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Interfaces with Other Disciplines

The consequences of a one-sided externality in a dynamic, two-agent framework☆

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ABSTRACT

We develop a dynamic model where all agents contribute to a global externality, but only those in a specific region suffer from it. We model this in a dynamic setting via a two agent, non-cooperative overlapping generations model and analyze the consequences for economic growth and intertemporal choices. We find that multiple steady states may result from this asymmetry. In particular, if the agent who is affected by the externality has to spend a large share of his income to offset it, then he may be stuck in an environmental poverty trap. We provide conditions for the existence of, and local convergence to, the equilibria, as well as a condition for the global convergence to the poverty trap. While, in addition to maintenance expenditures, externalities tend to be addressed via studying taxes, investment in R&D or alike, we focus on capital market integration. Specifically, agents in the affected region can open up their capital market to enable capital inflows. We investigate whether an open capital market improves or worsens their welfare. While we do find that capital market integration eliminates the environmental poverty trap, we show that capital market integration is not always in both agents' interest. In particular, we provide conditions under which the agents prefer autarkic or integrated capital markets.

1. Introduction

We often observe situations in which an individual, a region or a country is unconcerned with negative externalities it imposes on others. This is where almost all investigations into environmental economics start. In this article, however, we focus on issues beyond the classical inefficiency discussion. There are situations where neither the standard policy interventions nor a Coasian bargaining process work.

The situation we have in mind is inspired by global climate change, but easily extends to most situations with a one-sided externality. Evidence collected by the IPCC (Climate Change, 2007; Pachauri & Meyer, 2014) from hundreds of scientific publications suggests that some agents will be heavily impacted by a temperature rise, while others are expected to be almost unaffected. This may, at least partly, explain some countries' lack of interest to join international climate change agreements or to undertake climate action (Finus, 2003). Moreover, the heavily affected agents are typically in nations with low per capita income. Hence, they face difficulties in allocating funds to mitigate emissions or to adapt to environmental change without compromising economic growth.

Several questions arise naturally from the setting described above. How do agents react on a one-sided externality? What does this mean for consumption, economic growth, and ecosystem dynamics? How to avoid potential problems if policy makers cannot follow the standard toolbox, comprising taxes, subsidies, command-and-control? In this regard, a first objective of this article is to present and discuss a dynamic framework in which one agent imposes a one-sided externality upon another one and study implications for economic growth and the environment.

Our modeling approach borrows heavily from the model of John and Pecchenino (1994) and extends it to a two-agent version. In particular, we assume that, while both agents affect environmental quality, only one of them suffers from its deterioration or gains from its improvement since it is local to him alone. Hence, this approach is consistent with empirically-relevant issues such

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as upstream polluter and downstream pollutee, or climate change where only one agent is expected to be affected. It is precisely this asymmetry which drives our results, which we believe to be novel to the literature.

We find that multiple steady states can result from this asymmetry. In particular, the agent who is affected by the externality may get stuck in a situation where fighting the externality absorbs most of his savings such that no funds are left for capital accumulation. We call this the environmental poverty trap. We show that, even though both agents hold the same technologies and primary factor endowments, if the agent who is affected by the externality is sufficiently poor in terms of initial capital endowments, then he may be stuck in this trap. We provide conditions for the existence of, and local convergence to, the equilibria, as well as a condition for the global convergence to the poverty trap.

Economists tend to assume the existence of a social planner or international agency which may intervene with the standard toolbox of taxes, subsidies, quotas or command-and-control. The first-best solution to treating an externality like this is then easily calculated and generally well-known. However, if one places this model more deeply into an international setting of regions or countries, it is unlikely that agents would be willing to be controlled by a planner unless it is in their mutual benefit. In other words, we do not believe in such an agency for the situation described above. The standard forms of economic interventions named above are unlikely to be beneficial to the non-affected agent in our setting.[1]

Thus, our second contribution is to advocate a novel approach to at least partly address this externality if policy interventions in form of taxes or subsidies as well as command-and-control methods are impossible. Our approach is to investigate whether capital market integration alleviates the environmental poverty trap. It turns out that capital market integration will eliminate the poverty trap. We show that this has a positive effect on the environment while the effect on welfare is ambiguous. Specifically, we find that a negative welfare effect occurs for a large and reasonable set of parameters. In particular, we show that poor and small agents fare better with integrated capital markets while rich agents, or those agents able to sufficiently impact their own environmental quality, should not integrate capital markets for environmental reasons alone.

