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IMACHI NKWU: TRADE AND THE COMMONS

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IMACHI NKWU: TRADE AND THE COMMONS

ABSTRACT. The conventional view is that an increase in the value of a natural resource can lead to private property over it. Many Igbo groups in Nigeria, however, curtailed private rights over palm trees in response to the palm produce trade of the nineteenth and early twentieth centuries. I use the Ostrom (2007, 2009) framework for analyzing social-ecological systems to guide the construction of a model of this transition. An increase in the resource price leads the owner to prefer communal harvesting, which simplifies monitoring against theft. I support this framework with evidence from colonial court records.

“Palm cutting always cause palaver.”

Obuba of Ububa, Nkwo Udara Civil Suit 111/37

1. INTRODUCTION

In this paper, I use the Ostrom (2007, 2009) framework for analyzing social-ecological systems to explain the adoption of communal palm harvesting (*imachi nkwu*) in response to commercialization of palm oil among the Igbo of southeastern Nigeria. I use this framework to identify the characteristics of the *resource system*, *resource units*, the *governance system* and *users* that explain this transition. Under communal harvesting, the majority of palm trees would be set aside for the use of the entire community, regardless of who owned the land under them. Harvesting was only permitted on specific days, during which each member of the community could harvest as much as he wished. Communal harvesting simplified the act of detecting theft, lowering its marginal cost. Monitoring under private property was largely undertaken by the property owner or his relatives, was non-cooperative, and required proving that a thief had attempted to steal oil from the owner's trees. Under communal property, thieves needed only to be caught taking more than their share by harvesting on the wrong day. Any member of the community could catch a thief. Though property owners surrendered a share of the harvest under common property, rising palm oil prices increased the incentive to steal, accentuating the benefits of this arrangement. Communal harvesting gave potential thieves incentives to monitor. Anything stolen was now also taken away from their share of the harvest. The value of this loss rose with the price of oil. Because theft often

occurred before palm fruits were fully ripe, the costs of early harvesting were now borne in part by potential thieves. These incentives increased aggregate monitoring under communal property, reducing returns to effort in theft and the responsiveness of this effort to the price of oil.

I construct a simple model in which the key result is that, if the price of palm oil rises above a certain threshold, communal property will improve the welfare of property owners while making potential thieves no worse off. I validate this account using information recorded in colonial Native Court transcripts. I use these materials in two ways. First, these provide historical evidence on how property rights worked, how they changed, and how they were negotiated. Second, these records serve as evidence that the mechanisms highlighted by the model were those that drove the transition from private to communal harvesting.

Disputes over palm harvesting reflected a split between property-owning elders and thieving youths who wished to steal oil in order to pay for bride price, taxation, schooling, and other expenses that required cash. This is evident from both the language and facts of the cases. In addition to the economic value of palm oil, the cases show that controlling access to palm produce was a source of political authority. Communal harvesting was a means for elders to retain symbolic control while making economic concessions. The cases reveal that the defense of property rights was costly, and was complicated by the need to prove both points of fact and points of law. While it was also costly to prevent violation of communal harvesting arrangements, the types of effort that went into monitoring under both arrangements show that it was easier to defend against thieves under communal harvesting. Communal harvesting was a scheme to reduce effort costs, though the specific rules used to implement it varied considerably across communities.

I test the framework in two ways. First, I extend the model to include colonial taxes, and argue that youths' needs to collect oil for tax payment made it rational for elders to surrender some of their rights. This too is evident in the court records. The need to pay tax encouraged greater theft by youths, and spurred the creation of communal harvesting arrangements. The conflict that occurred over this transition drew in colonial officials, who struggled to simultaneously maintain the prestige and authority of the elders on whom they depended to implement colonial rule, while averting social conflict and collecting tax revenue. Second, I use characteristics of the *resource system*, *resource units*, the *governance system* and *users* to account for differences between Igbo systems of property rights over palm trees and those practiced by the Yoruba and Urhobo.

This study relevant to three broader questions. *First, why does common property exist?* The literature stresses benefits of the commons, including scale economies, risk pooling, and equity, and the difficulties of dividing it. *Second, what facilitates collective action?* The literature suggests several conditions for regulation of the commons, including group cohesiveness, feasibility, information, and resource value. *Third, how does trade affect the commons?* Conventional wisdom originating with Demsetz (1967) argues that that trade encourages externality-reducing shifts from common to private property. Though the literature has moved on from this, it has not, to my knowledge, considered that price increases could lead to a transition from private property to common property. For the Igbo, equity, political considerations, and, most significantly, the costs of maintaining private property relative to those of monitoring collective harvesting drove the adoption of communal harvesting. The Igbo implemented collective palm-cutting in relatively small, homogenous communities, using already-existing institutions of local governance. Trade did not erode the commons.

2. FRAMEWORK

2.1. **General framework.** Ostrom (2007, 2009) provides a general framework for the analysis of social-ecological systems (SESs). An SES consists of four first-level subsystems, each of which is made of multiple second-level variables:

- (1) *The Resource System.* Second-level variables include: sector, clarity of boundaries, size, human-constructed facilities, productivity, equilibrium properties, predictability, storage characteristics, and location.
- (2) *Resource Units.* Second-level variables include: mobility, growth or replacement rate, interaction among units, value, size, distinctive markings, and spatial and temporal distribution.
- (3) *The Governance System.* Second-level variables include: Government and non-government organizations, network structure, property-rights systems, operational rules, collective-choice rules, constitutional rules, and monitoring and sanctioning processes.
- (4) *Users.* Second-level variables include: number, socioeconomic attributes, history, location, leadership/entrepreneurship, norms/social capital, knowledge of SES and mental models, dependence on resource, and technology.

This framework helps identify variables relevant for studying any specific SES. For example, Ostrom (2009) applies it to the question of when communities will avert a “tragedy of the commons.” She identifies characteristics of the *resource system* (size, productivity, and predictability), of *resource units* (mobility), of the *governance system* (collective-choice rules) and of *users* (number, leadership, norms and social capital, knowledge, and importance) as predictors, based on case study evidence. I am concerned with common pool resources, defined by their high subtractability of use and the difficulty of excluding potential beneficiaries (Ostrom, 2010). Understanding how property rights will respond to trade requires applying the framework to three questions:

2.1.1. *Why does common property exist?* Private property over resources increases investment incentives, makes collateral available, eases exchange, and generates information (Libecap, 2007). Why does the commons persist, despite its apparent inefficiencies?

Characteristics of the *resource system* and *resource units* shape likely outcomes. First, these can create particular benefits to common property. Scale economies can make common property attractive, as in the case of Alpine pastures (Netting, 1976). Similarly, a semicommons allows users to operate on multiple scales; the English open fields, for example, combined larger-scale common grazing with smaller-scale individual grain production (Smith, 2000). Common property or scattering within a semicommons can allow risk pooling (McCloskey, 1976). Resources requiring large collective infrastructure, such water in an irrigation system, are unlikely to be divided (Baland and Platteau, 2003). Where output is a public good, common property can enhance efficiency by reducing free riding (Besley and Ghatak, 2009).

Second, the benefits of securing exclusive access to a resource depend on its characteristics. Resources for which conservation and improvement require investment and maintenance are more likely to be privatized (Baland and Platteau, 2003). Coastal salmon harvesters in the Pacific Northwest gained more accurate information about the effects of harvesting on salmon stocks if rival users could be excluded. Upstream harvesters could not gain a similar advantage, and were more likely to tolerate trespass (Johnsen et al., 2009).

Third, the costs of surveying, defining, registering, marking, and defending rights will all depend on resource characteristics. Where resources are mobile or difficult to observe, property rights are more likely to be assigned to output flows rather than resource stocks (Libecap, 2007). For example, the negative externalities of oil extraction at multiple points from the same reservoir create pressures for solutions such as unitization, prorationing, and lease consolidation (Libecap

and Wiggins, 1984). However, the transactions costs required to achieve these outcomes are increased if, for example, both oil and gas exist within the same reservoir, or price fluctuations make information about resource value costly (Libecap and Smith, 2002). Diffuse ownership of small plots of land in France weakened support for consolidation and enclosure (Grantham, 1980).

Characteristics of the *governance system* also influence outcomes. States may intervene where definition of rights becomes too complex for users, where a need is perceived to mobilize resources for growth, or where state support of a particular property rights regime will benefit a politically powerful constituency (Libecap, 1986). Assuming that the state responds to users' demands for reform, however, ignores heterogeneous social structure and culture, and presumes the state is responsive to users' demands (Platteau, 1996). It is unrealistic to assume that formalization efforts will simply recognize existing claims. Women, in particular, are likely to lose rights, while elites typically manipulate registration processes in their favor (Platteau, 1996). Allocation of rights generates both wealth and political influence, making it contentious (Libecap, 2007).

Specification, monitoring and enforcement of rights are separate functions, and states will not necessarily provide these. Political disorder can leave the state too weak to determine property rights (Grantham, 1980). What Libecap (2007) calls "political transactions costs" also create path dependency, as they make initial allocations of property rights difficult to change later. Budgetary pressures and staffing levels may lead governments to under-provide definition and enforcement of property rights (Alston et al., 1996).

All defense of property requires effort by the possessor. On frontiers, such as California during the Gold Rush and the Amazon more recently, communities of users have initially defined *de facto* property rights and helped each other to enforce their claims. (Alston et al., 1999; Umbeck, 1977). In these situations, it is more likely that *de jure* rights enforced by the state will differ from *de facto* rights defined by possessors. This can lead to conflict when competing claimants have differing capacities for violence (Alston et al., 2012). In the history of US land policies, allocations based on prior use, adapted to local conditions, and free of government mandates were generally the most effective in avoiding resource degradation (Libecap, 2007).

Political economy and legal considerations frequently lead to inefficient outcomes (Libecap, 1986). In US fisheries, for example, governments have been emphasized the rights of all citizens to access, and have been unwilling to support voluntary agreements that could be considered antitrust violations, or to assign rights over large areas (Johnson and Libecap, 1982). Inefficiently

small producers have received the support of the state both on the US great plains, and in the oil sector (Hansen and Libecap, 2004; Libecap and Smith, 2002). Prorationing has become more common than unitization or lease consolidation in the US oil sector, since it satisfies the participation constraints of small producers, not because it is efficient (Libecap and Wiggins, 1984).

Characteristics of *users* also matter. Demands for equity are particularly powerful, and help explain support for common property (Baland and Platteau, 1998). Subjective views matter; for example, individuals may sabotage land sales to outsiders after privatization (Platteau, 1996). On the Northwest Coast, reciprocal gifts insured First Nations groups against environmental shocks, strengthening their incentives to invest in building their salmon stocks. These gifts also provided possible rivals with a reason not to intrude on a group's fishing stocks, lessening the potential for conflict and violence (Johnsen et al., 2009). Monitoring common property may be cheaper, since users can work together to monitor each other and exclude outsiders (Runge, 1986).

If there are limited returns to investment or few new technologies available, the benefits of division may be low (Platteau, 1996). Fixed investments made under an existing property rights arrangement raise the transactions costs of altering the regime (Libecap, 2007). Resources such as land often have non-economic value to users that inhibits privatization: in Africa, land is important for reasons of ancestry, emotion, group membership, social insurance, and its safety relative to financial assets (Platteau, 1996).

2.1.2. *What facilitates collective action?* The capacity for collective action shapes the costs of supporting a common property regime. Characteristics of the *resource system* and of *resource units* influence its feasibility. Commons are governed more effectively when monitoring of resources and use is low-cost and verifiable, and when resources, population, technology, and socioeconomic conditions change slowly (Dietz et al., 2003). Feasibility demands that inexpensive means of conflict resolution and clear boundaries exist, so that intruders and violators are readily detectable and easily punished (Ostrom, 1991). Information is needed about the limits of the resource; because this is costly, resource dilemmas are rarely resolved before the problem has become severe (Libecap and Smith, 2002). Specific features such as scattering can mitigate strategic behavior (Smith, 2000). Resource value can make regulation worthwhile (Libecap and Smith, 2002).

