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Farm production efficiency and natural forest extraction: Evidence from Cambodia

Trung Thanh Nguyen[a,*], Truong Lam Do[a,b], Priyanka Parvathi[c], Ada Wossink[d], Ulrike Grote[a]

[a] Institute for Environmental Economics and World Trade, Leibniz University Hannover, Königsworther Platz 1, 30167 Hannover, Germany
[b] Department of Planning and Investment, Vietnam National University of Agriculture, Hanoi, Vietnam
[c] Institute of Development and Agricultural Economics, Leibniz University Hannover, Königsworther Platz 1, 30167 Hannover, Germany
[d] Department of Economics, University of Manchester, Arthur Lewis Building 3.025, Manchester M13 9PL, UK

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ABSTRACT

Farm production and natural forest extraction remain principal livelihood strategies of local people in many rural areas of the developing world. In this paper, we apply stochastic frontier analysis to evaluate farm production efficiency and simultaneous equations modelling to estimate the interrelationship between farm production efficiency and natural forest extraction. We use a two-year panel dataset of 430 rural households in Stung Treng province of Cambodia. We find that natural forest extraction is decreasing in farm production efficiency. Our results suggest that improving farm production efficiency, via the promotion of rural education and privatization of farm land, should be considered an integral component of natural forest conservation policy.

1. Introduction

It is estimated that a significant number of people, approximately 300 million (WWF, 2014) to 800 million (Chomitz, 2007), live in or near natural forests (Perge and Mckay, 2016). Many of these people in developing countries are poor and are largely excluded from public services, partly because these areas are typically remote and badly connected to the rest of the economy (Liu et al., 2016; Parvathi and Nguyen, 2018). Therefore, farming and extraction of natural forests remain their principal livelihood strategies (Edirisinghe, 2015). This is because other livelihood activities such as non-farm self-employment or off-farm wage-employment opportunities are often limited in these areas. However, farming activities of rural households in the developing world are often inefficient (Gedara et al., 2012; Manjunatha et al., 2013; Koirala et al., 2016), and thus might not be able to provide adequate food and sufficient income to farmers and their families. Consequently, rural smallholders may still depend on natural forests either as an economic mainstay or as a supplementary source of household income (Walelign, 2017).

At the same time, natural forests continue to degrade at alarming rates in these regions (Dinh et al., 2017), although recent conservation efforts might have slowed down the speed of deforestation and forest degradation (FAO, 2010). Therefore, increasing farm production efficiency and reducing natural forest degradation are still major development and conservation concerns. Many empirical studies have examined key determinants of farm production efficiency (Omonona et al., 2010; Nguyen et al., 2012; Ho et al., 2017) or ways to reduce natural forest degradation (see reviews by Wunder et al. (2014) O'Donnell et al. (2014)) separately. But we found only one study which explores the interrelationship between these two issues, namely Illukpitiya and Yanagida (2010). These authors develop separate farm level models for measuring farm technical efficiency and forest dependency and then analyse the relationship between these two results. While this is a step forward, the approach suggested is still restrictive because it does not account for potential simultaneity and endogeneity biases. Farming and extracting forest products are connected through smallholders' input allocation decisions and through potential technical interdependencies. In addition, there are differences in rural households' characteristics and in their economic conditions and these factors might affect both households' productive efficiency and their forest extraction.

Therefore, an improved insight into the empirical interrelationship between farming efficiency and forest extraction takes on an added significance in the context of conservation management. In a number of developing countries ownership of natural forests rests with the state and a system of protected forest areas such as forest national parks or forest natural reserves has been established as a means of forest biodiversity conservation (Hayes, 2006; van Rensburg and Mulugeta, 2016). Such forest conservation strategies might not be able to reduce rural households' participation in (illegal) hunting and logging, and

* Corresponding author.
E-mail address: thanh.nguyen@iuw.uni-hannover.de (T.T. Nguyen).

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collecting non-timber forest products from these protected areas (Le Gallic and Cox, 2006) because forests are an important livelihood resource (Kura et al., 2017). Although the extraction of natural forests by rural households living in close proximity to forests might be less depletive than logging activities by timber companies there is evidence that even indigenous people can degrade forest resources (Nguyen et al., 2015).

Against this background, our paper aims to address the following questions: (i) how to take into account the non-separability of farming efficiency and foraging activities in farm level modelling? (ii) what are the factors promoting or hindering farm production efficiency in forest peripheries? and (iii) to what extent how does an increase in farm production efficiency reduce natural forest extraction by smallholders? This understanding is policy relevant as it can contribute to the formulation of successful rural development and natural forest conservation initiatives.

