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Abstract

With the rapid expansion of private forest plantations worldwide, their impacts on local development are under scrutiny by NGOs and researchers alike. This study investigates the impacts of private forest plantations on local infrastructure and social services in rural Tanzania. We take a comparative approach involving households living in villages adjacent to private forest plantations and households in villages adjacent to a state-owned plantation. We use survey data from 338 households to analyze their perceptions about the impacts of the plantations on the number and quality of roads, bridges, and health centers, as well as on school enrolment and quality of education. We triangulate the results from a logistic regression model with observations of the size and quality of infrastructure and social services in the villages and with findings from focus group discussions. The results show that the private forest plantations have positively affected local infrastructure and social services in adjacent villages. The results suggest that large-scale private forest plantations can contribute to rural development in developing countries. We highlight the importance of taking into account the perceptions of various groups in society when assessing the sustainability of forestry investments and their impacts on local communities.

JEL-Codes: H410, M140, Q010, Q150, Q230.

Keywords: private forest plantations, infrastructure, public goods, perceptions, socio-economic impacts, Tanzania.

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1. Introduction

Forest plantations have been increasingly promoted to satisfy the rising demand for forest products in the world. The decline of timber supply from natural forests has been accompanied by an increase in the supply of timber from planted forests in the past three decades and this trajectory is expected to continue in the coming years (FAO, 2015; Indufor, 2012; Payn et al., 2015; Pirard et al., 2017). Rising wood demand, availability of land and suitable climatic conditions have encouraged investment in forest plantations in the tropics (Indufor, 2012). Private investment in forest plantations play an increasing role especially in developing countries because public institutions often lack the financial incentives and capacity to ensure sustainable forest management (World Bank, 2008). Tanzania has a long history of promoting private forestry to contribute to development and poverty alleviation (URT, 1998). Accordingly, private forest plantations have been increasing rapidly in the country and are expected to be a major source of wood supply in the coming years (AFF, 2011; Indufor, 2011). Tanzania is also among the countries with the fastest growing area of certified forests in Africa (FSC, 2015).

The socio-economic impacts of large-scale private forest plantations are highly debated. On the one hand, non-governmental organizations, researchers and local communities have voiced concerns about the adverse impacts of such plantations. Recurring concerns are related to conflicts about land ownership, displacement of local households and restrictions on their access to and control over land and other natural resources (Bleyer et al., 2016; Charnley, 2005; Gerber, 2011; Gerber and Veuthey, 2010; German et al., 2014; Locher and Müller-Böker, 2014). For example, Gerber (2011) found that displacement of local people was associated with the expansion of industrial forest plantations in the global south. On the other hand, studies and anecdotal evidence indicate that private forest plantations may lead to positive socio-economic impacts. Such impacts include employment opportunities, higher wages, better living conditions and improved access to infrastructure (Bleyer et al., 2016; FAST, 2014; Landry and Chirwa, 2011; Pirard et al., 2017). For example, private forest plantations were associated with positive impacts on the wealth and perceived well-being of local households and on employment and infrastructure in Mozambique (Bleyer et al., 2016; Landry and Chirwa, 2011). Unfortunately, these studies did not use a design that allow identification of the causal impacts of plantations on communities.

In this study, we examine the perceptions of local households in rural villages in Tanzania about the impacts of nearby FSC-certified private forest plantations on local infrastructure (health centers, roads and bridges) and social services (school enrolment and quality of education). It is important to consider the perceptions of local people in investigating the socio-economic impacts of investments in land use changes, especially in long-term and risky investments such as forestry operations (Edelman et al., 2013; Locher and Müller-Böker, 2014; Pirard et al., 2017; Smalley and Corbera, 2012). Using household data from villages nearby private and state-owned plantations, we apply ordered logistic regression analysis to quantitatively examine the relation between the plantations and their perceived impacts by households. Further, we examine if the perceptions of households differ depending on their socio-economic characteristics. Evidence shows that perceptions of households about impacts of plantations vary among different socio-economic groups (Bleyer et al., 2016; Landry and Chirwa, 2011; Pirard et al., 2017). We analyze data from focus group discussions to triangulate the results of the regression analysis with community perceptions about the impacts of the plantations on local infrastructure and social services. We further triangulate our results with results from visual inspection of the size, operation and quality of infrastructure in the study area.

Despite the continued expansion of private forest plantations in developing countries and increased interest in their impacts on local development, there are only few well-identified quantitative micro-level studies on the topic. Moreover, these studies have focused on the (expected) impacts of private plantations on employment, incomes or wealth and access to forest products of households in adjacent

communities (Bleyer et al., 2016; Landry and Chirwa, 2011). However, community development implies more than an increase in household income or wealth. Investments in infrastructure and social services sustain long-term development and poverty alleviation (Arrow et al., 2012; Casaburi et al., 2013; Duffy-Deno and Eberts, 1991). Still, national and local governments in developing countries often lack the financial resources to improve infrastructure provision, especially in remote rural areas. In such situations, the role of private sector investment can be vital (Collier and Cust, 2015).

Our study contributes to three academic areas. First, it extends the literature on the impacts of private forest plantations on local development by providing quantitative evidence on the impacts of private plantations. We take a comparative approach involving households in villages adjacent to plantations of an FSC-certified private forest company (intervention group) and households in villages neighboring a state-owned plantation (comparison group) and account for differences between villages to disentangle the contribution of the private plantations to local infrastructure and social services. Most studies on the impacts of private plantations are based on qualitative data and do not triangulate the results from the qualitative surveys with quantitative data on impacts on the ground (Locher and Müller-Böker, 2014; Obidzinski et al., 2012). Quantitative studies on the socio-economic impacts of private forest plantations thus far have not used (valid) comparison or control groups to identify the causal impacts of plantations. Landry and Chirwa (2011) used quantitative data to assess the potential socio-economic impact of plantations in Mozambique and dealt with expected or anticipated impacts reported by local households (ex-ante analysis), not actual impacts realized after operations started. Besides, they did not use a control group to causally link the plantations with the anticipated impacts. Bleyer et al. (2016) used quantitative ex-post data, but their comparison village is not located near a plantation; households near state or community owned plantations may constitute a more valid comparison group. Besides, responses from villages near plantations were not assessed relative to responses from the comparison village and differences between villages were not accounted for in the analysis, hence attribution could not be established. Second, our study contributes to the literature on the private provision of public goods by highlighting the role of corporate social responsibility and sustainable business interest as drivers of pro-social investments in public goods (Besley and Ghatak, 2007; Starr, 2008). Third, it contributes to the literature on the socio-economic impacts of sustainable forestry operations, in particular on the influence of FSC certification on the socio-economic impacts of forest plantations (Kalonga and Kulindwa, 2017; Romero et al., 2013; Romero et al., 2017).¹ We provide support for the hypothesis that standards and monitoring by independent certifying bodies and the potential increase in the market values of certified forest products may lead private plantations to invest in the development of local communities. The results of the study are pertinent to current concerns about the contribution of modern large-scale private forest plantations to sustainable development in developing countries.

The remainder of the paper proceeds as follows. The next section introduces the conceptual framework. Section 3 describes the study context and data. Section 4 presents the identification strategy and method of analysis. The results and robustness checks are described in Section 5. The last section concludes.

¹ Forest Stewardship Council (FSC) is an independent global not-for-profit organization that sets standards for responsible forest management to promote socially, economically and environmentally beneficial outcomes (FSC, 2015).

2. Conceptual framework

2.1 Theory of change

To investigate the impacts of private forest plantations on local infrastructure and social services, we developed a theory of change (ToC), based on Ingram et al. (2016), that identifies the causal links between forest plantations, local infrastructure and social services (Figure 1). As part of the process of developing the ToC, findings from scientific and grey literature on the topic were reviewed. To take into account the views of stakeholders likely to be impacted directly or indirectly by plantation activities, we consulted community members and plantation managers in the study villages about their views on the socio-economic impacts of forest plantations in their vicinity (Rogers, 2012; Vogel, 2012).

