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Abstract

This paper examines the possible effects of external investment inflows on the development of local rural economies, taking into account two recurrent features of many developing countries: capital market segmentation and environmental externalities. To investigate this issue, we examine a model with two sectors: the "local sector" and the "external sector". Physical capital accumulation in the latter sector is driven by foreign direct investments, while in the former sector it follows a Solow-type accumulation mechanism. We assume that the production activity of the external sector damages the environment while the local sector relies on natural resources. In this context, we give the conditions under which capital inflows can promote diversification of host economy while improving welfare of local populations. If these conditions are not satisfied, external investments fuel a welfare reducing process (for the local community) and a self-enforcing growth of the external sector at the expense of the local one.

Keywords: Two-sector model, foreign direct investments, environmental negative externalities, self-protection choices, structural change.
JEL: F21, F43, D62, O11, O13, O15, O41, Q20

1. Introduction

In the last decades local rural economies have become increasingly exposed to external investments, such as foreign direct investments (FDI) or capital inflows from urban or richer areas.[1] FDI as percentage of GDP increased by more than seven times between the 1980s and the 2000s in low income countries, where most of the population lives in rural areas, and by more than five times in middle income countries.[2] This trend comes along with the on-going globalization process and the increasing demand for raw materials and commodities. The importance of the search for raw materials as a key FDI driver is the object of a large debate in the literature.[3] Recent estimates (Wiedmann et al., 2013) show that OECD countries tend to externalize their resource-intensive production processes by extracting raw materials that are available elsewhere.While the domestic material footprint of OECD countries has declined since the 1990s, their overall footprint turns out to have increased, both in absolute term and per unit of GDP, when accounting for raw material extraction. These developments have generated a heated debate on the

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[1]For the sake of simplicity, in what follows we will generally refer to FDI as the main form of external investments. The same considerations and results from the model apply also if the external investments accruing to the local community come from domestic capitals from richer areas.

[2]Authors' calculations based on World Development Indicators accessed on February 2015.

[3]Following the taxonomy proposed by Dunning (1993), resource seeking FDI aim at acquiring resources (e.g. raw materials and natural resources) that are unavailable at home or that are available only at a lower cost in the host country (such as unskilled labor). See, among others, Helpman (1984), Markusen and Maskus (2002), Slaughter (2003), Gerlach and Liu (2010) for in-depth analyses of this issue.

consequences that the growing exposure to external investments can have on the development of rural economies.

On the one hand, supporters of FDI in developing countries claim that external investments favor the economic growth of these economies, which can lead to a reduction of both poverty and environmental degradation within these communities (Gorgen et al., 2009; Chaudhuri and Banerjee, 2010). This expected effect on local economies can contribute to explain why governments often implement policy measures aimed at attracting FDI. UNCTAD (2006), for instance, calculates that 2078 out of 2267 national policy changes, introduced between 1992 and 2005 around the world, were favorable to FDI.

On the other hand, opponents of external investments in rural economies argue that these interventions often tend to deteriorate the local environment. Recent contributions (FAO, 2009, 2012; Heumesser and Schimd, 2012), in fact, document a number of cases in which FDI have had perverse environmental impacts impoverishing the main resource on which local dwellers rely for their subsistence. Several studies find that the health and economic conditions of some local rural populations have been severily damaged by the polluting activities of external investments (Jorgenson, 2009; Herzer and Nunnenkamp, 2012).[4] As a consequence, FDI may not necessarily bring about a higher welfare level in the local communities and in some cases may actually increase their poverty levels, compelling indigenous populations to leave their activities and look for alternative occupations.

Despite the increasing number of studies that focus on the debate discussed above, in the last few years the empirical literature has not managed to provide a clear-cut evidence in favor of one position or the other. In addition, most empirical and theoretical research has focused on the link between FDI and the economic growth of the receiving country (see for instance Alfaro et al., 2010; Azman-Saini et al., 2010; Herzer, 2012; Forte and Moura, 2013). The impact that FDI can have on the local environmental quality and on the welfare of indigenous populations, instead, is much less investigated and, at the same time, more controversial.[5]

The present paper aims to get a deeper understanding on the potential effect that external investments can have on the development of local rural economies. For this purpose, we propose a simple two sector model that investigates the dynamics characterizing a small open economy in which the local sector relies on natural resources for its production. The proposed formalization takes into account both the environmental externalities possibly generated by external investments and the capital market segmentation that is often typical of developing countries. On the one hand, in fact, external investments may enhance local development as external investors enjoy better access to capital markets than local dwellers. On the other hand, they can generate environmental externalities that tend to damage the local production which, unlike the new incoming activities, is highly dependent on natural resources.

The structure of the paper is the following. Section 2 discusses the related literature, section 3 introduces the model, while sections 4-6 investigate the properties of the dynamic regimes that emerge from the model. Section 7 examines the welfare implications deriving from the model. Section 8 illustrates the economic interpretations of the results of the model presenting some real-world examples. Section 9 provides a few concluding remarks.

[4]One of the most notable examples in this sense is provided by the heavy ecological damages suffered by the Nigerian local community provoked by the oil and gas exploitation activities along the Niger Delta (UNDP, 2006; Salami et al., 2012).

[5]See, for instance, the long-standing and voluminous literature on the so-called Environmental Kuznets Curve, which reaches conflicting results on the relationship between FDI-related economic growth and environmental degradation (Omri et al., 2014 as well as Dinda, 2004; Kijima et al., 2010; Pasten and Figuerosa, 2012, for surveys of the literature) or the empirical literature on the so-called "pollution haven hypothesis", which could not provide conclusive evidence on whether more lenient environmental regulations actually attract FDI (Cole, 2004; Cole and Fredriksson, 2009; He, 2006; Ghertner and Fripp, 2007; Levinson and Taylor, 2008; Millimet and List, 2004; Mulatu et al., 2010). While these two research areas can provide useful insights on the relationship between FDI and natural resources, they mainly focus on nation-wide effects of FDI rather than on local rural economies. In what follows we will not examine their lively debate as this goes beyond the scope of the present paper.

2. Related literature

The present paper is strictly related to two main strands of the literature that have never been taken jointly into account so far: on the one hand, the vast literature on the effects of FDI, on the other hand, the research line on environmental defensive behaviors.

As to the former, many studies have investigated the effects of FDI, especially on the growth performance of the receiving country, both from the theoretical and the empirical viewpoint. In this regard, it is possible to identify at least three main channels through which FDI can have a positive impact on the growth of the host country. In the first place, FDI increases capital accumulation in the receiving country by introducing new inputs and technologies (Dunning, 1993; Blomstrom et al., 1996; Borensztein et al., 1998; Saggi, 2002; Kemeni, 2010). In the second place, it tends to raise the level of knowledge and skills in the host country through labor and manager training (de Mello, 1996, 1999; Liu et al., 2001; Hansen and Rand, 2006). In the third place, FDI can increase competition in the host country industry by overcoming entry barriers and reducing the market power of existing firms (Chung, 2001; Bitzer and Görg, 2009; Nicolini ad Resmini, 2010; Damijan et al., 2013). The three channels mentioned above can influence growth by raising the productivity level of the host country. This seems to be confirmed by several studies (e.g. Globerman, 1979; Blomstrom and Persson, 1983; Ericsson and Irandoust, 2001) which observed a positive relationship between FDI and labor productivity. Other studies, however, pointed out that several conditions are required for FDI to produce the potential beneficial effects on economic growth described above. In particular, a key role is played by the sectoral composition of FDI: FDI in the primary sector tend to have a limited or even negative impact on the growth of the host country, while FDI in the manufacturing sector often give rise to positive spillover effects on the local economy (UNCTAD, 2001; Aykut and Sayek, 2007; Chakraborty and Nunnenkamp, 2008). Other studies, moreover, find that the impact of FDI crucially depends on the income of the receiving country and that only above a given income threshold level FDI generates positive productivity spillovers (Barrios et al., 2003; Girma, 2005; Mayer-Foulkes and Nunnenkamp, 2009).[6]

Finally, some scholars (Aitken and Harrison, 1999; Djankov and Hoekman, 2000; Konings, 2001; Agosin and Machado, 2005; Herzer et al., 2008; Waldkirch and Ofosu, 2010) express an even more critical viewpoint on the role played by FDI in the development of the host economies. Their findings suggest that in some countries FDI can crowd-out local firms and can have negative effects on the economic growth, at least in the short term. Again, the characteristics of host countries may play a crucial role in this regard: Mayer-Foulkes and Nunnenkamp (2009), for instance, find that US FDI tend to promote income convergence to per capita income US levels for rich countries, while they tend to widen the income gap from the US for many low- or middle-income countries which have a lower bargaining power.

Beyond the literature on FDI, the second (and so far separate) research line upon which the present paper is built is the one on environmental defensive behaviors. By this term, we refer to the individual choices that agents do to self-protect from environmental degradation. The progressive deterioration of the environmental quality that often comes along with economic growth may induce changes in the individuals' consumption habits, leading them to replace previously free environmental goods with costly private goods.[7]

Following the contributions by Antoci and Bartolini (1999, 2004), this strand of the literature has proved with different analytical tools that this substitution mechanism may lead the economy along an undesirable (welfare-reducing) growth path, not only when agents are assumed to have bounded rationality (see, for instance, Antoci and Borghesi, 2012) but also when they are assumed to be perfectly

[6]As pointed out in the literature (Alguacil et al., 2011; Alfaro et al., 2004; Blomstrom et al., 1994; Balasubramanyam et al., 1996; Borensztein et al., 1998; Kemeni, 2010; Lim, 2001; Reiter and Steensma, 2010), moreover, the impact of FDI on the receiving country depends also on a large set of additional factors, such as institutional and legal contexts, corruption and social capability, the degree of the competition or complementarity with local activities, the technological gap, the level of human capital in the host economies, the development of financial markets and receptiveness to trade, as well as investment regulation and labor intensity in investment sectors.

[7]See Antoci et al. (2008) for an exhaustive discussion and classification of the possible self-defensive choices induced by environmental degradation.

rational (Antoci et al., 2005; Bartolini and Bonatti, 2002, 2003).

The present paper relates to this literature in so far as the possible environmental degradation induced by FDI may lead agents to operate a similar substitution process. The deterioration of the local ecosystem, in fact, may induce (or compel) the indigenous population to modify its work habits (beyond its consumption habits), replacing the working activity in the local sector which heavily relies on natural resources with that in the new incoming sector set up by the External Investors. In other words, people may be compelled to leave their rural activities due to the agricultural productivity loss deriving from the environmental degradation produced by FDI, and look for a job in the external sector. This may generate a self-enforcing mechanism: an increase in the external investments tends to raise the environmental degradation, which induces the host economy to shift away from the local sector and to increasingly rely on further investments in the external sector.

To examine this issue, we investigate a two-sector model with two kinds of agents: (i) local agents, who can work either as employees in the external sector or as self-employees in the local sector which directly exploits the natural resource and (ii) external agents, who (differently from local agents) have access to physical capital at an exogenous price r and hire labor force for their own production activity. The arrival of new external investments, therefore, creates environmental damages but also new labor opportunities in the host economy considered in the model.

We thus have two main links between the local and the external sectors, one positive and one negative, respectively: (i) the external sector generates revenues that can be invested in the local sector and (ii) the external sector generates environmental degradation in the rural region which causes a productivity loss to the local sector. While the literature has identified many other possible links between the local and the external sector, in what follows we will focus on these two links since the two opposite externalities described above are more strictly related to the kind of rural economy that we intend to examine and make the overall impact of FDI on the local economy a priori ambiguous.

