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The impact of a shade coffee certification program on forest conservation using remote sensing and household data

Ryo Takahashi [a,*], Yasuyuki Todo [b]

[a] Policy Research Center, National Graduate Institute for Policy Studies, 7-22-1, Roppongi, Minato-ku, Tokyo 106-8677, Japan
[b] Department of International Studies, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8563, Japan

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ABSTRACT

In recent years, shade coffee certification programs have attracted increasing attention from forest conservation and development organizations. The certification programs could be expected to promote forest conservation by providing a premium price to shade coffee producers. However, little is known about the significance of the conservation efforts generated by certification programs. In particular, the relationship between the impact of the certification and producer characteristics has yet to be examined. The purpose of this study, which was conducted in Ethiopia, was to examine the impact of a shade coffee certification program on forest conservation and its relationship with the socioeconomic characteristics of the producers. Remote sensing data of 2005 and 2010 was used to gauge the changes in forest area. Employing a probit model, we found that a forest coffee area being certified increased the probability of forest conservation by 19.3 percentage points relative to forest coffee areas lacking certification. We also found that although economically poor producers tended to engage in forest clearing, the forest coffee certification program had a significant impact on these producers. This result suggests that the certification program significantly affects the behaviors of economically poor producers and motivates these producers to conserve the forest.

1. Introduction

It is widely known that deforestation in less developed countries, especially in Africa, is a widespread problem, estimating that 1 billion hectares of forest land will be converted to agricultural land by 2050 (Tilman et al., 2001). A loss of forest area directly leads to a loss of biodiversity because deforestation proceeds most rapidly in areas that are rich in biodiversity (Balmford, 1994).

Many of the numerous studies on forest management have noted the importance of traditional coffee production for forest conservation and biodiversity protection. Coffee is traditionally grown in the understory of shade trees, and the agroecosystems of shaded coffee preserve the forest and provide an important refuge for biodiversity (Greenberg et al., 1997; Mas and Dietsch, 2004; Moguel and Toledo, 1999; Perfecto and Snelling, 1995; Perfecto et al., 1996; Wunderle and Latta, 1996). In fact, many studies found a strong relationship between the shaded coffee system and biodiversity, such as an environment rich in orchids, birds, ants, butterflies, and hymenopterans (Moguel and Toledo, 1999; Nestel and Dickschen, 1990; Nestel et al., 1993; Nir, 1988; Perfecto et al., 2003). However, the forest areas that are currently operating under the shaded coffee system are rapidly being converted into plantations for modern industrial coffee production, and these plantations include few or no shade trees (Moguel and Toledo, 1999; Perfecto et al., 1996). One of the major reasons for this rapid transformation is the low yield of the shaded coffee system (Rappole et al., 2003). Although the coffee yield has been improved by the modern coffee system, the modern system is accompanied by higher environmental costs. In particular, the modern coffee system triggers forest reduction, increased erosion, chemical runoff, and consolidation. In combination, these effects threaten the long-term sustainability of the ecosystem (Perfecto et al., 1996; Rappole et al., 2003; Staver et al., 2001).

In recent years, shade coffee certification programs have attracted increasing attention from conservation and development organizations that seek to reduce producers' incentives to convert forest area used for shaded coffee production into plantations for industrial production (Fleischer and Varangis, 2002; Perfecto et al., 2005; Philpott and Dietsch, 2003; Taylor, 2005). Certification programs offer an opportunity to link environmental and economic goals by providing a premium price to producers who maintain shade trees and thereby contributing to the protection of forest cover and biodiversity.

However, few empirical studies have examined the significance of the conservation efforts generated by shaded coffee certification programs. Mas and Dietsch (2004) conducted a survey in Mexico to evaluate the effect of coffee certification on biodiversity conservation. Unfortunately, because these researchers studied an area that was likely to meet the criteria used by the major certification programs, their results could not prove that the certification program was the cause of the conservation effects.

* Corresponding author. Tel.: +81 4 7136 4852; fax: +81 4 7136 4853.
E-mail addresses: inter.takahashi@gmail.com (R. Takahashi), yastodo@k.u-tokyo.ac.jp (Y. Todo).

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A study conducted in Mexico by Philpott et al. (2007) evaluated the ecological benefits of coffee certification programs (Fair-trade Labeling Organizations and Certimex Producer Lists) by examining the area's vegetation and the richness of the area's species, such as ants and birds. Their results revealed no significant differences between certified and uncertified areas in terms of shade management or the diversity of ants and birds. However, the coffee certification programs in their study only issued organic and/or fair trade certifications, and shade coffee certification was not part of their research, simply because no farms in the area under study had obtained shade coffee certification. Although other certification programs, such as fair trade certification and organic certification, include environmental criteria, the primary goal of each certification program is different (Ponte, 2004). For example, the purpose of fair trade certification is to guarantee a price floor to marginal producers in less developed countries (Basu and Hicks, 2008). Thus, it is less clear whether other certification programs can be expected to lead to forest conservation (Philpott et al., 2007).

