

The Dynamics of Foreign Direct Investments in Land and Pollution Accumulation

Simone Borghesi^{1,2}  · Giorgia Giovannetti^{3,4} ·
Gianluca Iannucci⁴ · Paolo Russu⁵

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Abstract Following the recent increase of foreign direct investments in land, this paper studies their possible effects on the development of a local economy. To this aim, we use a two-sector model (external and local) with heterogeneous agents: *external investors* and *local land owners*. We assume that both sectors are negatively affected by pollution, but only the external sector is polluting. The local government can tax the external sector's production activities to finance environmental defensive expenditures. We first examine the equilibria that emerge in the model from the dynamics of pollution and physical capital, and then investigate the conditions for the coexistence of the two sectors and the impact of the external sector on the revenues of the local population. Using numerical simulations, we show that a revenue-increasing path may occur only if the pollution tax is high enough and the impact of the external sector on pollution is low enough. Otherwise, foreign direct investments may end up impoverishing the local population.

Keywords Foreign direct investments · Land grabbing · Two-sector model · Environmental negative externalities · Pollution taxation

✉ Simone Borghesi
Simone.Borghesi@eui.eu

Giorgia Giovannetti
giorgia.giovannetti@unifi.it

Gianluca Iannucci
gianluca.iannucci@unifi.it

Paolo Russu
russu@uniss.it

¹ FSR Climate, European University Institute (EUI), Via Boccaccio 121, 50133 Florence, Italy

² Department of Political and International Sciences, University of Siena, Siena, Italy

³ Robert Schuman Centre for Advanced Studies, European University Institute, Florence, Italy

⁴ Department of Economics and Management, University of Florence, Florence, Italy

⁵ Department of Economics and Business, University of Sassari, Sassari, Italy

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1 Introduction

The first decade of the millennium has witnessed a surge of foreign direct investments (FDI) in land, a phenomenon often referred to as *land grabbing*.¹ This trend has been particularly pronounced in Africa and Asia (see Fig. 1a, b) that account for about 73% of the host economies in which the FDI in land are realized.² Investments have been generally taking place through purchases or long term leases (typically 50 years and some 99 years, see Cotula 2012). The land rented by foreign investors has been mainly used for food and biofuel production. In the case of food production, many FDI in land derived from countries that are poor of water and arable land, such as the Gulf States (Zoomers 2010), that adopt this kind of FDI as a way of outsourcing domestic food production. In the case of bio-fuel production, instead, the biggest players are high-income OECD countries and emerging economies, which include some important bio-fuel producers, such as China and South Korea (Cotula et al. 2009).³ Since the beginning of the financial crisis, moreover, land started to be acquired not only by investors interested in agriculture of food crops, but also by financial institutions that expected an increase of its value. Indeed, as Deininger et al. (2011) have pointed out, the loss of attractiveness of investing in other assets provoked by the financial crisis contributed to the rapid diffusion of land acquisitions in many continents. According to Deininger et al. (2011), only 20% of announced investments have been followed by agricultural production, and in these cases, the crops were particularly water intensive.

The increasing number of FDI in land has generated a heated debate among scholars and policy makers on their potential effects. Some authors consider this phenomenon as an opportunity to improve local physical capital for agricultural production, while others highlight the negative long-term implications for food security (Arezki et al. 2015).

Following the publication in April 2012 of Land Matrix, a new integrated dataset on FDI in land developed by a net of international research centers,⁴ several studies have provided valuable information on the empirical dimension of the land grabbing phenomenon.⁵ Among them, for instance, Rulli et al. (2013) have compiled data on transnational land acquisition. Using that data set, Coscieme et al. (2016) have performed an interesting exercise that allows to evaluate the biocapacity acquired/lost at the global scale.

While the aforementioned studies can provide important information for future empirical analysis, little attention has been paid so far to the theoretical foundations of the land grabbing phenomenon. Although the latter has attracted much attention in the public opinion, particularly for its potential consequences on the environmental and economic conditions of

¹ By this term, we refer to FDI in land acquisition to produce agricultural goods in developing countries (Saturnino et al. 2011).

² Authors' own estimations based on data retrieved from <http://www.landmatrix.org>.

³ In a study on the drivers of FDI for bio-fuel in Sub-Saharan Africa, Giovannetti and Ticci (2016) have shown that capital is attracted by water abundance, weak institutional framework and ill-defined land property rights.

⁴ This dataset considers signed deals in all the acquisitions of land by domestic and international investors larger than 200 hectares for activities spanning from agricultural production to tourist resorts. Although the dataset still suffers from a few problems, such as changes of definitions over time and a degree of uncertainty on some deals, it is an important source of information that can open new research strands in the next few years.

⁵ See Oya (2013) for a critical methodological discussion on the empirical literature and databases concerning land grabbing. See also Liao et al. (2016) for a discussion of the shortcomings of the research on land grabbing.

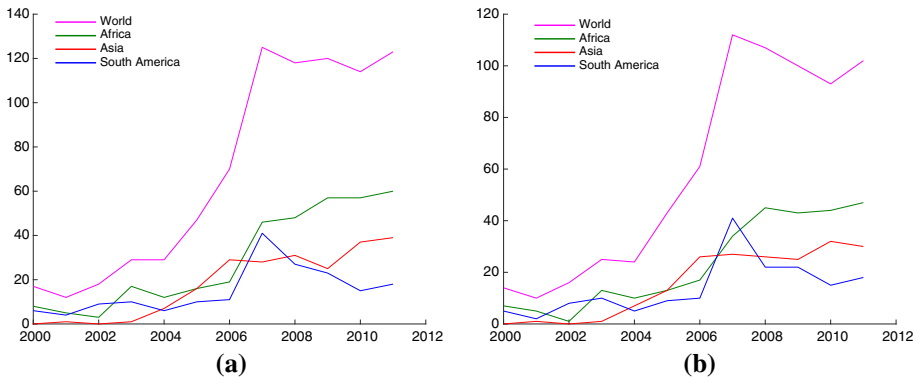


Fig. 1 International deals by intention of investments. **a** All sectors and **b** agriculture. *Source:* Land Matrix database

the receiving country, the on-going debate has generally lacked sound theoretical basis to support one opinion or the other. The model presented below intends to fill this gap and contribute to this debate by proposing a simple theoretical framework that may allow to evaluate the potential effects of the phenomenon described above. For this purpose, this paper proposes a two-sector model (an *external* and a *local* sector) with heterogeneous agents (*external investors* and *local land owners*) to analyse the effects of FDI in land acquisition on economic development and environmental degradation of the host economy. It investigates the dynamics characterizing a small open economy, in which both sectors are negatively affected by the pollution level. Both sectors produce agricultural goods using sector-specific physical capital and the land endowment of the host economy as inputs.⁶

In such a context, the local land owner can rent her land to the external investors or use it for the local production process.⁷ The rent price is set by the land rental market and we assume, for simplicity, instantaneous adjustments in the price level. We suppose that only the external sector is polluting and that the local government can tax its production activity and use the entries generated from the pollution tax to finance environmental defensive expenditures.

From the analysis of the model it emerges that there are two locally attractive stationary states, one in which the economy is specialized in the local sector and one in which the external and the local sector coexist. Numerical simulations suggest that the revenues of local land owners may be greater at the stationary state in which the economy is specialized in the local sector than at the stationary state in which the two sectors coexist. However, if the pollution tax is high enough and the impact of the external sector on pollution is low enough, then the introduction of an external sector may have beneficial effects on the revenues of

⁶ For the sake of simplicity, we suppose that each agent inelastically employs all her labour endowment in the production process, so that the labour input is equal to one in the production function. This simplifying assumption allows to exclude labour from the inputs of the production function and to focus on the land owner's choice between land and capital, which is the object of our analysis.

