



Optimal dynamics in a two-sector model with natural resources and foreign direct investments



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ABSTRACT

In this paper we analyze the optimal dynamics in an economy with three factors of production which are labor, a renewable natural resource and physical capital, and two sectors, i.e. the industrial sector and the local sector. External investors invest in the industrial sector as long as the return on the invested capital is higher than in the other economies. The activity of the industrial sector generates a negative impact on the environmental resource. In this context, we show that external investments may generate path-dependent economic dynamics. More specifically, three stationary states may coexist, two saddle points and a repeller. Furthermore, the time evolution of the stock of the environmental resource is monotonic; that is, a *U-shaped* path (i.e. the *environmental Kuznets curve*) cannot be observed along which the stock is initially decreasing and then becomes definitively increasing.

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1. Introduction

Industrialization processes and global integration of economies have increased the exposure of local rural communities to foreign direct investments. Unlike industrial activities, local production is usually very dependent on environmental dynamics. For local populations, natural systems represent means of subsistence or valuable economic services and assets. It has been estimated that in some large developing countries ecosystem services and other non-marketed goods account for a part of the source of livelihood of rural and forest-dwelling poor households which is between the 47% and the 89% on the whole. In these frameworks, local activities are exposed to multiple sources of pollution produced by the external investors. The unsustainable management of natural resources in local activities can trigger a vicious circle of poverty and environmental degradation. Indeed, the struggles of local communities against external agents, which threaten the environment, increase all over the world; that fact suggests that this interaction may not be insignificant. Many grassroots protests are against environmental degradation caused by extractive, fishery and agriculture activities of large firms. Case studies of struggles by poor communities, to gain control over the natural resources and to deal with injustice and environmental degradation created by the big companies, have been documented for instance in [1] and [2]. Since the late eighties, the impact on poverty and deforestation produced by the expansion of large mechanized agriculture, livestock and timber activities has been analyzed in [3,4], and, more recently, in [5]. In other cases, local communities are negatively affected by processes of industrialization and urbanization. China provides some of the most symbolic examples of rural communities harmed by the arrival of new manufacturing firms. Heavy damages to agriculture and fishery sectors caused by Chinese industrialization have been documented, among the others, by Economy [6], World Bank

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[7] and Chang [8]. Other examples are provided by textile activities in India. As shown by Boopathi and Rameshkumar [9] for Tamil Nadu, the promotion of investments in this sector is accompanied by a devastating industrial pollution which is causing an increasing loss of water and agriculture productivity and a reduction in the cultivable area. One of the possible mechanisms according to which the industrialization processes may negatively affect local communities has been highlighted by some recent theoretical works focused on the undesirable effects of the industrialization processes (see, e.g., [10–13]). According to this literature, the environmental degradation -caused by the industrial production- may be an engine of welfare-reducing economic growth. The vicious mechanism can be summarized as follows: (1) the industrial activities cause environmental degradation and a consequent reduction in labor productivity in natural resource-dependent sectors (agriculture, tourism and so on); (2) the reduction in labor productivity in these sectors incentives individuals to work in the industrial sector as waged workers; this causes a reduction in equilibrium wages in the industrial sector and a consequent expansion of the industrial activity; (3) the increase in industrial production causes further environmental degradation which, in turn, gives rise to a further expansion of the industrial sector and so on.

As a difference with the above cited theoretical literature, our paper focuses on the positive effects that the external capital inflows may produce, even though these flows encourage the expansion of an industrial sector which generates a negative impact on environmental resources. We develop a dynamic model describing the links between local communities and external investments, including the negative environmental impact and the job effect of external capital inflows. In our model, the effect of poverty-reduction of external capital flows operates through the labor market by creating new labor opportunities in the industrial sector. Our work is complementary to that of Antoci et al. [13], where external investment inflows may generate a self-enforcing growth process related to an increase in local agents' poverty. Indeed, we analyze an economy with the same features; however, as a difference with respect to the analysis developed in [13], we assume that individuals' labor allocation choices are determined by a benevolent social planner who has the objective of maximizing individuals' welfare. In this context, we aim at pointing out those conditions which allow the external investments to generate an increase in welfare. More specifically, we show how the optimal labor allocation choices are related to the pollution rate of the industrial sector and to the carrying capacity of the environmental resources. Even though we consider a very simple framework, the dynamics generated by our model may exhibit multiplicity of saddle point stable stationary states. This implies that the expansion of the industrial sector, which in our model is strictly related to the labor allocation choices of the local community, may be a path-dependent process.

The article is organized as follows. Section 2 presents the model; Sections 3 and 4 investigate the basic properties of dynamics that emerge from the model; Section 5 deals with the numerical methods used to approximate solutions and Section 6 provides the results of some numerical tests; Section 7 concludes.

2. The model setup

We study the dynamics of an economy where the production activities depend on three factors of production: labor, a renewable natural resource and physical capital. In this economy there are two sectors, the “industrial sector” and the “local sector”, and economic agents belong to two different communities, the “External Investors” (I-agents) and the “Local Agents” (L-agents). We assume that I-agents invest in the industrial sector and do not face credit constraints; that is, they invest in this economy as long as the return on the produced capital is higher than the ones in the other economies. The I-agents also hire the labor force provided by the L-agents. In this respect, the L-agents use their own working capacity partly working as employees for the I-agents and partly in the local sector, where they directly exploit the natural resource. In order to fix our ideas, the local sector can be considered as the farming one, even though it may include fishery, forestry or also tourism. On the other hand, the industrial sector includes all the activities which are intensive in physical capital and generate a negative impact on the environmental resource.

This is a stylized scenario, but it can represent the main differences among the sets of options that local populations and external investors can use to generate their income flows and to protect themselves from environmental degradation. The use of intensive labor techniques, employment of family labor and constraints in access to credit markets are often crucial features for the production activities of local communities. For instance, Barbier [14] summarizes a review of empirical literature about the relationship between poverty and natural resource in developing countries by observing that the rural poor are almost “assetless”. They depend “critically on the use of common-property and open access resources for their income”, they rely on small plots of lands and on selling their labor which is their only other asset. As in [15], we model these settings by excluding that the local agents can accumulate physical capital and by assuming that they can rely on two productive inputs, namely their labor and natural capital.

By contrast, external investors usually manage intensive capital activities based on the employment of wage labor and their companies or firms are able to gain access to capital markets. In addition, their production is characterized by a high degree of mobility; indeed, it relies on wage labor, which is also available in other economies, and on physical capital, that can be employed elsewhere. Moreover the external investors can defend themselves against a reduction in capital returns in the local economy by moving their capital toward other economies.

Both populations of economic agents are represented by a continuum of identical individuals and the size of each community is equal to 1. In this respect, we may deal with a “representative” L-agent and a “representative” I-agent. We assume that the production functions of the two sectors are concave, increasing and homogenous of degree 1 with respect to their inputs. In particular, the production function of the representative L-agent is given by

$$Y_L = E^\alpha L^{1-\alpha},$$

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