The ToC in Figure 1 depicts the causal relations between the interventions, outputs, outcomes and ultimate impacts of private forest plantations. Interventions refer to the activities or operations performed by forest plantations. The private forest company, to be introduced in Section 3, invests in planting trees and wood processing activities (e.g. sawmill). These activities generate direct and indirect outputs. Examples of direct outputs are sawn timber, poles, and pallets as well as non-wood products such as carbon credits. Indirect outputs may include infrastructure and social services that the company finances in villages adjacent to its plantations. The private forestry company may decide (for reasons discussed in Section 2.2) to invest in the construction and improvement of roads, bridges, school and health center facilities in neighboring villages. These outputs can lead to short-term outcomes such as improved access to infrastructure (e.g. roads and bridges) and social services (e.g. quality education and increased school enrolment) in the villages. We measure such outcomes using indicators: variables that approximate outcomes of the activities of the plantations. In this study, the specific indicators used were household's perceptions about the impacts of the plantations on the number and quality of health centers, the length and quality of roads and bridges, quality of education, and the number of children in schools in their villages. Improved availability of infrastructure and social services enhances the relation of the company with stakeholders such as local communities, customers, workers and NGOs and helps its plantations retain their FSC certification status. Improved infrastructure and social services and good relations with stakeholders are expected to lead to medium-term outcomes such as increased profit, market share and market access for forest owners and better human capital and access to markets for villagers. For example, schools and health centers may lead to a healthy and better educated work force as well as satisfied communities that will contribute to the viability of the business of the plantations. Workers and their dependents can readily get health services and schools if these are available in their villages. This is expected to reduce missed working hours due to travel to get health services elsewhere and improve the quality of human capital leading to increased productive capacity. Investment in roads and bridges may facilitate the commercial activities of the company thereby raising profits. Roads and bridges contribute to increased market integration and access to information for local households, which in turn lead to positive economic outcomes. The short and medium-term outcomes are expected to contribute to impacts, which are the ultimate results of the processes and outputs. Rural livelihoods assets consist of natural, financial, physical, social and human capital (Ellis, 2000). Hence, we hypothesize that the activities of the private forest plantation improve rural livelihood resources in the form of local infrastructure, particularly, physical capital (health centers, roads and bridges) and human capital (education quality and school enrolment), which can contribute to local development.

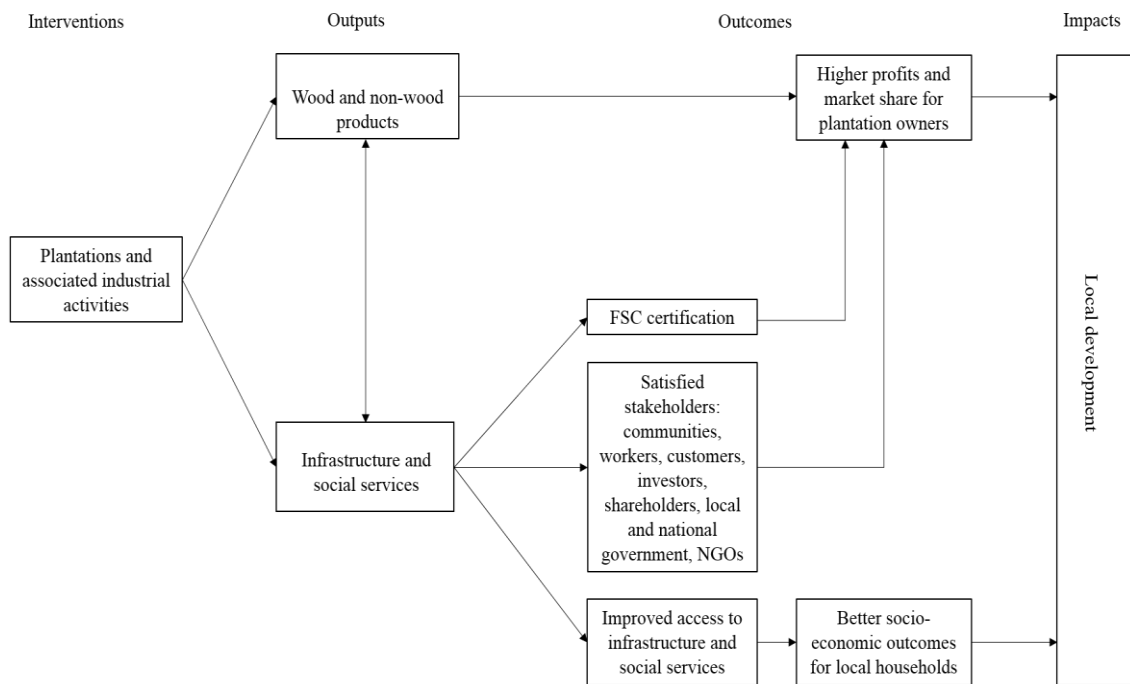


Figure 1: Theory of change for impacts of private forest plantations on local infrastructure and social services

2.2 Why invest private capital in public goods?

There can be multiple reasons for a profit-seeking company to invest in local infrastructure and social services. First, there is a direct benefit to the company where roads and bridges are used to transport inputs and outputs, and schools and health centers may lead to better educated and healthier workers. Second, studies show that corporate social responsibility (CSR) leads to the provision of public goods by for-profit private firms operating in a competitive environment (Besley and Ghatak, 2007; Starr, 2008). Besley and Ghatak (2007) show that more responsible firms with social investments enjoy higher returns as a reward for good behavior. Hence CSR can be part of profit-maximizing strategy by businesses with external effects. Besley and Ghatak (2007) also show that CSR by profit seeking firms can be more efficient in providing public goods compared to government or non-for profit entities. This is mainly due to government failure and weak monitoring in the public sector. Starr (2008) extends the notion of reciprocal fairness to the case of businesses. Reciprocal fairness implies that people treat kindly those people who have treated them well, but treat negatively those who have treated them poorly. Drawing from insights gained from experimental studies on social preferences and pro-social behavior of individuals, she posits that people react positively to companies that are fair in dealing with their stakeholders. Investors screen companies into socially responsible portfolios based on their relations with customers, workers and communities. To attract shareholders and investors, private companies may invest in a socially responsible way, even at the cost of forgoing some profits. Hence, pure public goods can be voluntarily supplied by private economic agents (Bergstrom et al., 1986; Cornes and Sandler, 1996). Third, companies may invest in local development to retain FSC certification or become certified. Certification is expected to lead to better market access and price premiums and enhance brand credibility and corporate reputation among customers and potential investors (Auld et al., 2008). Consumers are expected to be more willing to pay for the products of certified plantations where certification is regarded as an indicator of the positive contribution of plantations to the development of

neighboring communities (Romero et al., 2017). One of FSC's sustainable forest management principles requires forest owners to maintain or enhance workers' and local communities' long-term social and economic well-being (FSC, 2012). The standards and monitoring by certifying bodies, and the expected market gains of certification, can act as incentives for private companies to invest in local development (Bass et al., 2001).

3. Study setting and data

3.1 The setting

The study was carried out in four villages in Mufindi district, in the Iringa region of Tanzania: Idete, Kihanga, Mapanda and Nzivi (Figure 2).² Mufindi district covers an area of 7,515 km² and in 2012 had a population of 265,829 with a density of 35.4 persons/km² (NBS, 2013). Iringa is one of the regions in Tanzania with the largest increases in forest plantations. The study villages were selected according to the following criteria, which support our identification strategy described in Section 4.1. First, they had to be located near forest plantations within the same administrative region. Second, community development projects had been undertaken in the villages by the respective plantations and that villagers work for the respective plantations. Third, the intervention and comparison villages are sufficiently far apart to minimize spill-over effects. Finally, villages in the two groups had comparable socio-economic and infrastructural features prior to the operations of the plantations. We used information from district offices, company documents and plantation managers to identify villages that fulfil these four criteria. Idete and Mapanda are adjacent to plantations owned by a private company and are considered as our intervention group. Kihanga and Nzivi are adjacent to a state-owned plantation and serve as our comparison group.