⁷ An interesting contribution that is germane to this study is the one by Corato et al. (2013) who examine the landholder decision to allocate land between two possible competing and mutually exclusive uses: conservation (leaving land in its pristine state) and development (using it as an input for agricultural production or for commercial forestry). Differently from their study, we assume the existence of two different actors (local land owners and external investors) and that land is used as production inputs of both existing sectors (rather than conserved and left unproductive). Moreover, while that model focuses mainly on the land conversion pace under uncertainty about the value of environmental services and irreversibility of the decisions, here we focus on the effects of external FDI in land on the revenues of local landholders.

local landholders. Indeed, the revenues of local agents are inversely related to the pollution level. Therefore, an increase in the pollution tax and a decrease in the impact of the external sector on pollution tend to increase the revenues of land owners.

The rest of the paper is organized as follows. Section 2 discusses how the present work relates to previous studies in the literature, Sect. 3 introduces the model, Sect. 4 defines the dynamics of the model, while Sect. 5 highlights its basic results. Section 6 illustrates, with the help of numerical simulations, some possible dynamic regimes. Section 7 investigates the effect of the external sector and of the related pollution tax on the revenues of local land owners. Section 8 concludes.

2 Related Literature

The present work builds upon and links together three main research strands that have evolved separately so far: (i) the effects of FDI on local economic development, (ii) the pollution haven hypothesis and (iii) the literature on environmental defensive behaviours.

The first strand is the object of a long-standing debate among scholars. Some authors emphasize the positive role played by FDI on economic development, while others are more critical. Authors emphasizing the “pros” highlight positive effects of FDI on physical capital accumulation in the host economy due to the introduction of innovative technologies and inputs (Borensztein et al. 1998; Kemeny 2010; Cipollina et al. 2012), of knowledge and skills through labour and manager training (Liu et al. 2001; Hansen and Rand 2006), and of industrial competition by overcoming entry barriers and reducing the market power of exiting firms (Chung 2001; Bitzer and Görg 2009; Nicolini and Resmini 2010; Damijan et al. 2013). On the contrary, other authors stress the negative effects on the development of the local economy generated by FDI via the crowding out of local firms (Aitken and Harrison 1999; Agosin and Machado 2005; Herzer et al. 2008; Waldkirch and Ofsu 2010). To examine the issue described before, in the paper we will restrict attention to FDI in land and examine its possible conflicting effects on the revenues of local landowners. Indeed, on the one hand, FDI in land increase the revenues of local agents who rent their land to the external sector; on the other hand they may cause the land a productivity loss that reduces the revenues of local land owners.

Also the second research strand, the *pollution haven hypothesis*, is the object of many studies and large discussions. The basic idea underlying this hypothesis is that the polluting firms from developed countries relocate part of their production activities in developing countries, where the environmental regulations are less stringent (Grether and De Melo 2003). Some authors argue that the more lenient environmental standards attract polluting FDI (see, e.g., Cole 2004; He 2006; Cole and Fredriksson 2009). However, other economists find no relationship between FDI and environmental regulations (see, e.g., Millimet and List 2004; Levinson and Taylor 2008). Differently from that literature, in the present case firms outsource their activities not in search of less stringent environmental norms but rather in search of an environmental resource that is scarce or missing at home.

Finally, the present study builds upon similar frameworks in the literature on environmental defensive behaviours proposed by López (2010) and Antoci et al. (2014, 2015a, b). These authors adopt two-sector models with environmental externalities and heterogeneous agents to investigate how local agents can self-protect from FDI-related environmental degradation

moving from the local sector to the external one. Our model, however, differs from these studies in several respects. While the aforementioned contributions study an industrial sector and a resource-dependent sector, analysing the allocation of labour endowment and the welfare of local workers, here two agricultural sectors are examined, analysing the allocation of land endowment and the welfare of local land owners. Moreover, in López (2010) and Antoci et al. (2014, 2015a, b) local agents can defend themselves from environmental degradation only by working for the polluting sector. In our model, instead, not only local agents can rent their land to the polluting sector, but also the government can defend local agents from environmental degradation by using the revenues raised through the pollution tax. In addition, differently from López (2010) and Antoci et al. (2014, 2015a, b) who measure environmental degradation in terms of depletion of natural resources, here environmental degradation is proxied by the pollution level. Finally, as mentioned above, we assume here that only the external sector is polluting. This assumption is adopted here for the sake of analytical simplicity. The same results would apply if we assumed that also the local sector is polluting but less than the external sector. We are fully aware that local sector production can sometimes be more polluting than the external one (e.g. when the local sector uses old polluting technologies while the external sector adopts new environmental-friendly ones). Moreover, anecdotal evidence shows also positive cases in which the external sector helped protecting the local environment, as in Tanzania where a Swedish enterprise has led an eco-friendly project of bio-fuel production (Havnevik and Haaland 2011). However, we will not look at those cases here since we are interested in the existence of reinforcing mechanisms and/or possible pathological situations that may arise when FDI bring about revenues for local agents at the cost of higher environmental degradation.⁸

3 The Model

Let us consider a small open economy with two production factors (land and physical capital) and two groups of agents: “Local land owners” (L-agents) and “External investors” (E-agents). In this context, we will analyse the accumulation of local physical capital and the evolution of pollution, which depends on production activities.

We assume that the production functions of the two sectors satisfy *Inada* conditions, i.e., are concave, increasing and homogeneous of degree 1 in their inputs. Moreover, we assume that the populations of local and external agents are both consisting of a continuum of identical individuals. The model, therefore, focuses on the choice processes of the representative agents of the two populations. The production function of the representative L-agent is given by:

$$Y_L = \tilde{A} K_L^\alpha L^{1-\alpha} \quad (1)$$

where $\tilde{A} := A/(1 + aP)$ is a measure of productivity of the local sector, which negatively depends on the stock of pollution P ; K_L is the physical capital accumulated by the representative L-agent; L is the land used in the local sector production; $0 < \alpha < 1$ and $A, a > 0$.

⁸ Examples of real cases in which the external sector caused serious environmental damages have occurred in Kenya (FIAN 2010), Tanzania (Arduino et al. 2012), Ghana (Williams et al. 2012), and Mozambique (Woodhouse 2012), particularly due to the intensive use of fertilizers and pesticides (both in food crops and bio-fuel production). In other cases the governments of some countries, such as Madagascar, Sudan, and Cambodia (see, Daniel and Mittal 2009; Haralambous et al. 2009) were forced to ask for international food aid relief due to the loss of land productivity of the local sector caused by the external sector's pollution.

The assumption of an inverse relationship between total factor productivity (\tilde{A}) and P implies that pollution reduces both land and capital productivity in the model.⁹ The negative impact of pollution on land productivity is widely recognized in the literature.¹⁰ In fact, chemical, biological and radioactive pollutants carried around by wind and water tend to settle on the ground, contaminating the crops planted there and causing soil degradation that reduces land productivity (FAO and ITPS 2015). Empirical and anecdotal evidence, moreover, suggest that pollution may damage also capital and its productivity in many different ways. For instance, extreme weather events deriving from climate change cause serious damages to physical capital and infrastructures, which reduce capital productivity (World Bank 2010). Think, for example, of floods or hurricanes destroying installations and roads, compelling transport means to remain unused and therefore unproductive; or heat waves that reduce the capacity of electricity transmission lines. Similarly, water pollution may adversely affect capital productivity. For instance, if storage containers leak, this may cause water table to become acidic, which can corrode the pipelines used in agricultural productions. Moreover, if water quantity is depleted, this may reduce or even halt the productivity of physical capital; this occurs, for instance, when engines overheat due to the lack of cooling water or when the capital used in the hydro sector (e.g. hydraulic turbines used to produce energy) is left idle due to water scarcity. Finally, pollution adversely affects the health status and the productivity of the livestock that represents an important input in the agricultural production process of many developing countries (Sejian et al. 2015).