This paper differs from the previous literature in several respects. In the first place, it shares with the literature on resource-seeking FDI the emphasis on the role of low-cost labor as an initial driver of FDI; however, differently from that literature, it sheds light on the possible self-enforcing mechanism described above: environmental degradation accompanying new incoming activities may give rise to an increasing labor mobility from the local to the external sector which -by providing the labor supply that is needed for external investments- further enhances FDI and the corresponding environmental depletion. In the second place, while most FDI studies focus on the spillover effects that may arise between local and incoming activities *within* the same sector, we investigate the case in which the two activities belong to different sectors and examine the spillover effects that may arise *across* sectors. In the third place, differently from previous studies on environmental self-protection choices, we will deliberately focus attention on the dynamics which can arise in a typical host developing economy. Finally, differently from the similar settings examined by Lopez (2010) and Antoci et al. (2012, 2014) who adopt two-sector models with environmental externalities and intersector labor mobility, in the present paper we will allow for international capital mobility and physical capital accumulation in both sectors. In our model, therefore, the different evolution of the physical capital stock in the two sectors will be endogenously determined.

3. The model setup

Let us consider a small open economy with three production factors (labor, physical capital and a renewable free-access natural resource) and two groups of agents: "Local Agents" (L-agents) and "External Investors" (I-agents). We will denote with the term "local sector" the production performed by the L-agents, and with the term "external sector" that of the I-agents. L-agents can use their endowment of labor force either to work as employees for the I-agents in the external sector or to work as self-employees and produce on their own by exploiting the natural resource in the local sector. To fix the ideas, one can think of L-agents as performing activities in agriculture or tourism and using small stock of assets, family work and the natural resources at disposal. In several developing countries, rural poor are quite dependent on provisioning and regulating functions of ecosystems such as services and products from forests, freshwater, coral reefs, mangroves, marine resources (TEEB, 2010; Barbier, 2010).

We assume that L- and I- agents' investments in physical capital follow different mechanisms and rules. The capital market is completely segmented and it is accessible only by the External Investors, who invest in the local economy as long as the correspondent return on capital is higher than in other economies. Local Agents, instead, can invest exclusively in the local economy and can finance their investments only by their savings.

We assume that the production functions of the two sectors satisfy Inada conditions, are concave, increasing and homogenous of degree 1 in their inputs. The production function of the representative L-agent is given by:

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

where:

E is the stock of a free access environmental resource;

L is the amount of time the representative L-agent spends on local sector production;

K_L is the physical capital accumulated by the representative L-agent;

$\alpha > 0$, $\beta > 0$, $\alpha + \beta < 1$ hold.

The L-agent's total amount of time is normalized to 1 and leisure is excluded, thus $1 - L$ represents the L-agent's labor employed by the representative I-agent as wage work. The production function of the representative External Investor is given by the Cobb-Douglas function:

$$Y_I = K_I^\gamma (1-L)^{1-\gamma} \tag{1}$$

where K_I denotes the stock of physical capital invested by the representative I-agent in the economy. The I-agents choose their labor demand $1 - L$ and the stock of physical capital K_I which they invest in the economy in order to maximize their profits. More specifically, the representative I-agent, in each instant of time, solves the following problem:

$$\max_{1-L,\ K_I} \left[Y_I - w(1-L) - rK_I\right] \tag{2}$$

where w and r are, respectively, the wage and the interest rate, considered as exogenously determined by each I-agent. However, the wage w is endogenously set in the economy by the labor market equilibrium condition,[8] while r is an exogenous parameter. We assume that K_I inflow is potentially unlimited. Therefore its dynamics are not linked to I-agents' savings but only to the productivity of K_I (which, in turn, depends on L and K_I).

In each instant of time, the representative local agent chooses the allocation of her labor between the two sectors. More precisely, we assume that she solves the following maximization problem:

$$\max_L \left[K_L^\alpha E^\beta L^{1-\alpha-\beta} + w(1-L)\right] \tag{3}$$

Furthermore, we assume that the accumulation process of K_L is described by the equation:

$$\begin{aligned} \dot{K}_L &= s\left[K_L^\alpha E^\beta L^{1-\alpha-\beta} + (1-L)w\right] - \delta K_L \qquad && \text{if } E > 0 \\ \dot{K}_L &= -\delta K_L && \text{if } E = 0 \end{aligned} \tag{4}$$

where the positive parameter δ represents the depreciation rate of K_L, the parameter $s \in (0,1)$ represents the (constant) saving rate and $\dot{K}_L$ is the time derivative dK_L/dt of K_L. The resources of the representative L-agent come from self-employment in the local sector ($K_L^\alpha E^\beta L^{1-\alpha-\beta}$) and from wage labor in the external sector ($(1-L)w$). To simplify, we assume that the prices of the goods produced in the local and in the

[8] For the sake of simplicity we exclude the possibility of importing labor from other economies.

external sectors are both equal to unity; the wage w is expressed in terms of the output of the external sector. When $E = 0$, then $K_L^\alpha E^\beta L^{1-\alpha-\beta} = 0$, namely, no production occurs in the local sector. We assume that in this case L-agents choose not to work in the local sector ($L = 0$) and consume all their wage w rather than save and invest a share of it to increase K_L. It follows that when $E = 0$ the stock K_L decreases over time at its depreciation rate.

The dynamics of E are described by a logistic function modified to account for the impact of the external sector:

$$\dot{E} = E(\overline{E} - E) - \eta \overline{Y}_I \qquad \text{if } E > 0 \tag{5}$$
$$\dot{E} = 0 \qquad \text{if } E = 0$$

where $\dot{E}$ is the time derivative dE/dt of E, $\overline{Y}_I$ represents the economy-wide average value of Y_I and η is a positive parameter measuring the environmental impact caused by the external sector. The positive parameter $\overline{E}$ represents the carrying capacity of the environmental resource.

Each economic agent considers $\overline{Y}_I$ to be exogenous; this implies that each agent takes the evolution of E as given and regards as negligible the effect of her choices on the dynamics of E, therefore nobody has an incentive to preserve or restore the natural resource. We assume that both communities (of Local Agents and External Investors) are constituted by a continuum of identical individuals. It follows that (ex post) the average output $\overline{Y}_I$ coincides with the per capita value Y_I.

4. Dynamics

The dynamics generated by the model are obtained by solving the maximization problems (2)-(3); the solutions to these problems allow to determine the equilibrium values of L and K_I. In particular, the maximization problem of the representative L-agent determines the following first order condition:

$$(1 - \alpha - \beta)\, K_L^\alpha E^\beta L^{-\alpha-\beta} = w \tag{6}$$

Similarly, the maximization problem of the representative I-agent gives rise to the following first order conditions:

$$(1 - \gamma) K_I^\gamma (1 - L)^{-\gamma} = w \tag{7}$$
$$\gamma K_I^{\gamma-1} (1 - L)^{1-\gamma} = r \tag{8}$$

We assume that the labor market is perfectly competitive and wages are flexible. I- and L- agents take w as given, but the wage rate and labor allocation between the two sectors continue to change until the labor demand is equal to labor supply. The labor market equilibrium condition is given by:

$$(1 - \gamma) K_I^\gamma (1 - L)^{-\gamma} = (1 - \alpha - \beta)\, K_L^\alpha E^\beta L^{-\alpha-\beta} \tag{9}$$

Furthermore, from equation (8), we have:

$$K_I = \left(\frac{\gamma}{r}\right)^{\frac{1}{1-\gamma}} (1 - L) \tag{10}$$

Substituting (10) in (9), we obtain:

$$L = \Gamma \left(K_L^\alpha E^\beta\right)^{\frac{1}{\alpha+\beta}} \tag{11}$$

where:

$$\Gamma := \left[\frac{1 - \alpha - \beta}{(1 - \gamma) \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}\right]^{\frac{1}{\alpha+\beta}}$$

Function (11) identifies the labor market equilibrium value $\widetilde{L}$ of L if the right side of (11) is lower than 1; otherwise, $\widetilde{L} = 1$, that is:

$$\widetilde{L} = \min\left\{1,\, \Gamma\left(K_L^\alpha E^\beta\right)^{\frac{1}{\alpha+\beta}}\right\} \tag{12}$$

Consequently, from (10), the equilibrium value $\widetilde{K_I}$ of K_I is determined by:

$$\widetilde{K_I} = \left(\frac{\gamma}{r}\right)^{\frac{1}{1-\gamma}}(1-\widetilde{L}) \tag{13}$$

The economy is specialized in the production of the L-sector if $\widetilde{L} = 1$ (and, consequently, $\widetilde{K_I} = 0$). The graph of the function:

$$K_L = \frac{1}{\Gamma^{\frac{\alpha+\beta}{\alpha}} E^{\frac{\beta}{\alpha}}} \tag{14}$$

(indicated as $\widetilde{K}$ in the Figures 1(a)-1(c) that will be explained below) separates the region of the plane (E, K_L) where $\widetilde{L} = 1$ (above it) from the region where $\widetilde{L} < 1$.

Note that from condition (12) we can distinguish two possible cases: (1) if either $E = 0$ or $K_L = 0$, then the economy specializes in the external sector (that is, $\widetilde{L} = 0$ and $\widetilde{K_I} = \left(\frac{\gamma}{r}\right)^{\frac{1}{1-\gamma}}$ are chosen); (2) if $E, K_L > 0$, instead, condition (12) excludes the specialization in the production of the external sector (i.e. $\widetilde{L} > 0$ always holds for $E, K_L > 0$). In this case, we can distinguish two subcases, that is: (i) the case without specialization in the local sector ($\widetilde{L} \in (0,1)$) and (ii) the case with specialization ($\widetilde{L} = 1$). When $E, K_L > 0$, the external sector never completely replaces the local sector since the productivity of labor employed in the local activities tends to infinity as the workers move away from this sector. On the contrary, when $E, K_L > 0$ the economy can fully specialize in the local sector though also the productivity of labor in the external sector tends to infinity as $(1-L) \to 0$. In this case, in fact, the labor employed in the external sector becomes increasingly expensive, therefore External Investors move their capital outside the economy and reduce K_I, which eventually goes to zero, so that the economy ends up fully specializing in the local sector.

4.1. Dynamics without specialization

If K_L and E are such that $\Gamma\left(K_L^\alpha E^\beta\right)^{\frac{1}{\alpha+\beta}} < 1$ (see (12)), then L-agents spend a positive fraction of their time endowment working in the external sector. Moreover, the following proposition holds:

Proposition 1. *The equilibrium wage rate is constant and equal to* $w = (1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}$.

Proof. In the context $\Gamma\left(K_L^\alpha E^\beta\right)^{\frac{1}{\alpha+\beta}} < 1$, the equilibrium wage rate is given by:

$$\begin{aligned} w &= (1-\alpha-\beta)\, K_L^\alpha E^\beta L^{-\alpha-\beta} = \\ &= (1-\alpha-\beta)\, K_L^\alpha E^\beta \left[\Gamma\left(K_L^\alpha E^\beta\right)^{\frac{1}{\alpha+\beta}}\right]^{-\alpha-\beta} = \\ &= (1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}} \end{aligned}$$

■

The equilibrium wage rate is completely determined by the labor elasticity of production in the external sector (γ) and by the capital cost (r). Any other parameter change does not affect the equilibrium wage although it may lead to a variation in equilibrium values of L, K_I and E.

