INSTITUTIONS AND SUSTAINABLE LAND USE: THE CASE OF FOREST AND GRAZING LANDS IN NORTHERN ETHIOPIA

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Abstract

Land is an essential factor of production for agriculture, horticulture, forestry as well as other land related activities. Institutions that govern its use determine the sustainability and efficient use of this essential resource. In Ethiopia all land is publicly owned. Such an institutional setting has resulted in major degradation of Ethiopia's land resources and dissipation of the resource rent, as available forest and grazing lands are exploited in a suboptimal fashion. An alternative to current institutional setting is to assign private property institution, but this will lead to welfare costs. In this paper, we examine the welfare effects (from consumer perspective) of change in institutional setting to forest and grazing lands using a unique data set covering 200 cross-section households in Tigrai, Northern Ethiopia. Finding suggest that changing the current institutional setting could indeed be welfare reducing. Given the finding, it is little wonder the government is reluctant to impose a private property institution on Ethiopia, despite continued land degradation.

Key words: institutions; sustainable land use; economic welfare.

JEL classification: K11; Q12; Q2; Q28

1. Introduction

Land is an essential factor of production for agriculture, horticulture, forestry as well as other land related activities. In many developing countries, inefficient use or exploitation of land reduces the amount of resource rent that can be collected, while lowering available future resource rents as land resources degrade over time in suboptimal fashion. Consequently, increasing poverty combined with lack of appropriate institutions governing land use causes peasants to invest too little in land improvements. A cycle of land degradation occurs because, as forests are mined, people turn to grasses, crop residues and livestock dung for fuel, which deteriorates the land further (Pearce and Warford 1993, p.25).

Land in Ethiopia is publicly owned.[1] Except for trees that fall in private backyards and farmlands forests/ trees and grazing lands remain largely free access resources. Under such an institutional setting or an unrestricted access condition agents would maximize benefits by putting effort to the extent that total cost is equal to total revenue, instead of marginal cost being equal to marginal revenue (Van Kooten and Bulte, 2000). Apparently, no agent will have an incentive to delay harvest, as doing so would only enhance the harvest opportunities of others. The outcome is excess depletion and dissipation of the resource rent.[2] It is quite common knowledge that the absence or ineffectiveness of institutions in terms of use regulations of the land resources resulted in severe degradation. Therefore, it would indeed be of public interest to alter this situation. An interesting question in here is how would a public policy aiming at altering the status quo affect welfare of private agents? What would be an optimal one or worth doing in terms of addressing the problem? By and large, there appear to be two opposing and perhaps diverging views as regards to land use/ownership in the country. One favours the status quo, i.e., state stewardship of land, and the other favours private

[1] Article 40 of the Constitution states: "the right to ownership of rural and urban land is exclusively vested in the state ... and shall not be subject to sale or exchange" (FDRE, 1995).
[2] For details about property rights/institutions, economic dynamics and rent capture see Van Kooten and Bulte 2000.

property institution. Though all these policy options are contemplated on the grounds of efficiency and sustainability they are not without welfare costs at individual household level. Therefore, it would be of great interest to empirically examine what the policy of completely enforcing private property institution to forest and grazing/dung resources would mean in terms of welfare of private agents.

The purpose of the current study is to examine the potential of the policy of assigning an alternative institutional setting, i.e., private property institution, using a unique data set covering 200 cross-section households in Tigrai province, northern Ethiopia. More specifically, in this paper we examine the welfare effects (from consumer perspective) of change in institutional setting to forest and grazing lands. Such a change in institutional setting could be envisaged to counter the dissipation of the resource rent and hence the degradation of agricultural and forest lands. Finally, we draw implications of our findings. We begin in the next section with land use in Tigrai, the theory on institutions and resources degradation is presented in section 3. Then, in section 4, we present the theoretical model of household's maximization problem along with a framework for analyzing/capturing the welfare effects of the change in institutional setting. In section 5, we outline an empirical model, and then section 6 results and discussions. We conclude by drawing some policy/research implications.

