A Model of Enclosures: Coordination, Conflict, and Efficiency in the Transformation of Land Property Rights*

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January 31, 2024

Abstract

Economists and historians have long debated the processes that led open-access land to become enclosed or transformed into private ownership. We construct a model of enclosure by applying the theory of aggregative games. Property regimes are equilibrium outcomes, and the returns to enclosure depend upon the aggregate enclosure rate. Equilibrium property regimes are determined by factors including population density, technological potential, enclosure costs, and the policy and institutional environment. In equilibrium, enclosure may be full, partial, or may not occur at all. Equilibrium may not be unique, with both full and no enclosure possible; in these cases, we analyze the equilibrium ownership regime using tools from the global games literature. We find that decentralized enclosure processes sometimes produce efficient enclosure but may also lead to inefficiently low enclosure, and outcomes may even fall short of second best. Policies to strengthen customary governance, compensate displaced stakeholders, or subsidize/tax enclosure can realign incentives, but addressing one market failure while overlooking others can worsen outcomes. Our analysis offers a unified framework for evaluating mechanisms and processes across Neoclassical, Neoinstitutional, and Marxian interpretations of enclosure processes, and we discuss how the model can also be applied to understand the emergence of more exclusive forms of land ownership in frontier regions, on managed commons, and in other kinds of hybrid land ownership regimes.

*We thank seminar participants at Hunter College and The Graduate Center at CUNY, and conference participants at Cornell and the IAEE for valuable comments. Klaus Deininger, Jonathan Morduch, and James A. Robinson provided commentary on earlier versions of this work. An online appendix with proofs and code to replicate and interact with all figures in the text can be found at https://jhconning.github.io/enclosure_book.

1 Introduction

The rise of private property rights in land is widely touted as a landmark institutional achievement. Thinkers from Adam Smith and Karl Marx to Karl Polanyi, Robert Brenner, and Douglass North all saw this transformation as pivotal to the rise of capitalism and modern economic growth. Substantial debate persists, however, about the causes and consequences of the enclosure and privatization processes that brought about these changes (Smith 1982; Marx 1992; Polanyi 1944; North and Thomas 1973; Brenner 1976).

The transformation of land ownership is of more than historical interest. Secure private ownership remains by no means universal. By one estimate, up to 2.5 billion people today derive livelihoods from access to land where statutory recognition of community and individual claims remains unclear or insecure (Pearce 2016).

Access to land around the world has traditionally been governed by a wide variety of arrangements, from open access to community regulated customary regimes with diverse tenurial arrangements (Berry 1993; Blaufarb 2016). Unlike modern private property, where owners theoretically have *de jure* absolute rights to exclude and to transfer, these systems rely, to varying extents, on *de facto* maintained possession and use within rule-structured communities or hierarchical relationships. Transfers, especially to outsiders, are frequently limited (Ribot and Peluso 2003; Sjaastad and Bromley 1997). While not meeting all criteria of modern private property, they may achieve more efficient land use than the open-access caricature to which they are often compared (Ostrom 1990; Bromley 1992b; Baland and Platteau 1996).

Still, concerns linger about potential inefficiencies. The inability to capture exclusive returns is said to lead to misallocation to slow the adoption of technological improvements and other productivity raising investments (e.g. Cornes and Sandler 1996; Besley and Ghatak 2010; Chen, Restuccia, and Santaeulàlia-Llopis 2023). Deploying arguments of this sort, advocates for private property have claimed that, by establishing more secure and transferable rights of exclusion, land privatization would bring about "improvements" by reducing inefficiencies, stimulating productivity enhancing investments, and releasing resources.[1]

Where and how has private property emerged? Are the processes that lead to transformation decentralized and emergent, or policy-imposed? Some argue that more exclusive property ownership emerges naturally, as rising population densities or the arrival of new commercial or technological opportunities raise expected benefits to more

1. Authors including Greer (2018), Linklater (2013), and Wood (2002) trace how, starting in the late 17th century, the language of "improvements" came to be paired with advocacy for private property.

exclusive access relative to the costs, society adapts through Coasian bargaining or other evolutionary processes[2]. Others argue instead that state intervention may be required to promote transformation in economies that otherwise might remain 'stuck' with 'backward' or inefficient property rights, or to deter or attempt to control processes that might otherwise devolve into costly property races or conflict. Other observers have been more cynical of the purposes and effects of state policies, arguing it is often captured and has served as a vehicle for land grabbing and dispossession.

Notable examples of private property formation associated with state-building efforts include the British Parliamentary Enclosure Acts of the 18th century (Mingay 1997; Allen 1992), reforms following the French Revolution that removed feudal priviliges and complex layers of ownership and privatized church and crown lands (Blaufarb 2016), frontier settlement policies and Liberal reforms to transform customary forms of tenure in the Americas and elsewhere (**allen2019**; Murtazashvili 2013; Greer 2018), and past and ongoing projects in Africa and other parts of the developing world to recognize and/or transform customary land tenures (Deininger and Bank 2003; Alden Wily 2018).

We build a simple yet flexible model framework to study decentralized, but possibly policy led, enclosure processes as equilibrium outcomes of an aggregative game. Private decisions to engage in costly enclosure are affected by environmental features such as population density, the potential for technology improvement, and private enclosure costs. Our benchmark model builds upon and re-interprets canonical analyses of labor misallocation under open access as developed by Weitzman (1974) and de Meza and Gould (1992). We extend earlier analyses by considering a richer parameterized model environment and using new equilibrium selection tools from the theory of global games. This allows us to establish a complete mapping from parametric descriptions of the economic and political environment onto the equilibrium mix of property regimes that emerges under decentralized enclosure processes.

Our framework allows us to offer a novel interpretation of how efficiency and distributional consequences are determined. First, our model captures a spillover effect associated with the classic problem of open access to land: that labor that enters open-access lands to capture rents does so without having to pay compensation for how it reduces labor returns in general. As more exclusive ownership is established through costly enclosure, this misallocation is reduced. Since some of the social benefits of reduced misallocation are spillover to others, there could be too little enclosure activity.

2. See, for example, Alchian and Demsetz (1973), North and Thomas (1973), Boserup (1965), and Libecap (1993).

However, there is a third potential external effect: as land is enclosed, a portion of the rent captured by a new encloser may be at the expense of existing informal or customary users if they are displaced without compensation. If this last rent-seeking effect dominates, decentralized enclosure processes may lead to property races and socially excessive enclosure and costly enforcement. Thus, depending on parameters, decentralized enclosure could lead either to efficient levels of enclosure (or nonenclosure), or to 'too much' or 'too little' enclosure relative to first- and second-best baselines. We offer a clear mathematical decomposition of these effects.

A key empirical issue in historical debates over the consequences of enclosure, an a key mediating variable theoretical models, is the extent to which enclosures displace or absorb labor as plots of land become enclosed. A famous result, due to Weitzman (1974) (see also (Samuelson 1974)), establishes that in a base model (with unchanging technologies and costless enclosure) labor will be displaced as open access areas are enclosed. As labor has less open-access areas to enter, labor supply to the enclosed economy rises, lowering wages. The rents captured by new landowners in the privatized competitive economy will always exceed the reduced misallocation, implying that labor "will always be better off with (inefficient) free access rights than under (efficient) private ownership of property." (Weitzman 1974, p. 225). Cohen and Weitzman (1975) build a 'Marxian theory of enclosures' around this result. Our richer model framework, allows us to show how this result is qualified, or over-turned in different environments.

The benchmark model, like much of the existing literature, assumes enclosure without compensation and makes other unrealistic assumptions. Evidence suggests that communities rarely leave access to land open for long (Baker 2003; Berry 1993; Ostrom 1990; Sjaastad and Bromley 1997; Baland and Platteau 1996; Baland and Francois 2005). Land and resources come to be regulated, sometimes quite strictly, through formal and informal laws, rules, and customs. Under many customary forms of tenure it is also observed that families may hold rights to specific plots that may become heritable or subject to rental or sale, particularly when traded is limited to other members of the community. For all these reasons, comparing customary tenure with situations of pure open access appears to be misleading at best. In extensions to our benchmark model, we allow for varying degrees of regulated access and factor market trade within unenclosed areas. We also allow for variation in the extent to which enclosers are expected to pay compensation to the displaced. We can interpret this as a measure of bargaining power or 'the balance of class forces' in a given situation. This allows our model to shed light on the evidence and interpretations of economic historians who have emphasized the relevance of political factors in determining efficiency and distributional outcomes (see, e.g., Chambers (1953), Brenner (1976), Allen (1992), (Whittle 2013), (Byres 1996)). The expanded framework thus allows us to evaluate many aspects of both evolutionary and conflict-based theories of the transformation of property rights. Later sections of the paper extend the model to handle issues related to frontier settlement policy and structural transformation.

The framework lends insight into a variety of policy debates and designs. Policy design is subject to a theory of the second best; policies designed to address one market failure without taking into account other market failures may lead to worse outcomes. For example, policies to strengthen customary land governance and regulation to correct labor misallocation, without also establishing compensation schedules for those that might be displaced by enclosures, may inadvertently increase the likelihood of costly property scrambles by raising the return that outsiders or connected elites stand to capture. On the other side, policies that mandate compensation to the displaced (or strengthen customary claims by barring outside claims), without also strengthening regulation and governance within customary areas, could inadvertently increase the likelihood of coordination failures and delay or impede efficient enclosure and technological transformation.

2 Preliminaries

The classic explanation for why labor is misallocated with open access land is that while operators on enclosed lands hire until the marginal product of the last unit of labor hired equals the market wage, that wage must match the *average* product that that unit of labor can capture by taking possession of land in the open access area and farming themselves. Consequently, in equilibrium, the marginal product of labor on enclosed land, MP_L^e will exceed that on unenclosed land, MP_L^c, violating a necessary condition for efficiency. Formally:

$$MP_L^e = w_e = AP_L^c > MP_L^c \tag{1}$$

Figure 1 depicts the misallocation implied by (1). The figure is drawn under the assumption that producers on both enclosed and unenclosed land have access to the same production technology and that half the land has been enclosed, implying an enclosure rate $t_e = \frac{1}{2}$. The horizontal axis measures, from left to right, the share of labor $l_e \in [0, 1]$ allocated to the enclosed sector.[3] For these assumptions, the marginal product

3. All figures are exact parameterized representations using the Cobb-Douglas production technologies described in section 3. In figure 1, the labor elasticity is set to $\alpha = 1/2$, the labor to land ratio

of labor curves will be the same in each sector, crossing at point E, which identifies the efficient allocation where half the labor allocated to the enclosed sector. This equalizes land-labor ratios and therefore marginal products across sectors. However, when labor entry into the open access sector is unregulated, the competitive equilibrium will be determined at C, where $MP_L^e = AP_L^c > MP_L^c$. The market equilibrium, for any initial enclosure rate $t_e \in (0, 1)$, will result in excessive labor intensity in the unenclosed sector compared to the social optimum. This situation is variously described in the literature as "labor congestion," "land overuse," or more evocatively as "the tragedy of the commons." The deadweight loss arising from this misallocation is represented by area AEC.

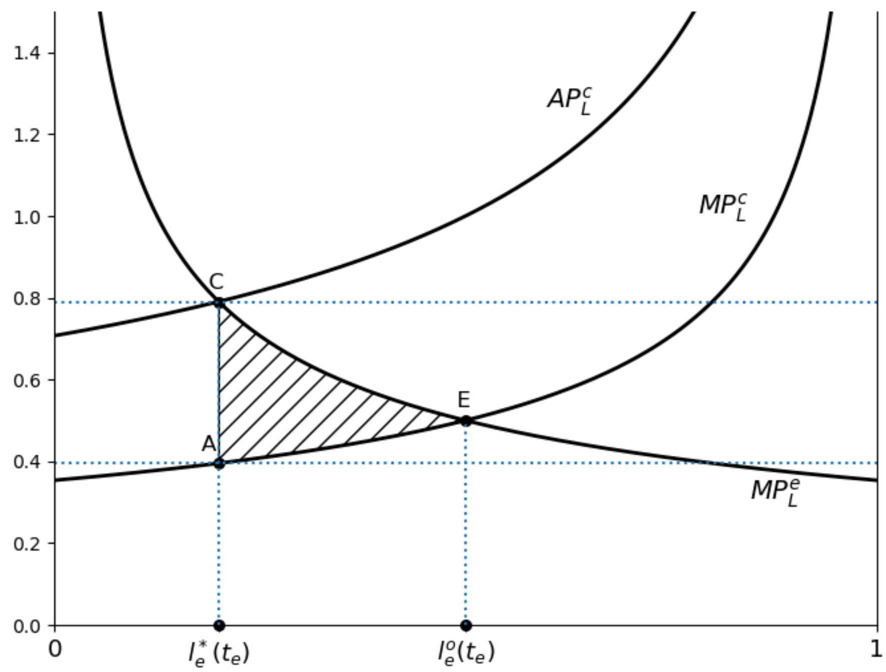

Figure 1: Labor allocations, given land enclosure rate $t_e = 0.5$.

Privatization is proposed as a solution to eliminate the misallocation. Once all previously unenclosed lands are enclosed, labor demand from this sector is reduced from AP_L^c to the marginal product curve MP_L^c, releasing labor and eliminating the deadweight loss at the new efficient market equilibrium at E. This result is well understood and unambiguous for the limiting case of *costless* enclosure in a purely open access

is $\bar{l} = \bar{L}/\bar{T} = 1$, identical technology is available in each sector ($\theta = 1$), and the enclosure rate is held fixed at $t_e = 1/2$.

scenario (Weitzman 1974).

This simple story becomes immediately more interesting and complicated, however, once the costs of enclosure (of establishing and enforcing new more exclusive private property) are considered and attention is focused on whether and how decentralized enclosure processes might lead to desired efficiency and distributional consequences, and the role of policy in influencing outcomes.