When $\Gamma\left(K_L^\alpha E^\beta\right)^{\frac{1}{\alpha+\beta}} < 1$, the dynamics of the capital invested in the L-sector are given by:

$$\dot{K}_L = s\left[K_L^\alpha E^\beta L^{1-\alpha-\beta} + (1-L)w\right] - \delta K_L =$$

$$= s\left[\Gamma^{1-\alpha-\beta}(\alpha+\beta)\left(K_L^{\alpha}E^{\beta}\right)^{\frac{1}{\alpha+\beta}} + (1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}\right] - \delta K_L \tag{15}$$

while the time evolution of E, for $E > 0$, is represented by:

$$\dot{E} = E(\overline{E} - E) - \eta K_I^{\gamma}(1-L)^{1-\gamma} =$$

$$= E(\overline{E} - E) + \eta\Gamma\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}\left(K_L^{\alpha}E^{\beta}\right)^{\frac{1}{\alpha+\beta}} - \eta\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}} \tag{16}$$

The system of equations (15) and (16), therefore, represents the dynamics of the economy in the case without specialization.

4.2. Dynamics with specialization

If $\Gamma\left[K_L^{\alpha}E^{\beta}\right]^{\frac{1}{\alpha+\beta}} \geq 1$ (that is, above the curve (14) in the plane (E, K_L)), the L-agents spend all their time endowment working in the L-sector, that is $\widetilde{L} = 1$, and the dynamics of the economy is described by the equations:

$$\dot{K}_L = sK_L^{\alpha}E^{\beta} - \delta K_L \tag{17}$$

$$\dot{E} = E(\overline{E} - E) \tag{18}$$

5. Stationary states

Three types of stationary states may be observed: 1) the stationary state $O = (E, K_L) = (0, 0)$, in which the economy is specialized in the external sector ($\widetilde{L} = 0$); 2) the stationary state $B_S = (E, K_L) = \left[\overline{E}, \left(\frac{s}{\delta}\overline{E}^{\beta}\right)^{\frac{1}{1-\alpha}}\right]$, in which the economy is specialized in the local (resource-dependent) sector and the stock E of the natural resource coincides with the carrying capacity $\overline{E}$; 3) two stationary states, $A = (E^A, K_L^A)$ and $B = (E^B, K_L^B)$, where the two sectors coexist. The following propositions illustrate the conditions under which these stationary states exist. The proofs are given in the mathematical appendix.

Proposition 2. *1) The point $O = (E, K_L) = (0, 0)$, in which the economy is specialized in the external sector, is always a stationary state of the dynamic system (4)-(5).*

2) The point $B_S = (E, K_L) = \left[\overline{E}, \left(\frac{s}{\delta}\overline{E}^{\beta}\right)^{\frac{1}{1-\alpha}}\right]$, in which the economy is specialized in the local sector, is a stationary state if and only if:

$$\overline{E} \geq \overline{E}_1 := \left(\frac{\delta}{s}\right)^{\frac{\alpha}{\beta}}\left[\frac{(1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}{1-\alpha-\beta}\right]^{\frac{1-\alpha}{\beta}} \tag{19}$$

3) If $\overline{E} > \overline{E}_1$, then there exist three stationary states: O, B_S and one without specialization, $A = (E^A, K_L^A)$, where $\overline{E} > E^A > 0$ (see Figure 1(a)).

4) If $\overline{E} < \overline{E}_1$, then there exist O and (generically[9]) either zero or two stationary states without specialization, $A = (E^A, K_L^A)$ and $B = (E^B, K_L^B)$, where $\overline{E} > E^B > E^A > 0$ and $K_L^B > K_L^A > 0$ hold(see Figures 1(b) and 1(c)).

[9] We used the term *generically* since there may exist one particular case in which the steady states A and B coincide, but this occurs only when the loci $\dot{K}_L = 0$ and $\dot{E} = 0$ are tangent.

Proposition 2 suggests that the economy can fully specialize in the local sector only if the carrying capacity $\overline{E}$ of the environmental resource is high enough. This result is intuitively appealing: agents can specialize in the production of the local sector that relies on natural resources only if the latter have a sufficiently high carrying capacity, which ensures a high productivity of the local sector over time.

The curve $\widetilde{K}$ in Figures 1(a)-1(c) separates the area of full specialization to its right (where $\widetilde{L} = 1$ and the full specialization equilibrium B_S lies, when existing), from the area of coexistence of the two sectors to its left (where $\widetilde{L} < 1$).

If the carrying capacity $\overline{E}$ is below a given threshold level ($\overline{E}_1$) then the full specialization equilibrium B_S does not exist; in this case there exist either two equilibria A and B in which the local and external sectors coexist, that lie at the crossroad of the loci $\dot{E} = 0$ and $\dot{K}_L = 0$ (see Figure 1(b)), or no equilibrium with coexisting sectors (see Figure 1(c), that illustrates a case in which the curves $\dot{E} = 0$ and $\dot{K}_L = 0$ do not intersect).

The following proposition gives sufficient conditions for the existence and non existence of the equilibria without specialization A and B (see case 4 of Proposition 2).

Proposition 3. *When $\overline{E} < \overline{E}_1$ (case 4 of Proposition 2), a sufficient condition for the non existence of stationary states without specialization is:*

$$\overline{E} \leq \overline{E}_2 := \left[\frac{\beta\eta \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}{\alpha + \beta} \right]^{\frac{1}{2}} \tag{20}$$

A sufficient condition for the existence of two stationary states without specialization is:

$$\overline{E} \geq \overline{E}_3 := \left[4\eta \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}} \right]^{\frac{1}{2}} \tag{21}$$

$$\eta < \eta_s := \frac{\left(\frac{\gamma}{r}\right)^{\frac{\gamma(2-2\alpha-\beta)}{\beta(1-\gamma)}}}{4\left(\frac{s}{\delta}\right)^{2\frac{\alpha}{\beta}} \left(\frac{1-\alpha-\beta}{1-\gamma}\right)^{2\frac{1-\alpha}{\beta}}} \tag{22}$$

Notice that $\overline{E}_2 < \overline{E}_3$ always holds; furthermore it is easy to check that $\overline{E}_3 < \overline{E}_1$ holds if and only if $\eta < \eta_s$; therefore, if $\eta < \eta_s$, there always exist values of $\overline{E}$ satisfying both the conditions $\overline{E} < \overline{E}_1$ and $\overline{E} \geq \overline{E}_3$.

According to Proposition 3, two stationary states without specialization are observed if the environmental impact (measured by η) of the external sector is low enough (i.e. $\eta < \eta_s$) and if the value of the carrying capacity $\overline{E}$ is neither too low nor too high (i.e. $\overline{E} \in [\overline{E}_3, \overline{E}_1)$). If, on the contrary, the carrying capacity $\overline{E}$ is sufficiently low (i.e. $\overline{E} \leq \overline{E}_2$, $\overline{E} < \overline{E}_1$) then only the stationary state $O = (E, K_L) = (0, 0)$, in which the economy is specialized in the external sector, exists. In this case FDI take place in a totally depleted environment in which local production is no longer possible. This case, though rather extreme at first sight, may be considered a valid description of those real-world situations in which FDI keep flowing to countries where the carrying capacity of the ecosystem is low and the land is no more productive.[10]

Proposition 3 has defined sufficient conditions for the existence of the equilibria A and B without specialization. From Propositions 2 and 3, moreover, we can also identify a necessary condition for their existence.

[10]See section 8 below for a real-world example of a similar situation. Notice, moreover, that we deliberately focus on these "extreme" situations in the paper as we are interested in the possible existence of self-reinforcing processes that may occur when FDI do not depend on the local environment. If the opposite occurs (i.e. if FDI depend on local natural resources), the model may generate a "circular outcome": in this case, in fact, when the stock of the renewable natural resource E decreases FDI will also decrease. This will tend to reduce their environmental impact, which will increase E again, leading to a growth in FDI and so on. We thank an anonymous referee for raising this issue.

Proposition 4. *A necessary condition for the existence of two stationary states without specialization is:*

$$\eta < \eta_n := \frac{\left(1+\frac{\alpha}{\beta}\right)\left(\frac{\gamma}{r}\right)^{\frac{\gamma(2-2\alpha-\beta)}{\beta(1-\gamma)}}}{\left(\frac{s}{\delta}\right)^{2\frac{\alpha}{\beta}}\left(\frac{1-\alpha-\beta}{1-\gamma}\right)^{2\frac{1-\alpha}{\beta}}} \tag{23}$$

where $\eta_n > \eta_s$ always holds.

Proof. Remember that, according to Proposition 2, the stationary state B does not exist if $\overline{E} \geq \overline{E}_1$ (in such a context, only the stationary state A exists) while, according to Proposition 3, the condition $\overline{E} \leq \overline{E}_2$ implies the non existence of both A and B (see (20)). Therefore, the stationary state B cannot exist if $\overline{E}_2 \geq \overline{E}_1$; it is easy to check that $\overline{E}_2 \geq \overline{E}_1$ holds if and only if $\eta \geq \eta_n$, where $\eta_n > \eta_s$. ■

In summary, the existence of B (the coexistence equilibrium with a relatively higher level of natural resources) is possible only if the carrying capacity $\overline{E}$ of the environmental resource is not too high (i.e. $\overline{E} < \overline{E}_1$) and if the environmental impact of the external investment, measured by η, does not surpass a certain threshold (i.e. $\eta < \eta_n$).

6. Dynamic regimes

All the possible cases that can be observed are illustrated in Figures 1(a)-1(c). For the sake of simplicity, we do not take into consideration the case in which the isoclines $\dot{E} = 0$ and $\dot{K}_L = 0$ have a tangency point below the curve (14), and therefore the stationary states A and B coincide. The following proposition characterizes the global dynamics emerging from the model.[11]

Proposition 5. *The dynamic regimes that may be observed under the dynamics (4)-(5) are the following:*

(a) if $O = (0,0)$, $A = (E^A, K_L^A)$ and either $B = (E^B, K_L^B)$ or $B_s = \left(\overline{E}, \left(\frac{s}{\delta}\overline{E}^{\beta}\right)^{\frac{1}{1-\alpha}}\right)$ exist, then A is a saddle point[12] and its stable branch separates the basin of attraction of the attractive stationary state O from those of the attractive stationary states B_s and B (see Figures 1(a) and 1(b), respectively);

(b) if only the stationary state $O = (0,0)$ exists, then every trajectory asymptotically approaches it (see Figure 1(c)), namely, $O = (0,0)$ is globally attractive.

The proof of this proposition is given in the mathematical appendix.

From Proposition 5, jointly with Propositions 2 and 3, we can infer the following main results:

(i) The point $O = (0,0)$, in which the natural resource is totally depleted and the economy is specialized in the external sector,is always locally attractive. If the carrying capacity $\overline{E}$ is sufficiently low (i.e. $\overline{E} \leq \overline{E}_2$, $\overline{E} < \overline{E}_1$), then no other stationary state exists and consequently point O is also globally attractive. In this case, whatever the initial state (E, K_L) of the economy, all trajectories eventually lead to O.

(ii) If the carrying capacity $\overline{E}$ is sufficiently high (i.e. $\overline{E} > \overline{E}_1$), and therefore agents have a higher incentive to work in the local sector, we observe a bistable dynamic regime with two locally attractive points, O and B_s. In B_s the external sector is ruled out and the economy is fully specialized in the

[11] By the term "global dynamics" we refer to the dynamics observed in the whole positive quadrant of the plane (E, K_L), not only in a neighborhood of a stationary state. The analysis of global dynamics seems particularly important in the present context since the amount and quality of the natural resources characterizing the country can be subject to external shocks (deriving from the negative impact of the FDI but also from possible exogenous factors such as extreme whether events) that may move the economy far from the stationary states.