Our article relates to the established literature as follows.[2] In Copeland and Taylor (1994), trade increases welfare if the environment is a local public good, although scale, composition and technique effects add up to higher pollution. Their extension to a pure public good (Copeland & Taylor, 1995) yields less stringent conclusions. We assume the environment to be a local public good as in Copeland and Taylor (1994), but take a dynamic approach.[3] Our results cannot be fully compared to those in Copeland and Taylor (1994), as we study capital market integration and not trade in goods. However, our result is that the environment always improves from capital market integration, while welfare in the polluted region nevertheless may decrease. The difference in results arises since in our case capital market integration links the returns to capital, while in Copeland and Taylor trade induces the South to produce with dirtier technologies.

There are other contributions to the environmental economics, overlapping generations literature that derive multiple steady states.[4] Prieur (2009) gives conditions under which a zero-maintenance equilibrium may arise which may lead to multiple steady states. In a recent contribution, Bella (2013) has shown that a poverty trap may occur in an endogenous growth model with environmental quality. The multiple steady states in these articles are caused by specific assumptions, like non-linearities or conditions on the utility function. In our case, the environmental poverty trap is a result of an international externality. In this respect, our model is close to John and Pecchenino (2002). They analyze the use of transfers for a cooperative and non-cooperative, short-run and long-run solution to a two-country overlapping generation model. The main differences between their and our model is that they treat environmental quality as a flow, and that they assume the same utility function for both countries. In contrast, in our model environmental quality is a stock, and we have an asymmetry in the utility function – while one country is concerned with environmental quality, the other is not. This leads to distinct conclusions, namely to our environmental poverty trap and the focus on capital market integration. Furthermore, our modeling approach allows us to obtain explicit results.

This article is structured as follows. Section 2 introduces the theoretical model. Section 3 studies the model without international capital mobility. In Section 4 we analyze the model by allowing for free trade through integrated capital markets. We derive the changes implied by the move from autarky to international capital markets in Section 5. Finally, Section 6 concludes.

2. The model

The model extends John and Pecchenino's overlapping generations model to a two-region perspective. We assume one region, called *Home*, to benefit from a public good. This public good is subject to a negative externality arising from pollution at *Home* and from the other region, called *Abroad*. Pollution is a by-product of consumption in both regions. Contrary to *Home*, region *Abroad* does not benefit from the public good. We, thus, deal with a directed cross-border externality imposed upon one region only. The dynamics in this model arise through capital accumulation and the effects of consumption on environmental quality. In this sense, we elaborate on the model by John and Pecchenino (1994), which will allow a direct comparison. We explicitly restrict the analysis to equal levels of total factor productivity as well as full employment, perfect information and perfect capital markets. Our intention is to show that, even though we assume everything else equal, there are already novel results from assuming a one-sided externality. All proofs can be found in the Supplementary material.

2.1. Environmental quality

Environmental quality Q_t deteriorates from emissions that come from consumption, c_t, and improves through abatement, A_t, with a

[1] Nevertheless, it may be sometimes worthwhile for the affected agent to subsidize the other agent to reduce his impact on the externality, see e.g. Hoel and Schneider (1997).

[2] Our modeling structure partially relates to the environmental economics literature dealing with closed-loop differential games. Mäler and De Zeeuw (1998) study a differential game of the acid rain problem. They consider N regions that minimize the cost of emission reduction, where emission reductions help to reduce the acid rain problem and thereby the damage from acid rain. Fernandez (2002) builds upon Mäler and De Zeeuw (1998) and studies a two-region differential game of managing water quality in a border waterway under trade liberalization and no trade. The advantage of our approach is that, by setting our model within the standard OLG framework, we can analyze consumption, savings and abatement decisions as well as allow for a study of income and changes in interest rates. The changes in the interest rates prove pivotal for the results of this article. This approach then allows us to place our results in close comparison to single-agent models like John and Pecchenino (1994).

[3] The predominant approach in the literature is static, see e.g. Rauscher (1991), Chichilnisky (1994), Copeland and Taylor (1994), Copeland and Taylor (1995)), as examples. For overviews we refer the reader to Esty (2001), Copeland, Taylor et al. (2004) as well as Jayadevappa and Chhatre (2000).

[4] In a recent survey, Azariadis (2006) describes what further mechanisms - apart from environmental ones - may give rise to poverty traps.

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