The private plantations are owned by Green Resources AS and are FSC certified. By 2016, Green Resources had developed about 17,000 ha of standing forest plantations on 74,000 ha of land, the majority of which used to be grassland with scattered shrubs and isolated trees. The company acquired the land on a 99 years lease from the Government of Tanzania, by negotiating with the relevant authorities in accordance with the 2006 Land Law. Under this law, land is granted by the village under the supervision and mandate of the District authorities and authenticated by the Ministry of Lands and Human Settlement Development through the Regional Office in Mbeya. The company's strategy is based on the sustainable development of the areas in which it operates. Its mission is to be Africa's leading afforestation company working for the benefit of shareholders, employees and adjacent communities by establishing, maintaining and harvesting high quality forest plantations (Green Resources AS, 2017). The company states that at least 10% of its revenues from carbon credits will be used for community development and environmental protection and has agreement with the villages to this effect. In line with this, the company invests in the local development of the villages adjacent to its plantations. Its plantations in the study villages consist of eucalyptus and pine trees (Green Resources AS, 2009).

For comparison purposes, we identified a state-owned plantation of comparable size with eucalyptus and pine trees, Sao-Hill forest plantation, which is also located in Mufindi district.

² The village is the lowest administrative unit in Tanzania. In this paper, the terms village and community are used interchangeably.

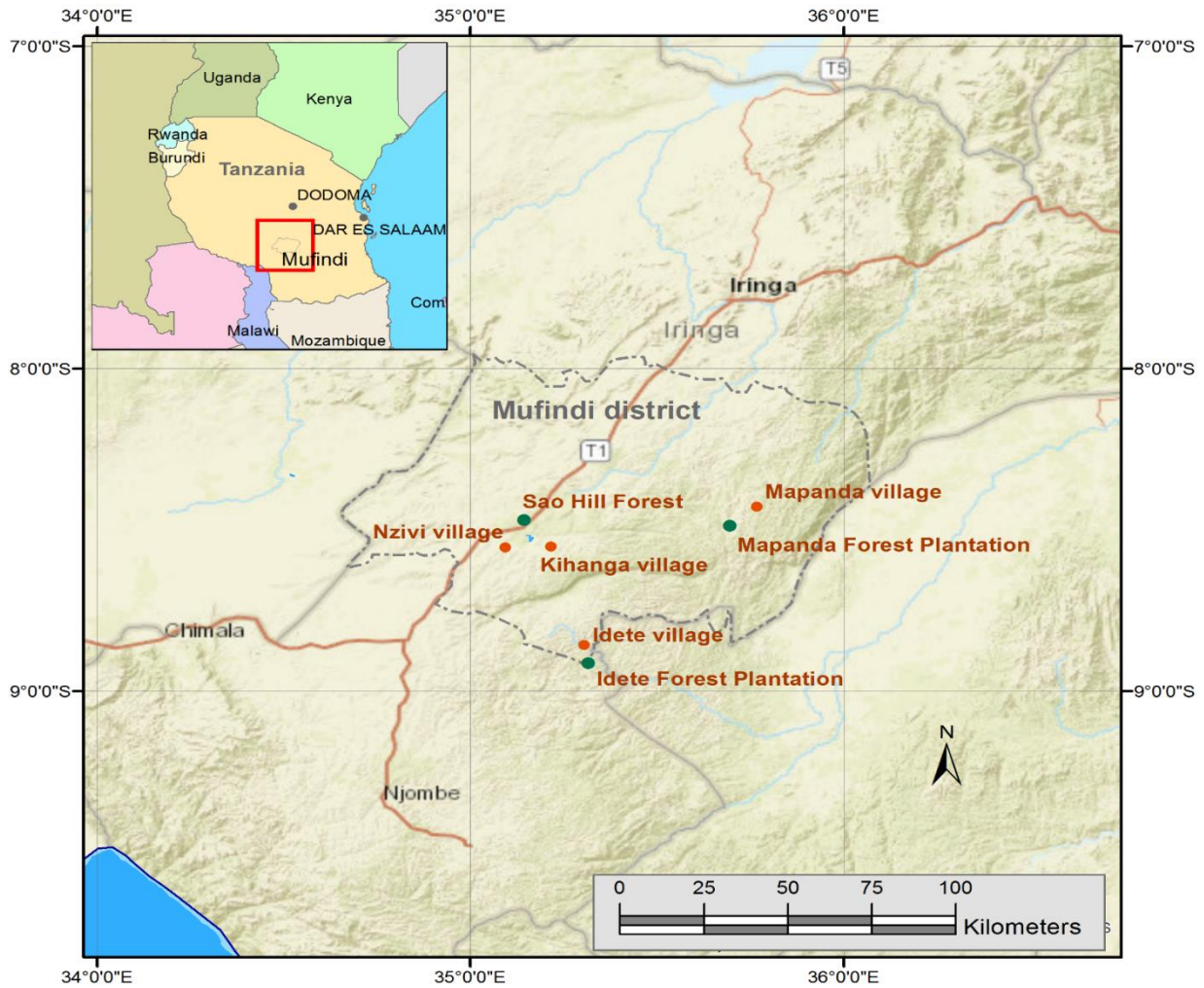


Figure 2. Map of study area, Mufindi district, Tanzania

3.2 Data

Data were collected in 2016 through a survey amongst 338 households (171 in the intervention and 167 in the comparison villages). Households were selected randomly from a village population register when available. In Idete and Mapanda, a register was not available and we divided the total number of households in the village by the desired sample size and used the result as an interval to select households in the villages (systematic sampling). Using structured questionnaires, we collected data on the socio-demographic and economic characteristics of their households and their perceptions about the impacts of the plantations in their villages. We asked respondents about perceived changes in local infrastructure and social services that are due to the operations of the plantations. Two enumerators administered the survey per respondent to avoid enumerator bias and errors from fatigue. A focus group discussion (FGD) was held in each village to discuss the socio-economic impacts of the plantations. Village leaders and key informants were asked to select representative groups of people in the villages (in terms of profession, gender, age and wealth). The focus groups had 10-20 participants to allow for a thorough discussion and active participation and took on average 1.5 hours. The household surveys and FGD were conducted by enumerators fluent in the local languages and English. Additionally, we used government reports and visual inspections to assess the existence, operation and quality of infrastructure in the villages and to triangulate the survey data findings. We used a 5-point scale (1 = Unusable, 2 = Poor, 3

= Satisfactory, 4 = Good, 5 = Very good) to rate the quality and operation each unit of infrastructure according to predefined criteria.

4. Identification strategy and methods of analysis

4.1 Identification strategy

Since the establishment of forest plantations adjacent to the villages was not random (but probably was related to suitable environmental conditions, land and labor availability and other policy factors), a randomized control trial (RCT) design is not possible. Hence, our identification strategy relied on identifying a group that is as comparable as possible to the intervention group and comparing the outcomes between the intervention and comparison groups (Ragin, 2014). The comparison group is used as a benchmark to measure differences in impacts. Our comparative approach uses villages adjacent to private forest plantations and villages adjacent to a state-owned plantation, all of which are located in the same district with similar agro-ecological and administrative environment. The village selection criteria outlined in Section 3.1 ensure that the major difference between the intervention and comparison villages is the management of the plantations. Thus, our approach enables us to assess the effects of the private plantations on the outcome indicators, while controlling for household and village characteristics. Since data on infrastructure and social services prior to the operations of the plantations were not available, we focused on the perceptions of households about the impacts of the plantations. Local households know who financed the infrastructure and social services and this will enable us attribute the impacts on the infrastructure and social services to the plantations.

Table 1 presents the results of the difference in means tests of the characteristics of the households in the intervention and comparison villages. There are no statistically significant differences in most of the characteristics of the households in the two groups, which suggest that the households in the groups are comparable. Although the intervention and comparison villages differ significantly in terms of average household size and share of income from agriculture, households in both groups consist on average of about five persons and agriculture remains their main economic activity. Households in the intervention villages on average farm larger hectares of land than households in the comparison villages. While a larger share of households in the intervention villages are involved in collecting forest products, households in the comparison villages obtain a larger share of their income from business activities.

