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Property rights, institutions and choice of fuelwood source in rural Ethiopia

Abebe D. Beyene, Steven F. Koch *

Department of Economics, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa

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ABSTRACT

This study examines the relationship between property rights, defined by land tenure security and the strength of local-level institutions, and household's preferences for fuelwood source. A multinomial regression model applied to survey data collected in rural Ethiopia underpins the analysis. Results from the discrete choice model indicate that active local-level institutions increase household dependency on open access forests, while land security reduces open access forest dependence. However, local level institutions are found to reduce the role of private fuelwood, while tenure security has not, at least yet, had any impact on private fuelwood collection activities. The results suggest that there is a need to bring more open access forests under the management of the community and increase the quality of community forestry management in order to realize improvements in forest conservation.

1. Introduction

Like residents of many developing countries, Ethiopians depend heavily on biomass resources such as fuelwood, dung and agricultural crop residues. According to the Central Statistical Agency (CSA, 2012), over 95% of the country's total energy for household cooking is derived from biomass fuels — 85% from firewood, around 4% from charcoal and more than 7% from leaves and dung. The rural population is even more dependent. At least 99% of the rural population uses wood and other traditional biomass resources, such as animal dung, leaves and residues (CSA, 2012), while Mamo et al. (2006) find that forest resources contributed, on average, 39% of household income. The heavy reliance on biomass energy sources has resulted in serious forest degradation. Between 1990 and 2010, the Food and Agriculture Organization of the United Nations (FAO) estimates that Ethiopia lost an average of 141,000 ha — 0.97% of the remaining forest area — each year (FAO, 2010). Fuelwood collection, together with land clearing for agriculture, overgrazing and other shocks (such as fires) also contributes to the unsustainable use and misuse of forests in Ethiopia.

Given that all major forests in Ethiopia are state-owned, while the government, like those in many other low-income countries, has neither the capacity nor the incentive to properly regulate these forests, such rates of forest degradation may not be that surprising. Mekonen and Bluffstone (2007) note that the regulation incentive is particularly low in Ethiopia, because forests produce goods used mainly by local villagers. State ownership combined with limited regulation leads to de facto open access to all forests, which, due to the tragedy of the commons (Hardin, 1968), is expected to aggravate the degradation and deforestation problems in the country. Fortunately, the problem has been recognized and there is keen interest within the government to alleviate or reverse the situation, as evidenced by the recent approval of the Ministry of Agriculture and Rural Development's Forest Development, Conservation and Utilization Policy and Strategy (MoARD, 2007).

Some of the objectives of MoARD (2007) include: (i) increasing the contribution of forests to the economic development of the country, (ii) maintaining ecological balance, and (iii) conserving and enhancing biodiversity, through the sustainable utilization and development of forest resources. To achieve these objectives, MoARD (2007) supports the provision of tree seedlings to farmers, as well as the continued extension of land tenure security. This latter policy component was modeled on an effort in Tigrai during the late 1990s. The initial 1990s program on land certification was extended to the country's main regions in 2003, with the objective of reducing tenure insecurity and its negative impact on land investment (Deininger et al., 2008). The success of these policies, however, hinges on the behavioral response of households to changes in tenure security, which is likely to depend upon their perceptions of a variety of institutional features.

There are three major issues within the literature that are relevant to this study. The first of these is the effectiveness of improved tenure

* Corresponding author. Tel.: +27 12 420 5285.
E-mail addresses: abebed2002@yahoo.co.uk (A.D. Beyene), steve.koch@up.ac.za (S.F. Koch).

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security on agricultural investments; a positive relationship implies improved fuelwood availability, and, thus, the potential for changes in the choice of fuelwood collection source. Deininger et al. (2009), for example, find that, despite policy constraints, a low-cost land registration program in Ethiopia has resulted in increased soil and water related investment. Holden et al. (2009) provide further evidence; land certification has led to improved maintenance of soil conservation structures, increased investment in trees, and increased land productivity. Mekonen (2009) finds that land tenure insecurity influences the decision to grow trees, but not the number of trees grown; however, Mekonnen used perceived expropriation of land in the five-year period after the survey as an indicator of land tenure insecurity, rather than actual certification, which we are able to use.