[12] That is, only two trajectories approach it, those belonging to its stable branch.

local sector, while the opposite holds in O. In this context, the coexistence between the two sectors can only occur in a transient way.[13]

(iii) For intermediate values of $\overline{E}$, and if the environmental impact of the external sector is low enough (i.e. if $\overline{E} \in [\overline{E}_3, \overline{E}_1)$ and $\eta < \eta_s$), we obtain a bistable dynamic regime with two locally attractive points, O and B. In B both sectors coexist.[14]

Figure 2(a) describes the last case. As the diagram shows, the system is path-dependent and trajectories converge either to O or to B, depending on the initial conditions: the trajectories starting to the left (right) of the stable branch of A will eventually converge to O (B). Figure 2(b) shows the projection in the plane (K_I, K_L) of the trajectories represented in Figure 2(a). Note that, when the economy reaches point O (see Figures 2(a) and 2(b)), both the stocks E and K_L become zero, while the external investment K_I reaches the equilibrium level K_I^*, which is the maximum value of K_I that can be observed in a stationary state.

7. Welfare of the representative L-agent

Let us now compare the welfare of the local population at the different equilibria emerging from the model. Notice that the welfare analysis performed in this section focuses on the impact that FDI may have on local revenues, deliberately neglecting the possible welfare loss deriving to Local Agents from FDI-related environmental degradation. If the latter effects were also taken into account this would tend to reinforce the present results on the possible undesirability of FDI. In fact, if we considered the negative effects that environmental degradation has on the welfare of the individuals, then FDI might turn out to be non-convenient (not welfare-improving) even in those cases in which they tend to increase the revenues for the local population. Think, for instance, of the numerous cases in which FDI contribute to increase local GDP but the environmental degradation that comes along with such investments causes irreversible damages to the health of the local population that cannot be fixed despite the higher amount of money at disposal of the local community. Therefore, if FDI turn out to be non-convenient in the present analysis they would be *a fortiori* welfare-reducing when accounting for the welfare loss caused by environmental degradation.

The remuneration of capital K_I invested by the representative I-agent is rK_I while the revenues of the representative L-agent are given by:

$$\begin{aligned}\Pi_L(E, K_L) &= K_L^\alpha E^\beta \widetilde{L}^{1-\alpha-\beta} + w(1-\widetilde{L}) \\ &= \begin{cases} \Gamma^{1-\alpha-\beta}(\alpha+\beta)\left(K_L^\alpha E^\beta\right)^{\frac{1}{\alpha+\beta}} + (1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}} & \text{if } \Gamma\left[K_L^\alpha E^\beta\right]^{\frac{1}{\alpha+\beta}} < 1 \\ K_L^\alpha E^\beta & \text{if } \Gamma\left[K_L^\alpha E^\beta\right]^{\frac{1}{\alpha+\beta}} \geq 1 \end{cases}\end{aligned} \tag{24}$$

Therefore, the revenues of the representative L-agent evaluated at the points $O = (0,0)$ and B_S are equal to, respectively:

$$\Pi_L(O) = \Pi_L(0,0) = (1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}$$

$$\Pi_L(B_S) = \Pi_L\left[\overline{E}, \left(\frac{s}{\delta}\overline{E}^\beta\right)^{\frac{1}{1-\alpha}}\right] = \left(\frac{s}{\delta}\right)^{\frac{\alpha}{1-\alpha}} \overline{E}^{\frac{\beta}{1-\alpha}} \tag{25}$$

[13] By this we mean that along the trajectories converging to B_s and O the two sectors can only coexist for a limited time period after which full specialization occurs. Conversely, the two sectors can indefinitely coexist along the trajectories leading to the steady state B.

[14] Recall that the stationary state B has a higher level of the stock of the natural resource (and capital accumulated in the local sector) with respect to the other stationary state A, in which both sectors coexist.

Notice that, from (24), the revenues evaluated at the attracting stationary state B where the two sectors coexist, $\Pi_L(B)$, are always greater than $\Pi_L(O)$. This implies that, when B exists, the self-enforcing process of specialization in the external sector -fuelled by environmental degradation- which drives the economy towards O, is always welfare reducing.

The effects generated by the external investments on the revenues of the L-agents can be better understood by comparing the dynamics generated by the two-sector model considered in this paper with the one-sector dynamics that would be observed in absence of External Investors. The latter is described by the system (17)-(18), in every point of the plane (E, K_L), and always admits a unique globally attractive stationary state $B_S = (E, K_L) = \left[\overline{E}, \left(\frac{s}{\delta}\overline{E}^{\beta}\right)^{\frac{1}{1-\alpha}}\right]$, coinciding with the stationary state B_S of the two-sector model, when existing. In the remaining part of this section we shall compare the revenues of L-agents in the stationary states of the two-sector model, with the revenues evaluated at the point B_S, $\Pi_L(B_S)$ (see (25)). Remember that B_S is always a stationary state under the dynamics without the external sector, while it is a stationary state for the two-sector model if and only if $\overline{E} \geq \overline{E}_1$.

Observe that $\Pi_L(B_S) > \Pi_L(O)$ holds if and only if:

$$\overline{E} > \overline{E}_4 := \frac{\left[(1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}\right]^{\frac{1-\alpha}{\beta}}}{\left(\frac{s}{\delta}\right)^{\frac{\alpha}{\beta}}} \tag{26}$$

where $\overline{E}_1 > \overline{E}_4$ always holds (see (19)). This implies that when, in the two-sector model, the stationary state with specialization B_S exists (i.e. when $\overline{E} \geq \overline{E}_1$), then $\Pi_L(B_S) > \Pi_L(O)$ holds. However, when B_S does not exist (that is, when $\overline{E} < \overline{E}_1$), then $\Pi_L(B_S) < \Pi_L(O)$ may hold; this occurs if the carrying capacity $\overline{E}$ is low enough, that is if condition (26) is not met. In such a case, the revenues of L-agents in O are higher than in the unique stationary state B_S of the one-sector model. In other words, if the carrying capacity is sufficiently low, Local Agents get higher revenues in an economy characterized by the presence of the external sector and total environmental degradation than in an economy that has no external sector (i.e. that is closed to external capital inflows). If, on the contrary, the carrying capacity is high enough, they are better off with full specialization in the local sector than in the external sector.

Let us now compare the revenues $\Pi_L(B)$ evaluated at the stationary state $B = (E^B, K_L^B)$ of the two-sector model, where the two sectors coexist, with the revenues $\Pi_L(B_S)$ evaluated at the stationary state B_S of the one-sector model.[15] For this purpose, we have to evaluate the difference $\Pi_L(B) - \Pi_L(B_S)$ (see (24)). Setting $\Pi_L(B) - \Pi_L(B_S) = 0$, we obtain the indifference curve IC (see Figure 3), defined by the equation:

$$\left(K_L^{\alpha} E^{\beta}\right)^{\frac{1}{\alpha+\beta}} = \frac{\left(\frac{s}{\delta}\right)^{\frac{\alpha}{1-\alpha}} \overline{E}^{\frac{\beta}{1-\alpha}} - (1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}{\Gamma^{1-\alpha-\beta}(\alpha+\beta)} \tag{27}$$

Il the stationary state B lies above IC in the plane (E, K_L), then $\Pi_L(B) - \Pi_L(B_S) > 0$ holds; vice-versa if B lies below IC. That is, Local Agents get higher revenues with the external sector than without it only if the equilibrium values E^B and K_L^B are high enough.[16] The above results can be resumed by the following proposition.

Proposition 6. *In the two-sector model, when the attractive stationary state O coexists with another attractive stationary state, either B or B_S (case a of Proposition 5), then the revenues of L-agents in O are lower than in B and B_S, that is: $\Pi_L(O) < \Pi_L(B)$ and $\Pi_L(O) < \Pi_L(B_S)$.*

Comparing the stationary states of the two-sector model with the unique stationary state B_S of the one-sector model, we obtain that $\Pi_L(O) > \Pi_L(B_S)$ holds if and only if $\overline{E} < \overline{E}_4$ (see (26)), that is, if the carrying capacity $\overline{E}$ is low enough. Furthermore, $\Pi_L(B) > \Pi_L(B_S)$ holds if and only if the stationary

[15] Remember that B and B_S cannot be simultaneosly stationary states in the two-sector model.

[16] It is easy to check that the curve (27) is a translation of the curve (14) and lies below it when the condition (19) does not hold, that is, in the context in which the stationary state B may exist.

state $B = (E^B, K_L^B)$ lies above the curve IC, represented by equation (27), that is, only if the values E^B and K_L^B are high enough.

Figures 3 and 4 illustrate the effect of an increase in the value of the parameter η, which measures the environmental impact of the external sector. The key role played by the parameter η in our model emerges clearly from Figure 3. As the Figure shows, the position of B depends on the value of the parameter η: as η grows, the position of B with respect to the curve IC lowers. More precisely, an increase in η (from $\eta = 4$ in Figure 3(a) to $\eta = 8.5$ in Figure 3(c)) shifts point B from above the curve IC (the region in which $\Pi_L(B) > \Pi_L(B_s)$ so that B is preferable to B_s) to below it (where the opposite occurs). In other words, if the environmental impact of the external sector η increases, the potential positive role of the openness to external investors decreases so that Local Agents can end up being better-off without the external sector.

Figure 4 shows the effects of an increase in the value of η on the equilibrium values (evaluated at point B of the two-sector model) of the following four variables: (i) $\Pi_L(B)$ (Local Agents' revenues), (ii) K_L (physical capital accumulated by Local Agents), (iii) K_I (capital invested by External Investors), and (iv) E (natural capital). In Figure 4(a), the value of $\Pi_L(B)$ is compared with Local Agents' revenues $\Pi_L(B_s)$ evaluated at the stationary state B_s of the one-sector model (which are obviously independent of the environmental impact of the external sector). Notice that as η increases, $\Pi_L(B)$ decreases and it eventually declines below the value $\Pi_L(B_s)$. This transition is associated with a rise in the stationary value of capital K_I invested by the representative I-agent (see Figure 4(c)). By harming the environment, the increase in K_I causes a reduction of E (see Figure 4(d)), which hinders the local accumulation of physical capital and leads to a reduction in the level of K_L evaluated at the stationary state B (see Figure 4(b)).