The *governance system* also shapes collective action. States undermine local regulation of the commons by withholding services, by imposing top-down management, and by facilitating intrusion of outside interests (Baland and Platteau, 2003). Rules must receive the support of users, and violations of social rules must be well-defined (Dietz et al., 2003). For example, authorities that supported herd reductions on the Navajo Reservation lost legitimacy, and grazing restrictions have been politically unpopular (Libecap and Johnson, 1980). Political economy concerns will also weigh on local governance structures; controls exercised within the commons will be subject to distributional pressures (Libecap, 1986).

Users' characteristics also matter. Johnson and Libecap (1982) highlight the importance of high contracting costs among heterogeneous users with difficult-to-observe effort in preventing informal agreements. Dietz et al. (2003) emphasize the need for frequent communication, social capital, and inexpensive exclusion of outsiders. In laboratory settings, communication may be more effective than punishment (Janssen et al., 2010). Levels of trust and cooperation are influenced by contextual and microsituational variables (Poteete et al., 2010). For example, individuals may learn to cooperate over time if their group contains a critical number of conditional cooperators (Vollan and Ostrom, 2010). Group cohesiveness provides past experiences of cooperation, existing arrangements, punishment systems, networks of mutual obligation, shared norms of reciprocity, trust, clear and stable group membership, and low rates of exit (Ostrom, 1991).

2.1.3. *How does trade affect the commons?* Several writers have adopted variants of the Demsetz (1967) approach, suggesting that resource value drives privatization. Umbeck (1977) argues that, if the gains outweigh the costs, individuals will make contracts with each other to divide property and will respect each others' rights, even in the absence of a state. This is more likely as the value of the resource rises. For Alston et al. (1996), demand for the security and collateral that come with title increase with proximity to markets that raise the productive potential of land.

Many communities, ranging from irrigation users in the Philippines to herders in Switzerland, have been able to successfully regulate existing common property resources for commercial use (Ostrom, 1991). Baland and Platteau (1998) note that Demsetz-type views are subject to selection bias; we observe not how institutions change, but which changes survive. These predictions ignore possibilities such as degeneration into open-access. Further, it is possible that the state simply expropriates the resource. Besley and Ghatak (2009) note that this has been common historically, and is less likely where the state has a monopoly on coercive authority, where coercion is costly,

where states can commit, build reputations, or have long time horizons, where resource prices are low, and where the quality of institutions is high.

Theories of how the commons may respond to trade base their predictions on characteristics of the *resource system*, *resource units*, the *governance system* and *users*. Taylor and Brander (1997), in discussing the possible immiserizing effects of trade, consider the depletion of a renewable resource under open-access, non-cooperative harvesting. Depletion of biomass in Ghana in response to trade liberalization follows a similar logic (Lopez, 1997). Hotte et al. (2000), when considering the effect of trade on property rights enforcement, consider the nature of poaching, enforcement, resource depletion, and alternative sources of employment. Copeland and Taylor (2009) specify a model in which, at low prices, open access should prevail. With price increases, however, private property, limited management, or the continuation of open access can occur. Critically, the response to trade depends on state capacity, on resource growth, and on technology.

2.2. Question. This paper asks why the Igbo adopted communal palm harvesting in response to the commercialization of palm produce. Answering this question within the Ostrom (2007, 2009) framework requires identifying the relevant characteristics of the *resource system*, *resource units*, the *governance system* and *users*.

2.2.1. Users. The Igbo are Nigeria's third-largest ethnic group. During the colonial period, they lived mostly in communities of a few hundred to over two thousand persons (Gailey, 1970, p. 23). The small size and homogeneity of these communities facilitated collective action. The Igbo used palm oil in cooking prior to commercialization (Martin, 1988, p. 32). Palm products were the most important Igbo exports during the nineteenth and twentieth centuries (Lynn, 1997, p. 34). The purchasing power of palm oil rose continuously over the nineteenth century (Allen, 2011). Assessment Reports for the Aba and Bende Divisions estimated that palm produce contributed between 1% and 51% of household income, averaging 20%.¹ In the Aba Native Court Area (NCA), for example, palm nuts were cut every 24 days. On each occasion a man would cut approximately 5 heads of fruit. Over a year, this would be enough to produce 3 tins of oil, worth 18s, and 400 lbs of kernels, worth £2/4/0 (Abadist 9/1/1362).

2.2.2. The resource system and resource units. Palm trees were rarely planted on purpose. One official estimated in 1907 that there were 6 palms per acre in the vicinity of Aba (Martin, 1988,

¹Abadist files 8/11/2, 14/1/1077, 8/11/12, 9/1/1362, and 9/1/1362.

p. 46). This scattering blurred boundaries and made monitoring more difficult. Palm fruits could be harvested year-round. While reaping palm fruit did not cause permanent damage to the trees, the village stock of palms was like a fishery insofar as the gathering fruits before they were ripe would reduce total yield. Once palm oil became an important source of cash with which to pay colonial taxation, early harvesting by some individuals could leave others without the means to pay tax when it came due.

2.2.3. *The governance system.* Authority was decentralized in Igbo society, with power divided between the *amala* (village council), the *Ezeala* (Earth priest), *umokpara* (the *ofo*-holders, or compound heads), the *okonko* secret society, and the age grades (Oriji, 1991, p. 31-42). These already-existing institutions of local governance facilitated enforcement of communal harvesting, though the diffuseness of authority could create problems of overlapping jurisdiction. Until 1929, British rule was carried out in Igboland using a system of “warrant chiefs,” who sat as members of local Native Courts. In 1928, annual poll taxes on adult males ranging from 4 shillings (s) to 7s were introduced. Late in 1929, the “Women Riot” against taxation, the warrant chiefs, the native courts and the depressed state of trade prompted reforms (Martin, 1988, p. 106). Native Courts were created, comprised in each village-group of a “massed bench of elders,” while Native Authorities were established that included the eldest man of each *ezi* (compound) and any young men they chose to co-opt (Martin, 1988, p. 121). Records from these reformed Native Courts are the principal sources for this study.

Colonial and anthropological evidence suggests that many Igbo areas of southeastern Nigeria responded to the export trade in palm produce during the nineteenth and twentieth centuries by limiting their recognition of the exclusive rights held by certain individuals and lineages over palm trees. In their place, Igbo groups such as the Ngwa enacted the practice of *imachi nkwu*, or communal palm-cutting.² Allen noted it in his Intelligence Report on the Ngwa (SP021 CSE 1/85/3708), as well as his unpublished “Ngwa Customs,” which is quoted at length by Chubb (1961, p. 48-49):

As soon as the commercial value of palm-oil and kernels was appreciated by the people, new regulations were formulated by the village councils to control the taking of produce from communal trees. Gradually these regulations were tightened up until at the present time strict laws exist governing the ownership of all palm

²The term itself comes from Chuku (2005, p. 51).

trees in a community. The majority of palm trees in a village are now reserved for the community, no matter whether they are of natural growth or have been planted by an individual... In order that each member of the community shall receive an equal benefit, and to prevent deterioration of the trees through continual cutting, a certain day is set apart generally once in 20 days, when every member of the community may cut as much produce as he desires. On this day a drum (*Nkwa Nkwu*) is beaten... This drum is in the care of an elder of the village, who is specially selected for this duty by the village council. Until this drum has been beaten any member of the community who takes produce from communal palm trees is guilty of an offence for which he may be fined one goat, or the equivalent of £1 by the village council. Since the introduction of general tax this system has been extended to include trees which in ordinary circumstances are privately owned. At the commencement of tax collection an order is promulgated by the village council to the effect that for a specific period, generally three months, the ownership of all private palm trees will be vested in the community.

Similar institutions were employed by the Aro, in Umuahia, and in other densely populated areas of Owerri Province (Chubb (1961, p. 49), Chuku (2005, p. 51)).

Allen explains *imachi nkwu* as a result of the palm oil trade and the “communal spirit” of the Igbo. Green (1941) adds taxes to this explanation. She conducted fieldwork during 1935 and 1937 at Umueke Agbaja, in Okigwi. While she found little land was left under group control, rights over palms were in a state of ambiguity, fluctuating between “restriction of rights to those who owned the land on which the palms stood and the extension of rights to anyone to cut anywhere” (Green, 1941, p. 17). She was told that, in the past, people had restricted cutting palm nuts to trees on their own land, but during a period when the population dwindled, it had been decided that individuals could harvest anywhere within Umueke (Green, 1941, p. 18). After the population recovered, cutting was once more limited to land of one’s own lineage. The eldest man in the village had been instrumental in passing the restriction. He had many trees on his land, and lacked the vigor to compete with youth in harvesting (Green, 1941, p. 17). She was told that the rule had been passed because “the strongest people cut to the detriment of the less strong,” and because of the introduction of the head tax. Some landowners who could not climb found others harvesting from trees on their land, but found these others unwilling to help them pay their own tax. By

1937, the youth of the village had successfully challenged the rule, forcing the elders to accept an “intermediate” position between the two extremes of communal and private rights over palms (Green, 1941, p. 19).

Together, these characteristics of the *governance system* suggest that considerations of equity, politics, and the costs of monitoring and enforcing property rights help explain communal harvesting of palm oil.

3. MODEL

3.1. Setup. There are two players – one elder E and one youth Y . The elder possesses a grove of trees that yield one unit of oil, which can be sold for a price of p . At the beginning of the game, the elder chooses between private property and communal property. If the elder chooses communal property, he also chooses what share θ of the oil he will offer the youth before the game begins. This is done subject to the constraint that he leaves the youth as well off under communal property as under private property. The purpose of this model is to demonstrate that, under reasonable conditions that fit those of the case under study, an increase in the price of palm oil can lead the elder to prefer communal property to private property, leaving the youth no worse off.

Under either property regime, the game has one stage. The elder chooses a level of costly monitoring, defending his grove against theft. This can be thought to encompass both pure monitoring and enforcement. Simultaneously, the youth chooses how much effort to expend in stealing. Under private property, the youth directs his efforts towards the entire grove. Under communal property, he only attempts to steal from the fraction $1 - \theta$ of the oil that he would not otherwise receive as his communal share.

3.2. Private property. Under private property, the elder chooses his level of monitoring $m > 0$. This costs him dm , where $d > 0$ is the elder’s marginal cost of monitoring effort. The youth exerts effort $s > 0$ in stealing. The youth faces a cost of stealing cs , and so $c > 0$ is his marginal cost of effort. The oil is shared according to the amount of effort expended. That is, the youth receives a share $\frac{s}{m+s}$, while the elder receives a share $\frac{m}{m+s}$. If neither party exerts effort (i.e. $m = s = 0$), then the elder receives the full unit of oil.

The elder and youth’s problems can be written as:

$$(1) \quad V_E^P = \max_m \left\{ \frac{m}{m+s} p - dm \right\}, \text{ and } V_Y^P = \max_s \left\{ \frac{s}{m+s} p - cs \right\}.$$

These are concave, and so they can be maximized from their first-order conditions. The elder and youth's best responses, then, are:

$$(2) \quad m_{BR}^P = \max \left\{ \sqrt{\frac{sp}{d}} - s, 0 \right\}, \text{ and } s_{BR}^P = \max \left\{ \sqrt{\frac{mp}{c}} - m, 0 \right\}.$$

Together, these give equilibrium levels of monitoring and theft:

$$(3) \quad m_*^P = \left(\frac{c}{c+d} \right)^2 \frac{p}{c}, \text{ and } s_*^P = \left(\frac{d}{c+d} \right)^2 \frac{p}{d}.$$

Substituting these equilibria into (1) gives the equilibrium payoffs under private property:

$$(4) \quad V_E^P = \left(\frac{c}{c+d} \right)^2 p, \text{ and } V_Y^P = \left(\frac{d}{c+d} \right)^2 p.$$

3.3. Communal harvesting. Under communal property, the elder begins by offering a share θ of the oil to the youth. He is willing to do this because the costs of monitoring under communal property are lower, for reasons outlined above. In particular, his marginal cost of monitoring is now γ , where $d > \gamma > 0$. It is assumed he can commit to θ . Communal property, however, also entails a fixed administrative cost of \bar{k} . This captures the cost of organizing and overseeing the harvest according to a set schedule of days.