It is useful to interpret the average product AP_L^c that labor captures in the unenclosed sector. When production is characterized by linear homogeneous production functions, by Euler's theorem, total output on unenclosed land can be decomposed as follows:

$$F(T_c, L_c) = F_L \cdot L_c + F_T \cdot T_c$$

where T_c and L_c are the total amount of land and labor allocated to the unenclosed sector. Dividing through by L_c gives an expression for the average product of labor in the unenclosed sector:

$$AP_L^c = MP_L^c + MP_T^c \cdot \frac{T_c}{L_c} \tag{2}$$

Expressing the average product as in (2) leads to a useful understanding of what labor is earning by entering open-access land. In many customary arrangements, land claims are established and maintained primarily through possession and use and through continued participation in the community. This is what has been called 'use-it-or-lose-it' possession (Platteau 1996). With T_c units of land allocated to the open access sector and L_c units of labor entering the sector, each unit of labor can be viewed as establishing possession over T_c/L_c units of land and the stream of benefits this generates. In equilibrium, a unit of labor must be indifferent between the wage $w_e = MP_L^e$ it can earn as a laborer in the enclosed sector and the earnings it can earn in the unenclosed sector. The latter is made up of a low MP_L^c due to crowding but augmented by the value of the land rents $MPT_c \cdot \frac{T_c}{L_c}$ it captures by establishing and maintaining possession. The vertical distance from $l_e^*(t_e)$ to point A in Figure 1 represents MP_L^c, while the vertical distance from A to C measures the value of the implied rents $MP_T^c \cdot \frac{T_c}{L_c}$. In an equilibrium with no further entry or exit, we might even think of the unenclosed sector as a sub-economy where these *de facto* land rights become tradable and priced on competitive factor markets within the community. We can then interpret (2) to mean that each unit of labor earns total income $w_c + r_c \cdot \frac{T_c}{L_c}$ from its residence and possession in the unenclosed sector, where $w_c = MP_L^c$ and $r_c = MP_T^c$. In equilibrium, labor must be indifferent between employment in the enclosed sector and what it can earn in the customary sector. This implies:

$$w_e - w_c = r_c \cdot \frac{T_c}{L_c} \tag{3}$$

Expression (3) formalizes the idea of rent-dissipation, or that labor is willing to sacrifice higher wage earning opportunities outside of the unenclosed sector, $w_e - w_c$, in order to establish and maintain land rent claims $r_c \cdot \frac{T_c}{L_c}$. This is associated with excessive entry into the unenclosed sector, since part of the rent that is captured is at the expense of other entrants. In the absence of regulation, each entrant fails to internalize this negative external effect, and there will be excess entry and rent dissipation.

In practice, of course, communities often do develop governance systems that regulate the use of commons and common property lands, and these institutional mechanisms may go a long way toward ameliorating these problems (Ostrom 1990; Platteau 1996; Bromley 1992a). One way to capture this is with a modification of condition (3) to include a governance parameter:

$$w_e - w_c = (1 - \mu) r_c \cdot \frac{T_c}{L_c} \tag{4}$$

Parameter $\mu \in [0, 1]$ in (4) can be interpreted in different ways. It may be interpreted as an access or rental fee that the user must pay to access customary land. Under this interpretation, the user pays $\mu \cdot r_c \frac{T_c}{L_c}$ to capture an income stream worth $r_c \frac{T_c}{L_c}$. Depending on the context, this might be paid to a manorial landlord, a village authority, etc. If $\mu = 1$ the user fully internalizes the impact of their entry; in this circumstance, there will be no excess entry or misallocation of labor since $w_e = w_c$ and the marginal products between sectors are the same.

We can think of intermediate situations where $0 \leq \mu < 1$ captures the idea that land claims may be insecure or contested. For example, a landlord might claim ownership rights to land, but if a tenant pays a customary rent below the market rate, they have acquired *de facto* customary land rights. As Allen (1982, p. 937) has pointed out, in the context of English enclosure debates, "[a] Though the consequences of enclosures have been the subject of controversy since the process began, the proximate cause has always been clear... [e]nclosures were invariably initiated by landowners because they expected that their tenant farmers would pay higher rents after the parish was enclosed."

Another interpretation is that μ measures the probability that a user who leaves the community (and therefore does not maintain continued possession) is able to retain land rights. For example, a user who attempts to rent out customary land (or leaves it in trust with relatives or neighbors) to pursue outside opportunities risks losing the claim with probability $(1 - \mu)$. Regardless of interpretation, when $\mu = 0$, a unit of labor that moves to opportunity loses its implied share of land for certain, and the model collapses to the familiar open-access situation. Intermediate situations with $0 < \mu < 1$ parameterize different levels of insecurity. At the far other extreme, when $\mu = 1$, labor can move out of the sector and still collect land rents, so marginal products on enclosed and unenclosed land are equated.

In the decentralized enclosure processes that we will explore in the paper, private actors choose to enclose whenever the market return r they can earn by renting out a newly enclosed parcel exceeds the cost of enclosure. The decision to enclose may become distorted, leading to socially excessive enclosure/enforcement, if those who acquire more exclusive rights do not compensate those who may lose be displaced and lose income sources from customary access. If we let $r_c = MP_T^c$ measure the return to land in the open-access unenclosed sector and require enclosers to pay compensation τ proportional to r_c, enclosure returns can now be written as $r - \tau \cdot r_c$ and τ can be used as a policy instrument to mitigate inefficiencies in the enclosure decision.

As we discuss in Section 5, policies that raise $\mu > 0$ can be thought of as giving recognition and protection to traditional usufruct land rights, while policies to raise τ establish and recognize customary ownership rights. Such policies, in combination, can lead the economy to more efficient resource allocation and enclosure and technology adoption decisions. To elaborate upon these ideas, we first establish a parametric version of a benchmark 'open access' model (with $\mu = 0$ and $\tau = 0$) that allows us to describe the types of equilibria that are likely to emerge in different economic environments under decentralized enclosure processes, along with their distributional and efficiency consequences.

3 Benchmark Model

3.1 Technology and Resources

We start by studying the special case of a purely agricultural production economy with an inelastic supply of labor and of land. Later, in section 6.2, we extend this to allow for an elastic supply of labor and a manufacturing sector. We assume linear homogeneous production technologies, but allow for technology change in the transition to a different property rights regime. Cobb-Douglas production functions will be used to derive closed-form expressions and exact graphic representations for most results, but from the theory of aggregative games, one can show that similar comparative static results hold for a broader class of concave and monotonic technologies.[4]

The production technologies in each sector are:

$$F(T_c, L_c) = T_c^{1-\alpha} L_c^{\alpha}$$
$$G(T_e, L_e) = \theta F(T_e, L_e)$$

Functions F and G are employed in the unenclosed (or customary) and the enclosed sectors, respectively, where T_i and L_i, $i \in \{c, e\}$ denote land and labor inputs employed in each sector.

Parameter θ measures the proportionate gain in total factor productivity achieved by enclosing land. When $\theta > 1$, enclosure facilitates the adoption of technological or organizational changes that increase productivity; for example, crops in a fence-enclosed plot might be less likely to be trampled or eaten by stray animals, or the adoption of more exclusive forms of ownership might be associated with agricultural intensification as suggested by Boserup (1965). When $\theta \leq 1$, enclosure leads to no improvements or even technological regress - it might be the case that fences or other barriers interfere with efficient resource use. Our choice to limit attention to homothetic transformations of technology following enclosure allows us to focus on key mechanisms that could lead enclosure processes to induce the adoption of more (or less) land-intensive production *techniques* on enclosed land even when the *technology* is not inherently more (or less) land-intensive.

The economy has a total endowment of $\bar{T}$ units of land and $\bar{L}$ units of labor. If T_e is the amount of enclosed land, then $T_c = \bar{T} - T_e$ land remains in the unenclosed sector; similarly for labor: $L_c = \bar{L} - L_e$. We denote the land-labor ratio, or population density, by $\bar{l} = \frac{\bar{L}}{\bar{T}}$. The share of land enclosed is denoted $t_e = \frac{T_e}{\bar{T}}$ and the share of labor employed on enclosed land is $l_e = \frac{L_e}{\bar{T}}$. Similarly, $t_c = 1 - t_e$ is the share of land that is unenclosed or common access, while $l_c = 1 - l_e$ is the share of labor allocated to the unenclosed sector. Linear homogeneity implies that we can express the value of total output on unenclosed and enclosed land in terms of the share of labor and land allocated to each sector:

$$\begin{aligned} F(T_c, L_c) &= F(t_c, l_c) \cdot F(\bar{T}, \bar{L}) \\ \theta F(T_e, L_e) &= \theta \cdot F(t_e, l_e) \cdot F(\bar{T}, \bar{L}) \end{aligned} \tag{5}$$

4. As long as players' profit functions can be characterized as continuous and concave, which is true for a wide range of production technologies (Acemoglu and Jensen 2013).

The essential difference between enclosed and unenclosed land is that on the former the 'owner-claimants' are able to perfectly exclude others from gaining access, whereas on the latter occupant's ability to exclude others is imperfect (in ways that we will later make precise) or absent. Enclosing land is costly. We follow de Meza and Gould (1992) in assuming a simple linear enclosure cost function: at a cost of c per unit of land, an owner-claimant can enclose land in the unenclosed sector. Enclosure costs can include fencing costs, settling property disputes, hiring guards, legal fees, or other forms of investment to improve and secure land claims.

Throughout the paper, the parameter vector $\varphi = (\theta, \bar{l}, \alpha, c)$ is used as a shorthand to summarize technology, population density, production labor share, and enclosure cost parameters that together describe the exogenous economic environment in which decisions are made.

3.2 First-best enclosure and labor allocations

Since it is costly, land enclosure is only socially worthwhile in economic environments where population pressure is high and/or enclosure facilitates the adoption of higher productivity technology, or $\theta > 1$. A social planner chooses the amount of land to be enclosed $T_e = t_e \cdot \bar{T}$ and the amount of labor allocated to the enclosed sector $L_e = l_e \cdot \bar{L}$ to maximize total output net of enclosure costs $c \cdot t_e \cdot \bar{T}$. If we scale this objective by dividing through by $\bar{T}$, we can think of the planner as choosing shares of land and labor t_e and l_e in the enclosed sector to maximize the value of output net of enclosure costs per unit of land:

$$\max_{t_e, l_e} \quad y(t_e, l_e) - c \cdot t_e$$

where, using our production technologies and share relationships $t_c = 1 - t_e$ and $l_c = 1 - l_e$, we have:

$$y(t_e, l_e) = [\theta F(t_e, l_e) + F(1 - t_e, 1 - l_e)] \cdot \frac{F(\bar{T}, \bar{L})}{\bar{T}} \tag{6}$$

A necessary condition for efficient labor allocation is that the value marginal product of labor be equal across sectors, as one can see from differentiation of (6) with respect to l_e. With the technology expressed in share terms as in (5), we can express the condition $MP_L^e = MP_L^c$ in terms of land and labor shares allocated to the enclosed sector:

$$\theta \cdot F_L(t_e, l_e) = F_L(1 - t_e, 1 - l_e)$$

For our Cobb-Douglas forms, this becomes:

$$\alpha\theta\left(\frac{t_e}{l_e}\right)^{1-\alpha}=\alpha\left(\frac{1-t_e}{1-l_e}\right)^{1-\alpha} \tag{7}$$

Equation (7) can be solved to find the *planner's labor allocation function* that tells us, for any share of enclosed land t_e, the efficient labor allocation share l_e to the enclosed sector:

$$l_e^o(t_e)=\frac{\Lambda_o t_e}{1+(\Lambda_o-1)t_e}, \quad \text{where } \Lambda_o=\theta^{\frac{1}{1-\alpha}}. \tag{8}$$

Notice that whenever $\theta>1$, we must have $\Lambda_o>1$ in (8) which implies that $l_e^o(t_e)\geq t_e$ for all $t_e\in[0,1]$, and with strict inequality for interior points. Therefore, at any interior enclosure rate $t_e\in(0,1)$, the planner finds it efficient to employ *higher* (or never lower) labor-intensity on enclosed land compared to unenclosed land, so $\frac{L_e}{T_e}\geq\frac{\bar{L}}{\bar{T}}\geq\frac{L_c}{T_c}$. Intuitively, when $\theta>1$, labor will be more productive on enclosed land where new technology is adopted and hence should be moved to the enclosed sector, until diminishing marginal productivity leads to a new equalization of marginal products between enclosed and unenclosed land. We draw attention to this obvious labor *augmentation* result to highlight the contrast to several decentralized enclosure situations studied below where, unless the expected productivity gain θ is above a high threshold, private enclosure will lead to *lower* labor-intensity on newly enclosed lands and therefore produce labor *displacement* effects.

Returning to the planning problem, if we substitute the optimal labor allocation policy $l_e^o(t_e)$ in (8) into the objective (6), the planner's objective is now solely a function of t_e. After some algebra, the maximization problem can be written:

$$\max_{t_e}\ z_o(t_e)-c\cdot t_e=\bar{l}^{\alpha}\cdot\left[1+(\Lambda_o-1)\,t_e\right]^{1-\alpha}-c\cdot t_e \tag{9}$$

where $z_o(t_e)=y(t_e,l_e^o(t_e))$.

Viewed in this way, maximization may be thought of as a two-step problem. Working backwards, the planner first solves for an optimal labor intensity function $l_e^o(t_e)$ at any enclosure rate t_e. The planner then incorporates this optimal policy (given by (8)) into the objective to solve for the optimal enclosure rate t_e^o that maximizes (9). This formulation will facilitate later comparisons to equilibrium allocations under decentralized and policy-driven enclosure games. It is also useful to note that, since, by assumption, the planner can enforce efficient labor allocations across sectors, the planner's land enclosure decision can be thought of as a technology adoption decision:

enclose if the marginal output gain from enclosing an additional unit of land, which increases TFP by a factor θ, exceeds the marginal cost c.