8. Interpretation of the results and real-world examples

We can now move on to explain the economic meaning of the analytical results of our model. We have found that the convergence to the stationary state B_s arises when the economy starts from a status of relatively high stock of both natural and physical capital accumulated by Local Agents. This scenario represents a prototypical case in which all Local Agents, having a sufficient initial stock of physical capital, are not willing to work as wage workers and are able to exploit services and products provided by a very high nature's prosperity. We include this case only for the sake of completeness, but it is extremely improbable that in developing countries the carrying capacity is so high and the Local Agents are so well endowed with capitals that External Investors are not able to find available labor force. The case of convergence to O or to B, instead, are more likely scenarios. In particular, inflows of external capitals drive the economy towards a stationary state (B) where the two sectors can coexist provided the external agents invest in activities which have not a heavy environmental impact. If external capitals are employed in activities with a strong environmental impact, instead, they lead the economy towards a stationary state (O) of full specialization in the external sector, total environmental depletion and no accumulation by Local Agents. The same results are obtained when external capitals enter economies with low carrying capacity or initially characterized by a very deteriorated environment. An example of these scenarios (with all the usual caveats needed in any parallelism between reality and stylized economies) may be represented by the interaction between primary activities and textile firms in peri-urban and rural areas financed by urban and foreign investors in countries that are resource-poor and abundant in low-cost labor such as Bangladesh. This country is characterized by a mix of low wage rate, dependence on natural capital, resource constraints (extreme population density and high environmental vulnerabilities) and large investments in highly polluting industry which are bringing low developmental gains for local populations or even welfare losses. According to a recent UNCTAD report (2013), in Bangladesh manufacturing, dominated by the garments and textile industry, is about to surpass the agriculture sector which still employs 47 percent of the population. The development of competitive export-oriented companies is among the priorities of the government and FDI in this sector are expected to play a major role. UNCTAD also reports that average FDI inflows to Bangladesh nearly doubled in the second half of the 2000s and highly competitive labor costs are one of the most important determinants of FDI attractiveness. FDI in textiles and wearing accounted for about 15 percent of total FDI inflows in the 2005-2011 period and most of them take place in Exporting Processing Zones (EPZ) where this sector represents nearly 80 percent of all FDI. The growth of textile firms, however, is a major source of environmental externalities for safety, fishery and agriculture. A recent assessment (Rahman et al. 2012) of heavy metal contamination of agricultural soil around Dhaka EPZ finds high concentrations of toxic metals due to unrestrained solid release and poorly treated fluid wastes from industrial facilities and it concludes that the area is seriously affected by different metals. Other studies focus on leather industry and report that non-sustainable techniques for tannery liquid and solid waste disposal pose heavy threats to public health and economic activities in surrounding areas (Paul et al. 2012, Human Rights Watch 2012). This evidence is consistent with the interpretation of Bangladesh as a case in which external capitals increase investments in polluting activities, exploit low cost labor and have a limited developmental role.

On the contrary, if η is relatively small, by allowing inflows of external investments, the economy considered in the model can converge to a durable coexistence of the two sectors and ensure an improvement in local welfare compared to that experienced in regime of closeness (see the comparison betweeen the two- and the one-sector dynamics). Referring to some real economies can provide a clearer intuition of this result. Bhutan, for instance, starting from lower poverty rates and greater environmental conditions and carrying capacity than Bangladesh (lower population density and richer natural capital), is trying to mobilize private investments and, in very recent years, to attract external capitals without renouncing to an active environmental policy.[17] Conservation of the natural environment is indeed one of the focal areas of government's development strategy and FDI policy encourages investments that contribute to green and knowledge economy. At the same time, over the last ten years, the country has experienced a rapid and broad poverty reduction especially in rural areas. Interventions for increasing returns to agriculture have been key drivers of rural dynamism (NBS and World Bank, 2014). Within our analytical framework, Bhutan can be seen as an economy which is likely to belong to the basin of attraction of B for η values which place B below the IC curve. A similar example but with better initial conditions and more success in attracting FDI is provided by Costa Rica, a middle-income and natural resource abundant country. Costa Rica, which is known for its commitment to environmental conservation, has been able to use FDI as engine of its economic dynamism and it is now applying a selective FDI policy focused on knowledge-intensive sectors and on clean technologies (OECD, 2012). In our model it can be seen as an economy converging to a state of economic diversification (i.e. towards B) in a context of relatively low η which ensures a welfare improvement for local populations.

9. Concluding remarks

The capacity of developing countries to attract external investments is the object of much attention both among scholars and policy-makers, giving rise to a heated debate between supporters and opponents of FDI, who tend to stress their positive and negative consequences for the local economy, respectively. To examine this issue the present paper has investigated a two-sector model that describes the dynamics of the local sector and of the external sector in a small open economy characterized by environmental externalities provoked by the external investments, and segmentation of the capital market (that is assumed to be open to External Investors but not to Local Agents).

As argued above, external investments can represent a crucial "push factor" for the local economy by increasing the existing capital both directly (through investments in the new incoming activity) and indirectly (through the possible reinvestment in the local sector of the higher wages earned by the Local Agents employed in the new external sector). External investments, however, can also generate a degradation of the local environment that may trap the host country in a vicious circle. In fact, the

[17] The government undertook a significant step towards more liberal conditions for entry of foreign investors in 2010 by publishing the FDI Policy 2010.

environmental degradation provoked by the polluting activity of the new incoming sector tends to reduce the productivity of the local primary sector, which can induce Local Agents to leave their original activity in the local sector and move to the external sector. This further enhances the production level of the latter and the related degradation of the local environment, thus possibly giving rise to a self-enforcing mechanism.

These considerations suggest that a trade-off arises from the FDI in a small-open economy that heavily relies on natural resources for its own production activity. On the one hand, the economic growth that may derive from the external investment in a new polluting sector can be used to invest in a locally "green" sector (such as, for instance, eco-tourism or biological agriculture). On the other hand, the potentially irreversible environmental damage deriving from the activity of the new polluting sector may shift the host country away from its local sector leading to a self-enforcing industrialization process that is then hard to be reversed. If so, the degradation of the local environment may "force" the host country to move along an ecologically-damaging growth path that resembles the one followed in the past by developed countries during their industrialization process, but that may turn out to be welfare-reducing in the long run for current developing countries where local activities are highly dependent on natural resources.

The potential negative effects of FDI discussed above, however, do not imply that an economy with no external investments and full specialization in the local sector would maximize the welfare of its citizens. In fact, as it emerges from the dynamics of the model, the welfare level of Local Agents can be higher in the case of external capital inflows and convergence to a stationary state in which both sectors coexist than in the absence of external investments. Openness to external investments, therefore, can lead to an improvement in the welfare of the local population even when the incoming capital is invested in polluting activities and they flow towards economies that are highly dependent on natural capital.

This successful scenario, however, can occur only if the initial endowment and the carrying capacity of the environmental resource are sufficiently high and the environmental impact of the incoming activities is sufficiently low. If, on the contrary, the opposite conditions apply, from the analysis of the model it turns out that external capital inflows can drive the economy towards the exhaustion of natural resources and a complete crowding out of the local sector or a diversified economy associated with lower welfare outcomes, for the Local Agents, than in absence of External Investors.

The results discussed above suggest that environmental preservation and protection should be considered by policy makers as a complementary measure to the openness to inflows of external investment. This applies also to those economies in which labor mobility would potentially allow full specialization in the incoming activities which are not dependent on environmental resources. It follows that environmental policies, in the form of support to the initial endowment of natural capital, protection of the local environmental carrying capacity and limitation of the pollution impact of external investments, constitute basic requirements for a welfare improving coexistence between the two sectors of the economy we have analyzed.

Further research will be needed to deepen and extend the results of the present analysis. In particular, it would be interesting to investigate how the current results may change when accounting for the policies that a government can implement to internalize the environmental externalities provoked by the FDI, possibly distinguishing among the different policy tools (e.g. carbon tax, pollution permits, standards etc...) that local government can adopt for this purpose.

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Mathematical appendix

Proof of Propositions 2 and 3

According to the dynamics (4)-(5), the point $O = (E, K_L) = (0, 0)$ is always a stationary state in that, by definition, $\dot{E} = \dot{K}_L = 0$ for $E = K_L = 0$ (point 1 of Proposition 2).

According to the dynamics (17)-(18), $\dot{E} = 0$ holds along the vertical line:

$$E = \overline{E} \tag{28}$$

while $\dot{K}_L = 0$ holds along the graph of the function:

$$K_L = \left(\frac{s}{\delta}E^{\beta}\right)^{\frac{1}{1-\alpha}} \tag{29}$$

The system (17)-(18) admits one stationary state (with $E > 0$) if the intersection point between (28) and (29):

$$B_S = (E, K_L) = \left[\overline{E}, \left(\frac{s}{\delta}\overline{E}^{\beta}\right)^{\frac{1}{1-\alpha}}\right]$$

lies above the separatrix (14), that is if (point 2 of Proposition 2):

$$\overline{E} \geq \overline{E}_1 := \left(\frac{\delta}{s}\right)^{\frac{\alpha}{\beta}} \left[\frac{(1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}{1-\alpha-\beta}\right]^{\frac{1-\alpha}{\beta}} \tag{30}$$

Let us now consider the stationary states without specialization (points 3-4 of Proposition 2 and Proposition 3). By (16), $\dot{E} = 0$ holds along the graph of the function:

$$K_L = f(E) := \frac{\left[A - BE(\overline{E} - E)\right]^{\frac{\alpha+\beta}{\alpha}}}{E^{\frac{\beta}{\alpha}}} \tag{31}$$

with derivative:

$$f'(E) = f(E)\left[B\frac{\alpha+\beta}{\alpha}\frac{2E - \overline{E}}{A - BE(\overline{E} - E)} - \frac{\beta}{\alpha}\frac{1}{E}\right]$$

where:

$$\begin{aligned} A &:= \frac{1}{\Gamma} > 0 \\ B &:= \frac{1}{\eta\Gamma\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}} > 0 \end{aligned}$$

It is easy to check that:

1. $\lim_{E\to 0^+} f(E) = \lim_{E\to+\infty} f(E) = +\infty$;

2. the graph of $f(E)$ meets the curve (14) for $E = \overline{E}$ and lies below it for $E < \overline{E}$ (remember that, above (14), $\dot{E} = 0$ holds along the vertical line $E = \overline{E}$);
3. according to the sign of the derivative $f'(E)$, $f(E)$ is decreasing for low enough values of E, it reaches a minimum at $E = E_m > 0$ and then becomes definitively increasing. Notice that $E_m \geq \overline{E}$ holds if and only if $f'(\overline{E}) < 0$, that is (see condition (20) of Proposition 3):

$$\overline{E} < \overline{E}_2 := \left[\frac{\beta\eta \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}{\alpha+\beta} \right]^{\frac{1}{2}} \tag{32}$$

where $\overline{E}_2 \to 0$ for $\eta \to 0$;
4. along the E-axis, $\dot{E} = E(\overline{E} - E) - \eta \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}$ holds, therefore we have $E_m \in (0, \overline{E})$ and $f(E_m) \leq 0$ if (see condition (21) of Proposition 3):

$$\overline{E} \geq \overline{E}_3 := \left[4\eta \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}} \right]^{\frac{1}{2}} \tag{33}$$

By equation (15), $\dot{K}_L = 0$ holds along the graph of the function:

$$E = g(K_L) := K_L \left(N - M \frac{1}{K_L} \right)^{\frac{\alpha+\beta}{\beta}} \tag{34}$$

where:

$$\begin{aligned} N \quad &:= \frac{\delta}{s\Gamma^{1-\alpha-\beta}(\alpha+\beta)} > 0 \\ M \quad &:= \frac{(1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}{\Gamma^{1-\alpha-\beta}(\alpha+\beta)} > 0 \end{aligned}$$

and:

$$g'(K_L) = \left(N + M \frac{\alpha}{\beta} \frac{1}{K_L} \right) \left(N - M \frac{1}{K_L} \right)^{\frac{\alpha}{\beta}} > 0$$

$$g''(K_L) = M^2 \frac{\alpha(\alpha+\beta)}{\beta^2} \frac{1}{K_L^3} \left(N - M \frac{1}{K_L} \right)^{\frac{\alpha}{\beta}} > 0$$

being $N - M\frac{1}{K_L} > 0$ when the graph of $g(K_L)$ lies in the positive quadrant of the plane (E, K_L). So $g(K_L)$ is a strictly increasing and convex function.