The L-agent's total endowment of land is normalized to 1. In each instant of time the representative land owner allocates her land endowment between the two sectors; so $1 - L$ represents the land that the local agent rents to the representative External investor. We assume that the allocation of land between the two sectors of the economy takes place at the beginning of the time horizon.¹¹ Land allocation between sectors is determined by the land market equilibrium price which equalizes the land demand from External investors to the land supply from Local land owners.

The production function of the representative External investor is given by:

$$Y_E = \tilde{B} K_E^\beta (1 - L)^{1-\beta} \quad (2)$$

where K_E denotes the stock of sector-specific physical capital invested by the representative E-agent in the economy; $\tilde{B} := B/(1 + bP)$ is a measure of productivity of external sector; $0 < \beta < 1$ and $B, b > 0$. The representative E-agent chooses her land demand $1 - L$ and the stock of physical capital K_E in order to maximize her profits, i.e.:

$$\max_{1-L, K_E} \left[(1 - \tau) \tilde{B} K_E^\beta (1 - L)^{1-\beta} - r_L (1 - L) - r_K K_E \right] \quad (3)$$

⁹ Several other contributions in the literature assume a negative impact of pollution on the output of the economy, using Cobb–Douglas production functions (e.g. Rezaei et al. 2012; Hackett and Moxnes 2015; Dao et al. 2017). In particular, Hackett and Moxnes (2015) adopt a formalization that is akin to the one presented here, assuming that pollution-related temperature increase affects total factor productivity through a climate damage multiplier that reduces the overall output. A few theoretical models (e.g. Ikefuji and Horii 2012; Bretschger 2017; Bretschger and Pattakou 2018), moreover, assume that pollution specifically affects capital. For instance, using a two-sector model, Bretschger and Pattakou (2018) assume that pollution stock harms capital and examine the effects of high marginal climate damages that may occur when temperature thresholds are reached.

¹⁰ It is estimated (FAO and ITPS 2015) that about one third of the total land available at the world level is degraded due to erosion, salinization, acidification and chemical pollution of soil.

¹¹ Notice that in a discrete time model, first land allocation takes place (say, at time t), and then production occurs (at $t + 1$). In the present context with continuous time, instead, the time horizon collapses to a single instant of time.

where $\tau \in (0, 1)$ is a parameter that measures the environmental taxation, r_L and r_K are, respectively, the land rental price and the cost of capital. We assume that r_K is an exogenous parameter, while r_L is endogenously determined by the land rental market equilibrium condition. We suppose that K_E inflow is potentially unlimited.

The maximization problem of the representative Local agent is instead the following:

$$\max_L \left[\tilde{A}K_L^\alpha L^{1-\alpha} + r_L(1 - L) \right] \tag{4}$$

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

$$\dot{K}_L = s \left[\tilde{A}K_L^\alpha L^{1-\alpha} + r_L(1 - L) \right] - \gamma K_L \tag{5}$$

where \dot{K}_L is the time derivative dK_L/dt of K_L , $s \in (0, 1)$ is the constant saving rate, and $\gamma > 0$ represents the depreciation of K_L . Equation (5) implies a Solow-type accumulation dynamics for the local sector, namely, with constant propensity to save, as in Solow (1956)'s growth model. Indeed, following Antoci et al. (2014), we assume that local agents are not forward looking and are unable to coordinate their choices. This implies that they maximize their own objective function at every instant of time, but they do not invest optimally (i.e. they do not solve an intertemporal optimization problem).¹²

To simplify, we assume that the prices of the goods produced in the local and in the external sectors are both equal to unity; moreover, the land rental price r_L is expressed in terms of the output of the external sector. Finally, the dynamics of pollution is described by:

$$\dot{P} = \delta \bar{Y}_E - \varepsilon P - \eta D$$

where \dot{P} is the time derivative dP/dt of P , \bar{Y}_E represents the economy-wide average value of Y_E , $\delta > 0$ is a parameter that measures the impact of the external sector on pollution, $\varepsilon > 0$ represents the decay rate of pollution P , D are the pollution abatement expenditures financed by taxation of external economic activities ($D = \tau \bar{Y}_E$), and $\eta > 0$ is a parameter that measures the effectiveness of pollution abatement expenditures. Therefore, the dynamics of pollution can be rewritten as:

$$\dot{P} = (\delta - \eta\tau)\bar{Y}_E - \varepsilon P \tag{6}$$

We assume that each economic agent considers as negligible the impact of her choices on \bar{Y}_E and on the time evolution of P (that is, \bar{Y}_E is considered as exogenously determined). Since E-agents are identical, the average output Y_E ex post coincides with the per capita value Y_E .

4 Dynamics

The dynamics is obtained by solving the maximization problems (3)–(4); the solutions of these problems allow to determine the equilibrium values of L and K_E . In particular, the maximization problem of the representative L-agent determines the following first order condition:

$$r_L = (1 - \alpha) \tilde{A}K_L^\alpha L^{-\alpha} \tag{7}$$

¹² As Antoci et al. (2012) have shown, pathological outcomes similar to the ones highlighted in this paper may arise even if we assume that agents are forward looking and can perform intertemporal optimization. This suggests that in the present context, the existence of coordination failures is likely to matter more than the degree of rationality of the agents in driving the findings of the model.

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

$$r_L = (1 - \beta) (1 - \tau) \tilde{B} K_E^\beta (1 - L)^{-\beta} \tag{8}$$

$$r_K = \beta (1 - \tau) \tilde{B} K_E^{\beta-1} (1 - L)^{1-\beta} \tag{9}$$

We assume that land rental market is perfectly competitive and land rental prices are flexible. E- and L-agents take r_L as given, but land rental price and land allocation between the two sectors continue to change until land rental demand is equal to land rental supply. The land rental market equilibrium condition is given by:

$$(1 - \beta) (1 - \tau) \tilde{B} K_E^\beta (1 - L)^{-\beta} = (1 - \alpha) \tilde{A} K_L^\alpha L^{-\alpha} \tag{10}$$

From Eq. (9), we have:

$$K_E = \left(\frac{\beta}{r_K} (1 - \tau) \tilde{B} \right)^{\frac{1}{1-\beta}} (1 - L) \tag{11}$$

Substituting Eq. (11) in Eq. (10), we obtain:

$$L = \Gamma (\tilde{A} K_L^\alpha)^{\frac{1}{\alpha}} \tag{12}$$

where

$$\Gamma := \left[\frac{1 - \alpha}{(1 - \beta) \left(\tilde{B} (1 - \tau) \right)^{\frac{1}{1-\beta}} \left(\frac{\beta}{r_K} \right)^{\frac{\beta}{1-\beta}}} \right]^{\frac{1}{\alpha}}$$

Function (12) identifies the equilibrium land allocation value \tilde{L} of L if the right side of Eq. (12) is lower than 1; otherwise, $\tilde{L} = 1$, that is:

$$\tilde{L} = \min \left\{ 1, \Gamma (\tilde{A} K_L^\alpha)^{\frac{1}{\alpha}} \right\} \tag{13}$$

Consequently, from Eq. (11), the equilibrium value \tilde{K}_E of K_E is determined by:

$$\tilde{K}_E = \left(\frac{\beta}{r_K} (1 - \tau) \tilde{B} \right)^{\frac{1}{1-\beta}} (1 - \tilde{L}) \tag{14}$$

The economy is specialized in the production of the L-sector if $\tilde{L} = 1$ (and, consequently, $\tilde{K}_E = 0$). The graph of the function (represented in green in Fig. 2a, b)

$$K_L := \bar{K}_L = \frac{1}{\Gamma (\tilde{A})^{\frac{1}{\alpha}}} \tag{15}$$

is the separatrix of the plane with pollution P on the vertical axis and physical capital K_L on the horizontal axis: it separates the region of the plane (P, K_L) where $\tilde{L} = 1$ (above it) from the region where $\tilde{L} < 1$ (below it).