It is easy to verify that the planner's benefit function $z_o(t_e)$ is everywhere concave-down ($z_o''(t_e) < 0$) and increasing for $\alpha \in (0, 1)$ when $\theta > 1$. Therefore, to determine whether land should remain unenclosed, partially enclosed, or fully enclosed, we only need to check the derivative $z_o'(t_e)$ – the marginal benefit of enclosure – at its end-points and compare it with the marginal cost of enclosure c, which amounts to checking whether $z_0(t_e) - ct_e$ is maximized at an interior point. The three possibilities are that $z_o(t_e) - ct_e$ is maximized with:

- **No enclosure:** $t_e^o = 0$, when $z_o'(0) \leq c$
- **Full enclosure:** $t_e^o = 1$, when $z_o'(1) \geq c$
- **Partial enclosure:** $t_e^o \in (0, 1)$, when $z_o'(0) > c$, $z_o'(1) < c$, and $z_o'(t_e^o) = c$

Consider the 'no enclosure' case. As $z_o'(0) \leq c$, the social marginal gain to begin enclosing land from $t_e = 0$ falls short of the social marginal cost c. Furthermore, since $z_o(t_e)$ is concave, we can deduce that $z_o'(t_e) \leq c$ for all $t_e \in (0, 1)$, so it is also not worthwhile to start enclosing land starting at any enclosure rate greater than zero.

We can now establish the map from different economic environments - as summarized by different configurations of our model parameters φ - onto optimal enclosure decisions. Differentiating (9) with respect to t_e to obtain an expression for $z_o'(t_e)$ and rearranging defines a parametric region of the values of φ for which no land enclosure is socially optimal. We can express this as a critical threshold for population density $\bar{l}$:

$$z_o'(0) \leq c \quad \Leftrightarrow \quad \bar{l} \leq \left[\frac{c}{(1-\alpha)(\Lambda_o - 1)}\right]^{\frac{1}{\alpha}} = \bar{l}_0^o(\theta) \tag{10}$$

Consider next the 'full enclosure' case, when $z_o'(1) \geq c$. Since $z_o'(t_e)$ is decreasing for all $t_e \in (0, 1)$, it is sufficient to check if it is greater than the cost of enclosure at the endpoint $t_e = 1$ to verify that full enclosure should occur. Using the derivative of $z_o(t_e)$ in (9) and setting $t_e = 1$ results in the parametric boundary condition:

$$z_o'(1) \geq c \quad \Leftrightarrow \quad \bar{l} \geq \Lambda_o \cdot \left[\frac{c}{(1-\alpha)(\Lambda_o - 1)}\right]^{\frac{1}{\alpha}} = \bar{l}_1^o(\theta) \tag{11}$$

Full enclosure is optimal for values of $\bar{l}$ above the locus $\bar{l}_1^o$ defined by (11).

The loci $\bar{l}_0^o$ and $\bar{l}_1^o$ are plotted as solid lines in $(\theta, \ln \bar{l})$ space in Figure 2.[5] The shaded

5. The Figure and subsequent diagrams actually plot the natural logs of the loci, not their values themselves.

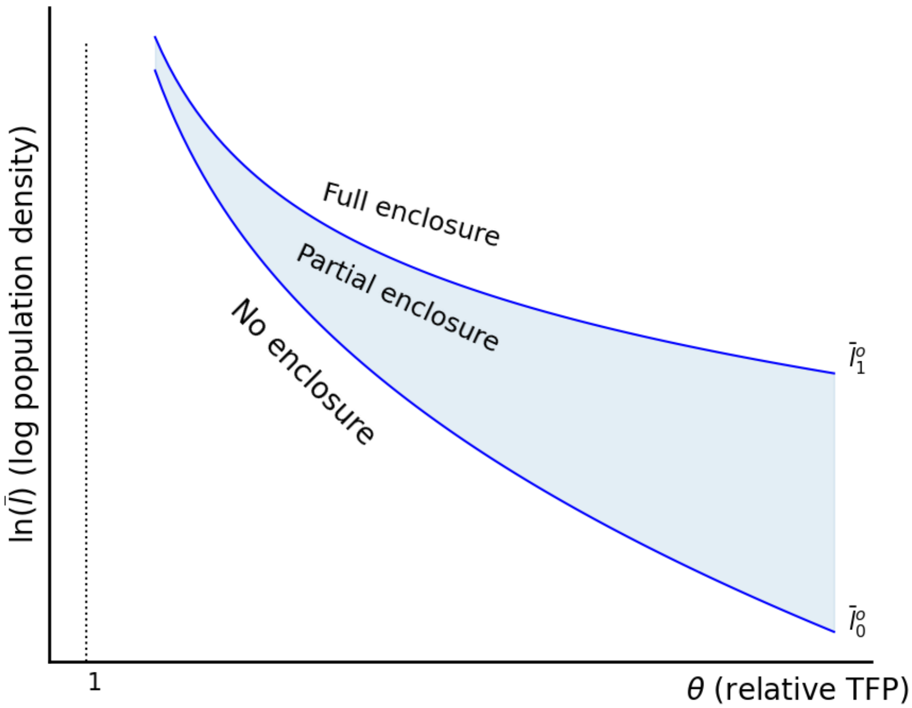

Figure 2: Socially efficient enclosure decisions as they depend on (log) population density $\bar{l}$ and expected TFP gain from enclosure θ.

parameter region between the two loci corresponds to situations where partial land enclosure is optimal. Figure 2 has a clear Boserupian, induced-agricultural-intensification interpretation: where land is abundant (i.e., population density $\bar{l}$ is sufficiently low), the benefits of enclosure fall below its costs, unless the potential productivity gains of enclosure θ (the gains from adopting new technologies or commercialization opportunities) are sufficiently high. Thus, $\theta > 1$ is necessary but not sufficient for some enclosure to be optimal. When $\theta > 1$, enclosure makes a plot more productive, but, in conditions of high land abundance where labor is already quite productive, the costs of enclosure plus the opportunity cost of drawing labor away from the unenclosed sector may be too high to offset these potential productivity gains. Consider an economy that starts at a point just below the $\bar{l}_0^o$ boundary where no enclosure is optimal. Suppose that sufficient population growth were to occur to push population density $\bar{l}$ above the $\bar{l}_0^o$ locus. In that case, the marginal social return to enclosure is pushed above its marginal social cost, and some land should be enclosed, improved, and operated with higher labor intensity. However, labor is drawn out of the unenclosed sector at rising marginal cost, so only as much land as is needed to accommodate the increase in population density should be enclosed.

3.3 Decentralized enclosure processes

In a decentralized economy, land enclosure decisions are made by private actors. Unenclosed land may have multiple existing users, but we assume that each unit of land has a potential encloser who has the option to enclose that unit at cost c, which establishes the right to exclude all others from that unit.[6] The encloser could be an outsider, an existing community user or, as in one scenario below, an existing landlord who had been charging a customary rent but is now determined to impose a new higher market-determined rate. It is useful to think of each unit of land as atomistic and enclosed land as being leased to a competitive, constant-returns enclosed production sector that employs the technology in (5). The enclosed land then earns a competitive rental rate, r, equal to the marginal value product of land in the enclosed sector $MP_T^e = \theta F_T$.[7] The constant-returns specification allows us to remain agnostic about the size distribution of farms and other details of the production process. With $w = MP_L^e$, and $r = MP_T^e$, total output in the enclosed sector is resolved into factor payments. This is an important contrast to de Meza and Gould (1992), who perhaps inadvertently build a form of scale economies into the enclosure process that complicates interpretation.

As enclosure decisions are made, labor will reallocate across sectors in search of the highest return until, in equilibrium, the wage determined by the marginal product of labor in the enclosed sector equals the average product a laborer can earn on remaining unenclosed land. Using the Cobb-Douglas production functions, this equilibrium labor market condition can be written as follows:

$$\alpha\theta\left(\frac{t_e}{l_e}\right)^{1-\alpha} = \left(\frac{1-t_e}{1-l_e}\right)^{1-\alpha} \tag{12}$$

Solving (12) for l_e gives the *labor reaction function* that tells us the equilibrium share of labor that will be allocated to the enclosed sector given enclosure rate t_e:

$$l_e^*(t_e) = \frac{\Lambda t_e}{1+(\Lambda-1)t_e}, \quad \Lambda = (\alpha\theta)^{\frac{1}{1-\alpha}} \tag{13}$$

6. More elaborate contest functions and associated strategic aspects of enforcing claims over land can be considered. See, for example, Baker (2003, 2008), and the discussion in Section 5.

7. It is conceptually equivalent to think of the encloser as hiring labor and earning a competitively determined profit, or to instead earn rents from charging a competitive access toll paid by laborers to obtain otherwise unimpaired access to the land (see discussion in Weitzman (1974, p. 230)).

Note that the Λ in the labor reaction function (13) is different from Λ_o in the planner's labor allocation function (8), and in particular $\Lambda < \Lambda_o$. At any partial enclosure rate $t_e \in (0,1)$, labor allocated to enclosed land in a private allocation will be lower than what a planner would allocate at a similar enclosure rate, or $l_e^*(t_e) < l_e^o(t_e)$. When $\Lambda > 1$ or $\theta > \frac{1}{\alpha}$ labor demand increases with the enclosure rate, when $\Lambda < 1$ labor demand falls. Since this will be critical to our analysis, we define the threshold at which the qualitative behavior of the model changes.

Definition. *Let $\theta_H = \frac{1}{\alpha}$. An economy with $\theta \geq \theta_H$ has **high-TFP gains to enclosure**. When $\theta < \theta_H$, the economy has **low-TFP gains to enclosure**.*

In contrast to the optimal labor allocation function of the planner in (8) which was convex, the labor reaction function in (13) can be concave or convex. When $\theta < \theta_H$ then Λ in (13) is less than one and $l_e^*(t_e)$ is convex to the origin, and when $\theta > \theta_H$, $l_e^*(t_e)$ is concave to the origin. The θ_H threshold thus determines whether enclosure decisions will be strategic complements or substitutes, and this turns out to matter to the often debated question as to whether land enclosures increased or decreased demand for labor, and hence wages in different historical situations.

Before we analyze this question in detail, we again build a map from the different possible economic environments described by points in the φ parameter space but now onto the equilibrium enclosure and resource allocation decisions that we expect to emerge from decentralized processes. The private marginal return to enclosing land is:

$$\begin{aligned} r(t_e) &= \theta \cdot F_T(t_e, l_e^*(t_e)) \cdot F(\bar{T}, \bar{L}) \\ &= \theta \cdot (1-\alpha) \cdot \left(\frac{l_e^*(t_e)}{t_e}\right)^{\alpha} \cdot \bar{l}^{\alpha} \end{aligned} \tag{14}$$

Substituting l_e^* from (13) into (14) yields:

$$r(t_e) = \theta \cdot (1-\alpha) \cdot \bar{l}^{\alpha} \cdot \left(\frac{\Lambda}{1+(\Lambda-1)t_e}\right)^{\alpha} \tag{15}$$

Each would-be claimant compares the expected rent to enclosure in (15) to its cost c, and encloses when $r(t_e) > c$. In a Nash equilibrium, each claimant makes a best-response enclosure decision, taking the actions of all other players as given. The other players' actions enter the rental rate payoff function (15) only via the aggregate enclosure rate t_e. The enclosure process, therefore, has the structure of an aggregative game (see e.g. Corchón 2021; Acemoglu and Jensen 2013).

The function $r(t_e)$ in (14) inherits characteristics from the labor reaction function, equation (13). In particular, the rental rate function r will be *increasing* in t_e when the expected TFP gain θ falls below the high-TFP threshold θ_H. It is *decreasing* in t_e whenever the expected TFP gain θ exceeds this threshold. We can again partition the parameter space into different enclosure decision regions similar to how we did in section 3.2 except that now we observe quite different behaviors in the low-TFP and high-TFP gain regions. Substituting $t_e = 0$ into (15) gives an expression for the threshold level of population density $\bar{l}$ above which enclosure becomes attractive ($r(0) > c$):

$$\bar{l} \geq \frac{1}{\Lambda} \left[\frac{c}{\theta} \cdot \frac{1}{(1-\alpha)} \right]^{\frac{1}{\alpha}} = \bar{l}_0^d \tag{16}$$

All economies with population density $\bar{l}$ above the $\bar{l}_0^d$ line satisfy the $r(0) \geq c$ condition. Similarly, the parameter region where we should expect full enclosure, $r(1) > c$, can be characterized by the following condition:

$$\bar{l} \geq \left[\frac{c}{\theta} \cdot \frac{1}{(1-\alpha)} \right]^{\frac{1}{\alpha}} = \bar{l}_1^d \tag{17}$$

The loci given by (16) and (17) are both hyperbolas in θ, $\bar{l}$ space. As defined earlier in (13), $\Lambda = (\alpha\theta)^{\frac{1}{1-\alpha}}$ is a decreasing function of θ that equals one at $\theta_H = \frac{1}{\alpha}$. The two-parameter loci intersect at this threshold. We can characterize all possible equilibrium enclosure outcomes in the decentralized private economy with these two loci. Figure 3 displays these loci in $\theta - \ln(\bar{l})$ (technology – log population density) parameter space.