Thus, taking θ as given, the elder and youth's problem scan be written as:

$$(5) \quad V_E^C = \max_m \left\{ \frac{m}{m+s} (1-\theta)p - \gamma m - \bar{k} \right\}, \text{ and } V_Y^C = \max_s \left\{ \theta p + \frac{s}{m+s} (1-\theta)p - cs \right\}.$$

Again, these are concave, and can be solved from their first order conditions. The elder and youth's best responses, then, are:

$$(6) \quad m_{BR}^C = \max \left\{ \sqrt{\frac{s(1-\theta)p}{\gamma}} - s, 0 \right\}, \text{ and } s_{BR}^C = \max \left\{ \sqrt{\frac{m(1-\theta)p}{c}} - m, 0 \right\}.$$

Conditional on θ , these can be used to give equilibrium levels of monitoring and theft:

$$(7) \quad m_*^C = \left(\frac{c}{c+\gamma} \right)^2 \frac{(1-\theta)p}{c}, \text{ and } s_*^C = \left(\frac{\gamma}{c+\gamma} \right)^2 \frac{(1-\theta)p}{\gamma}.$$

Substituting these into (5) gives the equilibrium payoffs under communal property, conditional on θ :

$$(8) \quad V_E^C = \left(\frac{c}{c+\gamma} \right)^2 (1-\theta)p - \bar{k}, \text{ and } V_Y^C = \theta p + \left(\frac{\gamma}{c+\gamma} \right)^2 (1-\theta)p.$$

Given these conditional payoffs, the elder will choose the minimum θ that satisfies the youth's participation constraint that $V_Y^C \geq V_Y^P$. In particular, he will choose:

$$(9) \quad \theta_*^C = \frac{\left(\frac{d}{c+d} \right)^2 - \left(\frac{\gamma}{c+\gamma} \right)^2}{1 - \left(\frac{\gamma}{c+\gamma} \right)^2}.$$

Substituting θ_*^C into (8) gives equilibrium payoffs under communal property:

$$(10) \quad V_E^C = \left(\frac{c}{c+d} \right)^2 \left(\frac{c+2d}{c+2\gamma} \right) p - \bar{k}, \text{ and } V_Y^C = \left(\frac{d}{c+d} \right)^2 p.$$

3.4. Commercialization. The elder will prefer communal property when $V_E^C \geq V_E^P$. From (4) and (10), this is equivalent to stating that he will prefer communal property when:

$$(11) \quad p \geq \left(\frac{c+d}{c} \right)^2 \left(\frac{c+2\gamma}{2(d-\gamma)} \right) \bar{k}.$$

That (11) is a positive cutoff for p follows directly from the assumption that $d > \gamma$. This is the main result of the model: a rise in the price of palm oil can induce the elder to switch to communal property in order to reduce monitoring costs, leaving the youth no worse off. If the elder is unable to choose θ , then a similar cutoff rule applies only if θ is sufficiently small (see Appendix B.1).

3.5. Other responses. Communal harvesting need not be the only option elders had available to cope with the rising costs of monitoring under private property. Why did they not respond by

cooperating in their defense of private property, manipulating the village council in order to more cheaply protect their rights, or simply pay the youth to harvest for them?

Cooperative monitoring by the elders would be one possible alternative to communal harvesting. I extend the model to include this possibility in Appendix B.2. There are two points to consider. First, cooperative monitoring would have entailed a greater collective action problem than under communal harvesting. When monitoring is a public good, it will be under-provided. Whereas youths would have a direct interest in protecting their communal share from theft, other property owners had no direct interest in each other's property. The extension in Appendix B.2 shows that this effort would only be provided if it were individually rational for each elder. An additional difficulty is that private monitoring might create negative externalities, as youth divert their efforts at theft towards less-secure plots. This would force all elders to monitor more intensively than if these spill-overs did not exist.

Second, there is no reason to treat cooperative monitoring as an alternative to communal harvesting; cooperative monitoring could equally be used to defend private and communal tenure. The extension in Appendix B.2 allows for this. With cooperative monitoring possible under both private and communal property, the switch to communal property is again occasioned by an increase in the price.

Judicial manipulation would have been self defeating. The village council was used to settle many disputes aside from palm harvesting. Traditionally, the village council gave orders for cleaning paths, regulated prices, and dealt with both economic and "minor judicial" matters, including issues arising within a single family or age grade (SP 021 CSE 1/85/3708). Damaging its credibility in this case would have made it less useful in other instances, especially as the village council did not have a monopoly over dispute resolution. Further, if the standard of proof were lowered artificially, punishments meted out by the village council would have become more arbitrary, and would not have been effective deterrents.

Wage labor was problematic for several reasons. I model one of these in Appendix B.2 – any worker employed to harvest oil for the elder would need to be monitored, in order to prevent him from keeping any oil for himself. Where the technology of theft and monitoring by a hired youth is the same as in the case with private property, I show in Appendix B.2 that the elder can indeed do no better paying a wage than he can by defending his own property. Similar difficulties would face an elder who attempted to hire a youth to monitor for him. In addition, the wage paid to the youth

would have to be made sufficiently high in order to elicit monitoring effort. I show in Appendix B.2 that the youth's monitoring costs would need to be low relative to the elder's costs for this to be profitable for the elder.

There are additional difficulties with wage labor not captured by this extension. Elders may have feared that giving up symbolic control of the harvest would have led to them losing control of their palms altogether. I give examples below where control of palms was politically valuable. Further, the timing of this payment presented a problem. Either elders would have to pay youth out of cash reserves prior to the harvest, or payment in cash afterwards would create the possibility of a hold up problem.

Further, wage labor was rare in Igbo society in before the Second World War. What wage labor did exist by the end of the colonial period was largely migrant and seasonal (Uchendu, 1965, p. 32). Martin (1988, p. 87-88) notes that, during the early twentieth century, "[m]arriage rather than contractual wage relationships continued to be the mainstay of labor recruitment." Hired labor was a minor component of the labor supply in pre-colonial Igboland. Slaves, age mates, and clientelist relationships remained important means of labor recruitment through the first half of the century (Brown, 2003, p. 38).

3.6. Other considerations. The model above abstracts away from altruism, observability, credibility of punishment, and Igbo seniority structures.

Adding *altruism* has the power to change the results. I extend the model to include this in Appendix B.3. If both the elder and youth take each other's material payoffs into account, it improves outcomes for both players, since monitoring and stealing are both reduced. If altruism is symmetric, this does not affect the material division of the oil, but does reduce the costs of both monitoring and theft. This improvement occurs under both private and communal property. Now that the youth cares about the fixed costs of common property \bar{k} , the elder's offer of θ is conditional on the price of oil. This, along with the addition of the youth's material payoffs to the elder's objective function, implies that the elder's preference for communal over private property is no longer necessarily equivalent to a price cutoff.

Adding reciprocity, would strengthen the case for common property. In public goods games, altruistic types will generally punish free riders, encouraging greater contributions (Fehr and Gächter, 2000). Reciprocity would have two effects. First, while I have not modeled monitoring by the

youth under common property, reciprocity would sustain greater aggregate monitoring than self-interest alone. This would reduce the returns to effort in theft, reinforcing the tendency for common property to become more attractive as the price rises. In addition, a youth motivated by reciprocity will view a relatively high offer of θ as “kind,” and reciprocate by lowering his effort in theft. This will make common property more rewarding to the elder, as it would partially offset the cost of an increase in θ , a benefit that would also rise with the price.

Adding *observability* would add little to the model. The sharing rule $\frac{s}{s+m}$ could be interpreted as the probability that the youth steals successfully. The model excludes *punishment*. The evidence below, however, makes it clear that thieves were sometimes taken before the village council. If punishment is costly, repeated interaction is needed to make it credible. Credibility would be greater under common property, because the greater number of potential witnesses and lower burden of proof reduced the costs of proving a case (see below). In addition, in experimental public goods games that resemble the common property scenario, individuals will punish bad behavior, even if it is costly, provides them no material benefits, and is not observed (Masclot et al., 2003).

Finally, the *seniority* structure of Igbo society has complex effects. I extend the model to include seniority in Appendix B.3, using a repeated game. The possibility of becoming an elder and acquiring trees of his own can be used to secure the youth’s respect for private property. If the youth is sufficiently patient, and the share θ offered to him under common property is small, then increases in θ can be used to encourage his adherence to common property, even if he cannot be made to respect private property. If θ is sufficiently large, however, this has the perverse effect of making the position of an elder less enviable, weakening the usefulness of the possibility of promotion as a tool to secure the youth’s cooperation. Colonial rule disrupted the Igbo seniority structure, gave youth outside options beyond their communities and changed the rules of the political hierarchy, weakening youths’ incentives to observe community rules. This helps explain examples in the court records where common property arrangements had collapsed, and where elders’ authority is questioned.

4. EVIDENCE

In this section, I present archival evidence on Igbo palm harvesting. I use this for two purposes. First, these sources contain descriptive material not found in other accounts. They provide detail on the administration, defense, and evolution of property rights in a very poor country. Second, these

can be used to show that the mechanisms stressed in the model were those that drove the evolution of property rights. I note that conflicts over palm harvesting in Igbo society largely pit elders against youths as interest groups, that defense of property rights was costly, particularly when palms were private, and that “communal” harvesting was used to restrict the effort costs associated with harvesting and monitoring. The primary sources I use are from the National Archives of Nigeria at Enugu. These consist mostly of Native Court records, and are described in Appendix A.

4.1. **Intergenerational conflict.**

4.1.1. *Evidence.* As in the model, the key participants in palm harvesting disputes were elders who exercised control of palm groves. This split can be found both in the language of the court cases and in the substantive facts behind them. Elders tell the court that laws are passed “for the young ones to stop cutting the palm nuts” (NU 195/37), claim damages for “cutting the elders’ palm nuts” (OGC 405/35), and sue as the defendants’ “father” (UNC 62/35) or as “the elder” (NU 55/25). Defendants might similarly use terms such as “father” to refer to their accusers (UNC 115/35). The facts of these cases show a similar division. A typical civil suit over palm harvesting in the court records involves an elder, either alone or on behalf of the *amala* (village council), bringing action against a youth or group of youths either for trespass on a private *okpulo* (private grove) or for violating the village’s rules concerning communal palm-cutting. Youth would coordinate their efforts in theft, in order to mis-inform the *amala* (village council) (UNC 115/35).

4.1.2. *Stakes.* The model emphasizes the distinction between elders and youths on the basis of their differing endowments of resources. Evidence already cited above shows that palm oil was of prime economic importance to the Igbo, and could contribute a meaningful portion of a man’s yearly income. In addition, elders and youth differed in their demands for cash. Green (1941, p. 18) reported that the young men of Umueke, in their dealings with the elders, had outlined these pressures:

if the [elders] had refused to concede what they wanted they would have seized their cows and sheep and sold them, since they must live somehow. As [her informant] said, it is all very well for the old men, they have all got wives, but the young ones have still to get together bride price to marry theirs and they need palm oil to sell (Green, 1941, p. 18).