From condition (13) we can distinguish two possible cases: (a) if $K_L = 0$, then the economy specializes in the production of the external sector (that is, $\tilde{L} = 0$ and $K_E = \left(\frac{\beta}{r_K} (1 - \tau) \tilde{B} \right)^{\frac{1}{1-\beta}}$ are chosen); and (b) if $K_L > 0$, instead, condition (13) excludes the specialization in the external sector (i.e., $\tilde{L} > 0$ always holds for $K_L > 0$). In this case, we

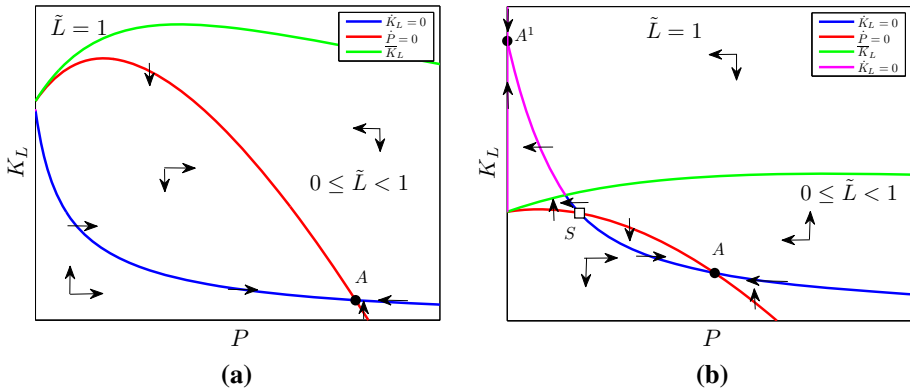


Fig. 2 Isoclines. *Parameter values:* $A = 1, B = 2, a = 5, b = 2, \alpha = 0.65, \beta = 0.35, \delta = 0.5, r = 0.1, s = 0.6, \eta = 1, \varepsilon = 0.55, \gamma = 0.19$. **a** $\tau = 0.12$ and **b** $\tau = 0.42$

can distinguish two sub-cases, that is: (i) the case without specialization in the local sector (i.e., $\tilde{L} \in (0, 1)$) and (ii) the case with specialization (i.e., $\tilde{L} = 1$). When $K_L > 0$, the external sector never completely replaces the local sector since the productivity of land used in the local activities tends to infinity as $L \rightarrow 0$. On the contrary, when $K_L > 0$ the economy can fully specialize in the local sector though also the productivity of land in the external sector tends to infinity as $(1 - L) \rightarrow 0$. In this case, the land rent price becomes increasingly high, therefore, E-agents move their capital outside the economy and reduce K_E , which eventually goes to zero, so that the economy ends up fully specializing in the local sector.

4.1 Dynamics Without Specialization

If $\Gamma \left(\tilde{A}K_L^\alpha \right)^{\frac{1}{\alpha}} < 1$ [see function (12)], then the representative L-agent rents a positive fraction of her total land endowment to be used by the representative E-agent. In this case, from Eqs. (8) and (11), the equilibrium land rental price is given by:

$$r_L = (1 - \beta) \left(\tilde{B} (1 - \tau) \right)^{\frac{1}{1-\beta}} \left(\frac{\beta}{r_K} \right)^{\frac{\beta}{1-\beta}} \tag{16}$$

When $\Gamma \left(\tilde{A}K_L^\alpha \right)^{\frac{1}{\alpha}} < 1$, moreover, the dynamics of the capital invested in the L-sector is given by:

$$\begin{aligned} \dot{K}_L &= s \left[\tilde{A}K_L^\alpha L^{1-\alpha} + r_L(1 - L) \right] - \gamma K_L \\ &= s \left[\alpha \Gamma^{1-\alpha} \left(\tilde{A}K_L^\alpha \right)^{\frac{1}{\alpha}} + (1 - \beta) \left(\tilde{B} (1 - \tau) \right)^{\frac{1}{1-\beta}} \left(\frac{\beta}{r_K} \right)^{\frac{\beta}{1-\beta}} \right] - \gamma K_L \end{aligned} \tag{17}$$

while the time evolution of P is represented by:

$$\begin{aligned} \dot{P} &= (\delta - \eta\tau)\bar{Y}_E - \varepsilon P \\ &= (\delta - \eta\tau) \tilde{B}^{\frac{1}{1-\beta}} \left(\frac{\beta}{r_K} (1 - \tau) \right)^{\frac{\beta}{1-\beta}} \left(1 - \Gamma \left(\tilde{A}K_L^\alpha \right)^{\frac{1}{\alpha}} \right) - \varepsilon P \end{aligned} \tag{18}$$

The system of Eqs. (17) and (18), therefore, represents the dynamics of the economy in the case without specialization.

4.2 Dynamics with Specialization

If $\Gamma \left(\tilde{A}K_L^\alpha \right)^{\frac{1}{\alpha}} \geq 1$ [that is, above the separatrix curve (15) in the plane (P, K_L)], the representative L-agent allocates all her land endowment to the production activity of the L-sector, that is $\tilde{L} = 1$. The dynamics of the economy in the case with specialization is described by the equations:

$$\dot{K}_L = s \left(\tilde{A}K_L^\alpha \right) - \gamma K_L \tag{19}$$

$$\dot{P} = -\varepsilon P \tag{20}$$

5 Stationary States

As it can be easily proved, a stationary state in which the economy is specialized in the external sector does not exist.¹³ Therefore, two types of stationary states may be observed:

- the stationary state $A^l = (P, K_L) = \left(0, \left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}} \right)$, derived from Eqs. (19) and (20), in which the economy is specialized in the local sector, and the pollution level is equal to zero;
- stationary states with both P and K_L strictly positive in which both sectors coexist [see Eqs. (17), (18)].¹⁴

The following proposition illustrates the conditions for the existence of the stationary state when the economy is specialized in the local sector.

Proposition 1 *The state $A^l = \left(0, \left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}} \right)$ is a stationary state of the system (19)–(20) if and only if*

$$A \geq \left(\frac{\gamma}{s} \right)^\alpha \left[\frac{1 - \alpha}{(1 - \beta)(B(1 - \tau))^{\frac{1}{1-\beta}} \left(\frac{\beta}{rK} \right)^{\frac{\beta}{1-\beta}}} \right]^{\alpha-1} \tag{21}$$

When existing, this stationary state is always attractive (see Fig. 2b).

Proof According to the system (19)–(20), it holds that $\dot{K}_L = 0$ for:

$$K_L = \left[\frac{sA}{\gamma(1 + aP)} \right]^{\frac{1}{1-\alpha}}$$

The dynamics (19)–(20) admits an unique stationary state $A^l = (P, K_L) = \left(0, \left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}} \right)$ if and only if A^l lies above the separatrix $K_L = \bar{K}_L$ [see function (15)], i.e, if $\bar{K}_L(0) \leq \left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}}$, that is:

¹³ Notice that, if the economy specializes in the external sector, then $K_L = 0$ and $L = 0$. If this is the case, from (5) it follows that the saving rate and/or the land rental price would have to be zero at the stationary states, which violates the assumptions underlying the model.