4.2 Methods of analysis

We estimate the following equation to analyze the perceived impacts of the private forest plantations on each type of infrastructure (number and quality of health centers, length and quality of roads and bridges) and social services (school enrolment and quality of education) in the villages:

$$Perceived\ impact_{ij} = \beta_0 + \beta_1 d_j + \beta_2 Private_{ij} + \beta_3 x_{ij} + \varepsilon_{ij} \quad (1)$$

Table 1. Mean comparisons of household characteristics

Characteristics	Description	Intervention villages	Comparison villages	p-value ^a
Age of head	Age in years	44.50 (15.59)	44.91 (13.15)	0.79
Sex of head	Dummy, 1 = male	0.82 (0.38)	0.76 (0.42)	0.15
Education of head	Education level, 0 = no schooling, 1 = kindergarten, 2 = primary, 3 = secondary, 4 = college and above	1.82 (0.90)	1.84 (0.87)	0.84
Household size	Number of members within the household	4.49 (1.96)	5.23 (2.06)	0.00***
Total farm size	Land size in hectares	1.98 (2.33)	1.43 (1.58)	0.01**
Employed by plantation	Dummy, whether a household member employed by plantation, 1 = yes	0.07 (0.26)	0.09 (0.29)	0.36
Forest use	Dummy, whether a household collects forest products, 1 = yes	0.95 (0.21)	0.90 (0.29)	0.08*
Total household income	Annual household income in million TZS in 2015 ^b	1.27 (1.48)	1.81 (4.09)	0.13
Share of agricultural income	Percentage of agricultural income in total income	59.13 (39.81)	43.45 (39.20)	0.00***
Share of business income	Percentage of business income in total income	11.30 (25.36)	22.44 (33.53)	0.00***
Share of forest income	Percentage of forest income in total income	5.18 (19.47)	7.39 (21.50)	0.33
Share of off-farm income	Percentage of off-farm income in total income	17.24 (30.63)	22.14 (35.60)	0.18

Note: Standard deviations in parentheses. */**/** indicate means for intervention and control villages are statistically different at 10/5/1% significance level.

^a We used t-test for comparing the means of the variables.

^b TZS is the Tanzanian currency shilling. The August 8, 2016 was €0.41 for 1,000 TZS.

where the dependent variable, *Perceived impact_{ij}* is the perception of household *i* from village *j* about the impact of the plantation on the respective infrastructure or social service in its village. We asked respondents to what extent they think that the forest plantations have changed the infrastructure and social services in their villages. Accordingly, the dependent variable has three ordered categories: 1 if the household perceived the plantation to have (greatly) decreased the quantity or quality of the infrastructure or social service, 2 if the household perceived the plantation to have no impact, and 3 if the household perceived the plantation to have (greatly) increased it. The village dummies, d_j , capture (un)observable factors which may vary between the villages and influence the perceptions of the households about the impacts of the plantations. These include differences in other kinds of infrastructure, area size of village, topographic characteristics, effects of other projects working on local development and differences in the trustworthiness of village leaders and councils in utilizing the funds allocated by plantations for community development projects. The main explanatory variable,

$Private_{ij}$, indicates whether household i lives in a village adjacent to a private forest plantation.³ The variable takes a value of 1 if the household lives in a village adjacent to a private plantation, and 0 otherwise. The main parameter of interest in equation (1) is β_2 .

Equation (1) also allows us to analyze whether household characteristics explain differences in the perceptions of households about the impacts of the plantations. We included a vector of household controls, \mathbf{x}_{ij} , to account for relevant household characteristics expected to influence their perceptions about the impacts of forest plantations. These include sex and education level of the household head, household size, size of farm land, total household income and whether a household member works for the plantation company. Studies and anecdotal evidence indicate that vulnerable groups (women, the less educated and the land poor) may perceive the impacts of plantations negatively (Bleyer et al., 2016). This may be due to the exclusion of these groups from the activities of the plantations or disproportionate impacts of plantations on these groups. For example, women and the less educated may be less likely to be employed to work on the plantations (Pirard et al., 2017). Differences in responses may also be due to other household specific factors (e.g., conflicts with plantations about land rights) unrelated with actual impacts on the outcome variables. For example, households who were relocated from their farm plots and those who largely rely on land for their livelihoods may perceive the impacts of plantations negatively (Bleyer et al., 2016). Hence, we included shares of the different income sources of the households as controls in equation (1) to proxy for the livelihood strategies of the households.

Equation (1) is estimated using ordered logistic regression analysis. Since the coefficients of an ordered logit regression cannot be interpreted directly, we further report marginal effects and odds ratios. The marginal effect approximates the effect of a unit change in an explanatory variable on the expected value of an outcome variable, keeping other variables constant. The odds ratio is the ratio of the likelihood that an outcome occurs to the likelihood that it does not, due to a marginal change in the explanatory variable.

5. Results

5.1 Cross-sectional mean comparisons about perceived impacts of plantations

Figure 3 compares the mean values of the outcome variables between the intervention and comparison groups. The responses are aggregated from a 5-point Likert scale (greatly decreased, decreased, no change, increased, greatly increased) to a 3-point Likert scale: (greatly) decreased, no change, (greatly) increased.⁴ Households in the intervention villages reported higher mean values of perceived positive impacts of plantations on local infrastructure and social services than households in the comparison villages. These are cross-sectional comparisons and do not control for household and village level characteristics that may also affect perceptions. In the econometric analyses in Section 5.2, we include household covariates and village dummies to explain the variation between the intervention and comparison groups.

³ Our main explanatory variable, $Private_{ij}$, varies by households even if households live in the same village. Hence, it is important to cluster standard errors at the village level to relax the independent observations assumption. This implies that observations are independent only across villages.

⁴ We used the Brant test of parallel regressions to assess whether all coefficients for each of the outcome variables satisfy the parallel slopes assumption. The results show that we cannot reject the null hypothesis of proportional odds ratios or parallel regressions (p-values > 0.05). This indicates that the outcome categories are independent and we can merge adjoining categories of the 5-point Likert scale for ease of interpreting the coefficients.