The main purpose of this study is to evaluate the impact of a shade coffee certification program on forest conservation. Employing the probit model, we compared the probability of forest conservation between the forest coffee areas with certification and those areas without the certification. We chose to analyze the certification program offered by the Rainforest Alliance, a major international nongovernmental organization (NGO) that is based in the US, and we selected Ethiopia as a case study because there is a dearth of empirical evidence regarding the impacts of coffee certification programs in the African context (Donald, 2004).

Another contribution of this study is that we examined how the impact of the certification varied among producers with different socioeconomic characteristics. Although the magnitude of the certification's impact on forest conservation may differ depending on the socioeconomic characteristics of the producers, no studies to date have examined this relationship. In this study, we particularly focused on the education level of the producer and the area of agricultural land under cultivation and examined the relationships between these characteristics and the impact of the certification program.

2. Description of the study area

2.1. Description of the Belete-Gera RFPA

We selected the Belete-Gera Regional Forest Priority Area (RFPA) as the study area. The Belete-Gera RFPA is 150,000 ha in size and is located in the Gera and Shabe Sombo District in the Oromiya Region (Fig. 1). This region is part of the highland rainforest, and the natural vegetation in this area is subject to an annual precipitation of 1500 mm and an annual average air temperature of approximately 20 °C. The topography of the Belete-Gera RFPA is complex, consisting of undulating hills of 1200 to 2900 m in height, with steep mountainous terrain in certain locations. The forest cover in the RFPA has decreased significantly despite the government's prohibition of wood extraction in the forest area. In particular, 40% of the forest area was cleared between 1985 and 2010 (Todo and Takahashi, 2011).

2.2. Wild coffee production and coffee certification

Coffee (*Coffea arabica*) is a native species that grows wild in the Belete-Gera RFPA. Because coffee production is not economically practical at high elevations (above 2300 m), wild coffee is typically found in the forest at an altitude of approximately 2000 m (indicated by the light and dark gray areas in Fig. 1). Each wild coffee area is managed by an individual producer, and the right to harvest wild coffee is granted to the producer in accordance with traditional agreements among the villagers. Producers commonly dry the wild coffee after harvesting and sell it as sun-dried, shade-grown coffee to local markets, but the selling price for this coffee has typically been fairly low (approximately 1 US dollar/kg in 2007 and 2008).

In 2007, a group of 555 coffee-producing households established the coffee associations and obtained shade coffee certification (henceforth referred to as "forest coffee certification") from the Rainforest Alliance. This effort was supported by the Japan International Cooperation Agency (JICA), a Japanese foreign aid agency, and the Oromia Forest and Wildlife Enterprise, a public institution responsible for forest conservation in the Oromia Region. Although the Rainforest Alliance originally primarily collaborated with producers operating larger plantations (Méndez et al., 2010), the Rainforest Alliance also provided a certification program that excludes modern, industrial coffee producers in an effort to encourage the use of the shaded coffee system to promote greater sustainability (Giovannucci and Ponte, 2005; Mas and Dietsch, 2004). The criteria used in the program include shade criteria regarding tree species richness and composition, tree height, tree density, number of strata in the canopy, and percent canopy cover (Philpott et al., 2007).

In the area under study, the certified producers obtained a price that was 15–20% higher than the regular price from the certification. In 2010, 58 associations participated in the certification program, with a total of 3050 participating coffee producers from among these associations (Table 1). The certification program was extended to areas that utilize the natural forest coffee system. Although most of the producers also produced the coffee using the improved seeds around their homestead but such coffee under the modern coffee system was strictly eliminated from the certified coffee. Once each year, an auditor from the NGO visits to assess the condition of the certified areas and the surrounding forest regions. If the auditor observes an expansion of the forest coffee area or a degradation of the forest (e.g., the logging of shade trees) in the certified area, the certification is withdrawn.

3. Data

3.1. Remote sensing data

In this study, we only considered areas that were forest-covered in 2005 and sought to determine whether these areas were deforested in 2010. We used the January 2005 and January 2010 satellite images of Landsat 7 from path/row 170/55 for our analysis.

To distinguish the forest areas from the non-forest areas, we utilized the normalized difference vegetation index (NDVI), a measure of vegetation that is commonly used in remote sensing studies (Davenport and Nicholson, 1993; Tucker et al., 1985, 2001). The NDVI records a value ranging from −1.0 to 1.0 that increases with the degree of vegetation biomass (Jensen, 1996). Following Southworth et al. (2004), we determined a threshold value of the NDVI for the forest areas on the basis of the information from the satellite images and fieldwork. We conducted ground-truthing to collect the locational data for 17 points at the boundaries delineating the forest regions from the non-forest areas that existed during the period of our study (according to interviews with several local residents). We chose the area with the highest NDVI value for each year as the threshold value for the forest areas. Forest areas are defined as areas that function as forests either physically or socially for local communities (Southworth and Tucker, 2001). Non-forest areas include agricultural lands, young fallow lands, rangelands, cleared areas, bare soil areas, and urban areas.

Although this methodology has been used in previous studies (Southworth et al., 2004; Takahashi and Todo, 2012; White and Nemani, 2006), the NDVI threshold value may be misestimated, which can lead to errors in the probabilities of forest conservation. However, because the same error would affect any locational unit within the same year, the forest transition in areas with and without the certification should be over- or underestimated to the same extent. Therefore, possible errors in the estimation of forest area from the satellite images do not generate a bias in the estimation results.