¹⁴ As it will be shown below (see Sect. 6) through numerical simulations, these stationary states are either attractive or saddle points.

$$A \geq \frac{\left(\frac{\gamma}{s}\right)^\alpha}{\Gamma^{\alpha(1-\alpha)}} = \left(\frac{\gamma}{s}\right)^\alpha \left[\frac{1-\alpha}{(1-\beta)(B(1-\tau))^{\frac{1}{1-\beta}} \left(\frac{\beta}{rK}\right)^{\frac{\beta}{1-\beta}}} \right]^{\alpha-1}$$

While the Jacobian matrix of the system (19)–(20), calculated at the stationary state A^l is:

$$J(A^l) = \begin{pmatrix} -(1-\alpha)s\tilde{A}K_L^{\alpha-1} & -\alpha sAK_L^\alpha \\ 0 & -\varepsilon \end{pmatrix}$$

with strictly negative eigenvalues: $-(1-\alpha)s\tilde{A}K_L^{\alpha-1} < 0$ and $-\varepsilon < 0$. Therefore, when the stationary state A^l exists, it is always attractive. \square

As Proposition 1 points out, the stationary state without external sector A^l , when existing, lies always above the separatrix \bar{K}_L (where $\tilde{L} = 1$) and it is always attractive. The following Proposition describes the global dynamics of system (5)–(6).

Proposition 2 *The set:*

$$\Omega = \{(P, K_L) : 0 \leq P \leq P^* \text{ and } 0 \leq K_L \leq K_L^*\}$$

where

$$P^* := \frac{\delta - \eta\tau}{\varepsilon} B^{\frac{1}{1-\beta}} \left[\frac{\beta}{rK} (1-\tau) \right]^{\frac{\beta}{1-\beta}}, \quad K_L^* > \max \left[\left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}}, \hat{K}_L \right]$$

and

\hat{K}_L is the maximum of the function (15),

is positively invariant under the dynamics (5)–(6); every trajectory starting outside Ω enters it in finite time. When the stationary state with specialization $A^l = (P, K_L) = \left(0, \left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}} \right)$ does not exist, then no sector definitively disappears from the economy (both sectors coexist).

Proof Considering Eq. (18), we can write:

$$\begin{aligned} \dot{P} &= (\delta - \eta\tau)\tilde{B}^{\frac{1}{1-\beta}} \left[\frac{\beta}{r} (1-\tau) \right]^{\frac{\beta}{1-\beta}} \left[1 - \Gamma \left(\tilde{A}K_L^\alpha \right)^{\frac{1}{\alpha}} \right] < (\delta - \eta\tau)\tilde{B}^{\frac{1}{1-\beta}} \left[\frac{\beta}{r} (1-\tau) \right]^{\frac{\beta}{1-\beta}} - \varepsilon P \\ &\leq (\delta - \eta\tau)B^{\frac{1}{1-\beta}} \left[\frac{\beta}{r} (1-\tau) \right]^{\frac{\beta}{1-\beta}} - \varepsilon P \end{aligned}$$

Since the maximum value that \tilde{B} can assume is B , then it holds $\dot{P} > 0$ for:

$$P \geq P^* := \frac{\delta - \eta\tau}{\varepsilon} B^{\frac{1}{1-\beta}} \left[\frac{\beta}{rK} (1-\tau) \right]^{\frac{\beta}{1-\beta}}$$

Indicating with \hat{K}_L the maximum of the function [see (15)] $K_L = \bar{K}_L(P) := \frac{1}{\Gamma(\tilde{A})^{\frac{1}{\alpha}}}$ (that always exists), and remembering that the value of K_L in the stationary state A^l is given by $\left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}}$, it holds $\dot{K}_L < 0$ for every $K_L > \max \left[\left(\frac{sA}{\gamma} \right)^{\frac{1}{1-\alpha}}, \hat{K}_L \right]$. \square

Proposition 2 implies that coexistence between sectors is possible. Indeed, if the stationary state A^l does not exist (i.e., the economy can not specialize in the local sector), then trajectories that enter the set Ω can approach either a stationary state or a limit set (e.g., a limit cycle) in which both sectors coexist.

If the economy is not specialized in the local sector, the stationary states of the system (17)–(18) are given by the solutions of the system of equations:

$$\begin{aligned}
 0 &= s \left[\alpha \Gamma^{1-\alpha} \left(\tilde{A} K_L^\alpha \right)^{\frac{1}{\alpha}} + (1 - \beta) \left(\tilde{B} (1 - \tau) \right)^{\frac{1}{1-\beta}} \left(\frac{\beta}{r_K} \right)^{\frac{\beta}{1-\beta}} \right] - \gamma K_L \\
 0 &= (\delta - \eta\tau) \tilde{B}^{\frac{1}{1-\beta}} \left(\frac{\beta}{r_K} (1 - \tau) \right)^{\frac{\beta}{1-\beta}} \left(1 - \Gamma \left(\tilde{A} K_L^\alpha \right)^{\frac{1}{\alpha}} \right) - \varepsilon P
 \end{aligned}
 \tag{22}$$

From system (22), we obtain that $\dot{K}_L = 0$ for:

$$K_L = F(P) := \frac{s(1 - \alpha)\bar{K}_L}{\gamma \bar{K}_L \Gamma^\alpha - \alpha s}
 \tag{23}$$

and $\dot{P} = 0$ for:

$$K_L = G(P) := \bar{K}_L - \frac{\varepsilon P(1 + bP)^{\frac{1}{1-\beta}} \bar{K}_L}{(\delta - \eta) \tilde{B}^{\frac{1}{1-\beta}} \left(\frac{\beta}{r_K} (1 - \tau) \right)^{\frac{\beta}{1-\beta}}}
 \tag{24}$$

Two cases can occur:

- (i) If $\delta - \eta\tau \leq 0$, i.e., the polluting impact of the external sector (δ) does not overcome the pollution abatement effect (η) of the defensive expenditures financed by tax entries (τ), then from Eq. (18) it holds that $\dot{P} < 0$ for every $P > 0$, therefore, there are no stationary states with $P > 0$ and the trajectories tend toward the axis $P = 0$.
- (ii) If $\delta - \eta\tau > 0$, namely, the pollution abatement effort made possible through the pollution tax is insufficient to counterbalance the polluting impact of the external sector, then the curve $K_L = G(P)$ lies always below the separatrix $\bar{K}_L(P)$ and there can be stationary states with $P > 0$ in which both sectors coexist.

Stated differently, cases (i) and (ii) above imply that if the pollution tax is high enough (above the ratio between δ and η) the economy will converge to an equilibrium without pollution, otherwise it will tend to a coexistence equilibrium in which the pollution level is positive. Moreover, $G(0) = \bar{K}_L(0)$, i.e., the curve $K_L = G(P)$ and the separatrix $K_L = \bar{K}_L(P)$ have the same intercept on the axis $P = 0$ (cf. Fig. 2b). It is not possible to compute analytically the number of intersection points that may be observed; however, from the shape of the curves $\dot{P} = 0$ and $\dot{K}_L = 0$ it follows that there may exist at most two stationary states with $P > 0$, i.e., the attraction point A and the saddle point S (see Fig. 2a, b).

6 Simulations

This section presents the results of some numerical simulations of the dynamics of our model.