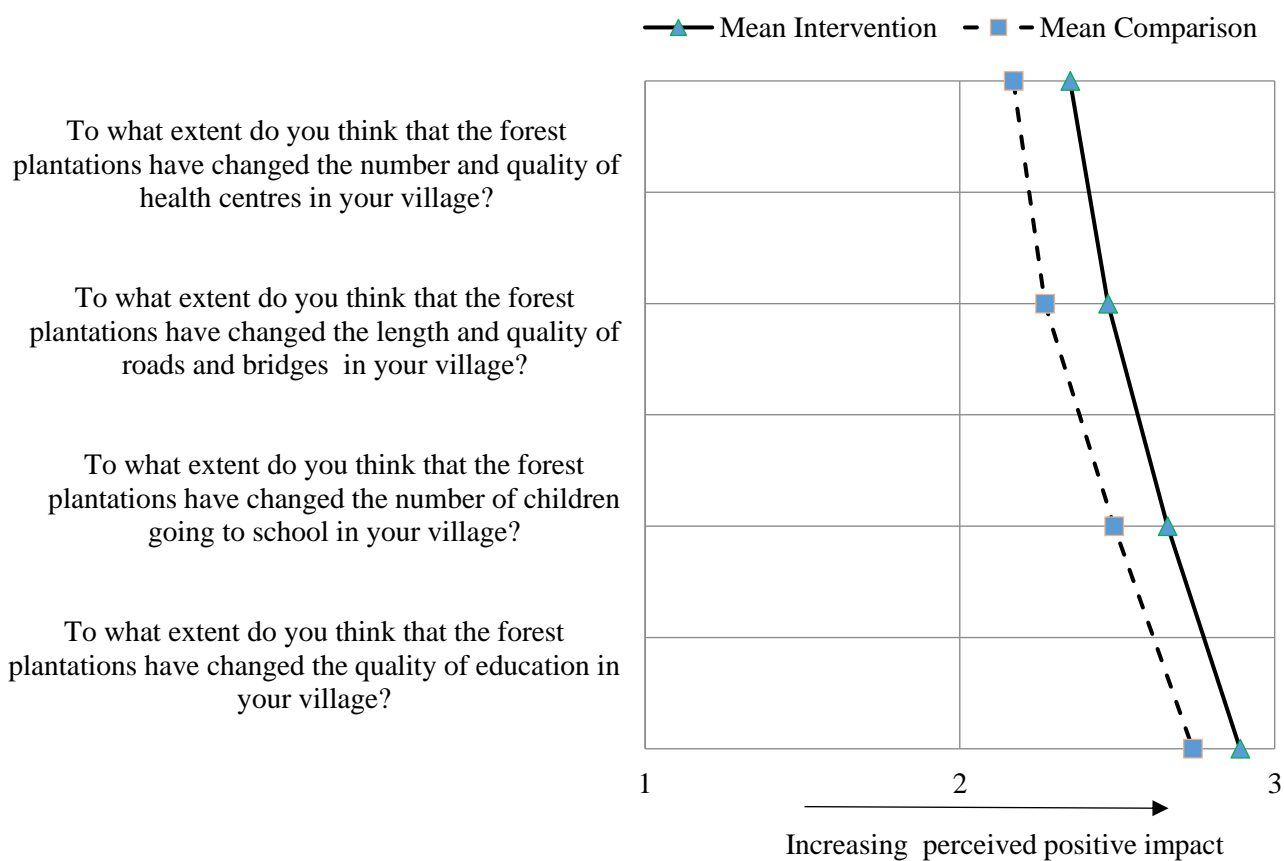


Figure 3: Mean values of household responses about impacts of forest plantations in intervention villages (solid line) and comparison villages (dashed line); Likert scale, 1 = (greatly) decreased, 2 = no change, 3 = (greatly) increased.

5.2 Econometric results

In this section, we present the results of the econometric analyses of the perceived impacts of the private forest plantations on each of the infrastructure and social services. Table A1 in Appendix A provides the descriptive statistics of the explanatory and dependent variables used in the estimations. We estimated all regressions using the 3-point Likert scale outcome variables. The results using the 5-point scale are qualitatively the same as the results of the 3-point scale and are presented in Table A2 in Appendix A.

5.2.1 Household perceptions about impacts of plantations on roads and bridges

Table 2 presents the results regarding the perceived impacts of the private forest plantations on the length and quality of roads and bridges. In column (a), we present the ordered logistic regression coefficients. The marginal effects and odds ratios are provided in columns (b) and (c) respectively. The private plantations are perceived by households to have statistically significant positive impacts on the length and quality of roads and bridges in their villages. Households in villages adjacent to the private plantations are on average 22.9% more likely to perceive that the plantations have (greatly) improved the length and quality of roads and bridges, compared to households in villages adjacent to the state-owned plantation. The odds ratio of 2.75 indicates that households in villages adjacent to the private

plantations are 2.75 times more likely to report that the plantations have (greatly) improved the length and quality of roads and bridges in their villages. These positive perceptions towards the private plantations could be related to the investment of the private company in roads and bridges in adjacent villages. FGD and observations of infrastructure in the villages confirm that the company had (co-)financed the construction and improvement of roads and bridges in neighboring villages.

Table 2. Impact of plantations on length and quality of roads and bridges

Variables	Ordered logit coefficients (a)	Marginal effects (b)	Odds ratio (c)
Private	1.011*** (0.032)	0.229*** (0.008)	2.747*** (0.087)
Age of head	0.019*** (0.005)	0.004*** (0.001)	1.018*** (0.005)
Sex of head	-0.504** (0.202)	-0.114** (0.045)	0.604** (0.122)
Education of head	0.261*** (0.073)	0.059*** (0.016)	1.298*** (0.095)
Household size	-0.056** (0.024)	-0.013** (0.005)	0.945** (0.022)
Total farm size	-0.060 (0.057)	-0.014 (0.013)	0.941 (0.054)
Employed by plantation	-0.165 (0.278)	-0.037 (0.09)	0.848 (0.235)
Forest use	-0.373 (0.379)	-0.085 (0.086)	0.688 (0.261)
Total household income	0.051** (0.020)	0.011** (0.005)	1.052** (0.021)
Share of agriculture income	0.000 (0.007)	0.000 (0.002)	1.000 (0.007)
Share of business income	-0.003 (0.009)	-0.000 (0.002)	0.997 (0.008)
Share of forest income	-0.001 (0.013)	-0.000 (0.003)	0.999 (0.013)
Share of off-farm income	-0.006 (0.009)	-0.001 (0.002)	0.994 (0.009)
Village dummies	Yes		Yes
Pseudo-R ²	0.048		0.048
Observations	289 ^a		289

Note: The dependent variable is response to “To what extent do you think that the forest plantations have changed the length and quality of roads and bridges in your village?”, 3-point Likert scale where 1 = (greatly) decreased, 2 = no change, 3 = (greatly) increased. Robust standard errors in parentheses are clustered at village level. **/** indicate statistically significantly different from zero at 5/1 % levels respectively.

^a Due to missing observations (which are evenly distributed over the intervention and comparison groups), the estimations were done using 289 observations.

Households with older and more educated heads and with higher incomes are more likely to report positive impacts of plantations on the length and quality of roads and bridges in their villages as

compared to their counterparts. This may suggest that older, more educated and richer households are more likely to benefit from the roads and bridges. On the other hand, male-headed and larger size households are less likely to report positive impacts of the plantations on the length and quality of roads and bridges. This may suggest that female-headed households are more likely to be impacted positively by the roads and bridges, for example fetching water and collecting firewood may have become less difficult. Households with more members may expect detrimental effects of plantations on their livelihood through potential reduced land availability in their villages and may therefore be less likely to report positive impacts. However, this result is not consistent for the other outcomes.

5.2.2 Household perceptions about impacts of plantations on quality of education

The private plantations are perceived by households to have statistically significant positive impacts on the quality of education in their villages (Table 3). Households in villages adjacent to the private plantation are on average 26.4% more likely to perceive that the plantations have (greatly) improved the quality of education in their villages, compared to households in villages adjacent to the state-owned plantation. The odds ratio for this is 3.68. The FGD and field observations show that the private plantation company invested in improving school buildings (class rooms and teachers' offices) and facilities (student desk chairs, teachers' housing duplex, toilets; see Table 6). Such investments are expected to reduce the number of teachers who leave the villages to work in urban areas (most likely to be the best teachers).

Households with older and more educated heads and those with higher income are more likely to perceive that plantations have (greatly) increased the quality of education in their villages as compared to their counterparts. This may be due the fact that such households are better informed and are able to process information to link the investments of the plantations with education quality. On the other hand, male-headed households and households whose members work for the plantations are less likely to perceive that the activities of the plantations have improved quality of education. This may suggest that female-headed households put more emphasis on the impacts of the plantations on education quality than male-headed households. The result related to households who work for the plantations is not as expected and could be due to household specific factors which influence their responses.

5.2.3 Household perceptions about impacts of plantations on school enrolment

Table 4 shows that the private plantations are perceived by households to have statistically significant positive impacts on the number of children going to school in their villages. Households in villages adjacent to the private plantations are on average 15.1% more likely to perceive that the plantations have (greatly) increased the number of children going to school, compared to households in villages adjacent to the state-owned plantation. The odds ratio for this is 3.18. This may be explained by a potential increase in the capacity of schools to accommodate more children due to school buildings, class rooms and school facilities financed by the private plantation company (see Section 5.3).