These generational conflicts were not only economic. They were also contests over political power. Whether palm trees were harvested communally or privately, control over them was a tool with which to wield political authority. Leeming reported that a common privilege of office for headmen and *ezealas* (Earth priests) in the Aba NCA was that certain days would be set aside for townsmen to cut and collect palm kernel heads while clearing the brush for the headman's farm (Abadist 9/1/1362). Oriji (2007) argues that these privileges were a consequence of the taboos needed to maintain the sacredness of authority in Igbo society. Since the *ezealas* (earth priests) and *okparas* (elders) were not permitted to engage in mundane economic activities, they were dependent on tribute. Elders in the court records make similar claims. One argued that all family land, *jujus* (magical objects), and palm nuts had been vested in him (NU 313/38). Another claimed monopoly over all palm groves as the eldest man (OVW 11/37).

Control of palms could be used as leverage. In one case, the elders found themselves unable to evict a man from their village for incest and adultery; instead they fined him £1 and denied him the right to cut palm fruits until this was repaid (NU 115/35). As political authority was diffused outside the *amala* (village council), other interests also exercised social control through regulation of palm cutting. In some villages, the *okonko* (secret society) had days specifically reserved for its members to harvest. In one suit, the defendant claimed that he had left the *okonko* (secret society) after converting to Christianity and had since been denied any rights over communal palms (NU 118/35).

The political value of this control helps explain why the elders attempted to settle disputes before the *amala* (village council) before taking cases to the Native Court. For example, in NU 55/25, the case was only brought to court after the defendant had been summoned to the *amala* (village council) by his father, but had refused to come. In another case, the plaintiff told the court that if the defendant had come to "beg" the *amala* (village council), no action would have been taken in court (NU 55/35). Often, at least one defendant had already settled in the *amala* (village council) before the case reached court, weakening the position of the other defendants who refused to do so (ANO 244/41, UNC 132/38, OVO 148/36). Those who refused to settle outside of court could be given additional fines for their recalcitrance (OVO 148/36).

By keeping control of the communal harvest, elders held on to symbolic authority. One witness informed the court that the elders of his community inspected the villagers before cutting began (NU 256/35). Similarly, violations of harvesting rules were interpreted as signs of disrespect. One

plaintiff, accused of having cut fruit on a day reserved for elders, was described by the plaintiff as a youth who “respects no elder” (NU 140/35). In his own defense, the defendant claimed that he had paid the dues necessary to become an elder, but had not been permitted to join the *amala* (village council).

4.2. The costs of defending property. The court records provide evidence of the costs of maintaining private rights over trees. In addition to the direct effort in monitoring, property owners had to prove points of fact and points of law in an environment where this was difficult. Although communal harvesting also required administration and monitoring, evidence from the court cases shows that this was simpler than what was needed under private property.

4.2.1. Private property. Landowners often had to depend on their own kin to detect violators. One of the plaintiff’s witnesses told the court that it was his children who had caught the defendant (Abadist 9/1/794: Mbutu Umu Ujima Group Court Civil Suit 142/35). In the sample of court cases, there is no evidence of cooperative defense of private property.

Even when a thief was caught infringing on rights of private property, enforcing judgment was costly, as it was difficult to prove facts. Factual disputes most commonly centered around the boundaries on which the trees stood (e.g. MGC 222/36). Proving facts before the *amala* (village council) and in the Native Court required either witnesses or oathing. A party who failed to bring supporting witnesses could lose on this ground alone (ONC 713/21). A witness might not be enough; in one case, the reviewing officer only accepted the evidence of the plaintiff’s witness because one of the defendants had contradicted his own story (MGC 256/35). Physical evidence was of no use; the plaintiff of one dispute brought to court one bunch of nuts he alleged had been cut by the defendant, but it would have been impossible from these to tell who had harvested them and from what tree (UNC 199/38). Inspection of the land by the court was possible, but also costly and potentially indeterminate.

Even with witnesses, oaths were frequently used to prove facts. In one case, the plaintiff was given judgment in the native court when he offered to swear on a Bible, but the defendants refused to provide one. The case was later reopened, and an inspection revealed that the defendants had in fact harvested from their own trees, and that the plaintiff had been motivated by malice (NU 217/38). Fear of supernatural punishment was not sufficient to induce truth-telling. The plaintiff of one suit accused the defendant and his people from going to the maker of the juju they had

sworn on, paying him to remove its power (Abadist 9/1/26: Omuma Civil Suit 25/29). Other litigants feared that their opponents, given the opportunity to swear falsely, would do so (Abadist 14/1/504: Arungwa and Amavor Group Court Suit 81/35).

Points of law were equally pernicious for landowners attempting to defend their rights. The claim that palms were harvested communally was a common defence (e.g. NU 154/35). Some of these assertions were outright lies. A plaintiff might try to cover his theft from a private grove by telling the court that his community's palm trees were communal (OVO 318/36). In some instances, however, the customary law was actually unclear. The young defendant in one case asked the court to decide whether he had the right to trees that had been planted by his father on land that had been pledged to his father. The court had to adjourn to consult elders on this point (NU 610/37). Further, the procedure for redress was complicated by the diffusion of political authority, as disputes could be alternately settled before the *amala* (village council), by the *okonko* (secret society), inside the *ezi* (compound), within the age-grade, or with the help of the *oke amadi*, the wealthy members of the community who Allen labeled "the true de facto rulers of the village" (SP 021 CSE 1/85/3708).

The Native Courts added an extra layer to this complexity and made their own procedural demands. Plaintiffs who had taken a criminal action might be told to start afresh with a civil suit (UNC 150/35). Political concerns also interfered with the working of the Native Courts. In one dispute, the District Officer ordered that the proceedings from an earlier and related case be read to the court. The plaintiff, writing for an appeal, complained that this had not been done, because the court clerk would have been afraid to read this judgment in front of the sitting chiefs (Abadist 9/1/26: Umuma Native Court Civil Suit 35/29).

4.2.2. *Common property.* This is not to imply that regulation of effort when palm trees were harvested communally was costless. Some of the same difficulties in proving facts and negotiating the Native Court system would have applied to communal harvesting. One of the greatest sources of difficulty was ambiguity in the law. In some cases, one side will claim that common harvesting was practiced, while the other party will deny it (e.g. OVW 35/37). A court unable to discern which claim was true might resort to the swearing of juju (NU 42/35).

It is impossible to state how common these uncertainties were. While anthropologists and officials will understate their frequency in order to explain an ideal type, court records will overstate them, since mis-understandings were a cause of disputes. Where they existed, these ambiguities

might be the product of a longer history of negotiation about property rights. In one example, the palms under dispute were owned in common by four towns, while both privately and commonly owned trees coexisted. Twelve years before, the plaintiffs' elders had made regulations concerning the use of these trees. They had killed a goat to mark the occasion, but the meat had been refused by the defendants' elders, who did not inform their youth of what had occurred. The youth, then, had no means of knowing what the rules were (UNC 49/35).

Collective action is made easier when the users of a natural resource are similar to each other. In cases where several quarters attempted to enact communal harvesting together or where other social conflicts intervened, co-operation would at times break down. For example, the community of Umueteghbe decided after repeated offenses against the communal harvesting regulations to no longer cut together, each *onumara* (quarter) keeping instead to its own land (NU 243/35). In another case, the *amala* (village council) had decided that each compound should cut separately after a violent dispute between the members of different compounds. Another witness in the same case, however, noted that regulations were still enacted to restrict harvesting during the time when tax payments came due (NU 192/27).

4.2.3. *Relative costs.* Where the rules were clear, monitoring under common property need only detect that a violation had occurred, not on whose land, and could be effected by any member of the village. Whereas defense of private property was a largely private act, maintaining the rules of communal harvesting was in the interest of the whole community. This is the critical distinction between the costs of monitoring under private and communal property in the model; while under private property the costs of monitoring rise with the price of oil, they do not rise as quickly under communal harvesting. The costs of maintaining private property could, as in the model above, be such that a regulated communal harvesting arrangement was preferred. The participants in one dispute explicitly told the court that they had united together in palm cutting because harvesting had led them to go to court too often (NU 111/37).

The mechanics of communal harvesting provided other advantages that simplified monitoring. The witnesses in one case indicated that they gathered together before harvesting; this would make supervision easier (NU 256/35). The rigid schedule of communal harvesting also eased monitoring. One violator had been caught when a villager noticed that a tree had been cut before the wooden bell had been rung. Cutting was halted until the perpetrator was found (Abadist 13/8/50: Aba Native Court Civil Suit 10/24). In another case, the *amala* (village council) had found the party

guilty of violating the communal harvesting rules by making everyone swear juju and prosecuting the man who refused (OVO 148/36). There were also positive spillovers across communities; the witnesses in one case knew to lie in wait to see if the neighboring community were trespassing on their land when their neighbors rung a bell to signal that communal cutting had begun (Abadist 9/1/268: Umuaro Native Court Civil Suit 283/33).³

4.3. Communal harvesting: variations on effort restriction. Communal harvesting was, above all, a means to restrict effort expended in harvesting palm oil. Those communities that practiced *imachi nkwu* attempted to maintain strict controls over when and how their members could cut. Where there were restrictions, specific days were set aside at regular intervals during which individuals could cut palm fruits at will. The beginning of the communal harvest was signalled by the beating of a drum, and cutting when it had not been rung was punishable by a fine.

Within these broad outlines, regulations differed by village. Leeming wrote in 1927 of the Asa NCA that:

The nuts are collected upon different principles in different villages of this area. In some there is a day definitely fixed upon which the village will collect communally and competitively. In other villages no such rules exist and people may collect where and when they will. In some cases the fruit of the trees in the immediate vicinity of the village is reserved for the older people (Abadist 14/1/1077).

In some villages, the men had been divided into two groups, each with separate turns (NU 284/37). Some villages ceased completely to recognize private rights over trees while others did not. The defendant in one suit listed for the court some individuals who had once held private rights to *Okpolor* [private] palm trees before the community had decided to deprive them of these (MGC 161/36). Consistent with the interpretation that these restrictions were imposed to reduce the negative externalities of harvest effort, some villages permitted cutting to be suspended if a resident were under arrest or away at court (ANO 281/38).

Whether individuals could hire helpers or sell their own turns varied. Mayne noted that among the northern Ohuhu of the Umuhia NCA, those individuals who could hire the greatest number of laborers from neighboring towns collected the most fruit (Abadist 8/11/12). In the village of

³This case is included in the Web Appendix.

Umuoke-nnunu, people were permitted to sell their turns, as was revealed when one of the defendants of one case was charged with selling his turn to each of the three other defendants at once (ANO 308/42). The defendant in another suit claimed that hiring of up to three reapers was permitted at Umuejea. Although the plaintiff disputed this assertion, he took action against the defendant, and not against the man to whom the defendant had sold his turn, and who had sold his harvest to the plaintiff's wife (NU 82/35). At Ndiegora, a stranger living in the town was brought to court because, on the orders of his host, he joined the community in harvesting, despite having been warned to go to his own town for this (ANO 109/41). Similarly, at Umumkpakara Mkpuru it was said that a person who hired an additional person was made to pay a fine. The defendant in a case from this village claimed that he had hired a man to cut nuts for his brother who was away at school, but the plaintiffs protested that he should have called a boy to cut, as an adult should not be called to cut in place of a young boy (ANO 167/43). Together, these examples show the varied strategies communities used to limit harvesting effort while maintaining an appearance of legitimacy and equity.

5. TESTS

I provide two tests of my explanation of communal palm harvesting. First, I add direct taxes to the model and show that the predictions fit evidence from the court records. Second, I use the Ostrom (2007, 2009) framework to explain why Yoruba and Urhobo practices were different.