Consider first Fig. 2. Numerical simulations show that if the pollution tax is low enough (e.g., $\tau = 0.12$ in Fig. 2a), the economy cannot fully specialize in the local sector. However, when the pollution tax gets sufficiently high (e.g., $\tau = 0.42$ in Fig. 2b), there exists also the locally attractive stationary state A^l so that the economy can converge to an equilibrium

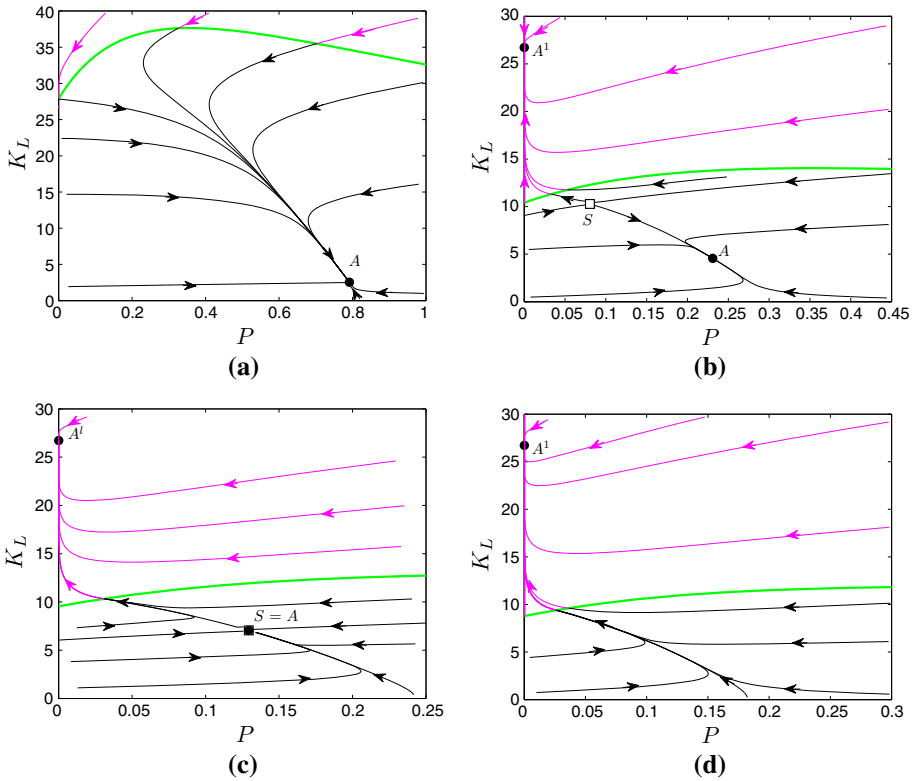


Fig. 3 Phase portraits. *Parameter values:* $A = 1, B = 2, a = 5, b = 2, \alpha = 0.65, \beta = 0.35, \delta = 0.5, r = 0.1, s = 0.6, \eta = 1, \varepsilon = 0.55, \gamma = 0.19$. **a** $\tau = 0.12$, **b** $\tau = 0.42$, **c** $\tau = 0.44$ and **d** $\tau = 0.46$

without external sector. This result is rather intuitive: since the pollution tax enters as a cost in the maximization problem (3) of the E-agents (the external investors), the higher (lower) the pollution tax, the lower (higher) the incentive for external investors to purchase the local land to establish their production activities in the region.

Figure 3 shows the phase diagrams corresponding to Fig. 2a, b as well as the trajectories that emerge from further increases in the pollution tax. Four types of dynamic regimes may be observed depending on the level of the pollution tax:

- (a) if the pollution tax is low enough, then a unique globally attractive stationary state A exists in which both sectors coexist (see Fig. 3a);
- (b) for intermediate values of the pollution tax, the dynamics is bi-stable and there are two locally attractive stationary states: A^l , in which the economy is specialized in the local sector, and A , where both sectors coexist (see Fig. 3b); the basins of attraction of A^l and A are separated by the stable branch of the saddle point S ;
- (c) if the pollution tax keeps on increasing up to a threshold level ($\tau = 0.44$) there are still two locally attractive stationary states (with and without full specialization in the local sector); however, in this case the saddle point S and the coexistence equilibrium A , located below the separatrix (15), coincide because the isoclines $\dot{K}_L = 0$ and $\dot{P} = 0$ are now tangent (see Fig. 3c);

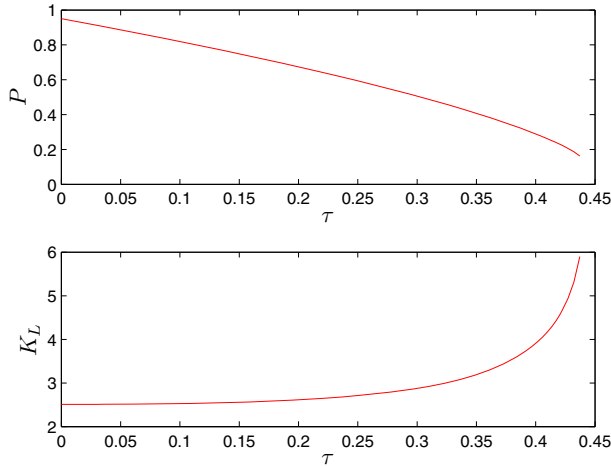


Fig. 4 Equilibrium values of K_L and P at the stationary state A , as τ changes. Parameter values: $A = 1$, $B = 2$, $a = 5$, $b = 2$, $\alpha = 0.65$, $\beta = 0.35$, $\delta = 0.5$, $r = 0.1$, $s = 0.6$, $\eta = 1$, $\varepsilon = 0.55$, $\gamma = 0.19$

- (d) if the pollution tax further increases beyond the threshold level indicated above, then the stationary state A^l becomes globally attractive, and, consequently, the economy always specializes in the local sector (see Fig. 3d).¹⁵

What is the pollution level to which these four dynamic regimes will converge? Recall that the entries coming from the pollution tax are used to finance environmental defensive expenditures [see Eq. (6)]. Therefore, if the pollution tax is low enough with respect to the polluting effect of the external sector, then environmental defensive expenditures are insufficient to abate pollution so that at the end of the day the pollution level is relatively high at the stationary state (around 0.8 in Fig. 3a). However, if the pollution tax gets high enough with respect to the impact of the external sector on pollution, then environmental defensive expenditures can effectively reduce pollution; therefore, the pollution level keeps on decreasing with further increases in τ becoming lower and lower at the equilibrium (less than 0.25 in Fig. 3b and less than 0.15 in Fig. 3c). When taxation overcomes a threshold level (i.e. above $\tau = 0.44$ in the present case) foreign investors flee away and the country is left with only the local (clean) sector so that pollution gets to zero at equilibrium (Fig. 3d). In this case, therefore, the country can enjoy a clean environment but has no more entries from FDI.

Figure 4 shows the equilibrium values of P and K_L at the stationary state A as the taxation level τ increases. As emerges from the diagram, pollution (local capital) is monotonically decreasing (increasing) with taxation. Notice that the curve of local capital has a positive vertical intercept, confirming that the local sector does not disappear (i.e. the economy does not specialize in the external sector) even when no environmental taxation occurs ($\tau = 0$).

¹⁵ Notice that the taxation values reported in Fig. 3a, b are not thresholds levels but numerical examples consistent with the dynamic regimes shown in these figures. On the contrary, $\tau = 0.44$ is a threshold value under the chosen parametrization such that the number of stationary states changes as taxation overcomes 0.44 (Fig. 3c, d). Similarly, under the chosen parametrization $\tau = 0.1371$ is the threshold level beyond which an additional attractive stationary state A^l emerges as we pass from Fig. 3a to b.