To answer these questions, we first present a theoretical economic model that accounts for the interrelationship between farm production efficiency and natural forest extraction. We then empirically test the interrelationship with a two-year panel dataset of rural households collected in 2013 and 2014 in Strung Treng province of Cambodia. We apply an econometric framework that allows us to control for simultaneity and endogeneity biases. The information provided by the framework developed in this paper is expected to be useful to guide policy makers and practitioners in designing effective programs for rural development and natural forest conservation. To our understanding, this is the first effort to investigate the interrelationship between, and the determinants of, farm production efficiency and natural resource extraction in a simultaneous econometric framework.

Cambodia is one of the least developed countries in the world and is characterised by a relatively low Gross Domestic Product (GDP) and a high dependence on natural resources (De Lopez, 2003; Scheidel et al., 2013) such as water and forests (Nguyen et al., 2015). Decentralisation has long been propagated as a means to enhance local engagement with governance structures of forest systems in Asia but is still of limited relevance in Cambodia (Shyamsundar and Ghate, 2014; Persson and Prowse, 2017). The country has started to experience rapid economic growth, after years of conflict and political isolation. However, agriculture remains the key economic sector accounting for 34% of the GDP and 51% of total employment (UNDP, 2014). The Cambodian farming sector is in the early stage of the transition process towards commercialization. The majority of farmers still practice small-scale subsistence farming with traditional, labour-intensive methods and minimal input use (Sharma et al., 2016). Also, the significant granting of economic land concessions to foreign and domestic agribusinesses causes a decline in the availability of land for smallholders (Bühler et al., 2015; Jiao et al., 2015). Moreover, the adoption and diffusion of technology in the Cambodian farming sector remains low (Ebers et al., 2017). This situation creates a need to increase the production efficiency of Cambodian small-scale farming. The country is rich in forest resources with a national forest cover of about 54% in 2015, a decline from 73% in 1990 (World Bank, 2015). Although natural forest extraction is one of the rural livelihood strategies (Nguyen et al., 2015), forest resources have been degraded over time in this country (Travers et al., 2015).

The remainder of the article is organised as follows. Section 2 presents the theoretical background for the study. Section 3 describes the study design, including the study area, data collection, and data analysis. Section 4 analyses and discusses the results. Section 5 summarizes and concludes.

2. Theoretical background

2.1. Farm production efficiency

Farm production efficiency evaluates the economic performance of a farm that faces resource scarcity. There are always two important components in farm efficiency analysis (Hoang and Nguyen, 2013). The first component estimates farm production efficiency scores and their variation across farms. The second component analyses the determinants of farm production efficiency in order to provide farmers and their advisors with useful information on how to improve efficiency.

In principle, farm production efficiency can be estimated either with parametric or with non-parametric techniques, including the Data Envelopment Analysis (DEA) or Stochastic Frontier Model (SFM). The SFM is more suitable to the farming sector because farmers operate in uncertain environments and are exposed to various production risks (Hardaker et al., 2004). Aigner et al. (1977) and Meeusen and van den Broeck (1977) use the SFM as follows:

$$q_i = x'_i\beta + v_i - u_i \quad (1)$$

where q_i represents the output of farm i, x'_i represents the input vector and β is the vector of unknown parameters. The symmetric random error v_i accounts for statistical noise and production risks that are beyond the control of the farmer (noise effect). The non-negative random variable u_i is associated with the production factors that are under the control of the farmer (inefficiency effect).

The graphic representation illustrates the basic features of the SFM (Fig. 1). Fig. 1 shows the production frontier for two farms i = {A, B},

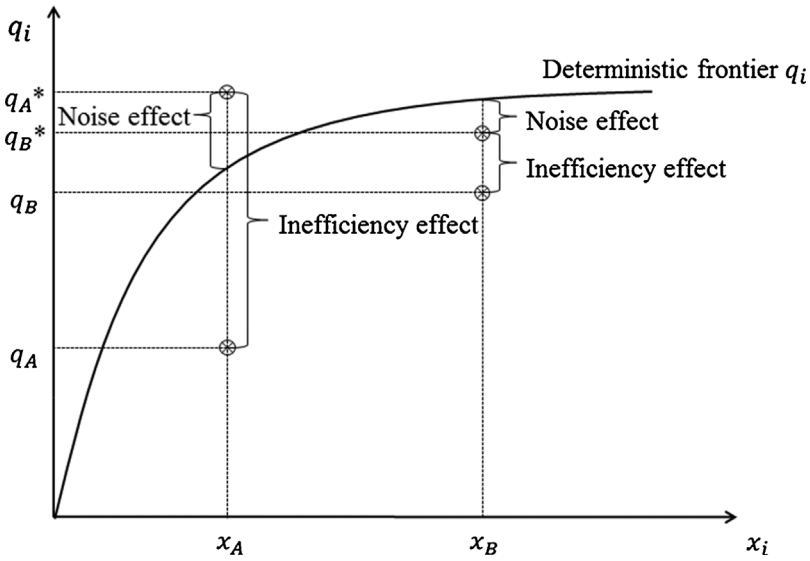

Fig. 1. The stochastic frontier model for efficiency analysis (Source: Coelli et al., 2005).