5.1. **Direct taxation.** Green (1941) suggests that direct taxation under colonial rule intensified the conflict between elders and youth over palm harvesting, leading to communal harvesting in places where it had not already existed. Taxes also help explain why communal harvesting persisted, despite low interwar prices of palm oil. Suppose now that the youth must pay a tax of τ from the sale of palm oil, so that he faces the constraint $\frac{s}{m+s}p > \tau$. If this is binding, it implies that his optimal effort does not yield enough oil to pay the tax, and so he will invest only enough effort to just meet this constraint, i.e.:

$$(12) \quad s^{TAX} = \frac{\tau m}{p - \tau}.$$

This will be the case when $s^{TAX} > s_{BR}^P$, or:

$$(13) \quad \frac{\tau m}{p - \tau} \geq \sqrt{\frac{pm}{c}} - m \Rightarrow m \geq \frac{(p - \tau)^2}{pc} \equiv \underline{m}(\tau).$$

This will occur if the elder's preferred level of defense m_*^P is greater than $\underline{m}(\tau)$:

$$(14) \quad \left(\frac{c}{c+d}\right)^2 \frac{p}{c} \geq \frac{(p - \tau)^2}{pc} \Rightarrow \tau \geq \frac{c}{c+d}p.$$

Substituting the youth's constrained best response function s^{TAX} into (1) allows us to rewrite the elder's problem as:

$$(15) \quad V_E^{TAX} = \max_m \frac{m}{s^{TAX} + m} p - dm = p - \tau - dm.$$

This simply restates the fact that, once the youth's tax constraint is binding, the elder can receive no more than $p - \tau$ from the plot, since any additional defensive effort will be offset by increased stealing by the youth. He will therefore not choose $m > \underline{m}(\tau)$. Since his optimal effort below $\underline{m}(\tau)$ is unchanged, his reaction function becomes:

$$(16) \quad m^{TAX} = \min \left\{ \left(\frac{c}{c+d}\right)^2 \frac{p}{c}, \frac{(p - \tau)^2}{pc} \right\}.$$

The model predicts then, that the imposition of a head tax on the youth will lead the elder to limit his defensive effort, knowing that he cannot keep the youth from stealing. Qualitatively, this will be similar to a common property regime in which $\theta = \tau/p$. Reducing monitoring in order to let the youth steal is, like communal harvesting, another mechanism by which the elder chooses to self-interestedly cede his property rights.

Poll taxes were introduced in Igboland in 1928, in order to bolster the power of the Warrant Chiefs through the creation of Native Treasuries (Afigbo, 1966; Gailey, 1970). The heart of disputes over palms was that they were a valuable source of cash income that could be used to pay tax. Usoro (1974, p. 60) makes a rough estimation⁴ that 20% of the value of palm oil exported in 1931

⁴ $\frac{0.25 \text{ adult males per person} \times 2,563,148 \text{ taxable population in the palm oil belt} \times 7/6 \text{ tax per adult male}}{\text{£}10.28 \text{ per ton estimated producer price} \times 118,133 \text{ tons exported}} = 19.9\%$

was collected as tax. At the time taxes were introduced, the value of the tax was roughly equivalent to one four-gallon tin of oil, though this physical burden doubled within a year due to falling prices (Martin, 1988, p. 113-117). Where palm oil was harvested privately, the receipts were put to uses for which cash was similarly necessary; the defendant in one case told the court that he had harvested palms to pay his younger brother's school fees (ANO 167/43). In another suit, one party had pledged an *okpulo ika* (private grove) belonging to the *ofo*-holder on behalf of the *onumara* (quarter) in order to pay the collective fine levied after the Women Riot (OVU 461/36).

It was difficult for youth to pay their taxes by means other than palm harvesting. Allen wrote that palm produce was the *only* means of obtaining cash with which to pay tax or purchase imports. There is little indication in either the literature or archival sources how individuals that did not have access to palm produce or paid employment were able to meet their tax obligations. Afigbo (1966, p. 551) writes that, when taxation proposals were discussed with the Igbo, district officers were asked if they would prosecute people who pawned their children to pay the tax. It is clear that men did pawn themselves to pay tax (Afigbo, 1966, p. 553), and that women sometimes had to use their savings to pay their husbands' tax the first year it was collected (Gailey, 1970, p. 98).

Even where there was no conversion from private to communal property, the introduction of direct taxation increased the incentive for youth without groves of their own to steal. Based on her own fieldwork, Green (1941, p. 19) argues that "anything tending to increase the need for money – the introduction of tax, the increasing demand for European clothing, for schooling and so on" made the definition of rights over trees more important and contentious, by raising the value of these rights. The defendant in one case admitted that the plaintiff owned the trees from which he had harvested and accepted his contentions that private groves belonged to the eldest man in the family and that it was not lawful for any other person to harvest from them. Even still, he had reaped from these trees because he had no other means of paying the tax (UNC 17/39).

In several court cases the communal controls imposed on palm cutting are stated directly by witnesses to have been linked to the payment of tax. In one example, a witness stated that the palms had been reserved for paying tax (UNC 62/35). In another, the plaintiff stated that a rule had been made four weeks previously that no-one was to cut palm fruits until notice was given. This would allow the fruits to ripen and yield enough oil for the payment of tax (OVU 418/35).

The difficulty of enforcing regulations made when palms were made communal for tax payment is a persistent theme of the court records. If regulations were violated too often, the restrictions

might become ignored (OVO 440/36) or “spoilt” (OVU 66/36). If this occurred, attempts could be made to renew the restrictions; the occasion could be marked with a symbolic act such as the sacrifice of a goat (OVU 418/35).

One difficulty not captured by the model is that of hold-out. Lone individuals might resist the conversion of their groves to common property for the purpose of tax payments. In one case, “the villagers” had asked all individuals who held palm trees on pledge to leave these to ripen, so that the *amala* (village council) could set them aside for general use. The defendant had objected, stating that he refused to give over his palm fruits so that others could pay their tax. The court found in his favor (UNC 35/39). Others were less successful. In one suit, the eldest man of his village had been forced by the young men to join what he called a “tax meeting.” When he hired two men to cut palm fruits from his trees, he had been fined 10s (MGC 161/36).

These conflicts were a challenge for colonial officials. The British depended on elders in order to project power at the local level, and so tried to protect their authority. Allowing elders too much exclusive control of palm groves, however, made it more difficult to collect tax revenue and created disaffection among youth. Officials, then, also limited elders’ accumulation of property. The aims of Indirect Rule and the means of funding it pulled the men on the spot in opposite directions.

These contradictions are clearly evident in two cases – UNC 89/38 and OVO 344/36. In the first case, the plaintiff had ceased to allow the young men to harvest fruit from his trees after he did not receive his share of the 10% rebate of tax revenues paid by the colonial government as compensation for assistance in tax-collection. By his own estimation, this would have been 15s. The defendants were then compelled to borrow money to pay their taxes. When their creditors troubled them, they gathered oil from the fruits on his land. The plaintiff protested:

I told them that my father never told me that one could take one’s palm trees by force, and that we use to appear in open square and pass a rule that the owners of the palm trees should allow young men to cut nuts for tax.

One witness told the court that the British officer had instructed the young men to meet with the elders in discussing these matters, but had also told the old men to limit themselves to one private grove only. The court found for the plaintiff, deciding that he should not be forced to surrender his palms and was free to carry on with his trees as he wished.

In the second case, the elders of Umuakole had initially responded to the poll taxes by arranging for a time during which young men could cut from private groves. The arrangement had collapsed,

and palms were being cut in common with no restrictions on the time of harvest. A meeting was summoned and juju administered that no one should cut except on appointed days. The defendants in the case had not adhered to this decision and forced their way into the plaintiff's land. A tax demand note was then received stating that 24 days remained until payment was due. The first defendant told the court that a meeting was then held and cutting suspended in anticipation of the tax payment. The defendants, however, were annoyed that, of the eleven persons in Umuakole with private palm groves, they believed only three were entitled to them. Further, the plaintiff and others had, in their view, exceeded what their ancestors had. The court initially found for the plaintiff, but on review the defendants were cautioned and discharged. The reviewing officer noted that the elders had very strong views on the case. They had claimed that, if the defendants were not punished, the young men would get out of control. Nonetheless, he believed it was the usurpation of private groves that had been at the heart of the trouble.

In both these cases, the youth admitted that the palm groves in question were the property of the elders, but were not willing to allow rights of ownership to interfere with their ability to pay tax. Colonial officials were caught in the middle. Contradictions between revenue and the maintenance of law and order forced local administrators into a balancing act.

5.2. Other cases.

5.2.1. *Yoruba*. Ownership of (mostly wild) palms in Yoruba-speaking parts of Nigeria was largely private. The lineage was the unit that owned both land and trees (Ward-Price, 1939). Many writers emphasize that they belonged to the head of the lineage on whose land they stood (Lloyd, 1953). Indeed, rights over palm trees on a plot of land marked ownership (Schwab, 1955). Many tenants who rented land were forbidden from exploiting existing palms or planting new ones (Ward-Price, 1939). Rights over palms might similarly be retained by the owner when land was pawned (Forde, 1951). Grants of uncleared land, by contrast, typically included ownership of the trees (Ward-Price, 1939).

There are several reasons why the Yoruba and Igbo responses diverged. Characteristics of the *resource system* and *resource units* differed. The Igbo responded first to European demand, since the densest grove of wild trees in Africa is found around Owerri (Lynn, 1997, p. 34). Combined with the unsuitability of Igboland for cocoa, this made palm oil more central to economic life, which made resource competition more responsive to trade. The *governance system* in the Yoruba

city-states that emerged after the fall of Oyo was dissimilar from the decentralized authority exercised in Igbo villages. The war chiefs who dominated political life in pre-colonial Yorubaland also dominated the production of palm oil (Oroge, 1971). *Users* also differed markedly. Resource competition in Igboland was intensified by its high population density. Yoruba-speaking provinces such as Ondo (56 persons per square mile in 1931), Oyo (37), Abeokuta (102), Ijebu (125) and even Ibadan (208) were less densely settled than the Igbo divisions that practiced communal harvesting, such as Aba (214), Owerri (527) and Okigwi (570) Martin (1988, p. 155). While a Yoruba farmer might farm a few acres annually, an Igbo farmer in Aba would often have access to an acre or less of land.⁵ This made palms more subtractable in Igboland.

5.2.2. *Urhobo*. Within Urhobo territory, the rules governing wild palms were similar to those in Igboland. Wild palms were communally owned and exploited, and the community would regulate when palms could be harvested, and how much fruit could be harvested by each individual (Aweto, 2005). Open and closed periods were set by the “gerontocratic” leadership of the village (Otite, 1979). This community ownership of palms differed from the more decentralized ownership of land by families (Otite, 1979).

Planted palms, by contrast, were harvested individually.⁶ This allows the *resource system* and *governance system* to held constant. However, both *resource units* and *users* differed across planted and wild palms. Wild palms were too few and too scattered to provide full-time work. An extensive palm plantation, by contrast, would have lowered the opportunity cost of private monitoring, since this could be combined with regular labor. Most planters in these areas were chiefs (Bridges, 1938). This lowered the costs of adjusting the institutional regime in response to this change in the nature of the resource.

Urhobo and related Isoko migrants, both called “Sobos” in colonial sources, were noted for their palm-harvesting camps in the Edo-speaking and eastern Yoruba-speaking parts of Nigeria (Forde, 1951). These migrants traveled to regions of greater labor scarcity where the local population neglected palm production (Udo, 1964). The rights they acquired differed from the system in Urhoboland, and typically took the form of leases. In the Edo-speaking regions, they paid an initial entrance fee of 12s, with a £1 annual rent for each camp. With time, many assimilated into their host villages (Usuanlele, 2007). In Ekiti, Yoruba lineage heads leased palm trees to immigrant

⁵Yoruba: (Forde, 1951). Igbo: National Archives Ibadan, CSO 26 20610, Assessment Report for Aba Division.

⁶I am grateful to a referee for alerting me to this distinction.

groups in return for annual payments of cash and oil (Lloyd, 1953). Similar arrangements were found in Ijebu Waterside, Owo, and Ikale (Forde, 1951). Faced with a Yoruba *resource system*, *resource units*, and *governance system*, Urhobo users harvested within Yoruba property rights institutions.