7 Welfare of Local Land Owners

In this section we perform a welfare analysis of the model comparing the revenues of L-agents at A^l and at stationary states in which both sectors coexist.¹⁶

The remuneration of capital K_E invested by the representative E-agent is $r_K K_E$ while the revenues of the representative L-agent are given by:

$$\begin{aligned} \Pi_L(P, K_L) &= \bar{A}K_L^\alpha L^{1-\alpha} + r_K(1 - L) \\ &= \begin{cases} \alpha\Gamma^{1-\alpha}(\bar{A}K_L^\alpha)^\frac{1}{\alpha} + (1 - \beta)(\bar{B}(1 - \tau))^\frac{1}{1-\beta} \left(\frac{\beta}{r_K}\right)^\frac{\beta}{1-\beta} & \text{if } K_L < \bar{K}_L(P) \\ \bar{A}K_L^\alpha & \text{if } K_L \geq \bar{K}_L(P) \end{cases} \end{aligned}$$

Therefore, the revenues of the representative L-agent in $A^l = (P, K_L) = \left(0, \left(\frac{sA}{\gamma}\right)^\frac{1}{1-\alpha}\right)$ are equal to:

$$\Pi_L(A^l) = \Pi_L\left(0, \left(\frac{sA}{\gamma}\right)^\frac{1}{1-\alpha}\right) = A^\frac{1}{1-\alpha} \left(\frac{s}{\gamma}\right)^\frac{\alpha}{1-\alpha}$$

The effects generated by the external investments on the revenues of 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:

$$\dot{K}_L = sAK_L^\alpha - \gamma K_L \tag{25}$$

According to the one-sector dynamics (25), the state $K_L = \left(\frac{sA}{\gamma}\right)^\frac{1}{1-\alpha}$ is always a globally attractive stationary state and corresponds to the stationary state A^l of the two-sector model, when existing. We shall compare the revenues of L-agents obtained at the stationary state A^l with those obtained at a generic state (P, K_L) where both sectors coexist. Observe that when both sectors coexist local agents are better-off (i.e. $\Pi_L(A^l) < \Pi_L(P, K_L)$) if and only if the following condition applies:

$$A^\frac{\alpha}{1-\alpha} \left(\frac{s}{\gamma}\right)^\frac{\alpha}{1-\alpha} < \alpha\Gamma^{1-\alpha} (\bar{A}K_L^\alpha)^\frac{1}{\alpha} + (1 + \beta) (\bar{B}(1 - \tau))^\frac{1}{1-\beta} \left(\frac{\beta}{r_K}\right) \tag{26}$$

Setting:

$$A^\frac{\alpha}{1-\alpha} \left(\frac{s}{\gamma}\right)^\frac{\alpha}{1-\alpha} = \alpha\Gamma^{1-\alpha} (\bar{A}K_L^\alpha)^\frac{1}{\alpha} + (1 + \beta) (\bar{B}(1 - \tau))^\frac{1}{1-\beta} \left(\frac{\beta}{r_K}\right)$$

we obtain the indifference curve (IC):

$$\alpha\Gamma^{1-\alpha} (\tilde{A}K_L^\alpha)^\alpha + (1 - \beta)(\tilde{B}(1 - \tau))^\frac{1}{1-\beta} \left(\frac{\beta}{1 - \beta}\right)^\frac{\beta}{1-\beta} - AK_L^\alpha = 0 \tag{27}$$

with $\Pi_L(A^l) < \Pi_L(P, K_L)$ (respectively, $\Pi_L(A^l) > \Pi_L(P, K_L)$) if the state (P, K_L) lies above (below) it, in the plane (P, K_L) . The following proposition holds.

¹⁶ In the rest of the paper we will use the term “welfare analysis” that is commonly used in the literature although we mainly focus on the effects that FDI in land have on the revenues of local land owners. We are fully aware that welfare implies a much broader notion than revenues as it depends on many additional drivers beyond revenues including, among other things, the environmental quality of the local ecosystem. This consideration, however, may actually reinforce some of the main results emerging from the analysis. Indeed, if external investments turn out to be non-convenient for local land owners in the present model, they would be a fortiori welfare-reducing if pollution deriving from such investments was properly taken into account.

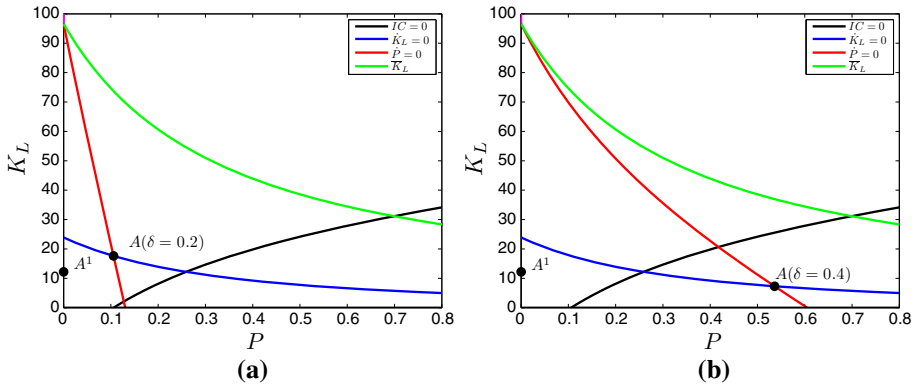


Fig. 5 Indifference Curve. Parameter values: $A = 1, B = 2, a = 5, b = 2, \alpha = 0.65, \beta = 0.35, r = 0.1, s = 0.6, \eta = 1, \varepsilon = 0.55, \gamma = 0.19$ and $\tau = 0.18$

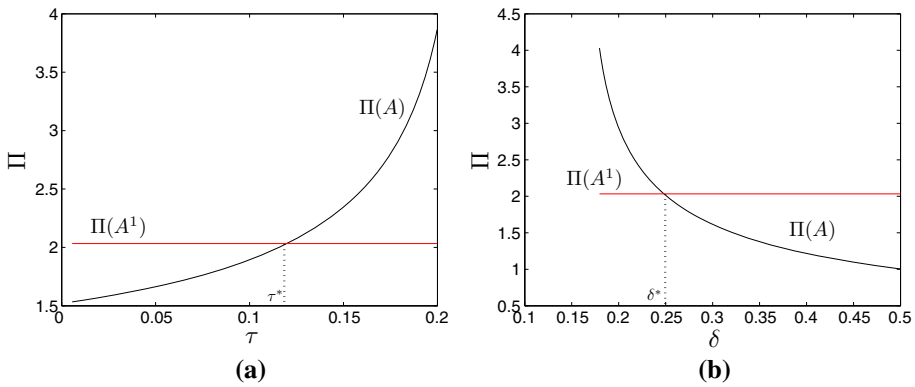


Fig. 6 Welfare analysis: relationship between revenues of local land owners and pollution tax (a), and impact of the external sector on pollution (b). Parameter values: $A = 1, B = 2, a = 5, b = 2, \alpha = 0.65, \beta = 0.35, r = 0.1, s = 0.6, \eta = 1, \varepsilon = 0.55, \gamma = 0.19$. **a** $\delta = 0.2$ and **b** $\tau = 0.18$

Proposition 3 *The revenues of L-agents, evaluated at a generic point (P, K_L) where both sectors coexist, are greater than in A^l (i.e., $\Pi_L(A^l) < \Pi_L(P, K_L)$, see Fig. 5a), if the point (P, K_L) lies above the indifference curve (27). Conversely, if the point A lies below the indifference curve (27), then $\Pi_L(A^l) > \Pi_L(P, K_L)$ (see Fig. 5b).*

As Fig. 5a shows, if the polluting effect of the external sector is relatively low ($\delta = 0.2$), then local agents can be better-off with the external sector than without it (the coexistence stationary state A being above the indifference curve). However, an increase in the polluting impact of the external sector (from $\delta = 0.2$ in Fig. 5a to $\delta = 0.4$ in Fig. 5b) can reverse this relationship and shift the coexistence equilibrium below the indifference curve so that local agents end up being worse-off with the external sector.

