also the environmental innovation: is it to promote directly new techniques, or to encourage new demands for low emission technologies? In the first case one enters into a technology push scheme, that promotes R&D by investment subsidies and venture capital support, in the second it is necessary to encourage new behaviour by taxation or by regulations. These two aspects of environmental innovation policies are indeed complementary and self-enforcing: new environmental technologies can be implemented only if appropriated measures will allow their demande to exist, while new demand can't be satisfied only by new technologies. Another dimension has to be taken into account, which is linked to the scope of this target: is it global and comprehensive, leading to general purpose technologies, or on the contrary focused on specific technologies? The following table (table 1), proposed by Lazarus and Kartha (2009), sum up different environment policy measures according to these two criteria (technology push/demand pull, global/specific).

Recent macroeconomic researches shed another light on the question of the optimal environmental policy mix, using an endogeneous growth framework, with knowledge (positive) and environmental (negative) externalities (Acemoglu D., Aghion P., Bursztyn L., Hemous D., (2012), for a pedagogical presentation see Aghion, Veugelers, Serre, 2009). The last ones are linked to the existence of a "dirty" sector, using fossils energy, and the first to a "clean" sector, or "green", using renewable energies. The model proves that if people act quickly, a moderate carbon tax and a high RD subsidy towards the environmental innovation allows realize an energetic transition at a low cost, without depressing the economic growth. The limit of this kind of model is linked to the ad hoc value of their structure and results, as proved by Hourcade, Pottier and Espagne (2011). They are generally calibrated with values considered as compatible with

more applied models. Some progress is waited with the confrontation of these theoretical models on empirical datas. (Pizer, Popp (2008)).

**Table 1 Environmental Policies according to the innovation strategies and targets.**

	<b>Technology push</b>	<b>Market pull</b>
<i>Comprehensive strategies</i>	R&D tax credits, matching funds, or other R&D incentives Competitive R&D funds (contests or bidding processes) Instruments for public-private partnerships in R&D Broad R&D "portfolio strategies" Patent/intellectual property rights (support and transfer) Technology transfer protocols Support for education and training	Economy-wide GHG taxes, permits, trading, or standards Removal of subsidies for GHG-intensive activities Sector-specific GHG permits or regulations (e.g. requiring all new power plants as net zero-emission after 20xx) GHG criteria for international finance (e.g., development bank or export credit agency rules) Voluntary ("avoid regulation") GHG programs
<i>Selective technology-specific strategies (pick winners or "clusters" of winners, or eliminate losers)</i>	Targeted government R&D programs Collaborative research programs and support for private R&D Technology cooperation and transfer programs Technology demonstrations Knowledge diffusion (e.g. extension services, marketing and publicity)	Incentives, requirements, and other support for low GHG technologies (feed-in tariffs, portfolio standards for renewable electricity or fuels, tax credits for nuclear and renewable energy, government procurement of efficient equipment or renewable fuels and electricity, etc.) Regulatory (technology-forcing) standards (e.g. emissions standards, appliance efficiency standards)

**Source : Lazarus et Kharta, 2009, p.13**

## **1.2. Towards a consistent and sustainable green fiscal policy**

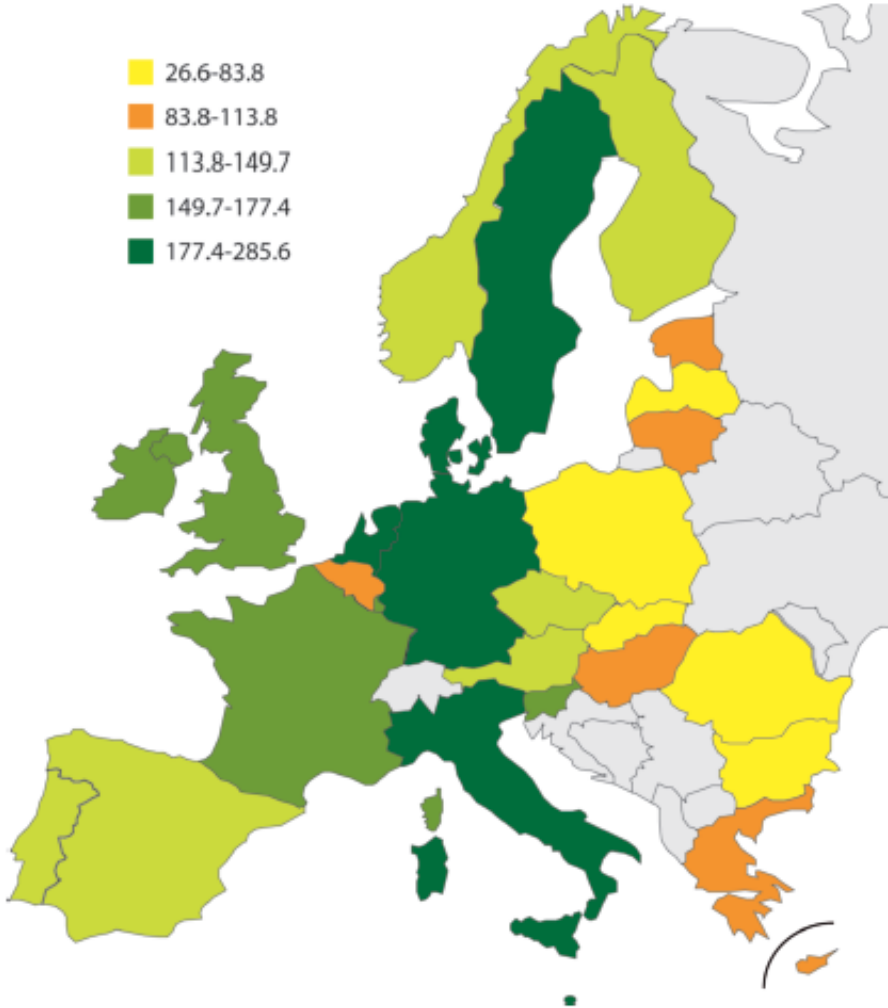
If we turn our attention to the design of public policy, it is clear that public policies that aim at promoting environmental innovation use a large choice of tools: regulation, generally of type "command and control", economic tools, as taxes and subsidies, or the creation of cap and trade schemes. All these kinds of instruments are jointly used, a situation that is unavoidable but can lead to some kind of inconstancy. If we follow a normative point of view, as in the Tirole report (J. Tirole, 2009) or in the Kolev recent Bruegel report (Kolev and alii, 2012), to be economically

