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Coffee Certification and Forest Quality: Evidence from a Wild Coffee Forest in Ethiopia

RYO TAKAHASHI and YASUYUKI TODO*
Waseda University, Tokyo, Japan

Summary. — Shade coffee certification programs that aim to conserve the forest and to prevent forest degradation have attracted an increasing amount of attention. However, such programs' impact on forest degradation remains unclear because of the absence of empirical evidence. In addition, there is heated debate about whether certification programs create an incentive for producers to expand their coffee-growing areas, which may accelerate forest degradation in the surrounding natural forest. This study, which was conducted in Ethiopia, aimed to evaluate the impact of a shade coffee certification program on forest degradation. Additionally, to provide empirical evidence for the debate, we examined the spillover effects of certification to surrounding forest areas and used remote sensing data of 2005 and 2010 to classify forest areas based on their density. We applied matching methods, such as the propensity score matching with different algorithms, to compare forest coffee areas with and without the certification. We found that the certified forest coffee areas slightly increased in forest density. By contrast, we observed drastic forest degradation in the forest coffee areas without certification. We checked the sensitivity of our results and found that our results are robust to potential hidden bias. Furthermore, our empirical results revealed that the natural forest areas within a 100-m radius from the forest coffee boundary area exhibited significantly reduced forest degradation compared with forest areas under similar environmental conditions but that such positive and significant impact diminished after 100-m distance. These results indicate that the certification program is effective in alleviating forest degradation in the certified area and in the surrounding natural forest.
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Key words — shade coffee, coffee certification, impact evaluation, remote sensing, Ethiopia, Africa

1. INTRODUCTION

Deforestation and loss of biodiversity are widespread problems in less developed countries, particularly in the nations of sub-Saharan Africa and Latin America (Hosonuma *et al.*, 2012; Mayaux *et al.*, 2013; Tilman *et al.*, 2001). Concurrently, many studies 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 (Buechley *et al.*, 2015; Greenberg, Bichier, Angon, & Reitsma, 1997; Hundera *et al.*, 2013; Mas & Dietsch, 2004; Moguel & Toledo, 1999; Perfecto, Rice, Greenberg, & Van der Voort, 1996; Perfecto & Snelling, 1995; Tadesse, Zavaleta, & Shennan, 2014; Wunderle & Latta, 1996).

Nevertheless, because of the shaded coffee system's low yield, many forest areas currently operating under that system are rapidly being converted into plantations for modern industrial coffee production(Jha *et al.*, 2014). According to Gobbi (2000), the average yield of the shaded coffee system is only 1.1 ton/ha, while the modern coffee system on average yields between 3.3 and 5.0 ton/ha. Lyngbaek and Muschler (2001) also show that the net profit of the shaded coffee system is lower than that of the modern coffee system at a given market price. Although the modern coffee system improves both yields and incomes, this improvement comes with increased environmental costs, such as forest reduction, increased erosion, and chemical runoff (Perfecto *et al.*, 1996; Rappole, King, & Vega Rivera, 2003a; Staver, Guharay, Monterroso, & Muschler, 2001).

To reduce coffee producers' incentives to convert to the modern coffee system, shade coffee certification programs have attracted increasing attention from conservation and development organizations (Fleischer & Varangis, 2002; Hundera *et al.*, 2013; Perfecto, Vandermeer, Mas, & Pinto, 2005; Philpott & Dietsch, 2003; Takahashi & Todo, 2013; Taylor, 2005). Certification programs seek to link environmental and economic goals by providing a premium coffee price to producers who maintain shade trees and thereby contribute to the protection of forest cover and biodiversity.

Blackman and Vega Rivera (2011) review the empirical literature on the benefits of coffee certification programs. However, previous studies cited in their study mainly focus on the economic benefits or impact of organic and fair trade certification without any regard to environmental effects. Another study by Mas and Dietsch (2004) conduct in Mexico attempts to evaluate the effect of coffee certification on biodiversity conservation. Unfortunately, because they study an area that was likely to meet the criteria used by the major certification programs, no farmers had obtained any certification. Therefore, their results cannot prove that the certification program is effective in the conservation of biodiversity.

More recently, Takahashi and Todo (2013) have more rigorously evaluated the impact of shade coffee certification on deforestation in Ethiopia, finding a significantly positive effect. Moreover, they reveal that the certification program examined in their study particularly affects the behaviors of economically poor producers in motivating them to conserve the forest (Takahashi & Todo, 2014). Additionally, Rueda, Thomas, and Lambin (2014) report the positive effect of certification on for-

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est cover using remote sensing data. However, the focus of these studies was the impact of coffee certification on forest quantity (e.g., size of forest area), not on forest quality (e.g., biomass and vegetation structure). Thus, it remains unclear whether the coffee certification system preserves forest quality.

