DIRECTED TECHNICAL CHANGE: THE TRAGEDY OF THE LOCALS

Giulia Valacchi, IHEID , 0041 788216786, giulia.valacchi@graduateinstitute.ch
Chiara Ravetti, IHEID, chiara.ravetti@graduateinstitute.ch
Tania Theoduloz, University of Cape Town, tathe21@hotmail.com

Overview

Directed technical change models have shown how to redirect innovation and production towards a green economy, with temporary policy combinations. We question this possibility in the presence of locally and globally polluting inputs, using a two-country model with a clean and dirty sector, and a resource used only by the developing country (South), whose exploitation creates global pollution. We analyse why, in such a scenario, policies undertaken by the North alone are not sufficient to avoid a natural disaster, since the South specializes and gains competitiveness in the resource-intensive sector. In order to reduce global emissions below catastrophic levels, the right to exploit the natural resource needs to be transferred from South to North. This solution comes at the costs of a direct payment to the developing country, and it does not ensure that the South will switch comparative advantage away from the dirty sector. Only in such a case the North can then suspend the purchase of the natural resource; if the comparative advantage remains unaltered, it will be necessary for North to maintain its buy-back policy over time.

Technology has always been central in environmental problems: production, in an open economy, is typically oriented towards sectors with more advanced technologies, thus changing the path of technological progress could redirect at the same time the productive structure of an economy and its environmental outlook. This becomes particularly relevant when we think about redirecting production from dirty sectors to cleaner ones. For a long time, environmental economists have looked at evolution of technology as an exogenously determined, independent random walk; technological shocks were considered as unexpected events that could starkly modify the historical evolution of an economy. Due to path dependency, green technologies are less advanced than their dirtier counterparts due to their late introduction. It could be possible to fill such a gap through a leapfrog advancement of the green technology or with a technology transfer from the dirty sector to the clean one. However, such technological changes are not exogenous or free, but can rather be influenced by a number of economic and political factors. It is a fundamental policy question to understand the mechanisms that could favour a shift towards greener technologies and what are the obstacles to the process.
Directed technical change models, first introduced in the context of environmental outcomes by Acemoglu "The Environment and Directed Technical Change" (2012), revolutionized the standard view, proposing the possibility of endogenous technical changes, stimulated by policy combinations of green-research subsidies and dirty-production taxes. Such policy mix would achieve a change in the production path of a country away from dirty sectors and towards clean ones, without lessening the growth prospects of the economy, while avoiding the occurrence of a natural disaster.
Models of directed technical change have been widely used since their first appearance. Hemous "Environmental Policy and Directed Technical Change in a Global Economy: the Dynamic Impact of Unilateral Environmental Policies"(2014) extended the original single-country model into a two-country, two-sector - clean and dirty - framework, finding that it is not sufficient to combine research subsidies and a carbon tax, but in an open economy it is also necessary for the developed country to impose a trade tax on the dirty goods produced by the developing country, due to its initial comparative advantage, in order to redirect the southern production into the clean sector.
Nevertheless, we find some crucial limitations in the precedent studies, namely the fact that path dependence on dirty technologies arises exogenously and can be modified without large competitiveness losses. We argue that for several developing countries (consider for instance countries abundantly endowed with fossil fuel resources, whose economy relies mainly on natural resource exploitation, such as Brazil, India, China, Russia and South Africa or Middle Eastern countries. These may unsustainably exploit their natural reserves, at the expenses of the environment, to subsidize the increasing growth of their booming economies. The case of South Africa is striking: this country is abundantly endowed with cheap coal, which it uses as a main source of energy and for export revenues. Coal accounts for 70% of primary energy consumption, 93% of electricity generation and contributes 2.5 billion euros to foreign exchange revenues from exports. However this implies very large emissions of CO2, with around 340 Mt per annum from fuel combustion, making South Africa the 15th largest emitter in the world) the reasons for producing dirty goods are structural, and depend particularly on their endowments of natural resources that could be exploited for production. Thus, while for Hemous' model it is sufficient that only the North undertakes trade and innovation policies, it might be quite unlikely that the South will abandon under the ground a wealth or resources, even if these might cause pollution.
With our model we want to move closer to the actual trade-offs that developing countries face when deciding how much to pollute.