Table 3. Impacts of plantations on quality of education

Variables	Ordered logit coefficients	Marginal effects	Odds ratio
	(a)	(b)	(c)
Private	1.303*** (0.045)	0.264*** (0.015)	3.679*** (0.164)
Age of head	0.035*** (0.006)	0.007*** (0.001)	1.036*** (0.006)
Sex of head	-0.858** (0.409)	- 0.174** (0.078)	0.424** (0.173)
Education of head	0.468** (0.180)	0.095** (0.033)	1.596** (0.287)
Household size	0.081 (0.079)	0.016 (0.016)	1.084 (0.086)
Total farm size	-0.118 (0.076)	-0.024 (0.015)	0.889 (0.067)
Employed by plantation	-0.882*** (0.222)	-0.179*** (0.049)	0.413*** (0.912)
Forest use	0.122 (0.237)	0.025 (0.048)	1.129 (0.267)
Total household income	0.093* (0.052)	0.019* (0.010)	1.097* (0.056)
Share of agriculture income	0.005 (0.005)	0.000 (0.000)	1.004 (0.005)
Share of business income	0.002 (0.005)	0.000 (0.000)	1.002 (0.005)
Share of forest income	-0.002 (0.008)	-0.000 (0.001)	0.998 (0.007)
Share of off-farm income	0.007 (0.009)	0.001 (0.002)	1.007 (0.009)
Village dummies	Yes		Yes
Pseudo-R ²	0.083		0.083
Observations	289		289

Note: The dependent variable is response to “To what extent do you think that the forest plantations have changed the quality of education in your village?”, 3-point Likert scale where 1 = (greatly) decreased, 2 = no change, 3 = (greatly) increased. Robust standard errors in parentheses are clustered at village level. */**/** indicate statistically significantly different from zero at 10/5/1 % levels respectively.

The results also indicate that male-headed households are less likely to perceive that the plantations have increased the number of children going to school as compared to female-headed households. This suggests that female household heads are more likely to value the impact of plantations on school enrolment than male household heads. Richer households and households who are involved in collecting forest products are more likely to perceive that the plantations have improved school enrolment in the villages as compared to their counterparts. Richer households may have been more likely to benefit economically from the plantations and be able to send their children to school.

Table 4. Impacts of plantations on school enrolment

Variables	Ordered logit coefficients (a)	Marginal effects (b)	Odds ratio (c)
Private	1.157*** (0.111)	0.150*** (0.014)	3.182*** (0.354)
Age of head	0.009 (0.015)	0.001 (0.002)	1.009 (0.015)
Sex of head	-0.838** (0.314)	-0.109** (0.037)	0.432** (0.136)
Education of head	0.271 (0.250)	0.035 (0.031)	1.312 (0.328)
Household size	0.039 (0.069)	0.005 (0.009)	1.039 (0.072)
Total farm size	-0.016 (0.076)	-0.002 (0.009)	0.984 (0.074)
Employed by plantation	-0.323 (0.507)	-0.042 (0.07)	0.724 (0.367)
Forest use	1.168*** (0.341)	0.151*** (0.043)	3.215*** (1.097)
Total household income	0.072** (0.030)	0.009** (0.004)	1.075** (0.032)
Share of agriculture income	0.002 (0.005)	0.000 (0.000)	1.002 (0.005)
Share of business income	0.003 (0.004)	0.000 (0.000)	1.002 (0.004)
Share of forest income	-0.005 (0.008)	-0.000 (0.001)	0.995 (0.008)
Share of off-farm income	-0.002 (0.013)	-0.000 (0.001)	0.998 (0.013)
Village dummies	Yes	Yes	Yes
Pseudo-R ²	0.084		0.084
Observations	289		289

Note: The dependent variable is response to “To what extent do you think that the forest plantations have changed the number of children going to school in your village?”, 3-point Likert scale where 1 = (greatly) decreased, 2 = no change, 3 = (greatly) increased. Robust standard errors in parentheses are clustered at village level. **/** indicate statistically significantly different from zero at 5/1 % levels respectively.

5.2.4 Household perceptions about impacts of plantations on health centers

Table 5 shows that the private plantations are perceived by households to have statistically significant positive impacts on the number and quality of health centers. Households in villages adjacent to the private plantations are on average 25.2% more likely to perceive that the plantation has improved the number and quality of health centers, compared to households in villages adjacent to the state-owned plantation do. The odds ratio of this is 3.52. The positive perceptions towards the private plantations company might be due to its investments in improving health centers in the villages. According to FGD and field observations, the company has financed a dispensary and improvement of existing health centers in adjacent villages (see Section 5.3).

Table 5. Impacts of plantations on number and quality of health centers

Variables	Ordered logit coefficients	Marginal effects	Odds ratio
	(a)	(b)	(c)
Private	1.259*** (0.120)	0.252*** (0.027)	3.522*** (0.421)
Age of head	0.013 (0.013)	0.002 (0.002)	1.012 (0.013)
Sex of head	-0.156 (0.206)	-0.031 (0.042)	0.855 (0.176)
Education of head	-0.020 (0.198)	-0.004 (0.039)	0.979 (0.194)
Household size	-0.077 (0.063)	-0.015 (0.012)	0.926 (0.058)
Total farm size	-0.032 (0.022)	-0.006 (0.005)	0.968 (0.021)
Employed by plantation	-0.039 (0.208)	-0.008 (0.042)	0.962 (0.200)
Forest use	-0.573** (0.179)	-0.115** (0.033)	0.563** (0.100)
Total household income	0.029* (0.015)	0.006* (0.003)	1.029* (0.015)
Share of agriculture income	-0.007 (0.011)	-0.001 (0.002)	0.993 (0.011)
Share of business income	-0.012 (0.014)	-0.002 (0.002)	0.988 (0.013)
Share of forest income	-0.009 (0.010)	-0.002 (0.002)	0.991 (0.009)
Share of off-farm income	-0.010 (0.007)	-0.002 (0.001)	0.990 (0.006)
Village dummies	Yes		Yes
Pseudo-R ²	0.058		0.058
Observations	289		289

Note: The dependent variable is response to “To what extent do you think that the forest plantations have changed the number and quality of health centers in your village?”, 3-point Likert scale where 1 = (greatly) decreased, 2 = no change, 3 = (greatly) increased. Robust standard errors in parentheses are clustered at village level. */**/** indicate statistically significantly different from zero at 10/5/1 % levels respectively.

Households with higher income were more likely to report positive impacts of the plantations on health centers than poorer households. This suggests that richer households are more likely to benefit from the health facilities or are able to afford to use the facilities. Households who collect forest products were less likely to report positive impacts than those who do not. This may be due to household specific factors that influence their responses.

5.2.5 Robustness checks

To examine the robustness of our results to alternative specifications, we first investigated if our results hold true for each of the intervention villages by including a dummy variable for each of the four villages in the estimations (See Table A3 in Appendix A). While households in Idete and Mapanda perceived

the plantations to have significant positive impacts on the length and quality of roads, school enrolment and quality of education, only households in Mapanda perceived the plantation to have a significant positive impact on the number and quality of health centers in their villages. This result may be due to the fact that while the private company co-financed a dispensary in Idete, it invested in building a dispensary, maternity ward and houses for nurses in Mapanda. Second, we explored if the perceived positive impacts of the private plantations are heterogeneous among different income groups. For this, we included an interaction variable of income quartile groups with the dummy variable $Private_{ij}$ as additional explanatory variable in all the regressions. We did not find any significant effect of the interaction variable, suggesting that perceived impacts do not vary across income groups. Third, to investigate if household specific factors (unrelated to the impacts on infrastructure and social services) affect the perceived positive impacts of the private plantations, we estimated the regressions including two more explanatory variables: whether a household was relocated from its landholding and whether a household considers the plantation a ‘good neighbor’ (see Table A4 in Appendix A). Our results remain robust.