6. IMPLICATIONS

While I look at one society, this study has broader implications for our understanding of common property, collective action, and the impact of trade on the commons. The basic result is that common property can limit the costs of competing over natural resources. If this competition becomes more intense as the value of the resource rises, common property will become more attractive relative to private property, not less. This case will be most relevant to examples where it is simpler to monitor that resource extraction has occurred, rather than where or how much. The effort restrictions imposed by *imachi nkwu* resemble the seasonal closures, limits on entry, and total allowable catch restrictions that are found in fisheries where users vary by skill (Johnson and Libecap, 1982). For the Igbo, common property existed because it helped reduce the costs of defending private property that had intensified as palm oil became commercialized. It provided a mechanism by which those who did not own trees of their own were still enabled to pay tax.

The court cases give a window into how property rights are managed in poor rural communities. The collective action needed for the operation of this scheme was facilitated by the relative ease of detecting violations, by the small size of Igbo communities, and by the fact that it could be enacted within an existing institutional arrangement. It was hindered by the diffuseness of authority in Igbo society, by instances where the rules governing harvesting were not clear, and by the additional complications created by the Native Courts as a competing jurisdiction. Collective action worked in part by giving the broader community an interest in preserving the communal arrangement. Here, the essential feature of Igbo society is that defense of property was largely private. The result, then, is most relevant where state enforcement of private property is weak. This is not true only of small agrarian communities, but of many situations in developing countries.

The Igbo, like many other societies, were able to successfully manage common property and pursue collective action in the presence of international trade. This echoes the general findings of Ostrom (1991). Consistent with Copeland and Taylor (2009) and Baland and Platteau (1998), it shows that a diversity of responses are possible to commercialization. The Ostrom (2007, 2009)

framework for analyzing social-ecological systems can be used to identify characteristics of the *resource system, resource units, the governance system and users* that will guide these responses.

REFERENCES

- Afigbo, A. (1966). Revolution and Reaction in Eastern Nigeria: 1900-1929. *Journal of the Historical Society of Nigeria*, 3(3):539–557.
- Allen, R. (2011). Global economic history: A very short introduction. *OUP Catalogue*.
- Alston, L. J., Harris, E., and Mueller, B. (2012). The Development of Property Rights on Frontiers: Endowments, Norms, and Politics. *The Journal of Economic History*, 72(03):741–770.
- Alston, L. J., Libecap, G. D., and Mueller, B. (1999). *Titles, conflict, and land use: The development of property rights and land reform on the Brazilian Amazon frontier*. University of Michigan Press.
- Alston, L. J., Libecap, G. D., and Schneider, R. (1996). The determinants and impact of property rights: land titles on the Brazilian frontier. *Journal of Law, Economics, and Organization*, 12(1):25–61.
- Aweto, A. (2005). Agriculture in Urhoboland. *P. Ekeh (ed.) Studies in Urhobo Culture*, pages 699–716.
- Baland, J.-M. and Platteau, J.-P. (1998). Division of the Commons: A Partial Assessment of the New Institutional Economics of Land Rights. *American Journal of Agricultural Economics*, 80(3):644–650.
- Baland, J. M. and Platteau, J. P. (2003). *Economics of common property management regimes*, volume 1 of *Handbook of Environmental Economics*, pages 127–190. Elsevier.
- Besley, T. and Ghatak, M. (2009). Property rights and economic development. *Handbook of Development Economics, Volume 5*, pages 4525–4595.
- Bridges, A. F. B. (1938). Report on Oil Palm Survey in the Western Provinces. *Rhodes House Library, Oxford: MSS. Afr.s. 679*.
- Brown, C. A. (2003). *“We were all slaves” : African miners, culture, and resistance at the Enugu government colliery*. Greenwood Press.
- Chubb, L. T. (1961). *Ibo land tenure*. Ibadan University Press, Ibadan.
- Chuku, G. (2005). *Igbo women and economic transformation in southeastern Nigeria, 1900-1960*. Routledge, New York.

- Copeland, B. and Taylor, M. (2009). Trade, tragedy, and the commons. *The American Economic Review*, 99(3):725–749.
- Demsetz, H. (1967). Toward a theory of property rights. *The American Economic Review*, 57(2):347–359.
- Dietz, T., Ostrom, E., and Stern, P. C. (2003). The struggle to govern the commons. *science*, 302(5652):1907–1912.
- Fehr, E. and Gächter, S. (2000). Fairness and retaliation: The economics of reciprocity. *The Journal of Economic Perspectives*, 14(3):159–181.
- Forde, C. D. (1951). *The Yoruba-speaking peoples of south-western Nigeria*. International African Institute London.
- Gailey, H. A. (1970). *The road to Aba: a study of British administrative policy in Eastern Nigeria*. New York University Press.
- Grantham, G. W. (1980). The Persistence of Open-Field Farming in Nineteenth-Century France. *Journal of Economic History*, 40(3):515–531.
- Green, M. M. (1941). Land tenure in an Ibo village: in south-eastern Nigeria. *Monographs on social anthropology*, 6:44.
- Hansen, Z. K. and Libecap, G. D. (2004). The allocation of property rights to land: US land policy and farm failure in the northern great plains. *Explorations in Economic History*, 41(2):103–129.
- Hotte, L., Long, N., and Tian, H. (2000). International trade with endogenous enforcement of property rights. *Journal of Development Economics*, 62(1):25–54.
- Janssen, M. A., Holahan, R., Lee, A., and Ostrom, E. (2010). Lab experiments for the study of social-ecological systems. *Science*, 328(5978):613–617.
- Johnsen, D. B. et al. (2009). Salmon, science, and reciprocity on the Northwest Coast. *Ecology and Society*, 14(2):43.
- Johnson, R. N. and Libecap, G. D. (1982). Contracting problems and regulation: the case of the fishery. *The American Economic Review*, 72(5):1005–1022.
- Libecap, G. D. (1986). Property rights in economic history: Implications for research. *Explorations in Economic History*, 23(3):227–252.
- Libecap, G. D. (2007). The assignment of property rights on the western frontier: lessons for contemporary environmental and resource policy. *Journal of Economic History*, 67(2):257.

- Libecap, G. D. and Johnson, R. N. (1980). Legislating commons: The Navajo tribal council and the Navajo range. *Economic Inquiry*, 18(1):69–86.
- Libecap, G. D. and Smith, J. L. (2002). The economic evolution of petroleum property rights in the United States. *The Journal of Legal Studies*, 31(S2):S589–S608.
- Libecap, G. D. and Wiggins, S. N. (1984). Contractual responses to the common pool: prorationing of crude oil production. *The American Economic Review*, 74(1):87–98.
- Lloyd, P. C. (1953). Some problems of tenancy in Yoruba land tenure. *African Studies*, 12(3):93–103.
- Lopez, R. (1997). Environmental externalities in traditional agriculture and the impact of trade liberalization: the case of Ghana. *Journal of Development Economics*, 53(1):17–39.
- Lynn, M. (1997). *Commerce and economic change in West Africa: The palm oil trade in the nineteenth century*. Cambridge University Press, Cambridge.
- Martin, S. M. (1988). *Palm oil and protest: an economic history of the Ngwa region, south-eastern Nigeria, 1800-1980*. Cambridge University Press, Cambridge.
- Masclet, D., Noussair, C., Tucker, S., and Villeval, M. (2003). Monetary and nonmonetary punishment in the voluntary contributions mechanism. *The American Economic Review*, 93(1):366–380.
- McCloskey, D. (1976). English open fields as behavior towards risk. *Research in Economic History*, 1:124–170.
- Netting, R. M. (1976). What Alpine peasants have in common: Observations on communal tenure in a Swiss village. *Human Ecology*, 4(2):135–146.
- Oriji, J. (2007). The end of sacred authority and the genesis of amorality and disorder in Igbo mini states. *Dialectical Anthropology*, 31(1):263–288.
- Oriji, J. N. (1991). *Ngwa history: a study of social and economic changes in Igbo mini-states in time perspective*. P. Lang, New York.
- Oroge, E. (1971). *The institution of slavery in Yorubaland with particular reference to the nineteenth century*. PhD thesis, The University of Birmingham.
- Ostrom, E. (1991). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
- Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences*, 104(39):15181–15187.

- Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, 325(5939):419–422.
- Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. *The American economic review*, 100(3):641–672.
- Otite, O. (1979). Rural migrants as catalysts in rural development: The Urhobo in Ondo State, Nigeria. *Africa: Journal of the International African Institute*, 49(3):226–234.
- Platteau, J. P. (1996). The evolutionary theory of land rights as applied to sub-Saharan Africa: A critical assessment. *Development and Change*, 27(1):29–86.
- Poteete, A. R., Janssen, M., and Ostrom, E. (2010). *Working together: collective action, the commons, and multiple methods in practice*. Princeton University Press.
- Runge, C. F. (1986). Common property and collective action in economic development. *World Development*, 14(5):623–635.
- Schwab, W. B. (1955). Kinship and Lineage among the Yoruba. *Africa*, 25(04):352–374.
- Smith, H. E. (2000). Semicommon property rights and scattering in the open fields. *The Journal of Legal Studies*, 29(1):131–169.
- Taylor, M. and Brander, J. (1997). International trade and open-access renewable resources: the small open economy case. *Canadian Journal of Economics*, 30(3):526–552.
- Uchendu, V. C. (1965). The Igbo of southeastern Nigeria. *Fort Worth, TX: Holt, Reinhart and Winston*.
- Udo, R. K. (1964). The migrant tenant farmer of Eastern Nigeria. *Africa*, pages 326–339.
- Umbeck, J. (1977). A Theory of Contract Choice and the California Gold Rush. *Journal of Law and Economics*, 20(2):421–37.
- Usoro, E. J. (1974). *The Nigerian oil palm industry*. Ibadan University Press, Ibadan.
- Usuanlele, U. (2007). Urhobos in Benin 1897-1945: Changing Patterns of Relations under Colonial Rule. *History of the Urhobo People of Niger Delta*, pages 483–496.
- Vollan, B. and Ostrom, E. (2010). Cooperation and the commons. *Science*, 330(6006):923–924.
- Ward-Price, H. L. (1939). *Land tenure in the Yoruba provinces*. Lagos : Printed by the Government Printer.

Appendix: Not for publication.

APPENDIX A. DATA APPENDIX

My sources of archival evidence fall into three categories:

- (1) *Native Court Records*: A selection of Civil Judgment Books from the Aba-Na-Ohazu (ANO), Nkwo Udara (NU), Obohia (ONC), and Ugba (UNC) Native Courts were used based on their availability. The Nkwo Udara series contains judgments from the Mvosi (MGC), Ovuku (OVU), Ovuoko (OVO), and Ovokwu (OVW) Group Courts. These are the principal sources for this study.⁷
- (2) *CSE*: Central Secretary's Office, Nigeria, 1906-1940. This contains a variety of correspondence, including Intelligence Reports.
- (3) *Abadist*: This series contains documents and correspondence relating to Aba Division, including Assessment Reports. Land dispute records in these files generally contain facsimiles of the relevant court proceedings as well as petitions to colonial officials about the judgments rendered and correspondence between officials concerning these cases. A sample from this series has been included in the Web Appendix. Specifically, this is Abadist 9/1/268. I was not able to copy a sample native court case from the National Archives in Enugu, since these are contained in bound volumes, but the transcript of Umuaro Native Court Civil Suit 283/33 contained in this record is of the same format as the cases in these books.

The Native Court records that are available date mostly from the 1930s and later. These are rough transcripts handwritten in English by the court clerk during proceedings. Each record begins by stating the names and home villages of the plaintiffs and defendants; in cases involving violations of palm-cutting regulations, it is not uncommon to see more than ten defendants in a single case. The statement of grievance and any claim for damages are also given. Parties make statements and call witnesses. Cross-examination by the opposing party and the court is common. Cases are often adjourned for further witnesses, inspection of the land, or swearing of juju. The court's decision is recorded, along with any statement by the president.