In the low-TFP economy, where $\theta < \theta_H$, the private return to enclosure r increases with the aggregate enclosure rate t_e, implying that enclosure decisions are strategic complements: Each decision to enclose raises the payoff to others' enclosure returns. This happens because labor entered unenclosed land until the *average* product of labor of the last worker is equal to the market wage w_e, while, in the enclosed sector, hiring stops when the *marginal* product of labor of the last worker hired equals the wage w_e. As long as $\theta < \theta_H$ this new marginal product will fall short of where the average product of labor had stood, and fewer workers are hired. This releases labor to the rest of the economy, further crowding what remains of the commons, lowering the market equilibrium wage and therefore raising the equilibrium rental rate and hence the return to further private enclosures. When $r(0) > c$ (i.e. in the parameter region above $\bar{l}_0^d$ and to the left of θ_H) the unique Nash equilibrium will involve full enclosure. When $r(1) < c$, (in the parameter region below $\bar{l}_1^d$ and to the left of θ_H) it does not pay for any individual potential encloser to start enclosing and the unique equilibrium is no

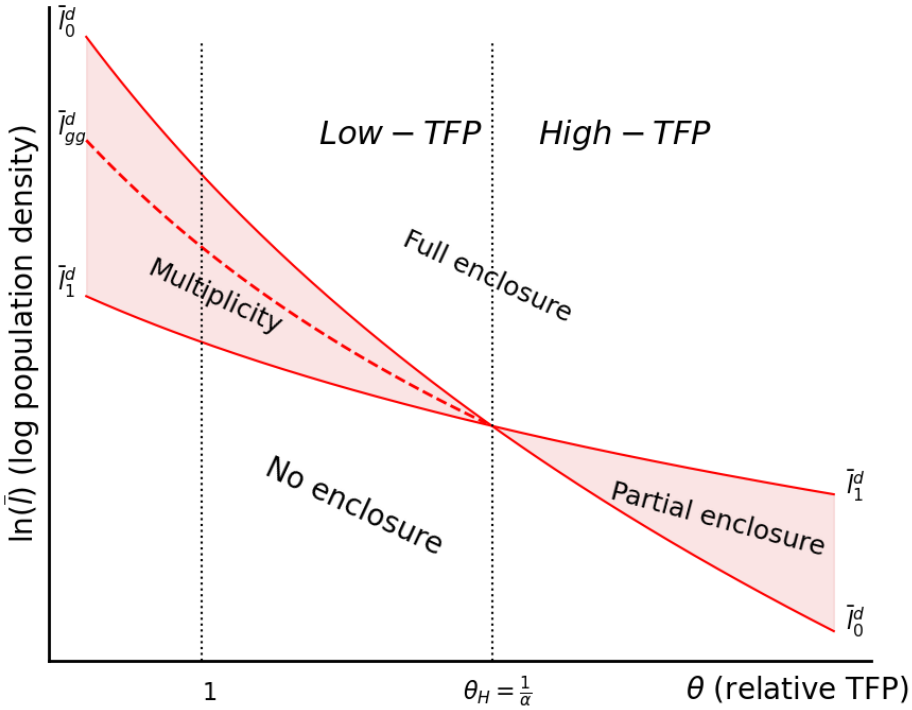

Figure 3: Decentralized enclosure equilibria.

enclosure.

Aggregative games with spillovers and strategic complementarities lead to multiple equilibria, and hence to possible coordination failures (Vives 2005; Acemoglu and Jensen 2013). This is the case for parameters in the shaded region where $\theta < \theta_H$ and where $r(0) < c$ and $r(1) > c$ in Figure 3. In this parameter region, 'no enclosure' and 'complete enclosure' are both possible Nash equilibria.[8] If no land is enclosed, so that $t_e = 0$, it would remain privately unprofitable for any one claimant to enclose land, yet all would find it profitable to enclose if all others did. In such environments, a perturbation to players' beliefs about the fraction of others enclosing could tip the economy into a cascade away from a no-enclosure equilibrium to full-enclosure (or vice versa). These are economies where sudden rapid changes in property holding patterns, net output, and income distribution are possible.

Next consider the high-TFP gain economies where $\theta > \theta_H$. Now, $r'(t_e) < 0$, so r is *decreasing* in the fraction of land enclosed t_e. Enclosure decisions in this region of the parameter space are strategic substitutes. Each new enclosure raises TFP by enough to

8. There is an additional, interior equilibrium with partial enclosure but that equilibrium is unstable.

increase labor demand on the plot. This reduces congestion on remaining unenclosed land, drives up wages, and exerts a dampening effect on the return to further enclosures. In the high population density and high-TFP gain region above $\bar{l}_1^d$, we have $r(1) > c$, and the result will be full enclosure. In the lower population density region below $\bar{l}_0^d$, we have $r(0) < c$, and the equilibrium will be no enclosure. Finally, if $r(0) > c$ and $r(1) < c$, in the parameter region between the two lines, the economy settles in a stable equilibrium with partial enclosure. This region is labeled accordingly in Figure 3.

3.4 Multiple equilibria and Global Games

The theory of global games (Carlsson and van Damme 1993; Morris and Shin 2003) offers a compelling criterion for selecting between the full- and no-enclosure equilibria in the multiple equilibria region of Figure 3, and a convenient means for identifying risk-dominant enclosure equilibria. To motivate this interpretation, we imagine there is a small amount of uncertainty about the relative TFP parameter θ. Potential enclosers observe a private signal of θ subject to a small random error, perhaps $x = \theta + \sigma\varepsilon_i$, where ε has mean zero and finite support. As σ approaches zero, parametric uncertainty vanishes and θ becomes essentially known by everyone but, as Morris and Shin (2003) show, remaining strategic uncertainty results in players relying on a unique cutoff strategy in Nash equilibrium: if θ is greater than some θ^*, a potential claimant encloses, which results in full enclosure whenever $\theta \geq \theta^*$. The cutoff θ^* is determined as the θ at which a potential claimant is indifferent between enclosing or not, given a uniform expectation over the fraction of others enclosing (i.e., a Laplacian belief about the enclosure decisions of others). Thus, θ^* (which is subsumed in $\Lambda = (\alpha\theta^*)^{\frac{1}{1-\alpha}}$) solves the following equation:

$$\int_0^1 \left[(1-\alpha)\frac{\Lambda}{\alpha}\bar{l}^{\alpha}(1+\Lambda t_e - t_e)^{-\alpha} - c\right] dt_e = 0$$

Simplifying and rearranging this expression reveals that full enclosure is the risk-dominant equilibrium if:

$$\bar{l} \geq \left[\frac{c}{\theta} \cdot \frac{1-\Lambda}{\Lambda^{\alpha} - \Lambda}\right]^{\frac{1}{\alpha}} = \bar{l}_{gg}^d \qquad (18)$$

The locus in (18) is drawn as a dashed red line in Figure 3 and labeled as $\bar{l}_{gg}^d$. Full enclosure occurs in the parameter space above the dashed red line in the low-TFP gain region. No enclosure occurs in the region below.

4 Efficiency and distribution under private enclosures

When do decentralized enclosure processes lead to socially efficient enclosure rates and labor allocation, and what are their distributional consequences? In what types of economies do they fail to bring about efficient allocations and what is the size and cause of misallocation? In this and the next section, we analyze these questions and posit a second-best efficiency benchmark to guide the design of policy interventions adapted to different environments.

Figure 4 superimposes the private enclosure decision regions of Figure 3 on top of the social planner's decision regions from Figure 2. This shows the economic environments in which private and social enclosure decisions diverge and, hence, in which decentralized enclosure leads to equilibrium allocations $(t_e^*, l_e^*(t_e^*))$ where net output falls short of potential.

In several economic environments, decentralized enclosure processes do lead to efficient outcomes. No private enclosure occurs in the decentralized economy in low-TFP-gain and low population density economies in the lower left-hand corner of Figure 4, and this matches the choice of the social planner. Similarly, decentralized processes lead to efficient full enclosure in the high population density and high-TFP gain economies of the upper right-hand corner of Figure 4.

Private and social equilibria do, however, diverge in several regions of the parameter space. Decentralized enclosure processes can lead to full enclosure in environments where a social planner would not enclose at all or as much. If we take the global games solution as guiding equilibrium selection, this result will be the case for the entire parameter region above the dashed $\bar{l}_{gg}^d$ locus and below the planner's $\bar{l}_0^o$ locus. High population density in these economies has driven the privately capturable rents to enclosure above the private cost of enclosure, despite the fact that the net social benefits of enclosure remain negative. As analyzed in depth below, this leads to excessive 'entry' into the enclosure business because enclosers fail to consider or offer full compensation for the value that the resources had generated for those now displaced by enclosure. Alarmingly, this situation can trigger a sudden cascade toward inefficient full enclosure even in economies where $\theta < 1$ and enclosure leads to actual technical regress.

The opposite type of situation arises in other economies. From Figure 4 it is evident that the decentralized economy fails to coordinate to begin enclosures in situations where it would be socially efficient to seek partial or full enclosure. This occurs in economies to the right of θ_H, above locus $\bar{l}_0^o$ but below locus $\bar{l}_0^d$, where the TFP gains to enclosure are high, but population density remains relatively low.

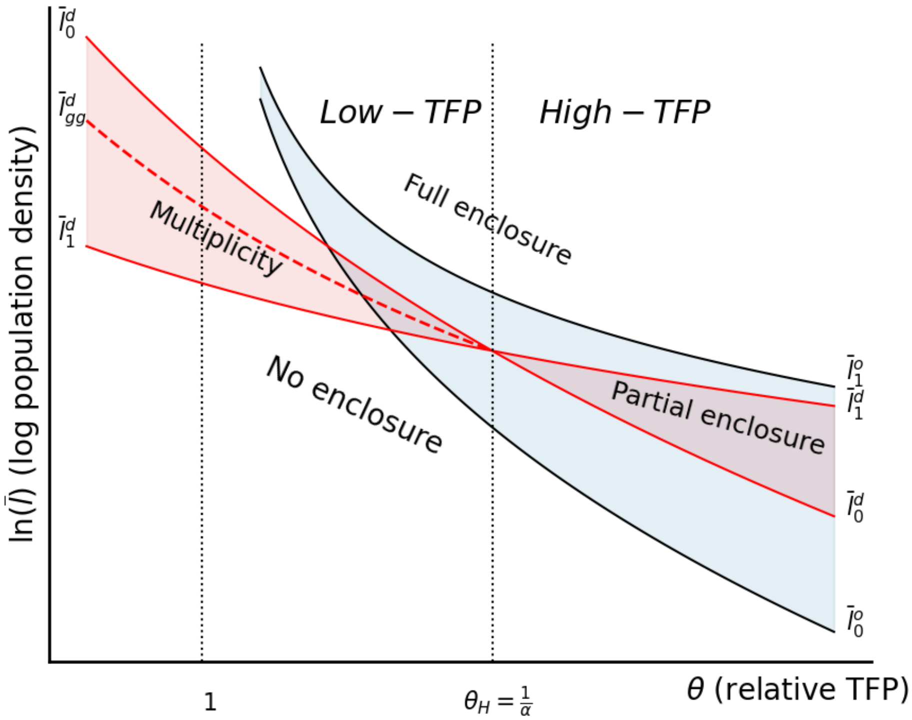

Figure 4: Optimal and Decentralized Enclosures Compared. Red-shaded areas describe regions with partial private enclosure or multiple equilibria. Blue-shaded regions describe socially optimal partial enclosure.

4.1 Are private enclosure rates even second-best?

Although it is easy to identify environments where private and social enclosure rates diverge, we cannot declare the unregulated, decentralized enclosure rate as 'too high' or 'too low' without a new benchmark. The reason is that the decentralized economy is subject to labor misallocation problems that the planner avoids, by assumption, in a first-best world. A more policy-relevant question is whether a planner, who also faces the constraint that labor entry into unenclosed areas cannot be perfectly regulated, could raise net output by choosing a different enclosure rate. Governments can often exert control over what land areas will be allowed to be enclosed, for example, through land settlement or zoning laws that clearly delineate where formal exclusive land claims will be recognized and registered. However, it may be much more difficult for the same governments to regulate entry into and 'squatting' on unenclosed frontier regions or informal settlement areas. Early land policy in the United States, both in colonial times and well into the 19th century, could be viewed as a succession of efforts to set and hold frontier lines, with authorities facing the perennial challenge of squatters/settlers venturing beyond these moving frontier lines (see e.g. Murtazashvili 2013; Alston, Harris, and Mueller 2012). The development of modern urban settlements from Lima to Dar es Salaam has been marked by similar access control challenges (de Soto 2000).

It will be useful to establish the planner's constrained or second-best optimum. Let the function $z(t_e) = y(t_e, l^*(t_e))$ describe the value of output per unit of land that could be achieved at different enclosure rates t_e, subject to the constraint that labor will react to any new enclosure by moving in search of the best return until equation (1) holds. We incorporate this constraint into the planner's objective (6) by substituting the labor reaction function $l^*(t_e)$ from (13) instead of the optimal labor allocation function $l_e^o(t_e)$ from (8) into the planner's objective (6). After some algebraic simplification, the constrained planner's objective can be written as:

$$z(t_e) - c \cdot t_e = \frac{1 + (\frac{\Lambda}{\alpha} - 1)t_e}{(1 + (\Lambda - 1)t_e)^{\alpha}} \cdot \bar{l}^{\alpha} - c \cdot t_e \tag{19}$$

This function gives us the output net of enclosure costs per unit of land in an economy at any given enclosure rate t_e when labor moves freely into the unenclosed sector. It differs qualitatively from the unconstrained total output function $z_o(t_e)$ from (9). While it must be true that $z(t_e) = z_o(t_e)$ at the end points $t_e = 0$ and $t_e = 1$ where there is no labor misallocation, it should be clear that $z(t_e)$ must lie below $z_o(t_e)$ at every interior point t_e since labor is misallocated relative to the optimum. We can now check whether the enclosure rate chosen by a decentralized economy t_e^* is 'too high' or 'too low' relative to a planner's constrained or second-best optimum by characterizing the enclosure rate t_e^c that maximizes the constrained planner's function $z(t_e) - c \cdot t_e$. This also informs the design of policies to guide decentralized enclosure processes toward a higher net output constrained-efficient allocation, as discussed in Section 5.

