Propagation of taste for climate resilience: evidence from cocoa value chain in Ghana

Authors: Yunyu Shu, Jiayue Zhang

While Sub-Saharan African countries are increasingly vulnerable to climate change, they also face lower marginal cost for carbon reduction. Existing studies point to payment for ecosystem services (PES) as a way of incentivizing reforestation, but it remains unknown whether market-based payment structure affects the cost-effectiveness, and if so, how it relates to heterogeneity in participants' beliefs. In this project, we investigate the cost-effectiveness of different PES policies for shade tree planting by cocoa farmers in Ghana, considering target population's heterogeneous beliefs about climate change risks and adaptation benefits.

Introduction

While Sub-Saharan African countries are increasingly vulnerable to climate change, they also face lower marginal cost for carbon reduction. However, it remains challenging for governments to meet the carbon reduction target while upholding productivity. Existing studies point to payment for ecosystem services (PES) as a way of incentivizing reforestation without exacerbating poverty (Alix-Garcia et al., 2015; Jack and Jayachandran, 2019; Jayachandran, 2022). But less is known about the cost-effectiveness when comparing alternative PES designs and accounting for heterogeneity in participants' beliefs. In this project, we investigate the cost effectiveness of different PES policies, considering target population's heterogeneous beliefs about climate change risks and adaptation benefits.

We study this question via the lens of cocoa production in Ghana, where shade management is encouraged to mitigate climate change risks. Shade management involves growing canopy trees on cocoa farms, which not only stabilizes production by retaining groundwater and reducing surface temperature but provides ecosystem services as a carbon sink. We conduct a lab-in-the-field experiment to investigate farmers' responses under two PES subsidies targeting shade management: one is the input-based variable PES that offers different subsidies based on green input levels, while the other is an output-based PES that applies different prices for cocoa beans produced from farms with different shade levels. Given heterogenous beliefs about climate change risk and adaptation benefit, farmers may respond differently to these policies. The input-based variable PES may attract more risk-averse agents, reducing income volatility; the output-based PES may attract higher-productivity farmers or those valuing shade benefits. The latter also offers farmers self-sustaining incentives and has the potential of reducing local government costs via varying output-based expenses and propagating along the value chain to international customers with higher demand or sustainable products.

Methodology

We conduct both the baseline survey and the lab-in-the-field experiment on a representative sample of 1287 cocoa farmers from 20 randomly selected communities in Nkawkaw District, Eastern Region of Ghana, which is the district with the largest population of cocoa farmers with various growing conditions.

Using detailed information about farmer's cocoa farming practice and elicited beliefs collected in the baseline survey, we document cocoa farmers' heterogeneous beliefs about climate change risks, and cross-sectional variation in the current shade level adoption.

In the lab-in-the-field experiment, we evaluate the impact of two different designs of PES, i.e., input-based variable PES (vPES, hereafter) and output-based market PES (mPES, hereafter) on farmers' program take-up, shade levels measured by number of forest and fruit trees, and related real-life decisions. We further investigate the role of information by interacting two PES treatments with a narrative-based information intervention on climate change risks and shade benefit. We estimate the overall impact and delve into mechanisms including heterogeneous beliefs and yield expectations under different weather conditions.

Main findings

We have three main findings. First, we find large variation in shade adoption despite uniform guidance from local authorities. Using detailed information about each farmer's current adoption of shade management, Figure 1 presents the distribution of number of shade trees per acre, including both timber trees and fruits trees. Although the COCOBOD offers a uniform suggestion of number of shade trees per acre, there is large variation in their actual implementation of shade management, with an average of 8.87 shade trees per acre and a median of 7 shade trees per acre. It suggests that farmers take various factors about their own plots into account when making decisions on the adoption of shade management.

Figure 1: Distribution of shade tree adoption
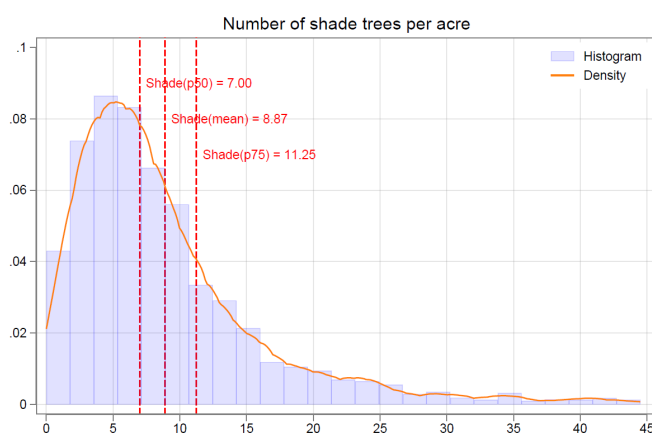
Next, we document cocoa farmers' heterogenous perceptions of climate change risks measured by consecutive dry weeks and rainy days in the dry season, shown in Figure 2. Apart from large variation across individuals, more importantly, when compared to the perceptions of the drought intensity in the past decade, the whole distribution of the expected number of consecutive dry weeks during the dry season in the next 30 years shifts toward the right, suggesting that on average people hold the perception of a more intensive dry

season in the future. However, there is no large difference between the perception of number of rainy days in the past decade and that in the next 30 years.

Lastly, the lab results show that PES is effective in incentivising shade adoption. Figure 3 presents the main outcome of the average treatment impacts on number of forest trees and fruit trees planted in the lab-in-the field game given certain PES subsidies and information interventions. We find both input-based and output-based PES designs improve shade management through forest tree planting. However, this effect doesn't extent to fruit trees. Under both input-based and output-based PES programs, farmers on average plant 7 more forest trees on farmland and enjoy 20% higher income than the control group, whereas a 10% larger impact under input-based PES.