2. Land Use in Tigrai

Tigrai region covers a total of about 50 thousand square km surface/land area (Table 1). Of this total landmass about 25 percent is cultivated or agricultural land. Historically, institutions/ property rights to land in Ethiopia were vested in either the *risti* system, the *gulti*

system/ private land holding, or the church. The *risti*[3] system was the dominant type of land tenure in Tigrai before the 1975 land reform. It was a communal land tenure in which the right to land was not exclusive but shared. Under this system, an individual had usufruct rights to land (*risti* rights) in a given community only if he was able to establish a direct line of descent from the recognized original holder of the land. Nevertheless, the individual's usufruct rights to land were not transferable to others through sale or mortgage, though there was room for temporary lease. Moreover, as the right to land under the *risti* sytem didn't imply a right to any specific parcel, land redistribution was undertaken periodically to ensure that new entrants/ family members were granted access. This implied land fragmentation. In addition, the fact that anybody's land parcels might be reallocated to a distance kinsmen and that no one could sell them for a profit nor leave it to a heir reduced a farmer's incentive to invest in long-term land improvements and, hence, implied land quality deterioration (Hoben, 1995; Hagos et al, 1999). The *gulti* system was characterized by absentee owners, as it was the royal kinsmen/ women who had the *gulti* holdings.

Forest/shrub and grazing land account for over half of the total land area of the region. Except for trees that fall in private backyards and farmlands, forests/ trees and grazing lands remain largely free access resources. For example, free collection accounted for the dominant part of all household fuel uses in our sample (Table 2). Natural forests and grazing lands were found to be the major sources of freely collected fuels while the private sources constituting a lesser proportion (Table 3). As a result of the free and uncontrolled grazing system that is prevalent in the region, livestock stay outside for most of the day both grazing/ browsing and searching for feed. Eventually, the animals leave their manure/ dung, which is free for use by any one and there is no defined ownership right to it. For instance, dung collected from rural

[3] As was the case in the rest of Africa (Besley, 1995), *risti* system/ communal land tenure may be regarded as egalitarian in the sense that the distribution was based on the principle of equality, with the land allocated by lottery after being divided into parcels according to quality.

hinterlands accounts for a significant portion of total household cooking fuel in some towns in Tigrai (Newcombe, 1989). This degrades the land further.

3. Institutions[4] and Resources Degradation: Theory

Renewable natural resources such as forests, grazing lands, fisheries, etc, constitute a significant part of our planet. Rural communities in developing countries depend primarily on these resources for fuel wood, construction material and livestock grazing. These resources are also important sources of livelihood elsewhere in the rest of the world. However, due to unrestricted access by users or in the absence of effective use regulations (rule structures), these resources are subject to over-exploitation on first-come, first-served basis. Alternative theories have been developed to explain the common pool resources problem. Three alternative theories are quite apparent in the literature. The structure of these theories range from a single agent decision framework (e.g., Gordon, 1954) through to game theoretic framework involving strategic interaction among multi agents (e.g., Cheung, 1970; Runge, 1981). One of these theories ascribes the common pool resource problem as 'the free-rider problem'. According to this theory, motivated by narrow self-interest each individual would tend to choose and/or behave independently to utilize the resource at an exploitative level in the expectation that others will do the same, leading to a situation in which all are made worse off. Because part of the cost is born by the entire group involved in using the resource, the social cost of harvesting an additional unit of a common pool resource exceeds the private cost. This is presumed to give individual agents an incentive to enjoy 'free-riding, which

[4] Institutions are systems of rules/norms that specify certain forms of action as permissible, others as forbidden, and provide for certain penalties and defense when violations occur (Runge, 1984). Through shaping the behavior of people with respect to each other and their belongings, possessions, and property; institutions provide assurance by setting the 'rules of the game'. These rules, hence, affect the welfare of agents through their effect on the rate of resource use and the distribution of returns. By coordinating behavior and reducing uncertainty in the realm of human interaction, they increase the value of a stream of benefits associated with economic activity.

finally ends up in overexploitation. Often, a simple prisoner's dilemma game model is used to explain the situation. Therefore, the incentive for free-riding could be avoided through completely defined private property rights to the resources.