Developed and developing countries may have very different environmental goals: while developed countries are more focused on cutting the global level of emissions, developing ones, are more reluctant to undertake green-production paths for fear of slowing down the growth rate of their economies. Developed countries, on the other hand, have already reached higher GDP per capita levels and are more concerned about environmental issues, they want to achieve production and reduce greenhouse gas emissions; they tend to preserve their natural resources rather than exploiting them. They are in the process of, or they already completed it, reconverting their dirty production along a more sustainable path, often offshoring dirty activities to lower developed countries.
Our model arises from the necessity to combine together two different factors: on one side the concept of directed technical change, which captures the path-dependency in the evolution of technology, but also on the other side a more accurate characterization of economic interactions and costs for developing countries.

Methods

We build a two-country - North and South - two-sector - clean and dirty - model with a localized natural resource, present only in South (North could be not endowed at all with the resource, or just not interested in exploiting it for production purposes, but rather engaged in preserving it). The natural resource can be used as a (cheaper) substitute for labor or capital in the production of the dirty goods, and whenever it is exploited it emits greenhouse gases that pollute equally in both countries. If not produced with the natural resource, the dirty goods still pollute, but only locally, in the country in which it is produced.

We first analyze the autarky economies of North and South, and then we open to trade. In autarky South prefers to produce the dirty goods using the local natural resource since it is cheaper. When we open to free trade also northern consumers have access to the cheap polluting goods produced in South and they want to consume it. Therefore, in an open economy without policy intervention the world will soon reach a natural disaster.

Results

When North decide to intervene with policy instruments in order to reduce the resource exploitation, its intervention is marginal: even the more drastic policy, which is a ban for northern consumers to buy southern dirty goods, is not sufficient to avoid the natural disaster since for consumers in South it is still convenient to rely on the polluting goods and therefore the southern dirty technology will not stop to grow; it will be impossible for North to catch-up with South dirty technological frontier and therefore it will not succeed in redirecting South towards a cleaner production. The only possibility left for North, in the case of South non-cooperation, (the non-cooperation case is the more plausible one, given the big cost for the developing country of abandoning the depletion of the cheap natural resource. For example for a country like South Africa would be tremendously costly to abandon coal, even if the government has made clear statements about committing to climate change mitigation, which shows that the government is aware of the negative implication of coal exploitation, but at the same time availability of cheap coal is the principal component for economic growth of the country) is to buy the property of the local resource at a price equal to the rent. This solution comes at a high cost for the developed country, in the form of a direct payment, and it does not ensure that the South will switch his comparative advantage away from the dirty sector. Only in such a case it will be possible to redirect technological change in the economy with short-term, temporary policies; if the comparative advantage remains unaltered, it will be necessary for North, in order to avoid the natural disaster, to maintain its buy-back policy over time.

Conclusions

In this paper we challenged the standardized directed technical change argument about the possibility of switching a developing economy from dirty to cleaner production only relying on policies undertaken by a developed nation. We built a two-region model where the natural resource is only localized in the developing country (or equivalently, even if it is present also in the developed nation, it is not exploited for production in order to achieve environmental protection goals), and we proved that the dynamics underlying the relation among the two countries may be more complicated than what highlighted in the literature: North is not able alone to redirect southern comparative advantage towards the green sector with the standard à la Hemous mechanism - simultaneous implementation of a trade tax on dirty input and a dirty research subsidy -.

Now a more complex set of policy should be put in place if we want to avoid a natural disaster: namely North needs to buy the property of the natural reserve in order to cut southern exploitation of the globally pollutant input. Such an intervention may be effect-less in a non-cooperation scenario where South keeps investing in dirty innovation, and the only possibility for North to avoid a natural catastrophe is to keep buying the resource forever. On the other side, if a cooperation between the two regions is achieved and South starts investing in clean innovation, it is possible to switch the original comparative advantage of the two countries under a short term implementation of the northern buy-back policy. If such a case arises we are back in à la Hemous scenario and a natural disaster can be avoided.