We can determine constrained-efficient enclosure policy regions by studying the properties of the second-best objective $z(t_e) - c \cdot t_e$. In the high-TFP gain region where $\Lambda > 1$ (and $\theta > \frac{1}{\alpha}$), $z(t_e)$ is increasing and concave, so the problem can be analyzed in the same way as (9) - by evaluating derivatives at endpoints. In the low-TFP gain region, where $1 < \theta < \frac{1}{\alpha}$, $z(t_e)$ is increasing and *convex*, so $z(t_e) - ct_e$ will be convex with a U-shape that implies a corner solution with either all or no land enclosed maximizes welfare. We find that full enclosure will be optimal when:

$$\bar{l} \geq \left[\frac{c}{\theta - 1}\right]^{\frac{1}{\alpha}} = \bar{l}^s \tag{20}$$

The superscript in $\bar{l}^s$ indicates that this locus applies to the second-best. To the right of the high-TFP threshold, where $\theta > \theta_H = \frac{1}{\alpha}$, the function $z(t_e) - ct_e$ in (19) is concave down and we can again check endpoint derivatives to determine whether enclosure should be zero, partial, or full. Enclosure should begin if:

$$\bar{l} \geq \left[\frac{\alpha c}{(\Lambda(1+\alpha) - \alpha)} \cdot \frac{1}{(1-\alpha)} \right]^{\frac{1}{\alpha}} = \bar{l}_0^s \tag{21}$$

While enclosure should be total if:

$$\bar{l} \geq \left[\frac{c}{\theta} \cdot \frac{1}{(1-\alpha)} \right]^{\frac{1}{\alpha}} = \bar{l}_1^s \tag{22}$$

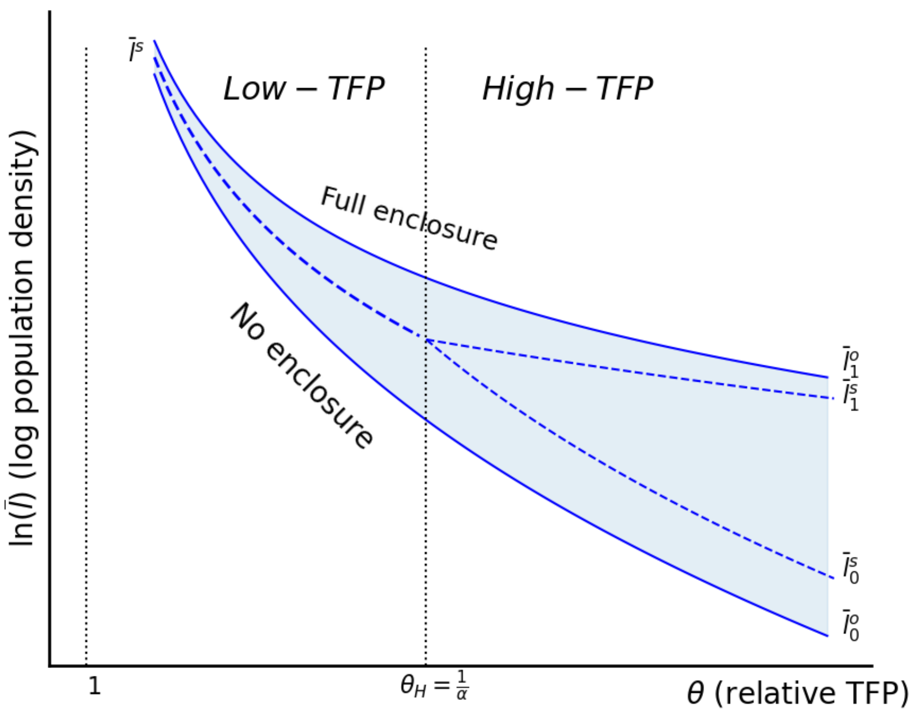

Figure 5: First-best and second-best enclosure as a function of the labor-land ratio and expected TFP gain θ on enclosed land.

Notice that the boundary $\bar{l}_1^s$ in (22) is exactly the same boundary l_1^d in (17) that described where full enclosure would occur under decentralized processes in high-TFP economies. Figure 5 shows these second-best or constrained-optimal enclosure regions delineated with dashed blue lines $\bar{l}^s$, $\bar{l}_0^s$, and $\bar{l}_1^s$, superimposed above the earlier first-best enclosure decision region boundaries from Figure 2. Compared to the unconstrained planner, the constrained social planner is hesitant to start to enclose in the region above the $\bar{l}_0^o$ locus but below the $\bar{l}^s$ and $\bar{l}_0^s$ loci. This is because initiating enclosures would create labor misallocation and enclosure costs that exceed the productivity gains to enclosure. Above the $\bar{l}^s$ locus to the left of θ_H, and the $\bar{l}_0^s$ and $\bar{l}_1^s$ loci to the right of θ_H, and below the $\bar{l}_1^o$ locus, the situation reverses. The constrained planner would choose full enclosure to reduce labor misallocation costs, but the unconstrained planner keeps some land unenclosed.

We can now meaningfully identify the environments where decentralized decisions lead to enclosure rates that are either 'too high' or 'too low' relative to a planner's second-best optimum and, therefore, where policy measures could raise net output. Figure 6 draws the constrained planner's decision regions on top of the earlier identified enclosure regions for the decentralized economy from Figure 3. The planner's first-best region is also indicated in lighter shading. The figure may seem complicated, but it is easily interpreted. Everywhere in the red-hatched region of the figure, above $\bar{l}_{gg}^d$ and below $\bar{l}^s$, there is too much enclosure: decentralized enclosure processes lead to total enclosure even though net output would be higher if there was no enclosure at all. On the contrary, in the blue-thatched region, to the right of θ_H but below $\bar{l}_1^s$ and above $\bar{l}_0^s$, decentralized processes lead to inefficiently low enclosure. In the more tightly thatched blue region between $\bar{l}_0^s$ and $\bar{l}_0^d$, coordination failure in the decentralized economy implies no enclosure at all takes place even though net output would be higher if it did. Policies to subsidize or stimulate enclosure can increase net output in these regions.

Other observations stand out. One striking fact is the possibility that small continuous changes to environmental parameters can precipitate sudden inefficient enclosure cascades of the sort we might associate with land grabbing or property races. This can occur in low-TFP gain economies, left of the vertical θ_H line and below the locus $\bar{l}_0^s$ in Figure 6. Consider an economy identified by any point just below the dashed $\bar{l}_{gg}^d$ locus where the economy remains efficiently unenclosed. Now, any combination of a slight increase in population density $\bar{l}$, an increase in the potential TFP gain θ, or any other factor that acts to raise the value of land rents may be enough to tip the economy above the dashed threshold and precipitate a race to enclose. This occurs even though 'no enclosure' remains the more efficient first-best and second-best choice. Net output decreases as agents drive up enclosure costs beyond any resulting social benefits. Policies to tax or otherwise dissuade enclosure in this region may be Pareto-improving. The potential inefficiency is particularly striking in the region where $\theta < 1$ where it is self-evident that each enclosure *lowers* TFP on any enclosed plot. Dasgupta and Stiglitz

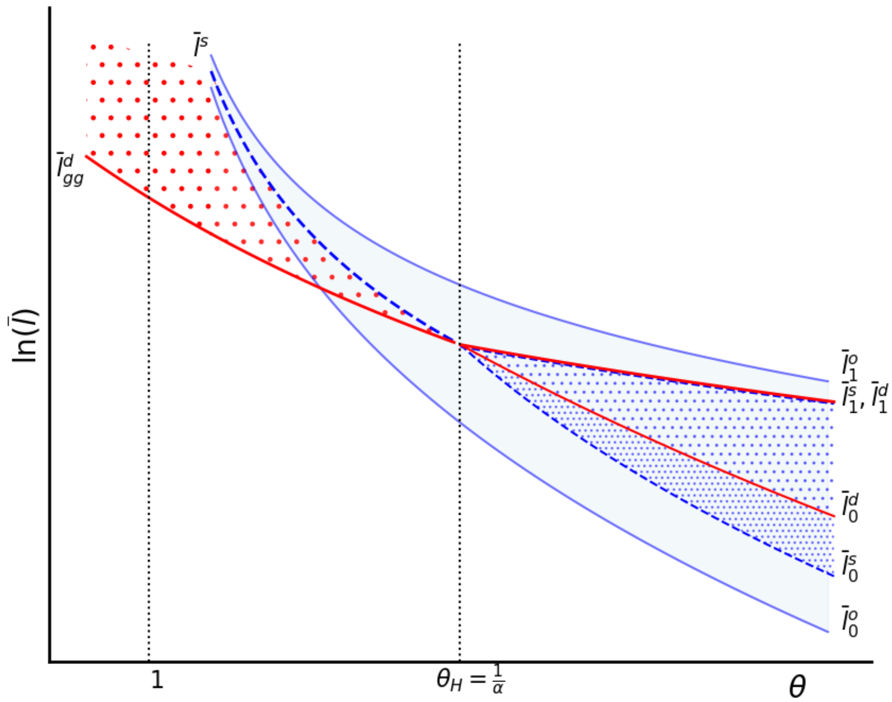

Figure 6: Comparing decentralized and second-best outcomes. In the red-hatched region, where $\theta < \theta_H$ decentralized processes lead to inefficient full enclosure; in the blue-thatched region, to inefficiently low enclosure, and within the finer hatched blue region, to no enclosure where some enclosure would raise net output.

(1980) has drawn attention to the possibility of similarly inefficient races in the case of patents and, in a less general model, Anderson and Hill (1990) have drawn attention to the possibility of inefficient property races to land. de Meza and Gould (1992, p.567) also drew attention to the possibility of what they called 'cusp catastrophes' and here we can more clearly identify the environments where this could happen with the global game equilibrium selection.

A qualitatively different scenario arises on the high-TFP gain side of the θ_H threshold. Here, in the entire hatched region above the $\bar{l}^s_0$ locus but below the $\bar{l}^d_1$ locus, coordination failures lead to decentralized equilibria enclosure levels that are too low and not even second-best. Within the sub-region above locus $\bar{l}^s_0$ but below the $\bar{l}^d_0$ locus, the decentralized private economy fails to initiate enclosures where some enclosure would clearly raise net output.

4.2 Labor release, wages, and distribution

A key theoretical observation in earlier papers is that, in an economy with well-behaved but unchanging technologies, *uncompensated* full enclosures will always lead to a lower equilibrium wage (w_e in our model), implying that labor "will always be better off with (inefficient) free access rights than under (efficient) private ownership of property" (Weitzman 1974, p. 225; see also Samuelson 1974). However, this result is derived for the special case in our framework where land is in open unregulated access ($\mu = 0$), enclosure is costless ($c = 0$), full and uncompensated ($\tau = 0$), and technology remains unchanged following enclosure ($\theta = 1$).[9] One contribution of the results following is to understand when this result generalizes.

Total labor earnings can be represented by the market wage w_e (which must also be equal to the average product of labor earned in the unenclosed sector) times labor supply $\bar{L}$. Substituting for $l_e^*(t_e)$ and using (13), we can write total labor income as a function of t_e:

$$Y_L = \alpha \cdot \theta \cdot F(\bar{T}, \bar{L}) \cdot \left(\frac{1 + (\Lambda - 1)t_e}{\Lambda} \right)^{1-\alpha} \tag{23}$$

In a completely unenclosed economy (with $t_e = 0$) there would be no privately held land so all output would go to labor $Y_L = F(\bar{T}, \bar{L})$. If instead all land is enclosed ($t_e = 1$) and held exclusively, then labor would now earn only the conventional neo-classical labor share α of total output, or $Y_L = \alpha \cdot \theta F(\bar{T}, \bar{L})$. Total output will be larger in the enclosed economy whenever $\theta > 1$ but labor gains from enclosure only in high-TFP gain economies where $\theta > \theta_H$. In the low-TFP economy, where $\theta < \theta_H$ and hence $\Lambda < 1$, labor's absolute income Y_L in (23) is decreasing in the enclosure rate t_e. Enclosures reduce labor earnings by extinguishing implied land rents and by releasing labor onto the market leading the wage to fall, as the encloser reduces the demand for labor on the plot. Cohen and Weitzman (1975) built a 'Marxian Theory of Enclosures' around a version of this labor displacement story in an eponymous paper. We discuss this and other papers in some of the theoretical and empirical debates surrounding the role of enclosures in the structural transformation of the economy in Section 6.2 of the paper.

In a high-TFP gain economy, the opposite becomes true: laborers as a group benefit from enclosure because the productivity increase on enclosed land is sufficient to increase the demand for labor, pushing up wages by enough to compensate for laborers' income loss from the loss of customary rights. We explore this and related topics of land and

9. Recall that the parameters μ and τ were briefly introduced in Section 2. In Section 5.1, we discuss these parameters in detail.

labor control policies in frontier regions in section 6.1.