The second of these is the relationship between fuelwood source choice and property rights regimes in developing countries. Jumbe and Angelsen (2011), who consider Malawi, find a high correlation between the specific attributes of fuelwood collection sources (such as area, species, and distance to the forest) and the household's choice of fuelwood collection source. Among the three types of fuelwood sources in their study: customary forests, plantation forests, and forest reserves, customary forests and forest reserves are substitutes, while substitution is more limited between plantation forests and forest reserves. However, Jumbe and Angelsen (2011) do not examine the role of either private sources or markets, which we are able to include in this study. Linde-Rahr's (2003) Vietnamese study, which is similar to Jumbe and Angelsen (2011), finds strong substitution between open access and private plantation forests. Unfortunately, only a few researchers have examined the role of private trees. Heltberg et al. (2000) find evidence of substitution between forest fuelwood and private energy sources (like dung, residues and homestead trees) in India. Similarly, Cooke et al. (2008) indicate that private trees and trees in common forests are fuelwood production substitutes for rural households in Ethiopia, India, and Nepal, at least for households owning land. With respect to Ethiopia, Mekonnen (1999), one of the first empirical studies of fuelwood substitution, cautions that the consumption of other biomass energy, such as dung and crop residues, is not likely to decrease, when more fuelwood is available, meaning that there is minimal substitution across fuelwood collection activities. In our analysis, we focus more explicitly on the multifaceted choice sets that face fuelwood consumers and producers, rather than the actual amount of production and consumption. Furthermore, we tie those choices to differences in land tenure and forestry institutions, which could not form part of Mekonnen's (1999) analysis. However, unlike Mekonnen, we do not examine actual levels of production, collection or consumption, which we hope to consider in future research.

The third of these is the examination of detailed common property design elements, or common property forestry institutions, that are well established in the literature (Ostrom, 1990; Agrawal, 2000, 2001; Agrawal et al., 2008). Using different measures of institutional elements, we are able to explicitly incorporate institutional roles and their effects on the choice of fuelwood source, extending Agrawal et al. (2008), Bluffstone et al. (2008) and Mekonnen and Bluffstone (2008). Ostrom (1990) and Agrawal (2000, 2001) find evidence that local level institutional elements, such as: clear access and extraction rules, fair and graduated sanctions, public participation, clear quotas and successful monitoring, contribute to better natural resource management. However, to our knowledge, the indirect relationship, from stronger institutions to rural household fuelwood production behavior, through better natural resource management, has not been considered. Hence, our study contributes to the literature by providing better information on the role of some of the specific elements of local institutions on household fuelwood collection decisions, when facing different forest property right regimes.

As outlined above, the available empirical literature focuses on rural energy consumption and production, is geographically limited, and does not emphasize either local-level institutions or tenure security on forestry resource use. Although the initial MoARD program has received some attention in the literature, that focus has been on the investment effects of the land certification policy. To our knowledge, no study has considered the possible impacts of the program on forestry use. Therefore, the purpose of this study is to add to the empirical literature by considering the determinants of the household's fuelwood source choice. Although household level variables are assumed to influence that choice, this analysis focuses on tenure security and local level institutions related to community forestry management to determine whether these policies and institutions are associated with any differences in collection activities at the household level. Our multinomial logit estimates indicate that active local-level institutions increase the probability of collection from open access areas, but reduce collection from private sources. However, although tenure security does reduce the demand for open access to fuelwood, tenure security does not impact household decisions to collect fuelwood from private sources. Similarly, the analysis provides some insight related to substitution patterns between fuelwood collection sources. Based on the findings of the study we provide policy implications related to the management and conservation of forests.

The remainder of the paper is organized in the usual fashion. Section 2 outlines the analytical framework, including the theoretical motivation and empirical methodology. The theoretical model examines cost minimization, rather than utility maximization, as is common in the literature. The empirical methodology, on the other hand, is based on an intuitive variant of the random utility model and its estimation, via multinomial logit. The data and study areas are described in Section 3. Empirical results and a discussion of these results are provided in Section 4, while Section 5 presents concluding remarks.

2. Analytical framework

2.1. Theoretical motivation

Consider a household requiring a predetermined amount of fuelwood for heating, cooking and lighting; we abstract from the underlying problem of determining the demand for energy at the household level, to keep the problem manageable. The household is assumed to be able to satisfy their fuelwood requirements from a variety of sources, $s = \{$*private* (p), *community* (c), *market* (m), *open access* (o) *or numerous sources* $(n)\}$, and is further assumed to minimize the cost of satisfying that need, subject to a number of constraints, including fuelwood collection/production constraints that are assumed to be source-specific, input constraints that are assumed to be determined by available resources, and various non-negativity constraints. In terms of notation, $F_s(X_s)$ represents the production (or purchase) function for source s using inputs X, which is assumed to depend on the available technology and institutions, w_{sj} represents the wage of input j associated with source s, x_{sj} represents input j used in source s, $\overline{F}$ represents the fuelwood requirement for the household, m is the market price of fuelwood, F_m is the amount purchased from the market, and $\overline{X}_j$ is the availability of input j for the household. Unfortunately, the available data does not include any directly observable prices, and therefore, other measures must be used, instead, as proxies; these will be described below.

Given the preceding notation, the household's minimization problem is outlined in Eq. (1).

$$\min_{X,F_m}\left[\left(\sum_s\sum_j w_{sj}x_{sj}\right)+mF_m\right]+\lambda\left[\overline{F}-\sum_s\eta_sF_s(X_s)\right]+\sum_j\theta_j\left[\overline{X}_j-\sum_s x_{sj}\right]. \tag{1}$$

The first term in Eq. (1) is the cost of producing, collecting or purchasing fuelwood; the second term requires the total collection/