The graphs of $f(E)$ and $g(K_L)$ have at most two intersections and therefore at most two stationary states without specialization exist. To check this result, note that the equations $\dot{E} = 0$ and $\dot{K}_L = 0$ can be rewritten respectively as:

$$\Gamma \left(K_L^\alpha E^\beta \right)^{\frac{1}{\alpha+\beta}} = \frac{\Gamma^{\alpha+\beta}}{\alpha+\beta} \left[\frac{\delta}{s} K_L - (1-\gamma) \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}} \right] \tag{35}$$

$$\Gamma \left(K_L^\alpha E^\beta \right)^{\frac{1}{\alpha+\beta}} = \frac{\eta \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}} - E(\overline{E} - E)}{\eta \left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}} \tag{36}$$

The right hand sides of (35) and (36) are coincident if and only if:

$$K_L = F(E) := -\frac{s(\alpha+\beta)(1-\gamma)}{\delta\eta(1-\alpha-\beta)}E(\overline{E}-E) + \frac{s(1-\gamma)\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}}{\delta(1-\alpha-\beta)} \tag{37}$$

The function $F(E)$ is strictly convex and therefore the graphs of the functions $g(K_L)$ and $F(E)$ can intersect at most twice; consequently at most two stationary states without specialization exist. According to this result, since the graphs of (28) and (31) (isocline $\dot{E}=0$) meet at the same point along the separatrix (14) and the same holds for the graphs of (29) and (34) (isocline $\dot{K}_L = 0$), we have that:

a) If $\overline{E} > \overline{E}_1$ holds (see condition (19) of Proposition 2), then the isoclines $\dot{E} = 0$ and $\dot{K}_L = 0$ have one intersection point above the curve (14), not belonging to it, and consequently they must have another intersection point below the curve (14) (point 3 of Proposition 2, see Figure 1(a)).

b) If $\overline{E} < \overline{E}_1$, then the graphs of $f(E)$ and $g(K_L)$ have (generically) zero or two intersection points (point 4 of Proposition 2, see Figures 1(b) and 1(c)).[18] This completes the proof of Proposition 2.

To prove Proposition 3 note that, in the context $\overline{E} < \overline{E}_1$, if the function $f(E)$ is decreasing in $(0, \overline{E})$, that is if the function $f(E)$ reaches the minimum at $E = E_m \geq \overline{E}$ (this occurs if $\overline{E} \leq \overline{E}_2$, see ((32)), then no stationary state without specialization exists. If instead $E_m \in (0, \overline{E})$ and $f(E_m) \leq 0$, that is if $\overline{E} \geq \overline{E}_3$ holds (see (33)), then two stationary states without specialization exist. Notice that $\overline{E}_1 > \overline{E}_3$ holds if and only if (see condition (22) in Proposition 3):

$$\eta < \eta_s := \frac{1}{4\left(\frac{\gamma}{r}\right)^{\frac{\gamma}{1-\gamma}}\left[\Gamma^{\frac{(\alpha+\beta)(1-\alpha)}{\beta}}\left(\frac{s}{\delta}\right)^{\frac{\alpha}{\beta}}\right]^2}$$

Proof of Proposition 5

The proof of this proposition is straightforward. In particular, it is easy to check, by referring to the arrows diagrams in Figures 1(a)-1(c), that:

1. The set:
$$\Omega = \left\{(E, K_L) : 0 \leq E \leq \overline{E} \text{ and } 0 \leq K_L \leq \left(\frac{s}{\delta}\overline{E}^{\beta}\right)^{\frac{1}{1-\alpha}}\right\}$$
is positively invariant under the dynamics (4)-(5); that is, every trajectory starting inside Ω at the time $t = 0$, remains in it for every subsequent time $t > 0$. Furthermore, by the Poincaré-Bendixson Theorem, every trajectory starting outside Ω, either enters it in finite time or approaches the stationary state $B_s = \left(\overline{E}, \left(\frac{s}{\delta}\overline{E}^{\beta}\right)^{\frac{1}{1-\alpha}}\right)$.

2. The region of the plane (E, K_L) delimited by the isoclines $\dot{E} = 0$ and $\dot{K}_L = 0$ is positively invariant. This implies that A is a saddle point while B and B_s are locally attractive stationary states.[19] Furthermore, no closed trajectory can exist around B and B_s. Consequently, by the Poincaré-Bendixson Theorem, each trajectory in Ω approaches a stationary state. In such a context, the stable branch of A separates the basins of attraction of the attractive states B and B_s from the trajectories along which the value of E becomes 0 in finite time, which belong to the basin of attraction of $O = (0, 0)$. When O is the unique stationary state (see Figure 1(c)), then its basin of attraction coincides with the positive quadrant of the plane (E, K_L).

[18] They have a unique point of contact only if they are tangent.

[19] When the isoclines $\dot{E} = 0$ and $\dot{K}_L = 0$ interesct transversally, the stationary states are hyperbolic, that is, they can only be of one of the following types: attractive point, repulsive point or saddle point.

References

Agosin, M., Machado, R., 2005. Foreign investment in developing dountries: does it crowd in domestic investment?. Oxford Development Studies 33, 149-162.

Aitken, B. J., Harrison, A. E., 1999. Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. American Economic Review 89, 605-618.

Alguacil, M., Cuadros, A., Orts, V., 2011. Inward FDI and growth: the role of macroeconomic and institutional environment. Journal of Policy Modeling 33, 481-496.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., Sayek, S., 2004. FDI and economic growth: the role of local financial markets. Journal of International Economics 64, 89-112.

Alfaro L., Chanda A., Kalemli-Ozcan S., Sayek S., 2010. Does foreign direct investment promote growth? Exploring the role of financial markets on linkages. Journal of Development Economics 91, 242-256.

Antoci, A. Bartolini, S., 1999. Negative Externalities as the Engine of Growth in an Evolutionary Context. Nota di lavoro 83.99, Fondazione Eni Enrico Mattei, Milano.

Antoci, A., Bartolini, S., 2004. Negative externalities and labor input in an evolutionary game. Environment and Development Economics 9, 1-22.

Antoci, A., Borghesi, S., Russu, P., 2005. Environmental defensive expenditures, expectations and growth. Population and Environment 27, 227-244.

Antoci, A., Borghesi, S., Galeotti, M., 2008. Should we replace the environment? Limits of economic growth in the presence of self-protective choices. International Journal of Social Economics 35, 283-297.

Antoci, A., Borghesi, S., 2012. Preserving or escaping? On the welfare effects of environmental self-protective choices. Journal of Socio-Economics 41, 248-254.

Antoci A., Russu P., Ticci E., 2012. Environmental externalities and immiserizing structural changes in an economy with heterogeneous agents. Ecological Economics 81, 80–91.

Antoci, A., Russu, P., Sordi, S., Ticci, E.,2014. Industrialization and environmental externalities in a Solow-type model. Journal of Economic Dynamics and Control 47, 211-234.

Aykut, D., Sayek, S., 2007. The role of the sectoral composition of foreign direct investment on growth. In L. Piscitello and G. Santangelo, Do multinationals feed local development and growth? 35-62, Amsterdam: Elsevier, 2007.

Azman-Saini, W.N.W., Zubaidi Baharumshah,A., Hook Law S., 2010. Foreign direct investment, economic freedom and economic growth: International evidence. Economic Modelling 27, 1079-1089.

Balasubramanyam, V. N., Salisu, M., Sapsford, D., 1996. Foreign direct investment and growth in EP and is countries. Economic Journal 106, 92-105.

Barbier, E.B., 2010. Poverty, development, and environment. Environment and Development Economics 15, 635–660.

Barrios, S., Goerg, H., Strobl, E., 2003. Explaining firms' export behaviour: R & D, spillovers and the destination market. Oxford Bulletin of Economics and Statistics 65, 475-496.

Bartolini, S., Bonatti, L., 2002. Environmental and social degradation as the engine of economic growth. Ecological Economics 43, 1-16.

Bartolini, S., Bonatti, L., 2003. Undesirable Growth in a Model with Capital Accumulation and Environmental Assets. Environment and Development Economics 8, 11-30.

Bitzer J., Görg, H., 2009. Foreign direct investment, competition and industry performance. The World Economy 32, 221-233.

Blomstrom, M., Persson, H., 1983. Foreign investment and spillover efficiency in an underdeveloped economy: evidence from the Mexican manufacturing industry. World Development 11, 493-502.

Blomstrom, M., Lipsey, R.E., Zejan, M., 1994. What explains developing country growth?. National Bureau of Economic Research, Inc, NBER Working Papers, 4132.

Blomstrom, M., Lipsey R.E., Zejan, M., 1996. Is foreign investment the key to economic growth?. The Quarterly Journal of Economics 111, 269-276.

Borensztein, E., De Gregorio, J., Lee, J-W., 1998. How does foreign direct investment affect economic growth?. Journal of International Economics 45, 115-135.

Chakraborty, C., Nunnenkamp, P., 2008. Economic reforms, FDI, and economic growth in India: A sector level analysis. World Development 36, 1192-1212.

Chandran, V.G.R., Tang, C.F., 2013. The impacts of transport energy consumption, foreign direct investment and income on CO2 emissions in ASEAN-5 economies. Renewable and Sustainable Energy Reviews, 24, 445-453.

Chaudhuri, S., Banerjee, D., 2010. FDI in agricultural land, welfare and unemployment in a developing economy. Research in Economics 64, 229-239.

Chung, W., 2001. Mode, size and location of foreign direct investments and industry markups. Journal of Economic Behavior and Organization 45, 185-211.

Cole, M.A., 2004. Trade, the pollution haven hypothesis and the environmental Kuznets curve: Examining the linkages. Ecological Economics 48, 71-81.

Cole, M. A., Fredriksson, P. G., 2009. Institutionalized pollution havens. Ecological Economics 68, 1239-1256.

Damijan, J.P., Rojec, M., Majcen, B., Knell, M., 2013. Impact of firm heterogeneity on direct and spillover effects of FDI: Micro-evidence from ten transition countries. Journal of Comparative Economics 41, 895-922.

de Mello, L.R., 1996. Foreign direct investment, international knowledge transfers, endogenous growth: Time series evidence, Department of Economics, University of Kent, U.K.

de Mello, L.R., 1999. Foreign direct investment-led growth. Evidence from time series and panel data. Oxford Economic Papers 51, 133-151.

Dinda, S., 2004, Environmental Kuznets curve hypothesis. Ecological Economics 49, 431-455.

Djankov, S., Hoekman, B., 2000. Foreign investment and productivity growth in Czech enterprises. The World Bank Economic Review 14, 49-64.

Dunning, J.H., 1993. Multinational enterprises and the global economy, Addisson-Wesley Publishing Company, Reading.

Ericsson, J., Irandoust, M., 2001. On the causality between foreign direct investment and output: a comparative study. The International Trade Journal 15, 1-26.

FAO, 2009. Foreign direct investment win-win or land grab?. World Summit on Food Security. Rome, Italy, 16-18 November 2009. Also available at: ftp://ftp.fao.org/docrep/fao/meeting/018/k6358e.pdf.

FAO, 2012. Trends and impacts of foreign investment in developing country agriculture. Evidence from case studies. Also available at: http://www.fao.org/fileadmin/user_upload/newsroom/docs/Trends.

Forte, E., Moura, R., 2013. The effects of Foreign direct investment on the host country's economic growth: theory and empirical evidence. The Singapore Economic Review 58, 1350017.