5 Externalities and Land Policy

Why do the private returns to enclosure often diverge from the social returns? On the margin, a private party chooses to enclose if the land rent they can capture via a new enclosure exceeds its cost. It is instructive to compare this privately captured net private benefit to the net social benefit that a *constrained* planner would calculate starting from the same enclosure and labor allocation. The constrained net *social* marginal benefit is determined by the derivative of $z'(t_e) - c$ which describes the planner's second-best objective.[10] We can write this out in a way that places the net private benefit to the encloser first and reveals two external effects that the private encloser fails to internalize:

$$\overbrace{\theta F_T^e \bar{f} - c}^{\text{net private benefit}} \quad \underbrace{-F_T^c \bar{f}}_{\text{external cost}} \quad + \overbrace{(\theta F_L^e - F_L^c)\bar{f} \cdot \frac{dl_e^*}{dt_e}}^{\text{external benefit}} \tag{24}$$

Where $\bar{f} = F(\bar{T}, \bar{L})/\bar{T}$ measures potential output per unit of land with no land enclosed. A private encloser considers only the net private benefit of (24) in making their enclosure decision. In situations of *enclosure without compensation* each private encloser ignores the external costs they impose upon customary users for being deprived of the implied land rental income F_T^c they had captured from the now-enclosed area. We might label this the 'rent-stealing' or 'rent-shifting' effect of uncompensated enclosures.[11]

The private encloser, however, also ignores potential 'external benefits' that their enclosure creates when $\theta > 1$ in the form of reduced labor misallocation, as higher productivity labor replaces lower productivity labor on newly enclosed land. This is captured by the last term of expression (24) which can be seen in Figure 1 as given roughly by the reduction in deadweight loss measured by distance AB[12]. When the net of these two external effects is negative, decentralized enclosure processes will lead to

10. Recall from (19) that $z(t_e) = [\theta F(t_e, l_e^*(t_e)) + F(1 - t_e, 1 - l_e^*(t_e))] \cdot \frac{F(\bar{T},\bar{L})}{\bar{T}}$

11. The choice of label depends, of course, on how one judges the legitimacy of the claims of existing (or potential) users of lands in the unenclosed sector. Regardless of the label one chooses, a complete analysis requires that we include the opportunity cost of foreclosing these alternate uses of land.

12. Though some labor will be displaced whenever $\theta < \theta_H$, for small marginal adjustments, this displaced labor will have the same marginal product of labor F_L^c as it moves into the unenclosed sector, while remaining workers on the newly enclosed plot now have a higher marginal product F_L^e. The net effect of enclosure, therefore, is to increase overall labor productivity, as long as $\theta > 1$. If $\theta < 1$ this external effect becomes a cost.

inefficiently high levels of enclosure, meaning that net output would be higher without enclosure. This happens to economies in the red-thatched regions of 6 below the high-TFP gain threshold. On the other hand, if the net external effect is positive, the decentralized economy produces inefficiently low levels of land enclosure (in the blue thatched regions to the right of the high-TFP threshold).

5.1 Regulation and Compensation

The benchmark assumptions of unrestricted access and uncompensated enclosure do not accurately reflect the complexities of many situations. To consider a wider and more realistic range of scenarios, we examine the effects of modifying two parameters, τ and μ, which were briefly introduced in Section 2 but were assumed to be fixed at $\tau = 0$ and $\mu = 0$ in the previous analysis. The parameter μ can be interpreted as capturing the degree to which access to the unenclosed area is regulated. The parameter τ on the other captures the degree to which the institutional or legal environment requires compensation for enclosures.

Consider first μ. As Elinor Ostrom (1990) and many other observers have emphasized, under customary land-holding regimes, land and other resources are often regulated in ways that can ameliorate some or all of the hypothesized misallocation of labor attributable to open access. Land use rights are often also individualized, often in subtle ways (Bromley 1992b; Baland and Platteau 1996). In the simplest instance, we can think of this as an access fee or membership cost that one must pay to be allowed to exploit the resource.

The equilibrium labor market condition (4) with μ now included becomes the following:

$$w_e - w_c = (1 - \mu) \cdot r_c \frac{T_c}{L_c} \tag{25}$$

The parameter $\mu \in [0, 1]$ can be given different interpretations. As mentioned previously, we could think of labor as having to pay an access fee or customary rent $\mu r_c \frac{T_c}{L_c}$ to a village authority or landlord in exchange for continued access to land that generates income $r_c \frac{T_c}{L_c}$. When $0 < \mu \leq 1$ the access fee is set below the implied value of the resource so the entrant stands to capture an economic rent (given by the right-hand side of 25) that continues to distort labor allocations. When $\mu = 0$ the situation is one of 'free access,' which was the maintained assumption of our previous analysis.

Another interpretation is that μ measures the security or alienability of land rights in the customary sector. In the benchmark model (where $\mu = 0$), a unit of labor that exits the unenclosed customary sector to pursue a wage opportunity w_e in the enclosed sector loses all claims to land possession in the customary sector worth $r_c \cdot \frac{T_c}{L_c}$. Suppose, however, that a unit of labor can instead retain a fraction $(1-\mu)$ of the claims $r_c \cdot \frac{T_c}{L_c}$ it leaves behind. For example, the unit of labor may rent the unoccupied land out to a local tenant with some risk that this new tenant will take possession. Under either interpretation, we can think of μ as ultimately influenced by the extent of community cohesion and/or organizational capacity.[13]

When $\mu = 1$, the unenclosed commons sector effectively regulates the entry of labor. Labor that tries to enter, or wishes to remain in, the unenclosed sector now fully internalizes the effect of its actions, and the marginal products of labor equalize between sectors. On the surface, this appears to be functionally equivalent to making customary property rights more secure, as it removes the threat that entry will crowd into the unenclosed sector and reduce the value of existing rents. However, as we show below, strengthening informal property rights in this way can, ironically, make land in the commons a more attractive target for inefficient property races and land grabbing. This is the theory of the second best at work: in a general equilibrium setting, reducing the size of distortion on one margin (e.g. adjusting μ to be closer to 1) does not necessarily improve efficiency as long as distortions remain on other margins.

While the parameter μ might measure the degree of community cohesion and its ability to regulate the entry of labor into the commons, the parameter $\tau \in [0,1]$ can be interpreted as measuring the amount of compensation that an encloser must pay to displaced stakeholders for the value of the use rights they may have lost by their exclusion. Whether compensation is paid or not may be determined by law or tradition or, more broadly, by bargaining power or the 'balance of class forces' in any given context. When the private encloser must pay compensation, they compare the return of enclosing a marginal unit of land $r(t_e) = \theta F_T^e$ with its cost, which includes the direct cost of the enclosure c plus compensation for a fraction τ of the loss of income incurred by displaced stakeholders. Enclosure will now take place whenever:

$$\theta F_T^e \bar{f} \geq \tau F_T^c \bar{f} + c \tag{26}$$

Note that when $\tau = 1$ private actors are led to fully internalize the external cost of their enclosure decision, as previously identified in expression 24. If, at the same time, $\mu = 1$ labor misallocation is also avoided, and therefore there is no longer any external

13. Since this determines a community's ability to impose access fees or other means of regulation or (under the second interpretation) to offer partial security, or a compensated exit arrangement, to those who might choose to leave to pursue outside opportunities.

benefit from reduced labor misallocation from private enclosure decisions either. Private and social marginal benefits and costs then coincide, and the decentralized economy leads to the social optimum.

One historically salient special case where $0 < \mu \leq 1$ arises when landlords and tenants contest claims over property rights over land, or the rental rate, in a customary regime. This, arguably, describes most landlord systems that evolved from the historical transformation of manorial systems and landlord estates (Binswanger, Deininger, and Feder 1995). In England, as serfdom and feudal structures were transformed and abandoned over the course of the fourteenth, fifteenth and sixteenth centuries, English peasants came to acquire considerable customary rights over the lands they worked, including rights of inheritance and protections against arbitrary evictions and rent increases. Landlords, of course, often tried to change the terms of these contracts in their favor, and peasants resisted.

The framework can capture some aspects of this struggle over property rights and its consequences. Assume that peasant customary land claims generate an income stream of $r_c \cdot T_c/L_c$ per unit of labor in the sector but that they must pay a customary rent to the landlord of $mu \cdot r_c T_c/L_c$. As long as $\mu < 1$, residence in the customary sector helps secure a residual economic rent, so some labor misallocation persists. Some economic historians, including Brenner (1976) and Wood (2002), have argued that distributional variables such as μ were ultimately determined by the 'balance of class forces' and this changed over time and place, in response to political events. In this context, suppose that at a cost c per unit of land, a landlord can enclose an area of land, evicting any customary tenant. The landlord then brings in a new tenant (or hires the same one) at the new, higher, enclosed sector rental rate r_e. From the landlords' perspective, this is like enclosure with partial compensation, with $\tau = \mu$. The enclosing landlords' return is now $\theta F_T^e - \mu F_T^c - c$ because they lose the income from the customary rent tenant when they replace them with a market rent-paying one. As Robert Allen (1982, p. 937) has argued of England: "Although the consequences of enclosures have been the subject of controversy since the process began, the proximate cause of enclosure has always been clear. Enclosures were invariably initiated by landowners because they expected their tenant farmers would pay higher rents after the Parish was enclosed."

Another obvious situation where the encloser would be forced to internalize the costs of lost customary uses due to enclosure occurs when existing users of the commons make the enclosure decisions, rather than outsiders. Their choice is whether to continue to maintain their own customary possession and technology and the income stream they earn from it or to make a costly investment to establish a more secure exclusive claim that may allow them to adopt a new production technology. In the United States, Preemption Acts passed in the 1830s and 1840s granted squatters' rights to settlers, required government surveys before sale, and granted settlers the right of first purchase. Settlers often formed claim clubs to deter outsiders from bidding (Murtazashvili 2013).

Legislation introduced in the 1990s established ground rules for enclosure processes to reform Mexican ejido land areas. Plots were typically farmed individually in ejidos. Land was held as communal property and could not be sold. de Janvry et al. (2015, p.3125) describe how the legislation enabled households to choose to obtain ownership certificates that "removed the link between land use and land rights." Consistent with what our framework would predict for environments where $\theta < \theta_H$, the authors found large-scale labor released after privatization. Households who obtained certificates became "28 percent more likely to have a migrant member," (p.3127) and larger migration effects where measured where property rights insecurity had been higher.

5.2 Policy Designs and the theory of the second best

We have identified situations where there could be excess enclosure relative to a second-best optimum and other situations in which there could be too little enclosure. A crude policy response would call for policies to subsidize or otherwise encourage enclosures for the second type of case and policies to tax or otherwise dissuade enclosure in the first. A more nuanced approach to policy design would, however, be guided both by the 'Specificity Rule' that policies be targeted at the source of the problem rather than respond to effects, and also be aware of the 'theory of the second best' problem in this general equilibrium setting, and attempt to address all distortions simultaneously.

Concretely, we study policy packages that aim to simultaneously regulate the commons while also setting compensation policies, by interpreting μ and τ now as policy variables. Policy needs to be coordinated across both policy fronts to obtain the best outcomes. This is broadly consistent with evolving modern land policy legislation and land formalization best practices that emphasize (if not always achieving) recognizing and strengthening existing local customary land governance structures, while also establishing protections for existing and weaker stakeholders against uncompensated expropriation by stronger parties (Alden Wily 2018; Deininger and Bank 2003).

Consider an alternative interpretation of the model in which μ and τ are treated as parameters. Solving explicitly for labor allocations with $\mu \in [0, 1]$ using our parametric model gives:

$$l_e^{\mu}(t_e) = \frac{\Lambda_\mu t_e}{(1+(\Lambda_\mu - 1)t_e)} \quad \text{where} \quad \Lambda_\mu = \left(\frac{\alpha\theta}{1-\mu\cdot(1-\alpha)}\right)^{\frac{1}{1-\alpha}} \tag{27}$$

The high-TFP threshold becomes $\theta_H^{\mu} = \frac{1}{\alpha} - \mu \cdot \frac{1-\alpha}{\alpha}$. One can see from these new expressions that, as μ ranges from 0 to 1, Λ_μ goes from Λ (in equation (13)) to the optimal Λ_o in equation (7). Labor allocations change from free access misallocation to first-best allocation as access to common land becomes more tightly regulated.

To see how enclosure incentives change when $\mu \in [0,1]$ and $\tau \in [0,1]$ we substitute $l_e^{\mu}(t_e)$ from (27) into (14) to get:

$$r_\mu^e(t_e) = \theta(1-\alpha)\bar{l}^{\alpha}\left(\frac{\Lambda_\mu}{1+(\Lambda_\mu-1)t_e}\right)^{\alpha} \tag{28}$$

and we can derive an analogous expression for $r_{mu}^c(t_e)$ which determines the implied rental rate of land within the unenclosed sector. The encloser now encloses a unit of land only when

$$r_\mu^e(t_e) - \tau\cdot r_\mu^c(t_e) - c = (1-\alpha)\bar{l}^{\alpha}\frac{\theta\Lambda_\mu^{\alpha} - \tau}{(1+(\Lambda_\mu-1)t_e)^{\alpha}} - c \geq 0 \tag{29}$$

Figure 7 shows how decentralized enclosure decision regions, which are shaded red and change with different combinations of μ and τ, compare to socially optimal decisions, which are shaded blue and do not change. Case a, shown in the upper left panel, corresponds to the benchmark model case of free access and enclosure with zero compensation. The enclosers' return is increasing in Λ_μ, implying that the returns from enclosure increase with $\mu > 0$. This occurs because a value of $\mu > 0$ makes labor appear cheaper to the enclosed sector, increasing the marginal value of land in the enclosed sector.

We can see this in Case b, shown in the top right panel. This corresponds to the case of a well-regulated commons ($\mu = 1$) and enclosure without compensation. Relative to the benchmark, enclosure is now more attractive, as operators in the enclosed sector no longer have to pay a wage premium. The possibility of inefficient failure to enclose disappears, but the range of environments where the economy is tipped into inefficient enclosure greatly expands. But notice that while lower population density economies are now more likely to commence inefficient enclosures, a higher μ lowers the threshold θ_H^{μ} below which there is strategic complementarity in enclosure, so 'catastrophic' property cascades to total inefficient enclosure become less likely for positive-TFP gain economies (when $\mu = 1$ we find $\theta < \theta_H^{\mu=1} = 1$).