For others like Hardin (1968) and Johnson (1972) the problem of common property externality "the tragedy of the commons" can only be resolved through imposition and enforcement of use rules by an external enforcer, the government. Hardin sees 'mutual coercion, mutually agreed upon by the majority of the people affected', and an external authority, the 'custodians', by which restrained access can be enforced as the only viable option. According to this line of theory when a group of people are placed in a setting, where upon all adopting a rule of restrained use of a common pool resource they could mutually benefit, they will not do so in the absence an external enforcer of agreements. Because each agent has an incentive to ignore the social cost of his harvest for fear that other agents will capture the benefits ahead of him.

The third line of theory belongs to the cooperative or conditional cooperative view. Give much importance to what they called 'assurance and uncertainty' in predicating behavior patterns of actors and argue that the institutional rules innovated by the users that help to reduce uncertainty and coordinate expectations are the best solutions to resolve the problem (Runge, 1981). This line of argument emphasizes on the idea that individuals are interdependent because of the non-separability of the cost functions that face them and thus, each individual bases her decisions on the expected actions of others. For them, the problem of the common property externality is uncertainty and some kind of institutional solutions that can confirm assurance can easily solve it. Indeed Runge argues that no player has an incentive to defect in a situation where everybody co-operates, it is possible for the players to assure each other that everybody chooses to co-operate and thus reach a stable co-operative Nash equilibrium.

4. Theoretical Model

4.1 Household's maximization problem

Consider the case of a farm household who is assumed to behave as if maximizing a well-behaved utility function defined over the quantities of commodities consumed q and environmental and household characteristics z, subject to budget constraint m. Let the household's utility function be specified as (Sadoulet and de Janvry, 1995):

(1) $u = u(q, z)$

Solving for the Lagrangian function of the household's utility maximization problem in the usual procedure and assuming the second-order conditions are satisfied gives us the ordinary (observed) demand function $q(p,m,z)$. Substituting the demand function derived from this constrained maximization into u gives us the indirect utility function:

(2) $u = v(p, m, z)$

Note that $v(\cdot)$ is the maximum utility that the household can reach for given prices p and income m.

4.2 Welfare effects of change in institutional setting

Now consider a change in price of i^{th} good p_i from p_i^0 to p_i^1 resulting from some public policy. For instance, such a public policy might emanate from the intention to change the existing institutional setting governing forest and grazing lands, e.g., wood and dung, to alter the open access condition and curb the devastation. Specifically, we assume that price of wood and dung change with all other things remaining unchanged. Imagine of a public scheme aimed at enforcing private property institution to forest/wood resources and grazing lands. Three policy alternatives could be envisaged at the disposal of policy maker: one,

completely defining/enforcing private property institution only for wood resources with grazing lands left intact; two, completely defining private property institution only for grazing lands with forest/wood resources left intact; and, three, defining private property institution both on forest/wood resources and grazing lands simultaneously. For tractability of the problem at hand we make the following simplifying assumptions: (i) the cost of completely defining private property rights is zero; (ii) to circumvent the scepticism private property institution might lead to imperfect completion and guarantee that harvests are socially optimal, we assume that the privatization scheme is reasonably fair and does not result in imperfect competition; (iii) buyers and sellers (resource owners) face same equilibrium price; (iv) as wood and dung are no more freely collected, privatization ultimately translates itself into increased prices.[5] Nonetheless, in general, the extent to which prices increase cannot be determined a priori.

The mechanism for operationalizing private property instution is that agents are granted an endowment of tradeable/transferable permits/deeds to the *in situ* resources, which they control over time. These deeds carefully defined/ specify the boundaries, as boundaries are so important in resolving disputes. Deeds are distributed in lots through lottery method, as experienced in the previous distribution of cultivated land. And that each lot has fair share of the present natural resource stock. The role of the regulator is confined to choosing the initial allocation of the endowments of permits/deeds and developing the rule governing the game.