5.3 Community perceptions and field observations of village infrastructure

Table 6 shows the various development projects undertaken by the plantations in each village as indicated by the FGD. Villagers neighboring the private forest plantations reported that the plantation company (co-)financed the construction and improvement of school buildings, teachers’ houses, roads and bridges, dispensaries and related facilities. In contrast, villagers neighboring the state-owned plantation reported fewer community development projects by the plantation. In the FGD, while men and the youth were mentioned as the groups who most benefitted from the community projects in Idete, all members of the community were mentioned to have benefitted in the other three villages.

Table 6. Community development projects undertaken by the plantations

Village	Group	Teachers Offices	Houses for teachers	School building and class rooms	Road and bridges	Toilets for schools	Houses for nurses	Dispensary
Kihanga				X				
Nzivi		X	X					
Idete		X	X	X	X	X		X
Mapanda		X	X	X	X		X	X

Field observations show that the private plantation company (co-)financed the construction of a secondary school, a maternity ward, a house for nurses, two bridges and a graded road in Mapanda. Similarly, it (co-)financed a nursery school, two class rooms in a primary school, teachers’ houses, a bridge and a road in Idete. Visual inspections indicated that the infrastructure in villages adjacent to the private plantations are generally of better quality and equipped with better facilities. School records show that more children attended schools in villages nearby the private plantations as compared to villages neighboring the state-owned plantation. The FGD and field observations confirm the results based on the reports by individual households in the villages.

6. Conclusions and discussions

The total area of forest plantations is increasing rapidly in the world and their impacts on local development have received increased attention in recent literature. Perceptions of local households matter in examining the impacts of forest plantations on communities. Against this background, we examined the impacts of large-scale private forest plantations on local infrastructure and social services as perceived by local households in rural villages in Tanzania. Our results show that households in villages adjacent to the private forest plantations perceived the impacts of the plantations on local infrastructure and social services more favorably as compared to households in villages adjacent to the state-owned plantation. Focus group discussions and visual inspections confirm that villages adjacent to the private forest plantations are better off in terms of the number and quality of health centers, length and quality of bridges, quality of roads and number of students in school.

Private plantation companies may invest in public goods such as infrastructure due to various motives. These motives include profit maximizing self-interest, easing business operations, corporate social responsibility and pro-social investments, as part of a (certification) strategy that requires contributions to community development and due to shareholder requirements for sustainable investments. These motives appear to increase the incentives of private plantations to invest in public goods by raising the expected (long-term) net benefits of investing in community development. Moreover, such investments and the resulting positive perceptions by local households may reduce the risk of conflicts with local communities and associated losses. Positive perceptions of local communities regarding the activities and impacts of the plantations may also reduce the vulnerability (and associated costs) of the companies to pressures from socially and environmentally oriented NGOs which may otherwise criticize their practices. So, investments in public goods may be regarded as the price private plantation companies pay for reducing such risks for their businesses. Hence, investments in public goods by private plantation companies may be part of a risk reduction and profit maximization strategy.

Over all, our results suggest that private forest plantations have positive impacts on local infrastructure and social services. The results are consistent with the findings of other studies that show the positive impacts of private forest plantations and certified forestry operations on the livelihoods of adjacent communities in East Africa (Bleyer et al., 2016; Kalonga and Kulindwa, 2017; Landry and Chirwa, 2011). The results further suggest that private forest plantations have stronger incentives to contribute to the development of adjacent communities than state-owned plantations, especially when the plantations are certified and commit to socially responsible sustainable operations. Hence, policies and strategies aimed at creating a conducive environment for private sector investments in forest plantations may enhance positive impacts from sustainable forest management beyond the boundary of the plantations. We found that perceived impacts of plantations are related to socio-demographic characteristics of households (income and sex of household head), indicating that the impacts of the plantations are not uniform across households and that some groups of people in communities perceive the impacts differently. These results suggest that stakeholder engagement and monitoring of impacts by plantations should take into account the heterogeneous views within communities, their different needs and differing potential impacts of their community related activities. It is important to ensure the coherence of plantation activities with adjacent communities and listen to their needs and priorities if such investments are to be beneficial for all stakeholders.

Finally, the following points need considerations regarding the validity of our results. First, although the study was conducted in only four villages, reducing the statistical power of our quantitative analysis, the internal validity of our results holds because villages within the same district were homogenous and our study villages can be regarded as representative. The nature of the outcomes, which are related to

local impacts of the plantations in adjacent villages, also justifies focusing on villages in the vicinity of the plantations. Besides, the large number of households - the level at which the outcome indicators are measured in our study - further increases validity. Notwithstanding these, we triangulated our quantitative results with qualitative analyses of community perceptions regarding the impacts through focus group discussions and with visual inspection of the level and quality of infrastructure and social services in the villages. Second, to attribute the impacts to private ownership, ideally the only difference between the plantations should be the form of ownership. In our study, the private plantations are FSC certified while the state-owned plantation is not. So, our results should be seen as providing insights on the contribution of the combination of these factors in enhancing positive impacts. Future research could try to disentangle the impacts of ownership from the impacts of certification. Third, we looked at plantations owned by one company, indicating a need for caution in generalizing our results to other plantations in Tanzania and beyond. An important line of future research could be to expand the analysis to a larger number of plantations and villages with various socio-economic contexts in developing countries.

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Appendix A

Table A1. Descriptive statistics of variables

Variable	Mean		Std. deviation		Min.		Max.		N	
	I	C	I	C	I	C	I	C	I	C
A. Dependent variables										
Perceived impact of plantation on number and quality of health centres ^a	2.35	2.17	0.62	0.55	1	1	3	3	171	167
Perceived impact of plantation on number and quality of roads and bridges ^a	2.47	2.27	0.59	0.65	1	1	3	3	171	167
Perceived impact of plantation on school enrolment ^a	2.89	2.74	0.33	0.49	1	1	3	3	171	167
Perceived impact of plantation on quality of education ^a	2.66	2.49	0.55	0.59	1	1	3	3	171	167
B. Household (hh) controls										
Age of head (in years)	44.50	44.91	15.59	13.15	23	20	85	85	169	163
Sex of head ^b (0=female, 1=male)	0.82	0.76	0.38	0.42	0	0	1	1	171	167
Education of head ^c (0-4)	1.82	1.84	0.90	0.87	0	1	4	4	171	167
Household size (in number)	4.49	5.23	1.96	2.06	1	1	12	11	171	167
Total farm size (in hectares)	1.98	1.43	2.33	1.58	0.10	0.20	12	16.4	168	164
Employed by plantation ^b (0=No, 1= Yes)	0.07	0.09	0.26	0.29	0	0	1	1	170	169
Forest use ^b (0=No, 1= Yes)	0.95	0.90	0.21	0.29	0	0	1	1	170	166
Total hh income (in million Tzs)	1.27	1.81	1.48	4.09	0.03	0	10	39.8	155	150
Share of agricultural income (%)	59.13	43.45	39.81	39.20	0	0	100	100	164	159
Share of business income (%)	11.30	22.44	25.36	33.53	0	0	100	100	164	159
Share of forest income (%)	5.18	7.39	19.47	21.50	0	0	100	100	164	160
Share of off-farm income (%)	17.24	22.14	30.63	35.60	0	0	100	100	164	159

Note: ^a I= intervention villages, C= comparison villages

^b categorical variable: 1= (greatly) decreased, 2= no change, 3= (greatly) increased

^c binary variable

^d categorical variable: 0= no schooling, 1= kindergarten, 2=primary, 3= secondary, 4= college and above

Table A2. Household perceptions about impacts of plantations on infrastructure and social services in their villages: Ordered logit estimation results using the 5-point Likert scale outcome variables from responses in original data