efficient all these instrument should lead to a unique price of avoided carbon, this price being a signal of the constraint that bind the limitation of greenhouse gas at the world, regional and national levels.

In reality things are pretty different. Regulations play a key role in the environment protection, with effects that are rather controversial. While Porter et Van der Linde (1995) argue that they help to promote the growth of firms rather than limiting their competitiveness, for most of the economists they are an imperfect mean of environment protection, mainly because their cost is not taken into account, and even known by the decision makers (Milliman et Prince, (1989), Palmer, Oates, Portney, (1995)). As they concern all the agents, whatever their depollution price, they can have a high collective cost. From this point of view taxation is a better solution. It is a more flexible toll, which gives an useful information on the depollution cost: if enterprises prefer to pay the taxes instead of reducing their emissions, it means the depollution cost is high, if they don't need to pay it that means the limitation target can be tightened. Cap and trade systems can be also used, in this case the allocation of polluting rights can be increased or decreased according to the evolution of the price of the pollution source on the market. Cap and Trade systems are considered as a flexible and efficient tool. For example according to the Joskow report on the US sulphur dioxide market, the implementation of a cap and trade system had reduced to an half the cost of the emission reduction, by comparison of the preceding command and control system. (Joskow et alii, 2000).



Figure 6: Implicit tax rate on energy (2009)



Source: Eurostat (Ratio of energy tax revenues to final energy consumption, deflated).

If this joint use is necessary to achieve the targets of environmental policies, their combination leads to large disparities in the carbon avoided price. These disparities exist between developing countries and developed

countries, between developed countries, and between technologies themselves, and they lead to large disparities in energy efficiency and ecological footprint between countries. The European experience, as reviewed by Zachman (in Kolev and alii, 2012), learns that the use of these three instruments on different scope and scale in Europe leads to large disparities in the price of avoided carbon, between countries and in the different uses of energy. These disparities are prejudicial, not only to the economic efficiency of the mitigation policy, but also from a distributive justice point of view. As economic theory proved it, the efficiency of environmental policy depends largely on the uniqueness of avoided carbon price, which is far from being reached on each level of environmental technology implementation. Too large disparities mean that some technologies are financed at a far high cost, which may lead to a waste of money that will not be sustainable if the technologies wouldn't prove to be available at a commercial level in the future. A sustainable fiscal policy means that the tax burden will not harm too much producers and consumers, while subsidies should disappear as far as green technologies become mature. On the other hand budget austerity will at one time or another oblige the government to give up fiscal measures that will prove to be inefficient. In fact reference to a unique price of avoided carbon can be understood as a normative benchmark that will help to monitor the policy choices. It remains that curving the road of innovation to a more environment friendly growth is a necessity for the fiscal policy.

### **3. Conclusions**

The purpose of this paper was to prove that the greening of growth was a rather difficult task, which encounters a lot of obstacles. Environmental innovation can bring about counterintuitive effects, like the rebound effects, if not supported by voluntary public policy aiming at shifting habits and practices. Moreover, the increasing use of ITC that is promoted by most of the innovation public policies exerts at first a rising pressure on energy and raw materials resources, and entails an increase in the energy demand through their electricity consumption. So "greening"

the ITC is an important policy stake, which will also need voluntary policies. The main reason explaining this situation lies in the difficulty to shift the market mechanisms towards a more decarbonized economy, especially in giving credible price-signals. To reach this goal it is necessary to define credible national and international policies, coming to long-term commitments and steady regulatory schemes.

The main question addressed in this paper was related to the Policy tools that are available to promote environmental innovation. They can be ranked in three main categories, regulation, tax and subsidies, and cap and trade systems. They can support either technology push or market pull technologies at a global or a technology specific level. On the long term, these measures should converge to a unique price of avoided carbon, which will allow them to be both coherent and sustainable.

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