Suppose that (p_i^0, m^0, z) and (p_i^1, m^1, z) for i=f,d, as in above are two budgets that measure the prices and incomes that our representative consumer would face under the two (different) policy regimes. It can best be conceived of (p_i^0, m^0, z) as being the status quo and

[5] There are two reasons that enforcing private property institution ultimately translates itself into increased prices: first is due to marginal user cost. An efficient market would have to consider not only the marginal extraction cost for the resource, but the marginal user cost as well. Hence, agents will take care of the scarcity rent of the resource. Second reason that the value of the resources is greater under the private property institution than under the status quo pertains to the risk averse behavior of agents, i.e., resource owners (Sadoulet and de Janvry 1995).

(p_i^1,w,m^1) as being the proposed change. How would, then, such price (policy) change affect the agents' well being? Following Sadoulet and de Janvry, (1995) the welfare change involved in moving from (p_i^0, m^0, z) to (p_i^1,m^1,z) can be expressed as the difference in indirect utility function:

(3) $\Delta u = v(p_i^1, m^1, z) - v(p_i^0, m^0, z)$.

The intuition is that if the utility difference in equation (3), as far as our agent is concerned, turns out to be positive the change in institutional setting would be worth doing it and not worth doing it if it turned out to be negative. However, note that utility theory/measure as in equation (3) is purely ordinal and we cannot quantify the utility change. Therefore, we need a convenient monetary measure of changes in our agent's welfare. We considered the equivalent variation (EV) as the motivation in here is to get a reasonable indicator of the likely welfare effects of price (policy) change being examined.[6] More importantly, the equivalent variation (EV) is quite strait away in that it uses current prices as the base and asks what income change at the current price would be equivalent to the proposed change in terms of its impact on utility. Therefore, we specify the equivalent variation EV as follows:

(4) $EV=e(p^0, u^1, z)-e(p^0, u^0, z)=e(p^0, u^1, z)-m^0$,

where p^0 and m^0 represent initial prices and income levels and u^1 stands for utility level with changed prices.[7] Given initial prices and income, equation (4) could be computed for individual or simultaneous price (policy) changes. Apart from the magnitude the direction of change as implied by the sign of the outcome is also important.

[6] For a further understanding about alternative welfare measures, CV (compensated variation) and CS (consumers' surplus) see Varian (1992), pp 160-163, Mas-Colell, Whinston and Green (1995), pp 80-91.

[7] Note that, alternatively, equation (7) could also be represented as $EV = e(\overline{p}, v(p^1, m)) - e(\overline{p}, v(p^0, m)) = e(\overline{p}, v(p^1, m)) - m^0$, for an arbitrary price vector $\overline{p} >> 0$ and gives the income required to reach the utility level $v(p, m)$ when prices are $\overline{p}$.

5. Empirical Model and Data

5.1 Empirical model

Essentially equation (4) is the relationship that enables us to measure/capture the effects of price (policy) change in some monetary form. Note that the first term in equation (4), $e(p^0,u^1)$ is the income level at which our representative agent achieves exactly utility level u^1, at prices p^0. And $e(p^0,u^1)- m^0$ is the net change in income that causes our agent to get utility u^1, at prices p^0. Assuming Cobb-Douglas utility function from the indirect utility function, equations (2), and making use of the expenditure function, we computed the welfare effects using. After deriving For numerical computation of the welfare changes we used the following money metric indirect utility function:

$$\Delta W = m\frac{\overline{p}_f^{\alpha}\overline{p}_d^{\beta}}{p_f^{1\alpha}p_d^{1\beta}} - m^0 \qquad (5)$$

where *W* stands for welfare and the symbol Δ for change.

Three things appear quite important for the numerical computation of welfare change using equation (5): numerical estimates/values of the substitution elasticities, i.e., α and β parameters; prices, p^0_i and p^1_i; and income, *m*. Assuming the utility function associated with wood and dung is of the form $u(q)=q_f^{\alpha}q_d^{\beta}$, where q_f and q_d are quantities of wood and dung consumed by household with $\alpha,\beta \in (0,1)$ and $\alpha+\beta< 1$. Note that wood and dung are substitutes in cooking. Therefore, we considered the variable cooking frequency as a reasonable proxy for the estimation of substitution elasticities. Hence, given initial prices and income, and parameter values, we calculate the welfare effects for three different scenarios: independent price (policy) change for *i*th good holding the other constant and simultaneous price (policy) change for both goods.