Consistently with Proposition 3, numerical simulations show that if the pollution tax is high enough with respect to the impact of the external sector on pollution, then the introduction of an external sector may lead the economy to a revenue-increasing path, i.e., $\Pi(A^l) < \Pi(A)$ (see Fig. 6a in which the curve $\Pi(A)$ crosses the horizontal line $\Pi(A^l)$ from below, at $\tau = \tau^*$, therefore $\Pi(A^l) < \Pi(A)$ for $\tau > \tau^*$). On the contrary, if the pollution tax is low enough

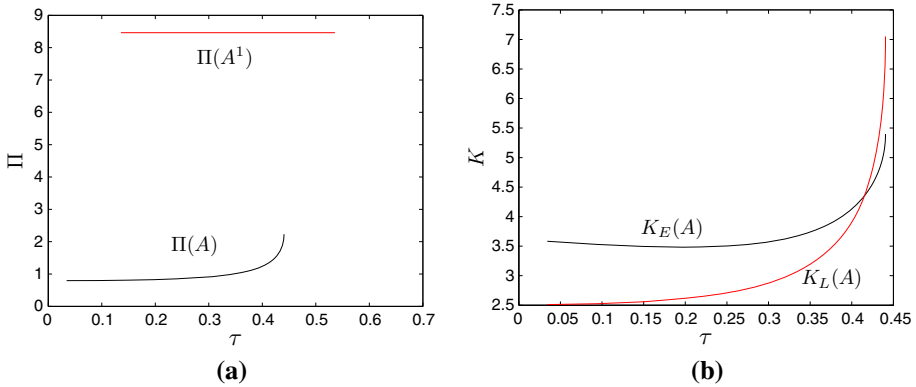


Fig. 7 Welfare analysis: relationship between pollution tax and revenues of local land owners (a), and capital levels in both sectors (b). Parameter values: $A = 1, B = 2, a = 5, b = 2, \alpha = 0.65, \beta = 0.35, r = 0.1, s = 0.6, \eta = 1, \varepsilon = 0.55, \gamma = 0.19$ and $\delta = 0.5$

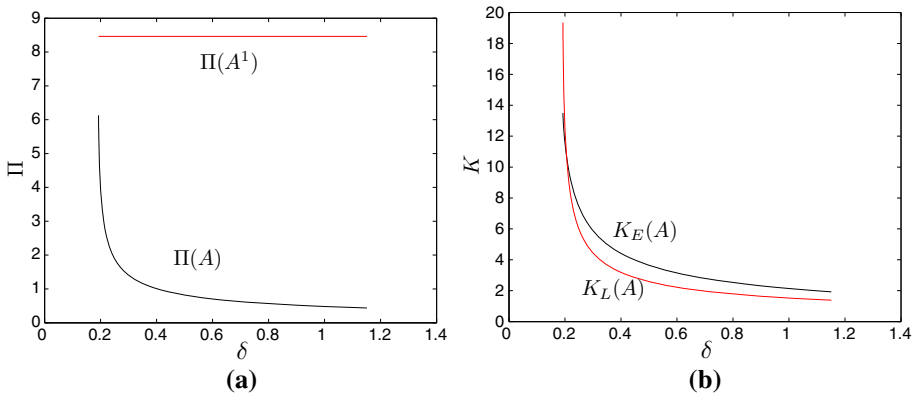


Fig. 8 Welfare analysis: relationship between impact of the external sector on pollution and revenues of local land owners (a), and capital levels in both sectors (b). Parameter values: $A = 1, B = 2, a = 5, b = 2, \alpha = 0.65, \beta = 0.35, r = 0.1, s = 0.6, \eta = 1, \varepsilon = 0.55, \gamma = 0.19$ and $\tau = 0.18$

with respect to the impact of the external sector on pollution, then a revenue-reducing path (i.e., $\Pi(A^l) > \Pi(A)$) may come along with the external sector (see Fig. 6a for $\tau < \tau^*$). Mutatis mutandis, a reduction in the revenues of local land owners may also occur if the impact of the external sector on pollution is high enough with respect to the pollution tax. This can be easily seen from Fig. 6(b): for a given level of the pollution tax ($\tau = 0.18$) we have $\Pi(A^l) > \Pi(A)$ when δ is above the threshold level ($\delta = 0.25$).¹⁷

From the numerical simulations shown in Figs. 7a, b, and 8a, b, we can infer the following main results:

- (i) an increase of the pollution tax may have positive effects on $\Pi(A)$ (see Fig. 7a) and on both local and external capitals (see Fig. 7b), since it decreases the pollution level, which increases the productivities \tilde{A} and \tilde{B} of the local and the external sectors, respectively;

¹⁷ Notice that the revenues of L-agents at the stationary state in which the economy is specialized in the local sector ($\Pi(A^l)$) are represented by an horizontal line (see Fig. 6a, b). Indeed, at the stationary state A^l there is no external sector in the economy, therefore the revenues of L-agents at A^l are invariant to an increase of the pollution tax or of the impact of the external sector on pollution.

- (ii) an increase of the impact of the external sector on pollution may have negative effects on $\Pi(A)$ (see Fig. 8a) and on both local and external capitals (see Fig. 8b), since it increases the pollution level, thus decreasing the productivities \tilde{A} and \tilde{B} of both sectors.

In summary, if the pollution level is relatively high, then the productivity of both sectors decreases. This has a twofold effect: on the one hand, it reduces the revenues of local land owners, on the other hand it induces external investors to move their capital out of the economy, towards other countries in which their capital can be more productive and they can get higher returns. As emerges from the numerical simulations described above (see Fig. 6a, b), to avoid that this is the case and ensure that the revenues of local land owners are higher at the coexistence equilibrium than in the absence of external investors, the pollution tax must be high enough and the polluting impact of the external sector low enough.

8 Conclusions

Foreign direct investments in land have increased substantially since the beginning of the new millennium, and have recently been the object of several empirical studies. However, to our knowledge, there is not yet a satisfactory theoretical model to investigate their effects on the economic conditions of local land owners. To fill this gap in the literature, the paper has investigated the possible effects of FDI in land on a small open economy with two sectors, external and local, and heterogeneous agents, external investors and local land owners. Both sectors are negatively affected by pollution, but only the external sector is polluting. We assume the possibility for the local government to tax the production activities of the external sector to finance environmental defensive expenditures that are meant to abate pollution and/or restore the originally cleaner environmental conditions.

Numerical simulations show that the dynamics of the model may be bi-stable. The stationary states in which there is specialization in the local sector and in which both sectors coexist are locally attractive. The basins of attraction of such states are separated by the stable branch of a saddle point. From numerical simulations performed on the model it emerges that if the pollution tax is low enough with respect to the impact of the external sector on pollution, this attracts FDI, so that the economy does not fully specialize in the local sector. On the contrary, if the pollution tax is high enough with respect to the polluting impact of the external sector, then the specialization in the local sector may occur.

As the model shows, FDI in land can increase the revenues of local land owners. This, however, requires a sufficiently low polluting impact of FDI and a sufficiently high pollution tax on their production activity. The former condition is needed to avoid an excessive productivity loss of local land, while the latter allows to finance pollution abatement expenditures that can counterbalance the rise in pollution brought about by the external sector. If these conditions are not satisfied, the land acquisition by foreign investors that has been rapidly spreading at the world level may impoverish local land owners. Moreover, since pollution tends to decrease land productivity in the long run, foreign investors might have an incentive to flee away from the country and move their capital outside the local economy once the productivity of the external sector starts decreasing, leaving the host country worse-off than in the absence of any foreign land acquisition. These results call for a proper regulation of the so-called land grabbing phenomenon from local governments through a sufficiently high pollution tax that may discourage polluting investments and can raise the entries for appropriate environmental policies. This aspect seems of primary importance if we want to

pursue a prosperous and sustainable coexistence of the local and the external sectors in those countries.

The problem presented in this paper has been analysed in a second-best framework in which agents do not coordinate their choices. A particularly interesting extension of the model would be to assume the existence of a benevolent social planner who can perform intertemporal optimization and investigate how results differ in an optimal control model as compared to the present one. This would also allow to compute the optimal tax on pollution that the social planner should set to balance the opposite needs of attracting FDI while preserving the local environment. We leave this analysis for future research.

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