Figure 2: Farmers' perception of consecutive dry weeks and rainy days in dry season
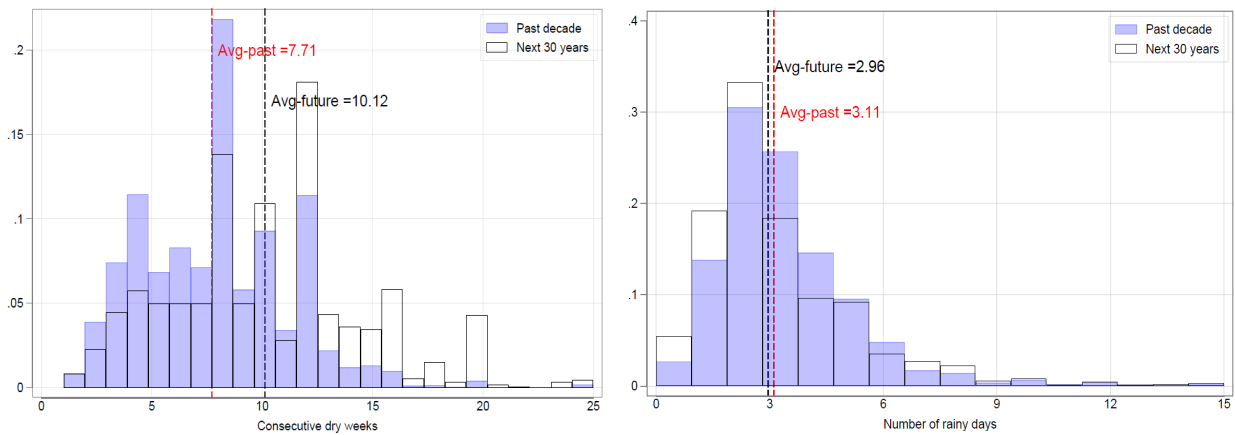
Note: This plot shows the distribution of farmers' perceptions of consecutive dry weeks and rainy days in the dry season for both the past decade and the next 30 years.

Figure 3: Main game outcomes

(a) Number of forest trees (game)   (b) Number of fruit trees (game)
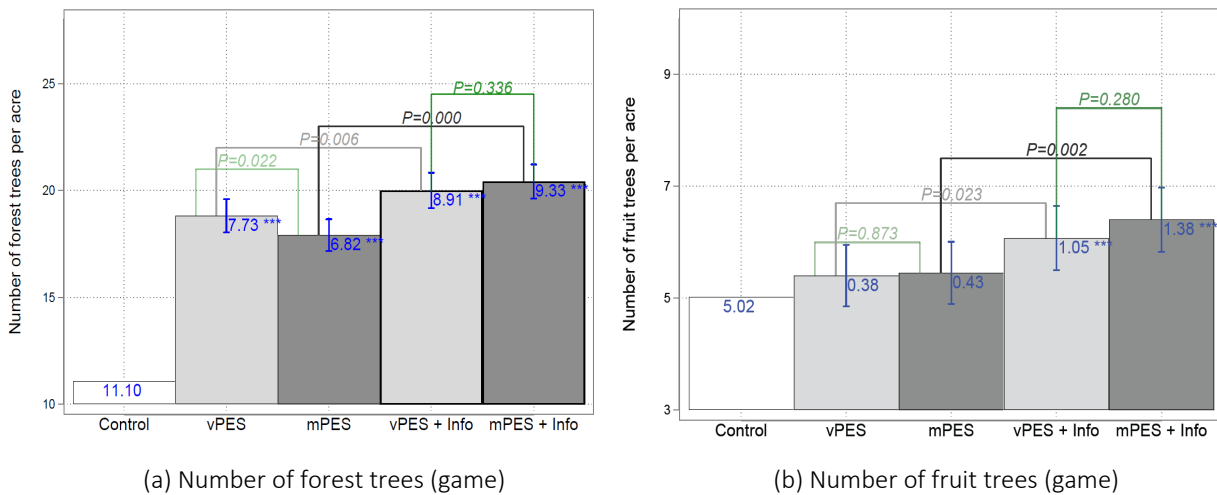
Note: This plot shows the average treatment impact on number of forest trees and fruit trees chosen to plant in the game across the different treatment arms.

The narrative-based information treatment appears effective. Forest trees planted increased by another 2 trees per acre among those receiving information compared to the policy-only groups. The information treatment also has positive spillovers over non-targeted outcome, fruit trees, of 1 tree per acre. The additional impact of nudging when coupled with output-based PES is mainly driven by farmers who are more pessimistic about the rising drought risks in the future.

Policy impact

The findings of this project offer valuable quantitative insights into the comparison of input-based and output-based PES policies. Despite both policies achieving a similar impact on the average level of shade management adoption, they may attract distinct target populations. Only input-based policy increased willingness to pay to participate in the program. This is potentially due to the high-risk aversion of the study population. Additionally, we shed light on the effectiveness of information-based policies in promoting climate-resilient technology adoption. Our findings highlight that, when combined with conditional cash transfers, information on climate change risk and shade benefit can effectively shift people's perceptions about their production capabilities as well as their subsequent actions.

Moving forward

More analysis is underway to depict additional mechanisms. Preliminary results rely on a single region's sample while a replication fieldwork in another region is scheduled to be implemented in early 2024 to expand the geographic coverage and build on generalizability of this study

References

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