5.2 Data and sampling design

The data used in this paper come from a survey of 200 cross-section households conducted in 2000 in Tigrai province, northern Ethiopia. Two-stage sampling was used to select the sample households. First 50 *tabias* – the smallest administrative unit in the region – were randomly selected from a total of 600 available *tabias*, and then a random sample of 200 households was selected from these *tabias*. Both quantitative and qualitative data were collected on cooking/baking frequencies of household, household's production (collection) and consumption of various biomass fuel types, and issues regarding household income; demographic characteristics of the household including age, sex and literacy level of the household head and household size. Also obtained from the survey were family resource endowments including total land holding, land area cultivated, and livestock holdings of household, village level factors including agro-ecological conditions or altitude range and distance traveled (time spent) to collect different fuels. Summary statistics of the variables considered in the analysis has been presented in Appendix Table A1.

Data on cooking/baking frequencies of household was weighted for respective end use share in the total household fuel (EESRC, 1995).

6. Results and Discussion

At first, empirical estimates of parameters of substitution elasticities between the two goods was obtained using Cobb-Douglas utility function. All the coefficients/parameters turned out to be highly significant, i.e., at 1 percent level. Results have been presented in Table 4. Having estimated parameters α=0.5, β=0.25; and considering p_f^0=1.50 (Eth Birr), p_d^0=0.25, and m^0=140.00 as initial prices and income we analyzed the likely effect(s) of price change, say from p_i^0 to p_i^1, resulting from change in institutional setting that could be envisaged to alter the open-access conditions of the fuel resources, on the well being of a representative

agent/consumer. The respective average values in the dataset were taken as initial prices and income for our representative agent. Effects on agent's well being were analyzed numerically under three alternative scenarios: first, price of dung (p_d) changes while wood price is held unchanged; second, price of wood (p_f) changes and price of dung held unchanged; and, three, simultaneous change in both prices. Because the extent to which the change in policy increases prices cannot be determined a priori, we computed the welfare effects of the policy change for alternative price levels. Three different levels of prices, i.e., 25%, 50% and 100% increase in price were considered. Our findings reveal there are private welfare costs involved, be it an independent price (policy) change in *i*th good or simultaneous price (policy) change in both goods. Results show that an independent 25% increase in price of *i*th good would lead to a welfare loss of some one-tenth of agent's income, whereas a simultaneous price increase of similar amount would lead to a welfare loss of two-tenth. We found that a simultaneous 25% increases in prices of wood and dung results in welfare loss equivalent to an independent 50% increase in wood price, with dung price held constant or 100% increase in dung price, with wood price held constant. The details are provided in Table 5.

Theoretically open access leads to rent dissipation. This implies that if land is privatized, rent would be captured (maximized), which according to economic theory is welfare-improving. That is, when price increases, income of the resource owner increases. Hence, the welfare impact of privatization for those who sell fuelwood increases. However, the results presented in here represent only the consumer side of the problem.

7. Conclusions

In Ethiopia all land is publicly owned, so traditional fuels are collected freely under open access conditions. Such an institutional setting has resulted in major degradation of Ethiopia's land resources and dissipation of the resource rent, as available forest and grazing lands are

exploited in a suboptimal fashion. An alternative to current institutional setting is to enforce private property institution. Using dataset from 200 cross-section households in Tigrai province, northern Ethiopia this paper estimated substitution elasticities between two fuel goods wood and dung. We then use these to derive crude estimates of the potential welfare costs of implementing a private property institution.

Considering average values in the dataset as initial prices and income for our representative agent/consumer, we numerically analyzed the effects on our agent's well being of the policy of enforcing private property institution under three alternative scenarios: first, price of dung changes while wood price is held unchanged; second, price of wood changes and price of dung held unchanged; and, three, simultaneous change in both prices. Because we cannot determine a priori the extent to which the change in policy increases prices, we considered three different price levels. Albeit simplifying assumptions, our findings reveal that privatization of the currently public/common pool resources such as forest and grazing lands/dung might indeed be welfare reducing. The findings hold be it an independent price (policy) change in one good or simultaneous price (policy) change in both goods, for different price levels. The loss in well being is some 14.00 to 56.00 Ethiopian Birr, or 10 to 40% of household average monthly incomes. Given the magnitude of the estimated loss, it is little wonder the government is reluctant to impose a private property institution on Ethiopia, despite continued land degradation and dissipation of the resource rent.