Variables	Impact on length and quality of roads and bridges	Impact on quality of education	Impact on school enrolment	Impact on number and quality of health centers
	(a)	(b)	(c)	(d)
Private	1.199*** (0.040)	1.368*** (0.067)	1.038*** (0.228)	1.318*** (0.101)
Age of head	0.019*** (0.005)	0.031*** (0.008)	0.014 (0.013)	0.012 (0.013)
Sex of head	-0.235 (0.240)	-0.652* (0.313)	-0.674 (0.499)	-0.204 (0.293)
Education of head	0.291*** (0.065)	0.443*** (0.089)	0.274* (0.239)	-0.010 (0.182)
Household size	-0.042** (0.015)	0.083 (0.057)	0.023 (0.047)	-0.091 (0.067)
Total farm size	-0.063 (0.048)	-0.167** (0.053)	-0.105 (0.068)	-0.041 (0.049)
Employed by plantation	-0.008 (0.392)	-0.803*** (0.172)	-0.453 (0.387)	-0.032 (0.158)
Forest use	-0.582 (0.555)	0.363*** (0.082)	1.784*** (0.370)	-0.292** (0.093)
Total household income	0.066* (0.033)	0.071* (0.028)	0.048*** (0.011)	0.040* (0.017)
Share of agriculture income	-0.001 (0.006)	0.007* (0.003)	0.008 (0.006)	-0.004 (0.011)
Share of business income	-0.005 (0.007)	0.004 (0.006)	0.009*** (0.002)	-0.013 (0.013)
Share of off-farm income	-0.006 (0.010)	0.008 (0.007)	0.004 (0.005)	-0.009 (0.005)
Share of forest income	-0.001 (0.012)	0.002 (0.007)	-0.001 (0.006)	-0.008 (0.008)
Village Fixed effects	Yes	Yes	Yes	Yes
PseudoR ²	0.057	0.074	0.057	0.063
Observations	260	268	269	274

Note: The dependent variable is response to “To what extent do you think that the forest plantations have changed the quantity and or quality of the respective infrastructure and social service in your village?”, 5-point Likert scale where 1 = decreased greatly, 2 = decreased, 3= no change, 4= increased, 5 = increased greatly. Robust standard errors in parentheses are clustered at village level. */**/***/ indicate statistically significantly different from zero at 10/5/1 % levels respectively.

Table A3. Household perceptions about impacts of plantations on infrastructure and social services in their villages: Ordered logit estimation results using individual dummies for each village

Variables	Impact on length and quality of roads and bridges	Impact on quality of education	Impact on school enrolment	Impact on number and quality of health centers
	(a)	(b)	(c)	(d)
Mapanda ^a	1.011*** (0.030)	1.303*** (0.040)	1.157 ^b *** (0.110)	1.259*** (0.120)
Idete ^a	0.485*** (0.140)	0.959*** (0.130)	1.851*** (0.070)	0.195 (0.120)
Nzivi ^a	0.099 (0.090)	0.736*** (0.110)	1.237 ^b *** (0.120)	0.197*** (0.050)
Kihanga ^a	Omitted	Omitted	Omitted	Omitted
Age of head	0.019*** (0.000)	0.035*** (0.010)	0.009 (0.010)	0.013 (0.010)
Sex of head	-0.504* (0.200)	-0.858* (0.410)	-0.838** (0.310)	-0.156 (0.210)
Education of head	0.261*** (0.070)	0.468** (0.180)	0.271 (0.250)	-0.020 (0.200)
Household size	-0.056* (0.020)	0.080 (0.080)	0.039 (0.070)	-0.077 (0.060)
Total farm size	-0.060 (0.060)	-0.118 (0.080)	-0.016 (0.080)	-0.032 (0.020)
Employed by plantation	-0.165 (0.280)	-0.882* (0.220)	-0.323 (0.510)	-0.039 (0.210)
Forest use	-0.373 (0.380)	0.122 (0.240)	1.168*** (0.340)	-0.573** (0.180)
Share of agriculture income	0.000 (0.010)	0.005 (0.000)	0.002 (0.000)	-0.007 (0.010)
Share of business income	-0.003 (0.010)	0.002 (0.000)	0.003 (0.000)	-0.012 (0.010)
Share of off-farm income	-0.006 (0.010)	0.007 (0.010)	-0.002 (0.010)	-0.010 (0.010)
Share of forest income	-0.001 (0.010)	-0.002 (0.010)	-0.005 (0.010)	-0.009 (0.010)
Total household income	0.051* (0.020)	0.093 (0.050)	0.072* (0.030)	0.029 (0.010)
PseudoR ²	0.048	0.083	0.084	0.058
Observations	289	289	289	289

Note: The dependent variable is response to “To what extent do you think that the forest plantations have changed the number and quality of health centers in your village?”, 3-point Likert scale where 1 = decreased, 2 = no change, 3 = increased. Robust standard errors in parentheses are clustered at village level. */**/** indicate statistically significantly different from zero at 10/5/1 % levels respectively.

^a Dummy variable: 1= Village as indicated, 0 otherwise.

^b In column (c), the coefficient for Mapanda village (an intervention village) is smaller in magnitude than the coefficient for Nzivi village (a comparison village), which might seem to suggest that the households in Nzivi perceive the plantation in their village to have higher significant positive impacts on school enrolment than households in Mapanda village do. However, as the outcome variables are

ordinal, the numbers cannot be compared directly. A test of the equality of the coefficients shows that we cannot reject the null hypothesis of equality of the coefficients (p-value = 0.7185), indicating that households in Nzivi and Mapanda have statistically similar positive perceptions about the impacts of the plantations on school enrolment in their villages..

Table A4. Household perceptions about impacts of plantations on infrastructure and social services in their villages: Ordered logit estimation results using household specific factors (whether the household was relocated and to what extent the household agrees that the plantation is ‘a good neighbor’) as additional explanatory variables

Variables	Impact on length and quality of roads and bridges	Impact on quality of education	Impact on school enrolment	Impact on number and quality of health centers
	(a)	(b)	(c)	(d)
Private	1.001*** (0.039)	1.234*** (0.079)	.112*** (0.118)	1.276*** (0.156)
Age of head	0.024*** (0.004)	0.038*** (0.007)	0.014 (0.016)	0.018 (0.015)
Sex of head	-0.519** (0.175)	-0.769* (0.437)	-0.811** (0.381)	-0.166 (0.229)
Education of head	0.298*** (0.076)	0.382* (0.198)	0.231 (0.336)	-0.005 (0.195)
Household size	-0.015 (0.043)	0.064 (0.059)	0.015 (0.068)	-0.066 (0.075)
Total farm size	-0.112* (0.064)	-0.099 (0.098)	-0.019 (0.104)	-0.046 (0.048)
Employed by plantation	-0.008 (0.392)	-0.899*** (0.212)	-0.361 (0.553)	0.097 (0.163)
Forest use	-0.433 (0.438)	-0.105 (0.228)	1.315** (0.548)	-0.601** (0.304)
Total household income	0.040** (0.014)	0.107** (0.054)	0.058** (0.024)	0.031* (0.016)
Household relocated ^a	-0.320*** (0.076)	0.030 (0.819)	-0.405 (0.865)	-0.420* (0.186)
HH perceives plantation ‘good neighbor’ ^b	0.068 (0.068)	0.205* (0.120)	0.320*** (0.062)	-0.031 (0.031)
Share of agriculture income	0.002 (0.009)	0.007 (0.006)	0.008 (0.007)	-0.007 (0.011)
Share of business income	-0.005 (0.011)	0.004 (0.004)	0.006 (0.005)	-0.014 (0.014)
Share of off-farm income	0.005 (0.010)	0.007 (0.008)	-0.001 (0.012)	-0.011 (0.007)
Share of forest income	-0.001 (0.013)	-0.002 (0.007)	-0.001 (0.011)	-0.011 (0.010)
Village Fixed effects	Yes	Yes	Yes	Yes
PseudoR ²	0.061	0.093	0.106	0.072
Observations	260	268	269	274

Note: The dependent variable is response to “To what extent do you think that the forest plantations have changed the quantity and or quality of the respective infrastructure and social service in your

village?”, 3-point Likert scale where 1 = decreased g, 2 = no change, 3= increased,. Robust standard errors in parentheses are clustered at village level. **/** indicate statistically significantly different from zero at 10/5/1 % levels respectively.

^a Binary variable: 0=No, 1=yes

^b Categorical variable: 1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree