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INTRODUCTION

Explorations in the Environment–Development Dilemma

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Although the financial and economic crises have diverted attention from global and local environmental threats and natural resources management issues in developing and developed economies, environment and development concerns must remain on the agendas. The IPCC just released the Working Group I contribution to the IPCC 5th Assessment Report, which will focus World's attention on topics such as the impact of climate change and the possible mitigation and adaptation options. This report follows the June 2012 United Nations Conference on Sustainable Development held in Rio. This meeting provided an occasion for the World to take stock of the situation (see e.g. Damon and Sterner 2012) and opened some new perspectives. For instance, member States decided to initiate a process for building a set of Sustainable Development Goals, based on the Millennium Development Goals, which will put at the core of the debate the relation between development and environment.

The link between development and environment is subjected to an important tradeoff, which goes back at least to the United Nations Conference on the Human Environment held in 1972 in Stockholm and to the Brundtland "Our Common Future Report" from 1987. The tradeoff is the following: on the one hand, developing countries aim at achieving higher standards of living; on the other hand, this development process is based on agricultural and

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industrial expansion, which is usually resource-consuming and environmentally damaging. Thus, protecting the environment and achieving development was considered irreconcilable. For instance, the Meadows Reports (Meadows et al. 1972, 2005) emphasized that rising world population, industrialization, pollution, food production and resource depletion are impossible to continue and will sooner or later become unsustainable and collapse (for a discussion of past experiences of collapsed societies, see Diamond 2013). However, subsequent work went beyond the incompatibility between development and environment, and focused on the complexity of the relation. One of the first attempts to tackle in academia the development–environment dilemma was the 1974 "Symposium on the Economics of Exhaustible Resources", which addressed burning questions on optimal rates of depletion and the role of markets. Capitalizing on this theoretical framework, an impressive empirical strand of literature aimed at evaluating the relation between development and environment. Views on the subject remain diverse ranging from, for instance, the assertion that "resource constraints do not constitute limits to growth" (Beckerman 1992) to more or less pressing warnings on imminent thresholds (Rockström et al. 2009). Altogether, these contributions seem to consider that the key to world sustainable development goes through solving the development–environment dilemma. Nevertheless, there seems to be much less agreement on what could and should be done (Van den Bergh and Mooij 2002).

This Special Issue (SI) builds precisely on this perspective. To capture the complexity and the diversity of the development–environment relation, the SI adopts a double perspective. On the one hand, from a methodological standpoint, it contains both empirical and theoretical papers; in particular, empirical papers cover multiple empirical techniques, such as simulations or regression-based analysis. On the other hand, it emphasizes the richness of the environment–development tradeoff, by looking at some major dimensions. From a macroeconomic perspective, it questions the environmental path followed by developing countries and the possible tradeoff between agriculture and deforestation, embedded in the wider problem of food security. From a microeconomic perspective, the SI presents evidence on the adaptation to climate change through devices that could be, or are already implemented, in African contexts.

One of the most frequently studied links between development and environment is related to the effect of the environment on economic growth. One historical reference point for the environment–growth analysis is the publication of the Meadows Report and its updates, emphasizing, in the context of exogenous growth models, conflicting effects between resource depletion or environmental degradation and economic growth. The development of the endogenous growth theory in the 1980's brought a fresh and very different perspective on the growth–environment relation. Indeed, in addition to short-run growth effects illustrated in exogenous growth models, in such a setup the environment can equally influence the long-run growth path (Barbier 1999). The impressive expansion experienced by the growth–environment analysis in the last two decades is testified by the regular publication of extensive surveys of the literature (see, for example, Smulders 2000; Brock and Taylor 2005; Xepapadeas 2005). It is probably fair to say that a new consensus is slowly evolving, stating that a decoupling of environmental effects from growth is possible, just as sustainable growth is possible; this will however require a much more ambitious environmental policy than what we have seen implemented to date (Sterner and Coria 2012). This makes it particularly important to contribute to and enlarge the literature on policies for environmental sustainability.

Within this literature, particular attention was given to the quality of the environment, by explicitly modelling abatement cost that can improve the environment. Since such costs are assumed to be financed by public funds, several contributions investigated the economic growth-effects of diverting such resources for protecting the environment. For example,

capitalizing on the work of Bovenberg and Smulders (1995), Fullerton and Kim (2008) study growth and environmental effects of capital and pollution taxes in an endogenous growth model with abatement.

Despite their complexity, these models rest on a simplifying hypothesis, by assuming that the government can finance environmental-improving public spending exclusively by taxes. However, an alternative major source of financing is the use of deficits and debt. Particularly for developing countries, the importance of the connection between debt and the environment was recognized ever since the Paris Club adopted in 1991 the possibility for members to perform debt-for-nature swaps. Debt-for-nature swaps are used as a tool for preserving environmental quality, and through their different forms they are designed to cutting off the foreign debt of indebted developing countries against an engagement to preserve the environment (see, for example, Hansen 1989).

To explore the interactions between public debt and environmental policy in developing countries (Fodha and Seegmuller 2013) build an overlapping generations (OLG) model, in which the government can finance environmental protection programs, i.e. pollution abatement, by issuing public debt. Under very general conditions, the authors exhibit a case of multiplicity in which two long-run steady-states exist, the first one characterized by a low level of capital and low environmental quality, and with opposite properties for the second. In addition, the multiplicity generates rather complex dynamics, as the first equilibrium is saddle point and the second is locally stable.

Based on their analysis, Fodha and Seegmuller (2013) emphasize conflicting effects between capital accumulation and environmental quality. Moreover, in a debt context as the one currently experienced by numerous developing countries, the economy can be condemned to an environmental poverty trap, in which the environment is protected to the cost of economic development. In addition, along their development path, developing countries might take benefit of both decreasing (increasing) their public debt (spending), as emphasized by the debt-for-nature swap mechanism. On the whole, Fodha and Seegmuller (2013) illustrate that developing countries should carefully assess the level of their debt before launching themselves into reforms designed to improve the quality of the environment, and open the door for future research focusing on estimating the possible presence of public debt thresholds in the relation between development and environment.

In their analysis, Mosnier et al. (2012) explore the fate of deforestation in the Congo Basin. This region harbours the second largest expanse of world tropical forests (FAO 2010), and its rich biodiversity is characterized by high endemism. Deforestation paces were until recently low when compared to Latin America and South Asia ones, but growth prospects put pressure on forested areas. The Congo Basin is thus a region of particular significance for the analysis of the environment - development link. Indeed, Congo Basin countries are currently experiencing the challenge of sustained growth without dramatically eroding their natural capital, and the dilemma is thus whether agriculture expansion does not too deeply encroach on forests.

Deforestation threatens the provision of global public goods, such as biodiversity preservation and climate change mitigation. Compensations offered to developing countries, which suffer massive deforestation, are aimed at solving the dilemma. For example, one way to support the compensation costs is through the REDD+ mechanism, as designed at CoP 11 of the UNFCCC meeting in Montreal. REDD+ projects have come at the centre of climate negotiations and are under scrutiny by scholars as well as by decision makers. The former are interested in a better understanding of deforestation drivers and therefore on incentives to reduce deforestation. The latter need reference levels of deforestation, which may allow

assessing the supply of REDD credits (Angelsen et al. 2011). In particular, unreliable reference levels may seriously undermine future REDD+ projects.

The Congo Basin is an illustrating case of such preoccupations. First, there is a lack of reliable data on the agricultural sector. Thus, simulated data may provide useful information on the agricultural sector under different scenarios. Second, Congo Basin countries have already absorbed half of REDD+ financing for Africa between 2010 and 2012 (Maniatis et al. 2013). The Mosnier et al. (2012) paper contributes to the bulk of methodologies dedicated to the identification of reference levels and thereby to land use dynamics at work in forested countries. Different approaches can be acknowledged where drivers of deforestation are more or less taken into account (see e.g. Angelsen et al. 2012 for a presentation of these methods). Mosnier et al. (2012) rely on simulation, by using the GLOBIOM (Global Biomass Optimization Model) partial equilibrium model, which was supported by the World Bank Sustainable Development Department (Megevand 2013) and which incorporates sectors that are involved in the deforestation process.

Mosnier et al. (2012) outline crucial trade-offs between agricultural development and the preservation of forest cover. Their results are highly sensitive to price movements, i.e. imported versus domestic agricultural products, and to transportation costs. International drivers, such as biofuels expansion or consumption patterns, as well as infrastructure investments, are shown to be particularly strong engines of deforestation, confirming the evidence from other regions. Not surprisingly, regional agreements could dampen deforestation rates. At last, it could be the case that the dilemma illustrated in this paper is shifted towards a new one, since environmental objectives may contradict food security.

Climate change will have significant adverse impacts on developing and especially African countries (Boko et al. 2008). This is particularly true in the agricultural sectors, which are sensitive to temperature and rainfall patterns in Sub-Saharan African (SSA) countries (see, Barrios et al. 2008 or Hassan 2010 among others). For instance, rain-fed agriculture is particularly under threat, with vital consequences in terms of food security. Climate change adaptation is therefore a major issue, especially in developing countries and in contrast to developed countries, which commit themselves to mitigation strategies. Put differently, environmental threats may not only severely impact food security, but also compromise efforts towards poverty alleviation. Until recently, environmental concerns were lacking in poverty reduction strategies, which usually target economic growth as an engine to alleviate poverty through trickle down effects. It may be argued that climate change adaptation can be considered as an example of environmental policy (like, for instance, the provision of climate insurance tools), and as a complement, rather than a substitute, to development policies. Adaptation in an African context may be achieved by different means: expanding irrigation infrastructures, adopting crop and animal varieties that are more resistant to arid environments, providing infrastructure that relaxes access constraints for crucial inputs or to output markets, as well as efficient devices for the transfer of agricultural weather related risks. Leblois et al. (2013) and Di Falco and Veronesi (2013) provide two complementary contributions on climate change adaptation in SSA contexts.

Leblois et al. (2013) focus on the provision of risk insurance mechanisms that capture more accurately the characteristics of SSA countries. The main challenge in this respect is that usual agricultural insurance schemes cannot be implemented in the SSA context, characterized by asymmetric information and high transaction costs. In such a context, agricultural producers often rely on informal insurance devices (see Carter 1997 for an investigation). However, such informal mechanisms are welfare-costly and may be an impediment to agricultural innovation. This calls for exploring other designs already experienced in other developing countries, like India or Mexico; for example, Barnett and Mahul (2007) review existing

experiences in such developing countries. Instead of evaluating crop damages, insurance contracts may be hedged on weather indices. Such an innovation in risk transfer is thus crucial in unravelling the environment–development dilemma, but the existent experience is still too crude and too narrow.

Leblois et al. (2013) adds to this strand of literature, by addressing methodological issues in the implementation of weather index insurance devices. For instance, implementation of weather index insurance requires detailed data; for example, average (village) level data are sensitive to income distribution and may hide high inter-individual variations in crop yields. Therefore, using plot level data should be preferred to account for potential biases related to idiosyncratic shocks and agricultural income distribution. Moreover, the authors show that complex indices do not outperform simpler ones, which potentially eases acceptation by agricultural producers. However, these methodological advances should be better qualified. For instance, the authors find that weather-based insurance generates benefits when agricultural producers have a rather high risk-aversion, a result that still holds if fertilizers' decisions are taken into account. According to Leblois et al. (2013), solving for the environmental-development dilemma as illustrated by the provision of weather based insurance may deliver less clear-cut results than expected. In particular, their conclusions are in line with other papers emphasizing detrimental effects of such promising devices (see e.g. Fuchs and Wolff 2011), and therefore call for further investigation.

Contrary to the prospective approach adopted by Leblois et al. (2013); Di Falco and Veronesi (2013) provide a retrospective assessment of climate change adaptation. Indeed, policymakers need feedback on adaptation strategies that are currently implemented by agricultural producers who are already being impacted by climate change. One important question is then how to evaluate the economic impact of adaptation. Ricardian models have been widely used, see Mendelsohn et al. (1994), and results are nowadays available for both developed and developing countries (for African countries, see, for example, Kurukulasuriya et al. 2006). Di Falco and Veronesi (2013) contribute to this brand of the literature by focusing on the impact of adaptation strategies on the risk exposure of Ethiopian agricultural households. They complement the study of Leblois et al. (2013) by covering several adaptation designs, such as new crop varieties or soil and water conservation strategies.

Di Falco and Veronesi's (2013) setup draws upon previous studies dedicated to the adoption of innovation. One usual problem is to disentangle the decision to innovate, i.e. to account for possible endogeneity of the decision to adapt to climate change. Therefore, they implement a two-stage framework. First, they estimate the decision to adapt that is supposed to depend on several variables related to the capital of agricultural households. More precisely, adoption depends on material capital such as machinery, natural capital like soil characteristics, and human capital such as the head of household and household's characteristics, which can be extended to their access to information. In the second stage, the authors estimate the risk exposure, taking into account the decision to adapt; risk exposure is supposed to be closely related to the characteristics of the distribution of agricultural production functions. They not only consider first and second moments, as put forward in the seminal work of Rothschild and Stiglitz (1970), but also investigate higher moments, including the skewness, which is of particular relevance for decision-making under risk (for example, downside risk is indeed closely related to precautionary motives). The estimation is made assuming two possible regimes, namely (i) to adapt or (ii) not to adapt, by considering endogenous switching between regimes. Their results provide encouraging signs, as adapters reduce their risk exposure, and therefore comfort the view that adaptation is a promising way towards better resilience.

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