However, the analysis considered only the consumer side of the problem and did not consider the producer side. Therefore, further research is needed to include the producer side and evaluate the net effects.

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Table 1 Population size by sex, area and density, Tigrai overall and by zone: July 2005

Zone	Population ('000)			Area (km^2)	Density (persons/km^2)
	Male	Female	Total		
Tigrai overall	2,080.0	2,143.0	4,223.0	50,078.64	84.3
Western	135.0	129.6	264.6	12,441.26	21.3
Northwestern	359.3	354.9	714.2	12,267.58	58.2
Central	614.6	637.5	1,252.1	10,353.50	120.9
Eastern	378.4	408.6	787.0	5,705.34	137.9
Southern	510.7	532.6	1,043.3	9,286.52	112.3
Mekelle (Metropolitan)	82.0	79.7	161.7	24.44	6,617.8

Source: CSA (2004)

Table 2 Distribution of sample households by mode/way fuel acquired (in %) (n=200)

Mode of acquisition	Fuel type	
	Fuel wood	Dung
Free collection	85.2	72.3
Buying	11.2	0.6
Own source (tree/cattle manure)	3.6	27.1
Total	100.0	100.0

Table 3 Distribution of sample households by source of freely collected fuels by type (in %) n=200

Source	Fuel type		
	Wood	Dung	Crop residues
Own farmland/backyard	15.0	33.0	62.5
Others' farmland	-	5.0	35.5
Grazing land	33.0	50.5	-
Forest land	52.0	-	-
Total	100.0	88.5[a]	98.0

[a] The remaining are households not using dung at all.

Table 4 Estimation results (standard error in parenthesis) of substitution elasticities (parameters)/Cobb-Douglas utility function (n=200)

Variable	Coefficient [a]
Wood	0.602 (0.027)***
Dung	0.250 (0.030)***
R^2	0.974
F-statistic	2967.27
Prob > F	0.000

[a] *** indicate significance at the 1%.

Table 5 Welfare effects of price (policy) change for a representative household under alternative scenarios and price levels (for α=0.5, β=0.25)

Scenario + Price combination	Income (m)	Price (Eth Birr)		ΔW
	(Eth Birr)	Dung (p_d)	Wood (p_f)	(Eth Birr)
Initial (m^0,p_i^0)	140.00	0.25	1.50	-
25% increase in p_d & p_f held constant	140.00	0.31	1.50	-14.00
25% increase in p_f & p_d held constant	140.00	0.25	1.825	-14.00
Simultaneous 25% increase in p_f & p_d	140.00	0.31	1.825	-28.00
50% increase in p_d & p_f held constant	140.00	0.375	1.50	-14.00
50% increase in p_f & p_d held constant	140.00	0.25	2.25	-28.00
Simultaneous 50% increase in p_f & p_d	140.00	0.375	2.25	-42.00
100% increase in p_d & p_f held constant	140.00	0.50	1.50	-28.00
100% increase in p_f & p_d held constant	140.00	0.25	3.00	-42.00
Simultaneous 100% increase in p_f & p_d	140.00	0.50	3.00	-56.00

Appendix

Table A1 Summary statistics of variables considered in the analysis (n=200)

Variable	Mean	Std Dev	Min	Max
Family size	5	2	1	12
Household income (monthly) (Eth Birr[a])	140.012	94.227	9.958	647.083
Number of cattle	4	3	0	14
Cooking frequency (monthly)	52.989	19.670	12.742	210.315
Wood price/shadow (Eth Birr)	1.483	7.285	0	18.376
Dung price/shadow (Eth Birr)	0.266	0.849	0	3.618
Wood consumption (kg/month)	117.875	86.310	0	420
Dung consumption (kg/month)	90.034	94.570	0	628.5
Kerosene consumption (lit/month)	1.745	6.890	0.11	97.68

[a] Birr is Ethiopian currency, currently $1 USD=9.91 Eth Birr