Gerlach, A.C., Liu, P., 2010 Resource-seeking Foreign Direct Investment in African Agriculture: A review of country case studies. AO Commodity and Trade Policy Research Working Paper No. 31, FAO, Rome.

Ghertner, D. A., Fripp, M., 2007. Trading away damage: quantifying environmental leakage through consumption-based, life-cycle analysis. Ecological Economics 63, 563-577.

Girma, S., 2005. Safeguarding jobs? Acquisition FDI and employment dynamics in U.K. manufacturing. Review of World Economics 141, 165-178.

Globerman, S., 1979. Foreign direct investment and spillover efficiency benefits in Canadian manufacturing industries. Canadian Journal of Economics 12, 42-56.

Gorgen, M., Rudloff, B., Simons, J., Üllenberg, A., Väth, S., Wimmer, L., 2009. Foreign direct investment in land in developing countries. Deutsche Gesellschaft für Technische Zusammenarbeit Division 45 Agriculture, Fisheries and Food, on behalf of Federal Ministry for Economic Cooperation and Development.

Hansen, H., Rand, J., 2006. On the causal links between FDI and growth in developing countries. The World Economy 29, 21-41.

He, J., 2006. Pollution haven hypothesis and environmental impact of foreign direct investments: The case of industrial emissions of sulfur dioxide (SO2) in Chinese provinces. Ecological Economics 60, 228-245.

Helpman, E., 1984 A simple theory of international trade with multinational corporations, Journal of Political Economy, 92(3), 451–471.

Herzer, D., Klasen, S., Lehmann, F.N., 2008. In search of FDI-led growth in developing countries: The way forward. Economic Modelling 25, 793-810.

Herzer, D., 2012. How does Foreign direct investment really affect developing countries' growth?. Review of International Economics 20, 396-414.

Herzer, D., Nunnenkamp, P., 2012. FDI and health in developed economies: A panel cointegration analysis. Kiel Working Paper No. 1756, February 2012.

Heumesser, C., Schmid, E., 2012. Trends in foreign direct investment in the agricultural sector of developing and transition countries: a review. University of Natural Resources and Applied Life Sciences, Vienna Department of Economic and Social Sciences. Also available at:http://www.gffa-berlin.de/images/stories/GFFA2013/studie%20der%20universitt%20wien.pdf

Jorgenson, A.K., 2009. Foreign direct investment and the environment, the mitigating influence of institutional and civil society factors, and relationships between industrial pollution and human health: A panel study of less-developed countries. Organization Environment 22, 135-157.

Kemeni, T., 2010. Does foreign direct investment drive technological upgrading?. World Development 38, 1543-1554.

Kijima, M., Nishide, K., Ohyama, A., 2010. Economic models for the environmental Kuznets curve: A Survey. Journal of Economic Dynamics and Control 34, 1187-1201.

Konings, J.,2001. The effects of foreign direct investment on domestic firms: Evidence from firm level panel data in emerging economies. Economics of Transition 9, No. 3.

Levinson, A., Taylor, M.S.,2008. Unmasking the pollution haven effect. International Economic Review 49, 223-254.

Lim, E-G., 2001. Determinants of, and the relation between, foreign direct investment and growth: A summary of the recent literature. International Monetary Fund IMF Working Papers, 01/175.

Liu, X., Parker, D., Vaidya, K., Wei, Y., 2001. The impact of foreign direct investment on labour productivity in the Chinese electronics industry. International Business Review 10, 421-439.

Lopez, R.E., 2010. Sustainable economic development: On the coexistence of resource-dependent and resource-impacting industries. Environment and Development Economics 15, 687-705.

Mayer-Foulkes, D., Nunnenkamp, P., 2009. Do multinational enterprises contribute to convergence or divergence? A disaggregated analysis of US FDI. Review of Development Economics 13,304-318.

Markusen, J. R. and Maskus, K., 2002. Discriminating among alternative theories of the multinational enterprise, Review of International Economics, 10, 694–707.

Mulatu, A., Gerlagh, R., Rigby, D., Wossnik, A., 2010. Environmental regulation and industry location in europe. Environmental and Resource Economics 45, 459-479.

Millimet, D.L., List, J.A., 2004. The case of the missing pollution haven hypothesis. Journal of Regulatory Economics 26, 239-262.

National Statistics Bureau and World Bank, 2014, Bhutan Poverty Assessment 2014, available at http://www.nsb.gov.bt/publication/files/pub2yu10210bx.pdf.

Nicolini, M., Resmini, L., 2010. FDI spillovers in new EU member states. Economics of Transition 18, 487-511.

OECD 2012 Attracting Knowledge-Intensive FDI to Costa Rica: Challanges and Policy Options, Making Development Happen Series No. 1, OECD.

Omri, A., Nguyen, D.K., Rault, C., 2014. Causal interactions betweeen CO2 emissions and economic growth: Evidence from dynamic simultaneous-equations models, Economic Modelling, 382-389.

Pasten, R., Figueroa, E., 2012. The Environmental Kuznets curve: A survey of the theoretical literature. International Review of Environmental and Resource Economics 6, 195-224.

Reiter, S.L., Steensma, H. K., 2010. Human development and foreign direct investment in developing countries: The influence of FDI policy and corruption. World Development 38, 1678-1691.

Saggi K., 2002. Trade, foreign direct investment, and international technology transfer: A survey. World Bank Research Observer, World Bank Group 17, 191-235.

Salami, D. K., Fatimah, K., Gazi, M. A., Makua Chukwu, G.O., Oke, M.D., Oloruntegbe, K. O., 2012. Foreign direct investment and environmental degradation of oil exploitation: The experience of Niger Delta. The International Journal of Applied Economics and Finance 6, 117-126.

Slaughter, M. J. Host country determinants of US foreign direct investments into Europe, in Foreign Direct Investments in the Real and Financial Sector of Industrial Countries. In H. Herrman and R. Lipsey, Foreign Direct Investment in the Real and Financial Sector of Industrial: Springer. 2003.

TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach,conclusions and recommendations of TEEB.

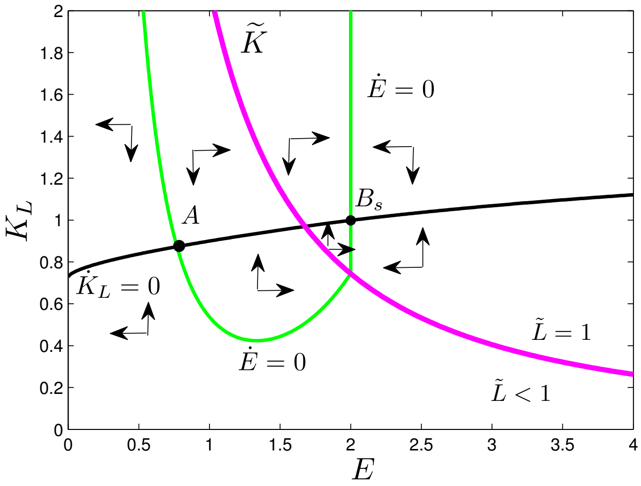
UNCTAD, 2001. World Investment Report 2001. Promoting linkages. New York and Geneva: United Nations.

UNCTAD, 2006. World Investment Report 2006. Promoting linkages. New York and Geneva: United Nations.

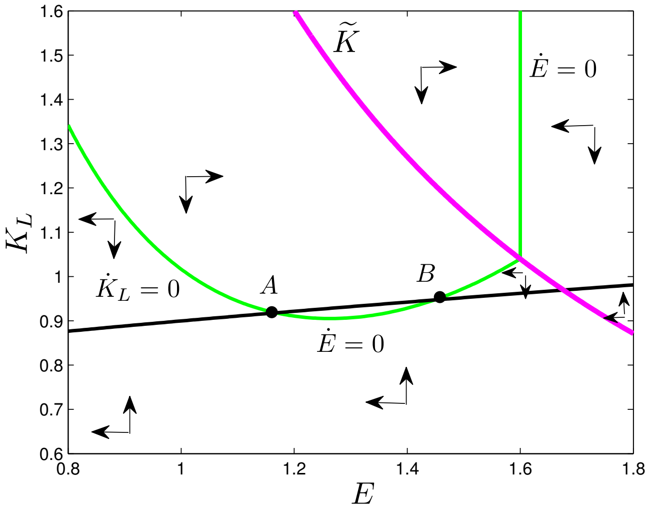
UNDP, 2006. Niger Delta Human Development Report. New York and Geneva: United Nations.

Waldkirch, A., Ofosu, A., 2010. Foreign presence, spillovers, and productivity: Evidence from Ghana. World Development 38, 1114-1126.

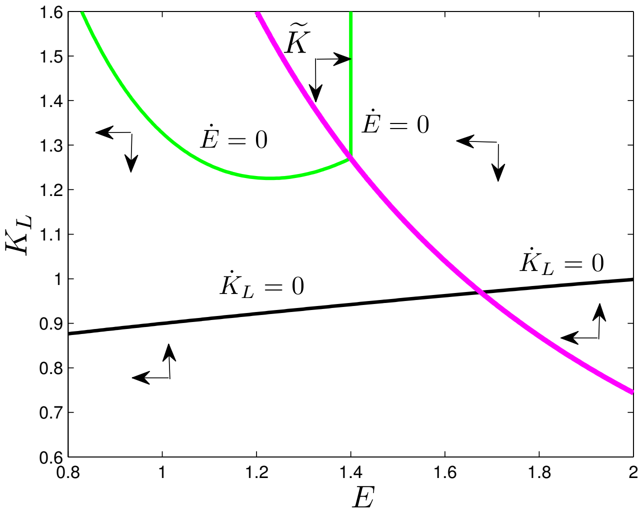
Wiedmann T.O. et al., 2013 The material footprint of nations, PNAS, doi:10.1073/pnas.1220362110.