Case c, shown in the lower-left panel of the Figure, describes economies with un-

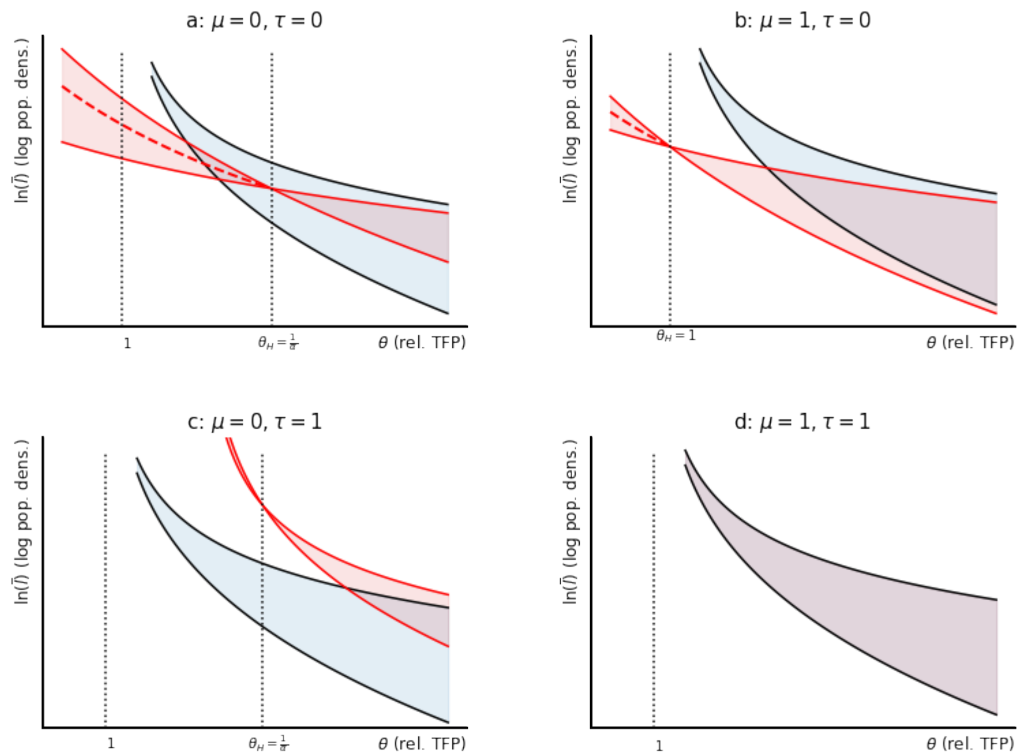

Figure 7: Comparing μ and τ policy regimes. (a) Benchmark case of an unregulated commons and zero Compensation to those displaced by enclosures; (b) A regulated commons but zero Compensation; (c) Unregulated commons but Full Compensation; and (d) Regulated commons with Full compensation where private enclosure decisions now coincide with socially optimal ones.

regulated commons access but policies of full compensation to those displaced by any enclosure. The compensation requirement lowers the return to enclosers relative to the benchmark, with the result that (when $\tau = 1$) the inefficient enclosure is now ruled out. At the same time, the range of economies where coordination traps lead to inefficient failure to enclose increases. This is an interesting case where – if there is no regulation of access to the commons – 'weaker' property rights protections ($\tau < 1$) may, in some circumstances, lead to higher net output than stronger property rights protections ($\tau = 1$), though likely at the cost of increased inequality. We see this, for example, for a range of high-TFP economies that would efficiently fully enclose when $\tau = 0$ (see panel a) but the same economies fail to enclose when $\tau = 1$ (see panel c). While this might seem to support the 'Agrarian Fundamentalist' view of "inequality as the necessary price of growth (Allen 1992, p.2)," our analysis reveals that there is nothing necessary about it when policy simultaneously acts to strengthen regulation of the commons.

Finally, the lower right panel shows the effect of policies that set $\mu = 1$ so that access to the commons is well regulated and, at the same time $\tau = 1$ so that enclosers must fully compensate those they displace. Decentralized decisions now perfectly coincide with those of the social planner. Cases b and c illustrate the 'theory of the second best' or the principle that, in a general equilibrium setting, reducing misallocation in one factor market may actually make things worse rather than better if other factor markets remain distorted.

6 Extensions and Applications

6.1 Encompassing interests and frontier settlement policy

Enclosure processes often come to be controlled by actors that have more unified and encompassing interests than the atomistic decision-makers considered above. For example, governments or colonizing companies acting as their agents often act to advance the interests of particular groups or to further some policy objective. In this section, we study how an organized interest might choose enclosure policy to maximize the value of captured land rents and how this differs from decentralized enclosure decisions.

Over the course of the 19th century, few persons would have as large of an impact over British colonial settlement policy and debates as the colorful and controversial Edward G. Wakefield. Confined to London's famous Newgate prison for several years for the crime of attempting to abduct and marry an underage heiress, Wakefield became interested in the topic of British colonial policy, likely influenced in part by observing other convicts being sent to Australia's distant penal colony. Wakefield was concerned with what he saw as a fundamental challenge in land abundant regions with large open frontiers such Australia or the United States. His concern was that newly arrived laborers would be drawn to possess lands and work independently, leading to dispersed and isolated settlements. Larger farms and employers that sought wage labor would then face high wages and an "inconstancy of labour" that would render their operations unprofitable (Wakefield 1849), and over time the entire colony would collapse, or fail to become established in the first place. This problem had been overcome in the past "by means of some kind of slavery (p.54)," but with that now banned in the British colonies, another solution was needed.

Wakefield's proposed corrective was a plan of 'systematic colonization' in which the colonial authorities, or the private land settlement companies acting on their behalf, would start by establishing much stronger preemptive rights over 'wastelands' in order to better deter informal settlements. They would then sell a portion of these lands but at a 'sufficient price' as to slow new immigrant laborers' access to land ownership. The intended result was to create more concentrated settlements and a more steady supply of labor at lower wages in order to promote the profitability and expansion of larger farms and other commercial interests. The proceeds from the sale of lands at artificially inflated prices would, over time, provide funds to subsidize the passage of new waves of migrants.

[14] Wakefield's impact on land settlement policies in South Australia, New Zealand, and parts of Canada was substantial. These settler colonies led to large-scale displacement of native peoples, but due largely to the organized political pressure of its newly arrived settlers and effective land surveying and registration, largely failed to set the high 'sufficient price Wakefield envisaged. More extreme policy designs to dispose of and block smallholder access to land to create a wage labor pool and/or diminish direct competition with a large estate sector were implemented in selected other regions, most notably in South Africa and other parts of Sub-Saharan Africa, as well as expanding frontier regions of Latin America (e.g. Binswanger and Deininger 1993; Solberg 1969; LeGrand 1984).

To fix ideas, consider a syndicate of claimants, possibly a land development company that has been given a large grant over unenclosed lands that may already have informal occupants. The syndicate's objective is narrowly pecuniary: its aim is to maximize the combined net total returns to its members from land enclosure. To simplify, we consider the case where the monopoly encloser derives income solely from enclosing land, which it then sells or rents out to competitive farm operators in the enclosed sector. This rules out having to consider potential labor monopsony effects that might arise if the large encloser were to also become a large farm operator and labor employer.[15] We re-adopt the benchmark assumptions that existing unenclosed areas are under free access (i.e. $\mu = 0$) and the encloser offers zero compensation to any existing occupants ($\tau = 0$).

The syndicate's objective may be stated as finding the enclosure rate t_e that maxi-

14. Karl Marx dedicated the entire last chapter of Capital, volume 1 to sidelong praise of Wakefield's theories as an illustration of some of his own ideas on 'primitive accumulation' and the creation of a wage labor class. Wakefield's 'great merit,' according to Marx, was "to have discovered in the Colonies the truth as to the conditions of capitalist production in the mother country." (Marx 1992, chapter 33).

15. See Conning and Kevane (2007) for an equilibrium analysis of land monopoly-labor monopsony factor market power interactions (but where land is already entirely enclosed) and the literature cited therein.

mizes land rent net of per unit enclosure costs:

$$\pi(t_e) = r(t_e) \cdot t_e - c \cdot t_e \tag{30}$$

where $r(t_e)$ is the market rental rate in the enclosed sector, as defined in expression (15). Profits per unit of land $\pi(t_e)$ in (30) can be concave or convex in t_e, depending on their inherited shape from $r(t_e)$. In a low-TFP gain economy, $\pi(t_e)$ is convex and the monopolist would check whether $\pi(1) > 0$ decides whether to fully enclose or not. Plugging $t_e = 1$ into (30) and solving as before, we find that this is the case for φ satisfying:

$$\bar{l} \geq \left[\frac{c}{\theta} \cdot \frac{1}{(1-\alpha)}\right]^{\frac{1}{\alpha}} = \bar{l}^m \tag{31}$$

In these low-TFP contexts, the condition (31) exactly matches the boundary condition $\bar{l}_1^d$ we saw earlier in the decentralized case in (17). In the atomistic case, when $\theta < \theta_H$, in economies above this l_1^d boundary but below the l_0^d boundary of (16) we had a situation where $r(1) > c > r(0)$, implying multiple equilibria at either $t_e = 0$ or $t_e = 1$. The coordination problem arises due to spillovers and strategic complementarities. The monopolist, however, internalizes these effects and will jump directly to the more profitable full enclosure allocation $t_e = 1$ in a range of environments where atomistic enclosure processes would not, even though it is socially inefficient. The objective here is not only to accumulate land but also to curtail labor's access to unenclosed lands to increase labor supply which lowers wages to the expanding enclosed sector, raising land rental prices.

Consider next the high-TFP environments. Here, the monopoly encloser changes strategy and now holds land off the market in many circumstances where the decentralized market and the social planner would enclose. To see this, notice that when $\theta \geq \theta_H$, the land returns function $\pi(t_e)$ becomes concave. This may yield a monopolist optimum with none, some, or total enclosure. We can check whether $\pi'(0) > 0$, so that some enclosure occurs, and also whether $\pi'(1) > 0$, suggesting full enclosure. Differentiating (30) with respect to t_e yields:

$$\pi'(t_e) = r(t_e) + r'(t_e)t_e - c \tag{32}$$

Plugging $t_e = 0$ into (32) results in $r(0) - c \geq 0$ as the condition for an encompassing interest to begin enclosure. This is the same threshold for starting enclosures as in the decentralized economy ($\bar{l}_0^d$ defined in (16)), which we reproduce and relabel here:

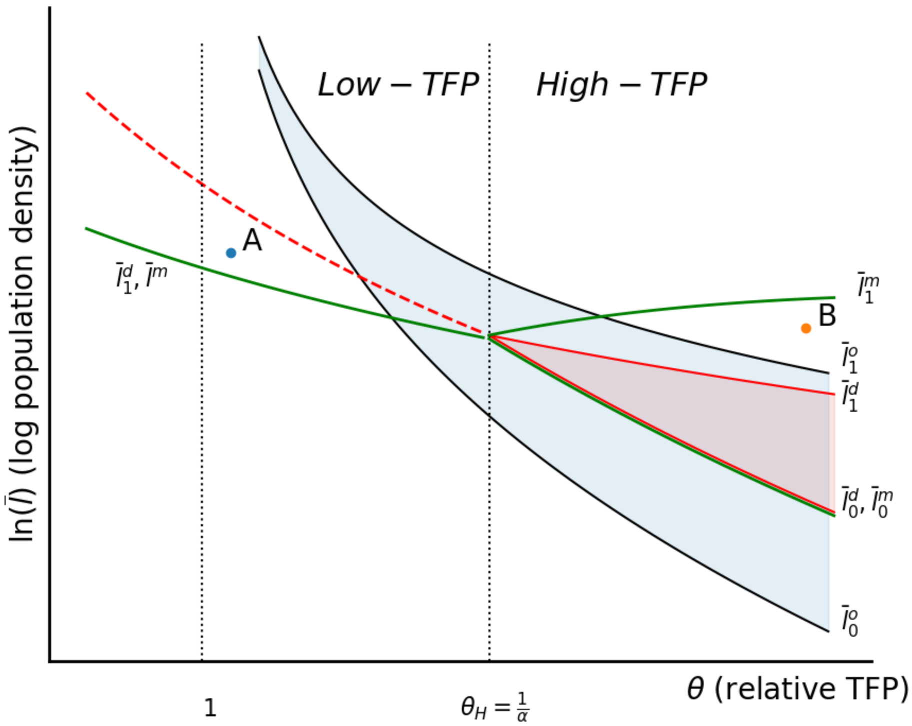

Figure 8: Monopolistic, Competitive, and Optimal Enclosures compared. The monopolist encloses everywhere above the thick green line in the low-TFP region. In the high-TFP region, the monopolist chooses partial enclosure between $\bar{l}_0^m$ and $\bar{l}_1^m$.

$$\bar{l} \geq \frac{1}{\Lambda}\left[\frac{c}{\theta} \cdot \frac{1}{(1-\alpha)}\right]^{\frac{1}{\alpha}} = \bar{l}_0^m \tag{33}$$

This suggests that in this region the monopolist begins to enclose at the same time as the decentralized economies do. However, as population density increases, the incentives of the monopolist diverge from those of decentralized enclosers because the monopolist internalizes the effect of increasing the enclosure rate t_e on the rental rate $r(t_e)$. Full enclosure requires that $\pi'(t_e)$ in (32) be greater than zero at $t_e > 1$. Calculating $\pi'(t_e)$ using $r(t_e)$ in (15) and rearranging gives the following description of the conditions under which an encompassing interest fully encloses:

$$\bar{l} \ \geq \left[\frac{\alpha c}{(1-\alpha)} \frac{\Lambda}{\Lambda(1-\alpha)+\alpha}\right]^{\frac{1}{\alpha}} = \bar{l}_1^m \tag{34}$$

Figure 8 shows where these monopoly loci lie relative to the decentralized and socially optimal enclosure regions. To summarize, in the low-TFP gain region, a monopolist does not face strategic uncertainty about whether other parcels will also be enclosed, so chooses to move to full enclosure in every situation where $r(0) < c$ yet $r(1) > c$. At a point such as A, the monopolist pushes to inefficiently enclose all land where the decentralized economy would not.

An entirely different situation emerges in the high-TFP economy when $\theta \geq \theta_H$. At a point like B in Figure 8, the monopolist chooses only partial enclosure even though land would have been fully enclosed in a more decentralized process or by a social planner. The monopolist finds it attractive to hold off from further enclosure because they understand that further enclosure and technological transformation will increase labor demand and wages in ways that begin to lower land rents, which is their source of income. This result can help to make sense of Alain de Janvry's (1981) observation that high-productivity capitalist commercial farmers in many parts of Mexico benefited from the maintenance of a low-productivity customary ejido lands sector because this helped to maintain a steady supply of low-wage labor to their sector, a situation that he labeled 'functional dualism.'

As in the analysis above, the assumption of free access ($\mu = 0$) and zero compensation ($\tau = 0$) does not fit many historical situations, but can be easily relaxed. Consider the settlement of the American frontier, where squatters streamed into new territories and formed well-organized claims clubs (Murtazashvili 2013). They and prospective settlers formed interest groups to pressure accountable governments to pass legislation that granted preemption and homesteading rights that helped to extend the land under settlement and to formalize their claims (de Soto 2000). The Jeffersonian grid system, the US land survey system, and hundreds of millions of acres of frontier lands (conquered and taken from native peoples) helped keep this dynamic moving forward (Linklater 2002). Claims clubs, other forms of organization, and emergent norms meant that informal settlements were highly regulated (μ high), and strong preemption rights implied that eventual privatization was mostly or entirely compensated (tau also high) as it was organized squatters and settlers themselves who typically formalized claims.

6.2 Enclosure and Structural Transformation

A large literature has debated the possible causal links between the transformation of property and social relations in agriculture, capitalist development, and the structural transformation of economies (North 1990; Byres 1996; Brenner 1976). Allen (1992, Chapter 1) points out that many of the narratives by both Marxist and non-Marxist economic historians share a set of assumptions and ideas that he labels 'Agrarian Fundamentalism.' In this view, peasant agriculture in general and customary property rights and open fields in particular are assumed to have acted as barriers to agricultural productivity growth. Enclosure and other policies to sweep away customary relations and production practices became not only important, but *necessary* for the rise of more modern and efficient property relations and farms. This ushered in capitalist agriculture, structural transformation, and, ultimately, the industrial revolution. There are, of course, deep differences of interpretation even within this shared view. Marx himself and political Marxists such as Robert Brenner and Ellen Wood have tended to describe enclosures as landlord-driven, top-down acts of 'primitive accumulation.' Enclosures and peasant dispossession were the mechanisms for the creation of a wage-dependent labor force and helped create new capitalist imperatives that also forced landlords and their tenants to make investments, cut costs, and make technological improvements that greatly increased agricultural productivity. Non-Marxist accounts also argue enclosures led to higher agricultural productivity but are more likely to argue that enclosure processes are the result of bottom-up, Coasian bargaining processes. They also tend to view labor release following enclosure as due less to displacement and more as a consequence of rising agricultural productivity and new labor market opportunities.

As we have mentioned above, (1975) extended Weitzman 1974 to build an equilibrium Marxian model of enclosures, and their model can be thought of as a special case of our model where enclosure is costless ($c = 0$), there is no regulation of commons usage ($\mu = 0$), zero compensation must be paid to the displaced ($\tau = 0$), and enclosure is assumed to be labor displacing ($1 \geq \theta < \theta_H$). These assumptions automatically build in agrarian fundamentalism, since full enclosure is costless and always raises output, but has strong displacement and distributional consequences.

Crafts and Harley (2004) added capital and a manufacturing sector to a similar model in order to sort through 'push' versus 'pull' effects and the role of population growth in British structural transformation debates.[16] Their calibrated model argues that although the 'pull' of labor into manufacturing (due to faster-rising productivity there) was likely the far larger force from the mid-18th century forward, 'British exceptionalism' cannot be understood without accounting for a substantial 'release' of labor out of agriculture provoked by the 'conversion to capitalist farming.' Allen's classic study of enclosures in the South Midlands over the period 1450-1850 finds evidence of significant labor displacement effects following enclosure in some regions, but at the same time also strongly challenges the Marxian view that this created a cheap indus-

16. These authors make assumptions that imply θ of around 1.25 and also assume enclosure is costless($c = 0$). They measure the gains from moving from an economy stuck at inefficient non-enclosure to one that achieves efficient total enclosure.

trial proletariat to jump start the industrial revolution. According to Allen, most of the displaced labor remained in rural areas for decades as surplus labor or in disguised unemployment. Only much later did sufficient 'pull' demand for labor from manufacturing materialize. Sir Arthur Lewis' famous theory (1954) starts from a similar description of circumstances in developing countries.

Assessing these various possibilities requires introducing a manufacturing sector alongside our enclosed and unenclosed sectors. A manufacturing sector provides a new source of potential labor demand. Written in share terms, the labor market balance condition becomes:

$$l_e + l_c = 1 - l_m \tag{35}$$

where l_m is the share of total labor $\bar{L}$ employed in manufacturing.

We assume manufacturing firms employ a constant returns to scale technology $G(K, L) = A_m \cdot K^{1-\beta} L^{\beta}$, with total factor productivity indicated by A_m and a stock of capital specific to the manufacturing sector by $\bar{K}$. As labor use in the sector is $L_m = l_m \cdot \bar{L}$, manufacturing output can be written:

$$G(\bar{K}, L_m) = l_m^{\beta} \cdot G(\bar{K}, \bar{L})$$

Let p denote the relative price of manufactures in terms of agricultural good. To keep things simple, we will assume this is a small open economy, so this relative price is determined on world markets. The value marginal product of labor in manufacturing is:

$$MP_L^m = p \cdot \beta \cdot \left(\frac{1}{l_m}\right)^{1-\beta} \cdot \bar{k}^{1-\beta}$$

and the value average product of labor in the customary sector is now:

$$AP_L^c = \left(\frac{1 - t_e}{(1 - l_m) - l_e}\right)^{1-\alpha} \cdot \bar{t}^{1-\alpha}$$

In equilibrium workers should have no incentive to re-allocate across sectors:

$$w = p \cdot MP_L^m = MP_L^e = AP_L^c > MP_L^c$$

Solving $MP_L^e = AP_L^c$ for l_e as we have before yields a new expression for labor demand on enclosed land:

$$l_e^*(t_e) = \frac{\Lambda t_e}{(1 + (\Lambda - 1)t_e)} \cdot (1 - l_m) \tag{36}$$

which modifies (13). Other expressions, such as the private return to enclosure $r(t_e)$ in (15), are similarly derived. The option of working in the manufacturing sector now potentially increases the opportunity cost of labor in the customary sector. Labor supply to manufacturing is now affected by the extent of agricultural enclosure, which is endogenous, but how elastic the response will be depends on the parameters that describe the production function (α and θ) and the economic and policy environment. The elasticity of labor demand, in turn, depends on β and production parameters in manufacturing. The model can capture both the possibility that structural transformation is held back by an endogenous failure to transform property relations in the countryside, but, in other economies, the possibility of premature or inefficient enclosure raising enforcement costs and low wage migration to the cities. Adding distortions such as a high minimum wage in the manufacturing sector leads to a version of the famous Harris and Todaro (1970) model with informality and disguised unemployment in both the rural and urban sectors.

7 Discussion and conclusions

In the Introduction, we stated that our framework nested and extended important earlier contributions. We are now in a position to make these connections more explicit. The seminal papers of Weitzman (1974) and Samuelson (1974) assume that technology is independent of the property regime ($\theta = 1$) and that the enclosure process is costless ($c = 0$). The important result they each demonstrate is that laborers will always be better off with inefficient free access rights than under a more efficient private property regime with new landlords – in short, the rents captured by the enclosers always exceed the efficiency losses they purportedly resolve.

Our paper is most closely related to de Meza and Gould (1992), who modeled enclosures as driven by the costly strategic choices ($c > 0$) of households modeled as a game that could lead to multiple equilibria and socially inefficient private enclosure outcomes. Their paper was path-breaking, but many results were demonstrated using graphical analyses to illustrate possible equilibrium outcomes by example. Our framework has provided a more fully specified general equilibrium analysis that formalizes and extends the logic of de Meza and Gould (1992) into a richer comparative static and policy analysis.

In recent decades, the world has witnessed another important wave of national land law rewriting and the launch of many new land property mapping, registration, and formalization / titling programs (Alden Wily 2018). Undoubtedly, an element influencing this growing interest has been pressure from international organizations emphasizing second-wave market reforms with institutions, property rights, and state capacity building at the center of their approach. This has led to large new funding commitments, policy support and pressure from the World Bank, other donors and multilaterals (North 1990; de Soto 2000; Deininger and Bank 2003). Coincident with these developments, new mapping and data technologies have greatly reduced the perceived cost of such efforts. At the same time, these programs often also reflect national government efforts to try to catch up with the transformation of customary property regimes that is already well underway. National legislation has tended to shift toward granting statutory recognition to rural communities as collective owners of their lands. This is a step toward acknowledging the existence of community property and customary law, and an important shift from past practice where states had often simply declared such lands to be held in trust by the state with few protections or, worse yet in many important instances, had declared such lands *terra nullis* to make way for large-scale expropriation and land transfers to privileged groups (Alden Wily 2018).

These programs aim to identify land claims by village entities and individuals, adjudicate disputes, map community and individual plot boundaries, regularize (i.e., zone) areas, and then issue certificates of residency or title as a way to formalize residency or ownership. Although land privatization often emerges via spontaneous processes, incorporating this into a new formal property regime can be a challenging task, riven with potential dangers as well as benefits. As James C. Scott has argued "[m]ost states are 'younger' than the societies they purport to administer ... patterns of settlement, social relations ... have evolved largely independent of state plans... The result is typically a diversity, complexity, and unrepeatability of social forms that are relatively opaque to the state, often purposefully so." (Scott 1998, p. 183) Opaqueness and complexity to outsiders have often protected communities against the predation of outsiders or by the state itself, but can also make desirable transformations more difficult and may serve to entrench the power of local elites such as chiefs who may earn rents as intermediaries under customary law and, therefore, have reason to oppose change (Onoma 2009). As our framework has shown, efforts to formalize property and establish more exclusive individual claims can lead to output-increasing change in some circumstances but can, in other circumstances, also lead to claim-shifting and conflict. Moreover, enclosure can often foreclose nascent land ownership rights. In terms of our model, the economy can be tipped into wasteful scrambles for property rights and land grabbing. The policy choices are not at all as simple or obvious as might be suggested by partial equilibrium economics textbook analysis. Some might say that such scrambles and grabs are already underway, and recognizing and formalizing customary title is indeed a necessary buttress to protect the rights of weaker claimants.

The diversity and complexity of the issues defy easy modeling, but our framework illustrates the key trade-offs. For example, in environments with low population density and low-TFP gain to enclosure, the misallocations associated with customary common property regimes will tend to be low relative to the costs of creating exclusive ownership. Introducing possibly well-intentioned policies to lower the cost of formalizing individual claims – lowering c in our model – could, in these environments, trigger inefficient property rights scrambles that risk displacing existing customary use-right holders and raising inequality. Weaker stakeholders (e.g. women or pastoralists) stand to lose the most in such scrambles. A wiser approach might be to recognize village and community ownership of land first and then strengthen the governance, transparency, and administrative capacity of those corporate entities to manage existing customary property regimes and only then turn to demand-driven individual formalization of property.

We hasten to add, however, that there can be situations, particularly in mid- to high-TFP environments ($\theta > \theta_H$), where coordination failure means that useful institutional transformation fails. In such cases, policies to lower or subsidize the cost (c) might jump start the process. But here again, it makes sense to strengthen local governance capacity first in order to make sure the more exclusive claims that are later established go to existing use-right holders and that safety nets and compensation mechanisms are in place to avoid or mitigate distributional costs, and possibly unblock resistance.

Population pressure and increasing economic activity have strained traditional property rights institutions in many parts of the world and contributed to the degradation of land and natural environments, particularly in low-productivity regions (Holden, Otsuka, and Deininger 2013; Baland and Platteau 1996). Many policy-makers invoke the idea that this is due to a 'tragedy of the commons' and that private ownership might provide better incentives to raise productivity and environmental protection. Our model acknowledges this potential misallocation and demonstrates how decentralized processes often lead to the emergence of such new property regimes. But these issues need to be studied in an equilibrium framework. From the labor-intensity expression $l_e^*(t_e)$ in (13) and previous results, we established that in high-TFP economies ($\theta > \theta_H$), enclosure will raise productivity by enough to lead to more intensive labor use on private parcels, drawing labor and pressure off less productive and crowded commons. However, in the low-TFP economy ($\theta < \theta_H$), the opposite is true. With each new enclosure, labor is displaced, which leads to further crowding and more intensive use of common land, which may be environmentally fragile. Worse yet, low-TFP gain environments, which appear stable at first, can be tipped into wasteful enclosure races that threaten to quickly displace existing use-right holders, raising inequality, and possibly crowding those displaced onto already crowded and environmentally fragile lands. Trade-offs such as these remind us that one should not dismiss customary property regimes as inherently less efficient and everywhere needing to be replaced. The equilibrium benefits and costs of different property regimes vary with the environment, and transitions should be handled with care.

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