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Analysis

Income inequality and the development of environmental technologies

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ABSTRACT

Within rich countries, a large dispersion in the capacity of generating environmental innovations appears correlated to the level of inequality. Previous works analyze the relationship between inequality and environmental quality in a static setting. This paper builds a dynamic model more suitable to analyze technological externalities driven by the emergence of a new demand for green products. Under fairly general assumptions on technology and preferences, we show that: 1. the relationship between inequality and environmental innovation is highly non-linear and crucially depends on per-capita income; 2. an excessive inequality harms the development of environmental technologies especially in rich countries. Key to our results is the fact that externalities generated by pioneer consumers of green products benefit the entire population only for relatively low income distances. The empirical analysis robustly confirms our theoretical results, that is: whereas for rich countries inequality negatively affects the diffusion of innovations, per-capita income is paramount in poorer ones.

1. Introduction[1]

The development of technologies aimed at preserving the environment represents an increasingly urgent priority in the political agenda. Among rich countries, a large cross-country variation in environmental regulation and in the capacity of generating environmental-friendly innovations casts doubt on the relevance of the so-called environmental Kuznets curve hypothesis (Grossman and Krueger, 1995), according to which, above certain income levels, economic growth is no more harmful for the environment but rather enables a progressive reductions of emissions per capita. In general, the common consensus of recent empirical analyses (Dinda, 2004; Harbaugh et al., 2002; Stern, 2004) is that the inverted U-shaped relationship holds for local pollutants, whereas no clear patterns emerge for global pollutants (i.e. CO_2 emissions) involving more indirect and long-term costs. Seminal theoretical studies suggest that North–south income and institutional differences can hamper the required reduction of global emissions (e.g. Chichilnisky, 1994; Chichilnisky and Heal, 1994; Lopez, 1994). As corollary of this view, income differences among countries might also affect local environmental quality in rich ones throughout the relocation of pollution-intensive activities in poor ones, the intensification of natural resources' trade and an indirect influence on the chosen level of environmental regulation (Dinda, 2004; Roca, 2003; Suri and Chapman, 1998).

Inequality within country also matters in framing constraints and incentives for investing in environmental innovations, which represents the main, culturally acceptable, way to invert the vicious circle between growth and environmental degradation. On the one hand, recent works use a political-economy argument to claim that the mechanical process of growth is not sufficient to generate pro-environmental policies and investments in green R&D (Magnani, 2000; Torras and Boyce, 1998). On the other hand, if the consumption of eco-friendly products increases with income, a standard "aggregation argument" would lead to the opposite conclusion, namely that higher income inequality fosters eco-friendly consumption patterns (Heerink et al., 2001). Accordingly, income inequality has a contrasting effect on the two forces that are recognized to drive environmental innovations (see Beise and Rennings, 2005): regulation and the demand for green products. From the empirical side, since the two effects tend to offset each other, no particular correlation should be observed between environmental innovation and inequality.

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The purpose of this paper is to extend the analysis of the relationship between income inequality and the diffusion of green products to a dynamic framework where the development of environmental innovations is demand-driven. In particular, the emergence of a sizable demand for green products allows to gradually generate profit opportunities in key sectors such as transport, agriculture, construction and energy. The scaling-up of clean production methods in these sectors is associated to relevant non-linearities in so far as the development of the appropriate infrastructures favors the replacements of polluting consumption patterns with green ones.

Our prior claim is that many environmental-friendly goods and services are produced and consumed locally (i.e. eco-building, renewable energy, recycling, bio-food, etc.), hence making internal markets particularly important to develop the technological know-how required to a large scale diffusion of these goods. Obviously, this claim does not apply to global emissions provided their public good nature. Therefore, our results should be interpreted having in mind that inequality within country is more likely to affect the search of technological solutions for local rather than for global problems.

As well-documented in the literature on demand-driven innovations (e.g. Bertola et al., 2006; von Hippel, 1988), pioneer consumers have a higher capacity to buy initially more expensive green products, hence they trigger innovations that, throughout price reductions, might enable low-budget consumers to adopt these products (pioneer consumer effect, PC). On the other hand, however, an "excessive income distance" between the two types of consumers does not allow the entire society to benefit from the externalities generated by rich consumers (consumption polarization effect, CP[2]). Note that this positive trickle-down externality can stem from general consumption externalities (imitation behavior, demonstration effects, network externalities, etc.) and/or technological externalities. Here, we focus on the former effect in order to emphasize the role of inequality in shaping long-term technological advantages.