(a) $\overline{E} = 2$

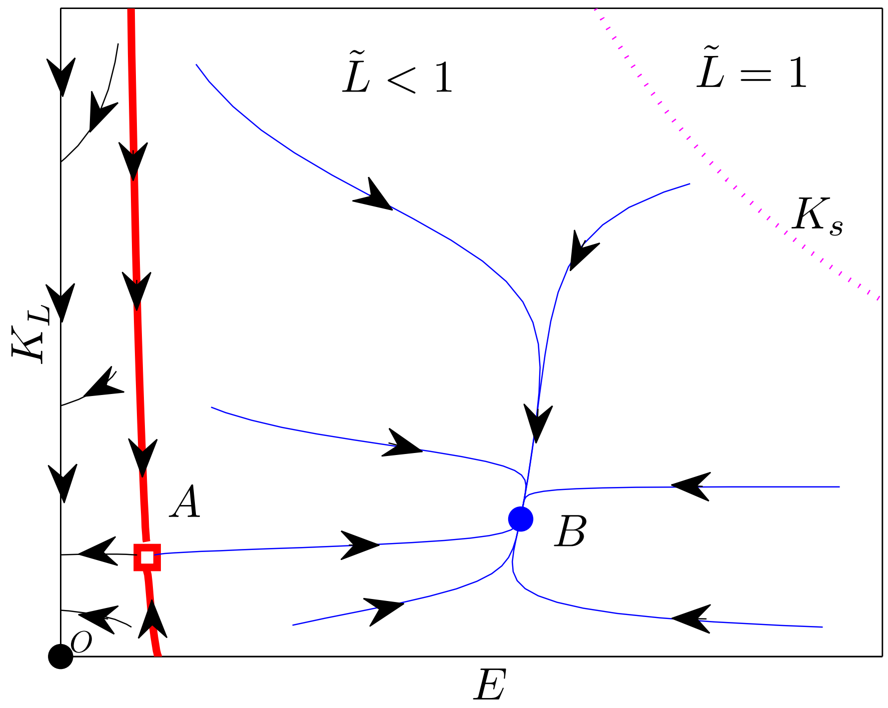


(b) $\overline{E} = 1.6$

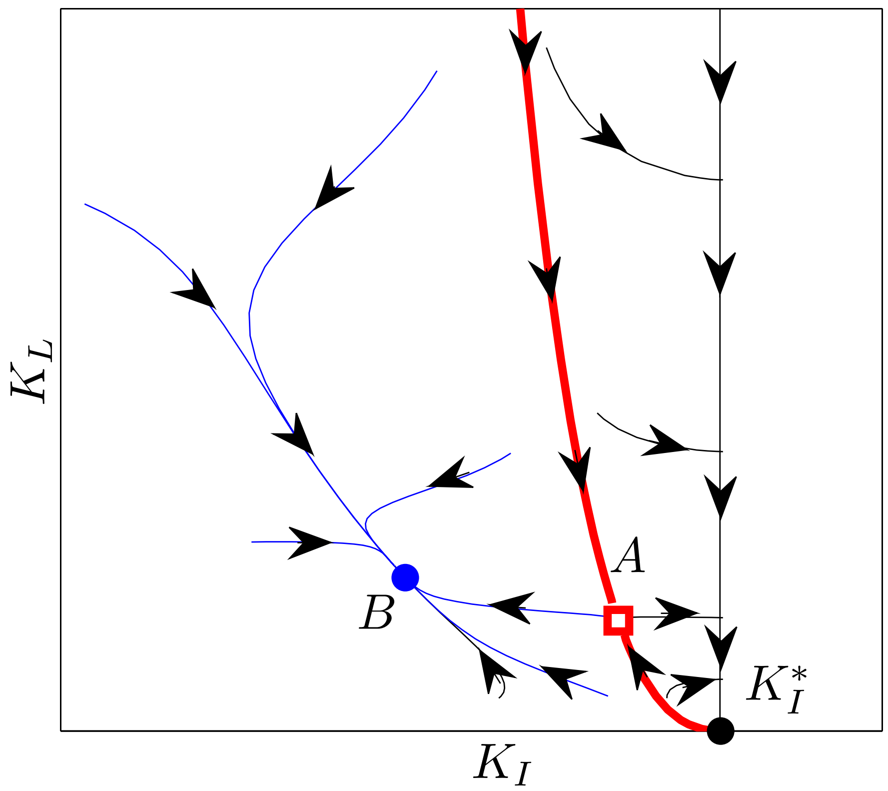


(c) $\overline{E} = 1.4$

Figure 1: Isoclines in the case of two stationary states (figures (a) and (b)) or no stationary state (figures (c)) (black curve: $\dot{K}_L = 0$, green curve: $\dot{E} = 0$, pink curve: separation line); parameters values: $\alpha = 0.1$, $\beta = 0.15$, $\gamma = 0.15$, $\delta = 1$, $\eta = 4$, $r = 0.2$, $s = 0.9$.

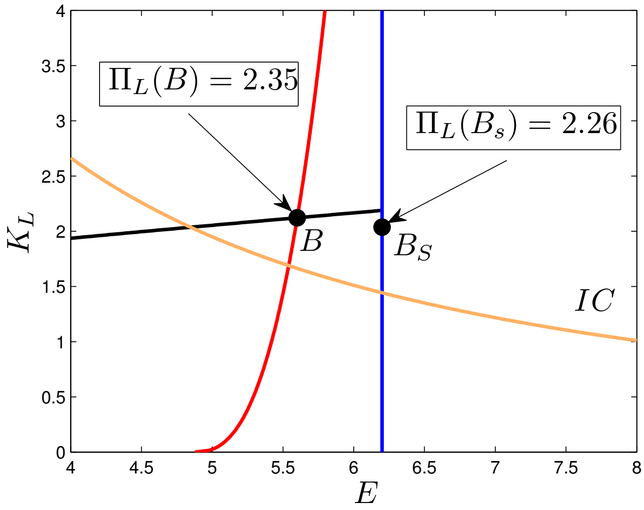


(a)

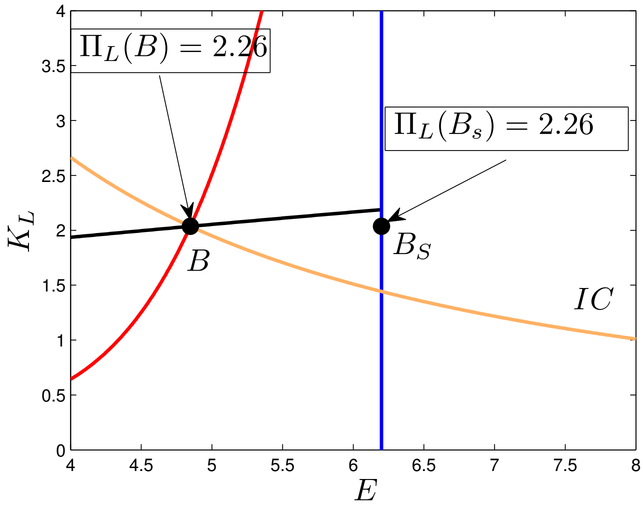


(b)

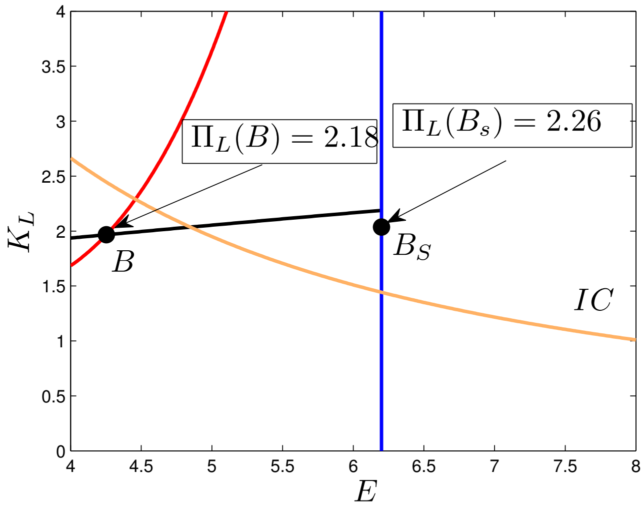
Figure 2: Simulation results with trajectories in the case of two stationary states, where $K_I^* = \left(\frac{\gamma}{r}\right)^{\frac{1}{1-\gamma}}$; parameters values: $\alpha = 0.25$, $\beta = 0.38$, $\gamma = 0.15$, $\delta = 1$, $\eta = 4$, $r = 0.01$, $s = 0.9$, $\overline{E} = 6.2$.



(a) $\eta = 4$



(b) $\eta = 7.177210595$



(c) $\eta = 8.5$

Figure 3: Revenues of Local Agents with ($\Pi_L(B)$) and without ($\Pi_L(B_S)$) the external sector; parameters values: $\alpha = 0.25$, $\beta = 0.38$, $\gamma = 0.15$, $\delta = 1$, $r = 0.01$, $s = 0.9$, $\overline{E} = 6.2$.

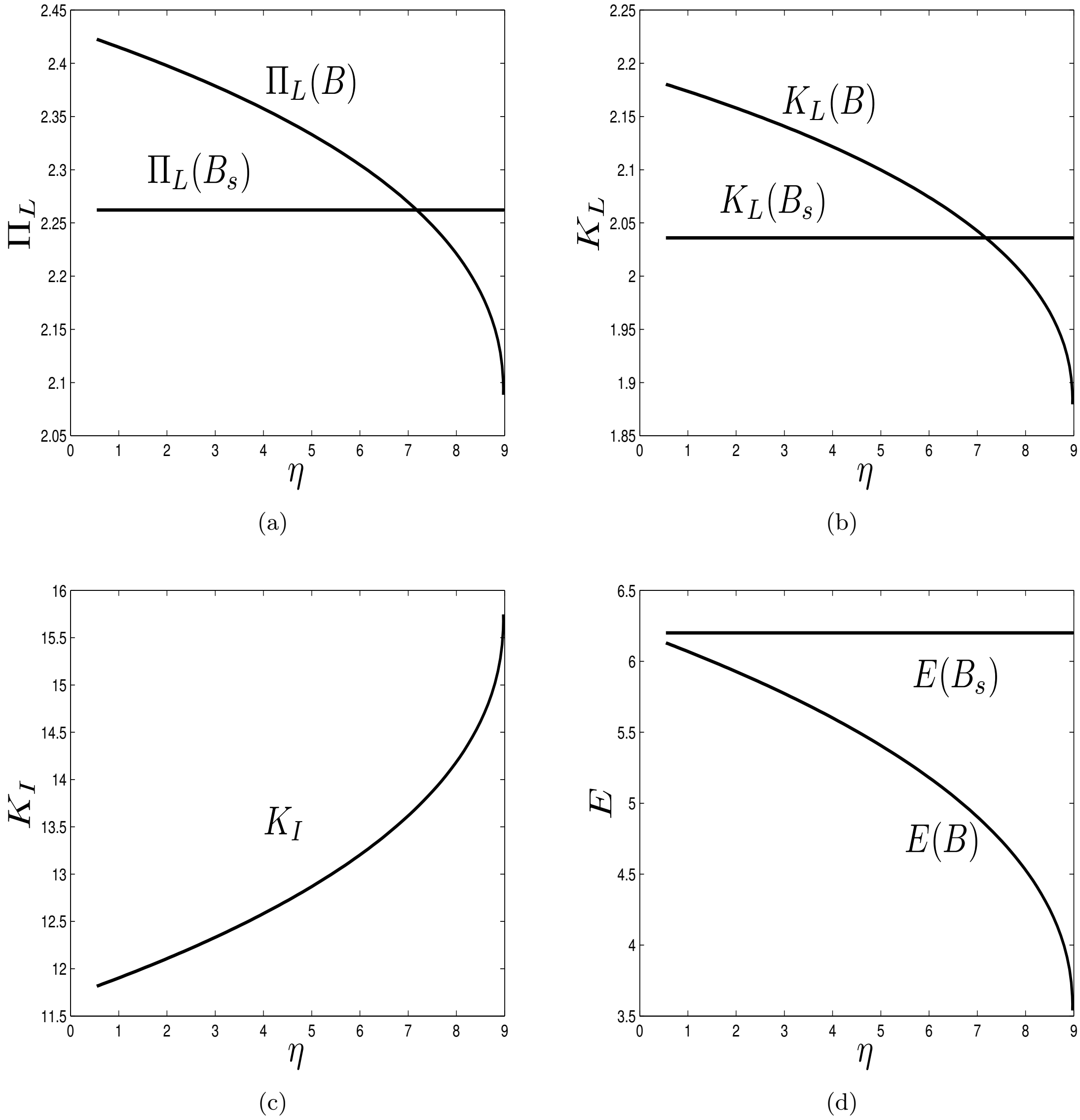


Figure 4: Simulation results with changes in the environmental impact of the external sector (η); parameters values: $\alpha = 0.25$, $\beta = 0.38$, $\gamma = 0.15$, $\delta = 1$, $r = 0.01$, $s = 0.9$, $\overline{E} = 6.2$.