⁷Citations of these cases are abbreviated for legibility. For example, Nkwo Udara civil suit 140 of 1935 is cited as NU 140/35

APPENDIX B. EXTENSIONS TO THE MODEL

B.1. θ as a fixed parameter. Suppose the elder is unable to choose θ , which is instead set by custom or by technological constraints. In that case, the condition that $V_E^C > V_E^P$ reduces to:

$$\left(\left(\frac{c}{c+\gamma} \right)^2 (1-\theta) - \left(\frac{c}{c+d} \right)^2 \right) p > \bar{k}$$

It will only be possible to satisfy this condition if θ is sufficiently small that the coefficient on p on the left hand side is positive. If this is the case, then communal property is preferred if the price of palm oil is sufficiently high. This is similar to the condition given in (11), except that the elder will never prefer communal property if the share he must surrender is too great.

B.2. Other responses.

B.2.1. Cooperative monitoring. Suppose now that, rather than one elder and one youth, there are N elders and N youth. I abstract away from negative spillovers that can arise from private monitoring by allowing each youth to steal from only one particular grove. That is, youth i can only steal from elder i , youth j can only steal from elder j , and so on. To further simplify the analysis, I will only consider symmetric equilibria.

Elders may now devote their efforts to either private monitoring, m , or cooperative monitoring g . The marginal cost of cooperative monitoring is δ . Define $G \equiv \sum_{i=1}^N g_i$ as the total amount of cooperative monitoring, and $G_{-i} \equiv G - g_i$ as total monitoring by all elders apart from elder i . I dispense with i subscripts below. If youth i devotes s units of effort to stealing from elder i , elder i devotes m units of effort to private monitoring, and total cooperative monitoring is G , then the youth is able to successfully steal a fraction $\frac{s}{m+s+G}$ of the oil, while the elder retains a fraction $\frac{m+G}{m+s+G}$.

Each elder's problem can be written as:

$$(17) \quad V_E^{PCM} = \max_{m,g} \left\{ \frac{m+g+G_{-i}}{g+m+s+G_{-i}} p - dm - \delta g \right\},$$

while each youth's problem can be written as:

$$(18) \quad V_Y^{PCM} = \max_s \left\{ \frac{s}{g+m+s+G_{-i}} p - cs \right\}.$$

Both (17) and (18) are concave, and so they can be maximized from their first-order conditions. Each elder's best responses, then, are:

$$(19) \quad m_{BR}^{PCM} = \max \left\{ \sqrt{\frac{sp}{d}} - s - g - G_{-i}, 0 \right\},$$

and

$$(20) \quad g_{BR}^{PCM} = \max \left\{ \sqrt{\frac{sp}{\delta}} - s - m - G_{-i}, 0 \right\}.$$

The youth's best response is:

$$(21) \quad s_{BR}^{PCM} = \max \left\{ \sqrt{\frac{(m+G)p}{c}} - m - G, 0 \right\}.$$

Comparing (19) and (20), it is apparent that the elder will either monitor privately or cooperatively, but not both. He will monitor cooperatively if $d > \delta$, and privately otherwise. If $d \leq \delta$, then, this collapses to the baseline private property case. This is the first result of considering cooperative monitoring. Although it provides social benefits (from the perspective of the elders) that private monitoring does not, a self-interested elder does not consider these in his decision. Cooperative monitoring entails a collective action problem, and may be under-provided.

Consider the outcome where $d \leq \delta$, and cooperative monitoring occurs. In a symmetric equilibrium, $G_{-i} = (N-1)g$. Substituting this into (20) and (21) and setting $m = 0$ gives equilibrium stealing and monitoring:

$$(22) \quad g_*^{PCM} = \left(\frac{c}{c+\delta} \right)^2 \frac{p}{Nc},$$

and

$$(23) \quad s_*^{PCM} = \left(\frac{\delta}{c+\delta} \right)^2 \frac{p}{\delta}.$$

Substituting (22) and (23) into (17) and (18) gives the equilibrium payoffs under private property with cooperative monitoring:

$$(24) \quad V_E^{PCM} = \left(\frac{\delta}{c + \delta} \right)^2 \left(1 - \left(\frac{N-1}{N} \right) \frac{\delta}{c} \right) p,$$

and

$$(25) \quad V_Y^{PCM} = \left(\frac{c}{c + \delta} \right)^2 p.$$

Now consider the case of communal property. Assume again that there is a fixed cost \bar{k} . I restrict analysis to the case where each elder offers the same θ . As with private monitoring, I assume that cooperative monitoring under communal property has a marginal cost $\sigma > 0$ that is lower than the cost of monitoring under private property (δ). Conditional on θ , each elder's problem can be written as:

$$(26) \quad V_E^{CCM} = \max_{m,g} \left\{ \frac{m + g + G_{-i}}{g + m + s + G_{-i}} (1 - \theta)p - \gamma m - \sigma g - \bar{k} \right\},$$

while each youth's problem can be written as:

$$(27) \quad V_Y^{CCM} = \max_s \left\{ \theta p + \frac{s}{g + m + s + G_{-i}} (1 - \theta)p - cs \right\}.$$

As in the private case, these can be solved from their first order conditions, giving best response functions:

$$(28) \quad m_{BR}^{CCM} = \max \left\{ \sqrt{\frac{s(1-\theta)p}{\gamma}} - s - g - G_{-i}, 0 \right\},$$

$$(29) \quad g_{BR}^{CCM} = \max \left\{ \sqrt{\frac{s(1-\theta)p}{\sigma}} - s - m - G_{-i}, 0 \right\},$$

and:

$$(30) \quad s_{BR}^{CCM} = \max \left\{ \sqrt{\frac{(m+G)(1-\theta)p}{c}} - m - G, 0 \right\}.$$

As under private property, cooperative monitoring will only occur if it is individually rational, that is, if $\gamma \geq \sigma$. Otherwise, this collapses to the case without cooperative monitoring. Following similar logic to the above, the equilibrium levels of cooperative monitoring and theft in a symmetric equilibrium with $\gamma \geq \sigma$ are:

$$(31) \quad g_*^{CCM} = \left(\frac{c}{c+\sigma} \right)^2 \frac{(1-\theta)p}{Nc},$$

and

$$(32) \quad s_*^{CCM} = \left(\frac{\sigma}{c+\sigma} \right)^2 \frac{(1-\theta)p}{\sigma}.$$

Payoffs conditional on θ are:

$$(33) \quad V_Y^{CCM} = \left(\frac{\sigma}{c+\sigma} \right)^2 \left(1 - \left(\frac{N-1}{N} \right) \frac{d}{c} \right) (1-\theta)p - \bar{k}.$$

and

$$(34) \quad V_Y^{CCM} = \theta p + \left(\frac{c}{c+\sigma} \right)^2 (1-\theta)p.$$

If each elder chooses θ subject to the constraint that $V_Y^{CCM} \geq V_Y^{PCM}$, this gives an optimal θ of

$$(35) \quad \theta_*^{CCM} = \frac{\left(\frac{\delta}{c+\delta} \right)^2 - \left(\frac{\sigma}{c+\sigma} \right)^2}{1 - \left(\frac{\sigma}{c+\sigma} \right)^2}.$$

Substituting this into (33) and (34) gives equilibrium payoffs:

$$(36) \quad V_E^{CCM} = \left(\frac{c}{c+\delta} \right)^2 \left(\frac{c+2\delta}{c+2\sigma} \right) \left(1 - \left(\frac{N-1}{N} \right) \frac{d}{c} \right) p - \bar{k},$$

and

$$(37) \quad V_Y^{CCM} = \left(\frac{\delta}{c + \delta} \right)^2 p.$$

As in the case without cooperative monitoring, these payoffs ensure that the elder will prefer common property so long as the price of oil is above a given threshold.

B.2.2. Wage labor. Suppose the elder hires the youth to gather palm oil. He offers a piece-rate wage of w for each unit of oil delivered. The youth, however, can steal some of this oil for himself. As before, if the youth exerts effort s in stealing and the elder exerts effort m in monitoring, assuming the same marginal costs as under the standard private property case, the youth will successfully steal a fraction $\frac{s}{m+s}$ of the oil, while the elder will receive a share $\frac{m}{m+s}$. Thus, the elder's problem, conditional on w , can be written as:

$$(38) \quad V_E^W = \max_m \left\{ \frac{m}{m+s} (p-w) - dm \right\},$$

while the youth's problem can be written as:

$$(39) \quad V_Y^W = \max_s \left\{ \left(1 - \frac{s}{m+s} \right) w + \frac{s}{m+s} p - cs \right\}.$$

Each player's best response function can be found from the first order conditions, as above. These can then be used to solve for equilibrium levels of stealing and monitoring. Conditional on w , the elder and youth receive payoffs:

$$(40) \quad V_E^W = \left(\frac{c}{c+d} \right)^2 (p-w),$$

and

$$(41) \quad V_Y^W = w + \left(\frac{d}{c+d} \right)^2 (p-w).$$

Comparing the expression for V_E^W in (40) to the expression for V_E^P in (4), it is apparent that the elder can do no better paying a wage than he can under private property. If $w = 0$, he does just as well paying a wage, while if $w > 0$ he does worse.

B.2.3. Paid monitoring. Suppose the elder hires a youth to monitor on his behalf. There will be no possible efficiency gains unless the youth's marginal cost of monitoring is less than that of the elder. Call this $e < d$. The elder offers a piece-rate wage of w for each unit of oil delivered. I abstract away from the problem that the hired monitor might steal, and instead focus on the elder's problem of providing the paid monitor with incentives to increase his effort.

If the thieving youth exerts effort s in stealing and the hired youth exerts effort m in monitoring, the thief will successfully steal a fraction $\frac{s}{m+s}$ of the oil, while the paid monitor will deliver a share $\frac{m}{m+s}$ to the elder. In equilibrium, both s and m will depend on w . Thus, the elder's problem can be written as:

$$(42) \quad V_E^{PM} = \max_{m,w} \left\{ \frac{m(w)}{m(w) + s(w)} (p - w) \right\}.$$

The monitor's problem, conditional on w , can be written as:

$$(43) \quad V_M^{PM} = \max_m \left\{ \frac{m}{m+s} w - em \right\},$$

while the thief's problem can be written as:

$$(44) \quad V_Y^{PM} = \max_s \left\{ \frac{s}{m+s} p - cs \right\}.$$

Following the same logic used to solve the standard private property case, equilibrium theft and monitoring will be given by:

$$(45) \quad m_*^{PM} = \frac{p}{c} \left(\frac{wc}{pe + wc} \right)^2,$$

and

$$(46) \quad s_*^{PM} = \frac{w}{e} \left(\frac{pe}{pe + wc} \right)^2.$$

Substituting these into (47), the elder's problem can be rewritten as:

$$(47) \quad V_E^{PM} = \max_m \left\{ \frac{wc}{wc + pe} (p - w) \right\}.$$

Solving (47) from its first order conditions gives the elder's optimal wage:

$$(48) \quad w_*^{PM} = \frac{\sqrt{e(e+c)} - e}{c} p.$$

Thus, the elder's payoff is:

$$(49) \quad V_E^{PM} = \left(\frac{c + 2e - 2\sqrt{e(e+c)}}{c} \right) p.$$

Because (49) is decreasing in e , the elder will only be able to do better than under private or common property if the hired youth's cost of monitoring is sufficiently low.

B.3. Other considerations.