In order to fix these ideas in a stylized way, we develop a simple theoretical model that establishes a weak asymmetry between green and non-green wants, being only the latter essential in an Inada sense. It will be shown that, under general assumptions on preferences and technological change, the effect of inequality on the diffusion of the new good is highly non-linear with the PC effect prevailing on the CP one for low levels of per-capita income, whereas the reverse occurs for high levels of per-capita income. Indeed, inequality harms the full development of environmental innovations, especially in those countries closer to the technological frontier and hence more likely to perform innovations (Aghion and Howitt, 2004). Due to a high income inequality, the positive externality brought about by the consumption of the rich might not be enough to enable the poor to buy eco-friendly goods, thereby the political-economy and the aggregation argument should go in the same direction. Moreover, high inequality not only pins down the emergence of appropriate environmental regulations, but also hampers the development of knowledge complementary to environmental-friendly behavior. Finally, an empirical validation of our model robustly confirms that inequality is strongly negatively related to various proxies of environmental innovation. This effect is particularly strong for richer countries whereas for poorer countries per-capita income is paramount.

The rest of the paper is organized as follows. Section 2 connects the literature on demand and innovation to the one on inequality and environmental quality. Section 3 presents the model, the main theoretical results and possible extensions. Section 4 is devoted to an empirical validation of the model whereas Section 5 concludes.

[2] Gordon and Dew-Becker (2007) show that the sharp increase in US earning inequality from the late 70s has been associated to a substantial dispersion in consumption habits (Wall-Mart effect) and in expected lifetimes.

2. Related Literature

The relationship between environmental quality and income inequality can be established looking at both sides of the causality nexus. Whereas the analysis of the distributive impact of environmental policies is becoming a key issue at stake for public economics (e.g. OECD, 1994, 2004), the issue of how inequality affects the level of emissions and of environmental degradation has been first investigated in relation to the debate about the North–south distribution of abatement costs and the effect of trade. From a normative viewpoint, it has been shown that allocating abatement efforts in countries with lower marginal costs—i.e. the poor ones—might lead to Pareto inefficiencies in the case of privately produced public goods (Chichilnisky and Heal, 1994). In this case, what really counts to reach efficiency is the opportunity cost of abatement in terms of utility, in which when it is higher the poorer is the country because the marginal utility of income is decreasing. As a result, the appropriate distribution of emission permits matter for reducing global emissions; in particular, rich countries should be endowed with fewer permits. Chichilnisky (1994) demonstrates rigorously that trade openness amplifies the over-exploitation of commons in southern countries if property rights on natural resources are ill-defined (hence, more is supplied at a given price w.r.t. the well-defined regime) and even more if subsistence workers have to resort on the pool of natural resources to make ends meet.[3] Interestingly for the focus of this paper, she concludes that "any policy that increases the opportunity cost of subsistence labor could have beneficial environmental effects" (p. 862).

Another more recent strand of literature directly focuses on the relationship between inequality within country and factors affecting environmental choices, such as regulation and demand. Boyce (1994) argued that, even in democratic societies, the decision power is not uniform across individuals, but depends on income levels through lobbying or policy capture. If benefits from environmental degradation and power are positively correlated, more equal societies characterized by more distributed power set expenditures for environmental protection at a higher level. According to Scruggs (1998) and Heerink et al. (2001), Boyce's argument holds only if one assumes implicitly that the rich prefer more pollution than the poor. The comprehensive evidence collected in a recent OECD study (2008) and in several other studies[4] shows that this is not the case. In particular, while rich and more educated households consume more and hence can have a worse impact on the environment, they also tend to buy environmentally-friendly innovative products. The study concludes that—except in the case of hybrid and electric cars—green innovative products are mainly bought by rich, whether for a preference or an income motif.

This critique leads to shift the interest towards a deeper investigation of the political-economy mechanisms able to generate a negative relationship between inequality and environmental quality. Magnani (2000) claims that inequality and expenditures for environmental R&D can be negatively correlated also if richer households prefer more environmental quality than poorer ones. Whereas the empirical analysis provides convincing support to her thesis, the theoretical result is

[3] Certainly, this does not mean that "enclosures" are enough to restore a socially optimal level of natural resources' utilization. Crude privatization of commons can have either a very positive or a very negative effect in preserving biodiversity reservoirs and natural stocks depending on the type of activities carried on in these places (research-intensive or resource-intensive, at least under imperfect markets). For these reasons, Chichilnisky (1996) suggests to complement market-based solutions with another institution, the International Bank of Environmental Settlements, which will help developing countries in obtaining an economic value for the forests and biodiversity reservoirs without destroying them.

[4] See for example Kahn (1998), Gilg et al. (2005), Diaz-Rainey and Ashton (2009). Somehow related is the fact that the quality of consumption is found to be strongly correlated with per-capita income (e.g. Hallak, 2006).