Meanwhile, a heated debate continues as to whether coffee certification may trigger forest degradation in the surrounding non-coffee natural forest. As Rappole *et al.* (2003a) note, one potential problem with certification programs is that they can create incentives for producers to convert an existing primary forest area into an area that produces shade coffee. However, Philpott and Dietsch (2003) dispute the claims of Rappole *et al.* (2003a), arguing that such degradation can be prevented by providing financial incentives for coffee producers and establishing rigorous certification criteria. Because no studies have yet examined such spillover effects of the coffee certification system, the debate between Philpott and Dietsch (2003) and Rappole, King, and Vega Rivera (2003b) has not yet reached a consensus (Chandler *et al.*, 2013; Hundera *et al.*, 2013).

The purpose of this study is to evaluate the impact of a shade coffee certification program on forest degradation including its spillover effects on the surrounding forest without forest coffee. We selected Ethiopia as a case study. To evaluate the impact of certification rigorously, we applied the propensity score matching (PSM) method with different algorithms and controlled for selection bias. We estimated the impact of certification by comparing the forest coffee areas with and without the certification. Additionally, we tested the sensitivity of estimates to potential hidden biases.

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 (Figure 1). This region is part of the highland rainforest, and the natural vegetation in this area is subject to an annual precipitation of 1,500 mm and an annual average air temperature of approximately 20 degrees Celsius. The topography of the Belete-Gera RFPA is complex, consisting of undulating hills that range from 1,200 to 2,900 m in height with steep mountainous terrain in certain locations.

The Belete-Gera RFPA is one of Ethiopia's important biodiversity hot spots. Within the forest, we can observe wild mammals, such as baboons, monkeys, and giant forest hogs, and different types of bird species. However, despite the government's prohibition of wood extraction in the forest area, the forest cover in the RFPA has decreased significantly in recent years. In fact, satellite images show that 40% of the forest area has been cleared between 1985 and 2010 (Todo & 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 2,300 m), wild coffee is typically found in the forest at an altitude of approximately 2,000 m (indicated by the light and dark gray areas in Figure 1). The right to harvest each wild coffee area is granted to individual producers in accordance with traditional agreements among villagers. The rights holders (producers) manage their coffee areas, e.g., by maintaining shade trees and harvesting coffee gradually, but they rarely apply any chemicals. Producers commonly dry wild coffee after harvesting it 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 2006, a group of 555 coffee-producing households from three villages in the Belete-Gera sought to obtain shade coffee certification ("forest coffee certification") from the Rainforest Alliance. The Rainforest Alliance is a major international non-governmental organization (NGO) based in the United States

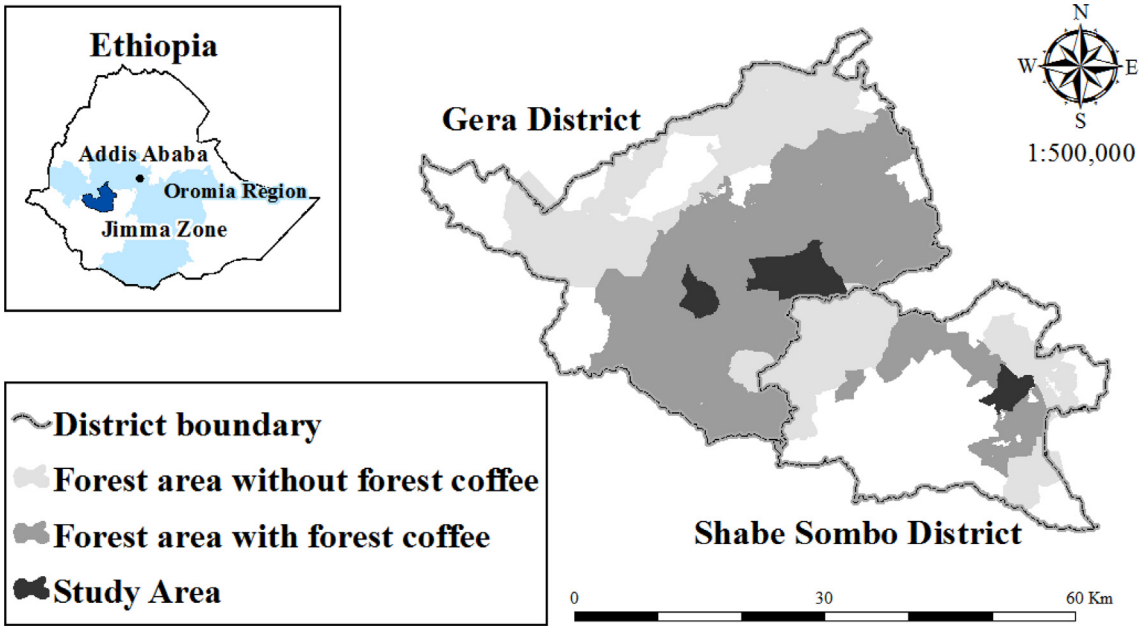

Figure 1. *A map of the Belete-Gera Regional Forest Priority Area, Ethiopia, showing the studied forest coffee-growing areas. The areas shown in dark gray represent the villages that produce forest coffee, and the light gray areas are the villages without forest coffee. The areas shaded black color are the study areas for this investigation.*

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