B.3.1. *Altruism.* Suppose that, in addition to valuing their own payoffs, each player has an altruism parameter $\alpha \in [0, 1]$, which he uses to weight the payoff received by the other player. Denoting payoffs as y , this is equivalent to stating that $V_Y = y_Y + \alpha y_E$, and $V_E = y_E + \alpha y_Y$. Under these conditions, the elder's problem with private property can be rewritten as:

$$(50) \quad V_E^{PA} = \max_m \left\{ \frac{m}{m+s} p - dm + \alpha \left(\frac{s}{m+s} p - cs \right) \right\},$$

while the youth's payoff is given as

$$(51) \quad V_Y^{PA} = \max_s \left\{ \frac{s}{m+s} p - cs + \alpha \left(\frac{m}{m+s} p - dm \right) \right\}.$$

Following similar steps to those given above gives equilibrium stealing and monitoring:

$$(52) \quad m_*^{PA} = \left(\frac{c}{c+d} \right)^2 \frac{(1-\alpha)p}{c},$$

and

$$(53) \quad s_*^{PA} = \left(\frac{d}{c+d} \right)^2 \frac{(1-\alpha)p}{d}.$$

It is clear from (58) and (59) that both players restrict effort as a result of their altruism. Equilibrium payoffs under private property become:

$$(54) \quad V_E^{PA} = \left(\frac{c}{c+d} \right)^2 \left(1 + \frac{\alpha d}{c} \right) p + \alpha \left(\frac{d}{c+d} \right)^2 \left(1 + \frac{\alpha c}{d} \right) p,$$

and

$$(55) \quad V_Y^{PA} = \left(\frac{d}{c+d} \right)^2 \left(1 + \frac{\alpha c}{d} \right) p + \alpha \left(\frac{c}{c+d} \right)^2 \left(1 + \frac{\alpha d}{c} \right) p.$$

Altruism, then, reduces each player's effort, increasing both players' material payoffs, even ignoring any utility benefits from altruism.

Under communal property, the players' payoffs can be rewritten to include altruism. For the elder, taking θ as given, this becomes:

$$(56) \quad V_E^{CA} = \max_m \left\{ \frac{m}{m+s} (1-\theta)p - \gamma m - \bar{k} + \alpha \left(\theta p + \frac{s}{m+s} (1-\theta)p - cs \right) \right\},$$

while the youth's payoff is given as

$$(57) \quad V_Y^{CA} = \max_s \left\{ \theta p + \frac{s}{m+s} (1-\theta)p - cs + \alpha \left(\frac{m}{m+s} (1-\theta)p - \gamma m - \bar{k} \right) \right\}.$$

Following the same logic as before gives equilibrium stealing and monitoring:

$$(58) \quad m_*^{CA} = \left(\frac{c}{c+\gamma} \right)^2 \frac{(1-\alpha)(1-\theta)p}{c},$$

and

$$(59) \quad s_*^{CA} = \left(\frac{\gamma}{c + \gamma} \right)^2 \frac{(1 - \alpha)(1 - \theta)p}{\gamma}.$$

Payoffs, conditional on θ , become:

$$(60) \quad V_E^{CA} = \left(\frac{c}{c + \gamma} \right)^2 \left(1 + \frac{\alpha\gamma}{c} \right) (1 - \theta)p - \bar{k} + \alpha \left(\theta p + \left(\frac{\gamma}{c + \gamma} \right)^2 \left(1 + \frac{\alpha c}{\gamma} \right) (1 - \theta)p \right),$$

and

$$(61) \quad V_Y^{CA} = \theta p + \left(\frac{\gamma}{c + \gamma} \right)^2 \left(1 + \frac{\alpha c}{\gamma} \right) (1 - \theta)p + \alpha \left(\left(\frac{c}{c + \gamma} \right)^2 \left(1 + \frac{\alpha\gamma}{c} \right) (1 - \theta)p - \bar{k} \right).$$

If the elder selects θ subject to the constraint that $V_E^{CA} \geq V_Y^{PA}$, he will choose:

$$(62) \quad \theta_*^{CA} = \frac{B_1 - B_2 + \alpha(A_1 - A_2)}{1 - B_2 - \alpha A_2} + \frac{\alpha \bar{k}}{p(1 - B_2 - \alpha A_2)},$$

where

$$A_1 = \left(\frac{c}{c + d} \right)^2 \left(1 + \frac{\alpha d}{c} \right),$$

$$A_2 = \left(\frac{c}{c + \gamma} \right)^2 \left(1 + \frac{\alpha\gamma}{c} \right),$$

$$B_1 = \left(\frac{d}{c + d} \right)^2 \left(1 + \frac{\alpha c}{d} \right),$$

$$B_2 = \left(\frac{\gamma}{c + \gamma} \right)^2 \left(1 + \frac{\alpha c}{\gamma} \right).$$

The final payoffs can be obtained by substituting (62) into (60) and (61). Now that the fixed administrative costs of communal property enter into the youth's payoff, the elder's offer of θ_*^{CA} is contingent on p . In addition, the fact that each player takes the other's payoffs into account when evaluating his own utility means that the condition $V_E^{CA} \geq V_E^{PA}$ no longer necessarily simplifies to a cutoff value for p .

B.3.2. *Seniority.* Suppose now that the standard game with one elder and one youth is repeated infinitely. The youth and elder each discount future payoffs by the factor β . The elder remains an elder indefinitely. Each period, there is a probability π that the youth can be promoted to the rank of elder. If that happens, the original elder and the newly made elder continue playing the game as elders with two newly-created youths. The purpose of this extension to the model is to assess the effect of a youth's future prospect of becoming an elder on outcomes under both private and communal property.

First, consider private property. I discuss one particular "cooperative" outcome, in which cooperation is sustained by the threat of a trigger strategy. In particular, the elder retains the entirety of his harvest for himself, offering nothing to the youth. The youth's adherence to private property, then, is sustained by nothing more than the promise that he will some day have property of his own.

For simplicity, I assume the elder does not monitor in this scenario. This gives the youth the opportunity to steal the oil for himself with negligible effort. Even so, the elder may be able to sustain the youth's cooperation through the threat of reverting to a punishment strategy and revoking the possibility of promotion to the rank of elder if the youth steals. Because the equilibrium in the static game is also a sub-game perfect Nash equilibrium, it is a natural candidate for a punishment strategy. If this occurs, the youth receives V_Y^P and the elder receives V_E^P forever, and the youth is never made an elder. Private property with no stealing will be implementable so long as the youth's payoff from continuation is greater than his payoff from the optimal one-shot deviation and its associated continuation payoff.

I denote V_Y^{PC} as the present value of lifetime utility for a youth who never deviates, V_Y^{PD} as the present value of lifetime utility for a youth who deviates in the current period, V_E^{PC} as the present value of lifetime utility for an elder if the youth never deviates, and V_E^{PD} as the present value of lifetime utility for an elder if the youth deviates in the current period. Following the setup above, these payoffs can be written as:

$$(63) \quad V_Y^{PC} = 0 + \beta ((1 - \pi)V_Y^{PC} + \pi V_E^{PC}),$$

$$(64) \quad V_Y^{PD} = p + \frac{\beta}{1-\beta} \left(\frac{d}{c+d} \right)^2 p \equiv p + \frac{\beta}{1-\beta} \lambda_Y p,$$

$$(65) \quad V_E^{PC} = \frac{p}{1-\beta},$$

and

$$(66) \quad V_E^{PD} = 0 + \frac{\beta}{1-\beta} \left(\frac{c}{c+d} \right)^2 p \equiv \frac{\beta}{1-\beta} \lambda_E p.$$

It is possible to use (65) to re-write (63) as:

$$(67) \quad V_Y^{PC} = \frac{\beta \pi p}{(1-\beta)(1-\beta+\beta\pi)}.$$

Thus, the youth will cooperate so long as $V_Y^{PC} \geq V_Y^{PD}$, which simplifies to:

$$(68) \quad \pi \geq \bar{\pi}^P \equiv \left(\frac{1-\beta}{\beta} \right) \left(\frac{1-\beta(1-\lambda_Y)}{\beta(1-\lambda_Y)} \right).$$

Thus, if the youth's prospect of becoming an elder is sufficiently promising, it can sustain his adherence to private property.

Now, consider a similar scenario under communal harvesting. Here, the elder offers the youth a share θ of the oil each period, keeping a share $(1-\theta)$ for himself. As before, the elder does not monitor, giving the youth the opportunity to deviate with negligible effort and appropriate the remaining share $(1-\theta)$ for himself. Again, the punishment strategy used is reversion to the static equilibrium under private property, and permanent removal of the possibility that the youth becomes an elder.

I denote V_Y^{CC} as the present value of lifetime utility for a youth who never deviates, V_Y^{CD} as the present value of lifetime utility for a youth who deviates in the current period, V_E^{CC} as the present value of lifetime utility for an elder if the youth never deviates, and V_E^{CD} as the present value of lifetime utility for an elder if the youth deviates in the current period. Following the setup above, these payoffs can be written as:

$$(69) \quad V_Y^{CC} = \theta p + \beta ((1 - \pi)V_Y^{CC} + \pi V_E^{CC}),$$

$$(70) \quad V_Y^{CD} = p + \frac{\beta}{1 - \beta} \lambda_Y p,$$

$$(71) \quad V_E^{CC} = \frac{(1 - \theta)p}{1 - \beta},$$

and

$$(72) \quad V_E^{PD} = 0 + \frac{\beta}{1 - \beta} \lambda_E p.$$

It is possible to use (71) to re-write (69) as:

$$(73) \quad V_Y^{CC} = \frac{(1 - \beta - \beta\pi)\theta + \beta\pi}{(1 - \beta)(1 - \beta + \beta\pi)} p.$$

Thus, the youth will cooperate so long as $V_Y^{CC} \geq V_Y^{CD}$. If $1 - \beta - \beta\pi > 0$, this simplifies to:

$$(74) \quad \theta \geq \frac{(1 - \beta + \beta\lambda_Y)(1 - \beta + \beta\pi) - \beta\pi}{1 - \beta - \beta\pi}.$$

If, however, $1 - \beta - \beta\pi < 0$, then the youth always deviates. The condition in (74) becomes a restriction that θ is less than a negative number, which cannot occur. This will be the case if either β or π are sufficiently large that the adverse effect of an increase in θ on the youth's expected payoff when he becomes an elder outweighs the benefit while he is a youth.

Comparing V_E^{CC} with V_Y^{PC} , it is clear that the elder will prefer private property so long as he can induce the youth to cooperate, since his per-period payoff is greater (p versus $(1 - \theta)p$). The possible advantage of common property here becomes the range of π over which the youth's cooperation can be secured. Define the following cutoff value for π :

$$(75) \quad \bar{\pi}^C \equiv \left(\frac{1 - \beta}{\beta} \right) \left(\frac{1 - \beta(1 - \lambda_Y) - \theta}{\beta(1 - \lambda_Y) - \theta} \right).$$

If the youth is sufficiently patient, i.e. if $\beta > \frac{1}{2(1 - \lambda_Y)}$, then $1 - \beta(1 - \lambda_Y) < \beta(1 - \lambda_Y)$. If this case holds, then $\bar{\pi}^C < \bar{\pi}^P$ for any $\theta > 0$. Otherwise, $\bar{\pi}^C > \bar{\pi}^P$ for any $\theta > 0$. Under communal property, it may be possible for the elder to secure the youth's cooperation, even if $\pi < \bar{\pi}^P$. If the youth is sufficiently patient, the elder will be better off gaining this cooperation than under infinite repetition of the static game. Consider the extreme case, where $\pi = 0$. Then, (74) simplifies to $\theta > 1 - \beta + \beta\lambda_Y$. If the elder makes this minimal offer of θ to the youth, he will be better off than with the infinite repetition of the static game so long as $(1 - (1 - \beta + \beta\lambda_Y))p > \lambda_E p$. This simplifies to the condition that $\beta > \frac{\lambda_Y}{1 - \lambda_E}$, i.e. that the youth is sufficiently patient.