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Local-economy impacts of cash crop promotion

by
J. Edward Taylor
Edward Whitney
Heng Zhu

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Abstract

A number of studies have examined the direct impacts of cash crop production on producer households. This is the first to quantify the general equilibrium impacts of introducing a new cash crop into a poor isolated economy, including impacts on environmentally sensitive fishing activities. We find that the introduction of oil palm production explains the striking growth in income in Uganda's Ssese Islands, including large-scale production spillovers to non-palm sectors, as well as a significant reduction in pressure on the Lake Victoria fishery. It appears that oil palm development, via a project that connected a commercial aggregator with small-scale farmers, enabled an economy at a low-level equilibrium to transition to a higher equilibrium state, with positive spillovers across households as well as across production sectors. Econometric evidence confirms results from simulations using an island-wide general equilibrium model parameterized from new micro survey data.

1 Introduction

Promotion of high-value cash crops frequently is an important component of agricultural intensification and diversification, especially in light of a rapid transformation and modernization of the global food system (Maertens et al., 2012; Mergenthaler et al., 2009; Reardon et al., 2009). The links between cash crop production and rural incomes are both direct and indirect. Govereh and Jayne (2003) found evidence that cash crop production can have synergistic effects on other household activities, including investments in food production. Gockowski and Ndoumbé (2004) concluded that export crop promotion in Cameroon indirectly facilitated agricultural diversification. Masanjala (2006) reported that cultivation of burley tobacco in Malawi was associated with higher income as well as higher food purchases. Not all research is optimistic, however. Some question whether export-oriented agricultural development is as environmentally sustainable as food production for domestic consumption. Barbier (1989) rejects this assertion for Indonesia, finding that major cash crops, including oil palm, are associated with significantly less soil erosion than staple root crops and noting "the main obstacle to sustainable agricultural development is the failure of any economic policy, whether promoting food crops or exports, to address adequately problems of resource management". Others question whether cash crop promotion impacts poverty in areas with missing or imperfect capital and insurance markets, given the common requirement of purchased inputs and hired labour in cash crop production. Such requirements often exclude the poorest farmers from directly participating in cash crop production (Poulton et al., 2001), leading to an unequal distribution of benefits, with the aforementioned barriers to entry excluding the extremely poor.

Previous empirical studies focus on direct beneficiaries (or adopters) of cash crops, and do not attempt to quantify potential spillover impacts on households that are not cash crop growers. Existing studies on the general equilibrium effects of cash crop adoption have focused on macroeconomic effects (Anderson et al., 2008; Arndt et al., 2010) and/or on the impacts on a region, rather than at the household level (Elbehri and Macdonald, 2004). In theory, cash crop development has both direct and indirect impacts on the livelihoods of rural populations. Direct impacts consist mostly of increased income to farmers who grow cash crops. Indirect impacts, or spillovers, include wages paid to workers on cash crop farms and downstream processers. They also include income spillovers to households that do not engage in cash crop production but may benefit from an increase in demand for goods and services when a cash crop injects new cash into local economies. Markets transmit the impacts of cash crop development from growers to other local production activities and households. Under a general equilibrium setting, it is possible for non-participating households to benefit from cash-cropping activities through indirect channels.

However, there is a downside to an economy built around cash crop production. The entire Kalangala economy is now vulnerable to oil palm price shocks. Market linkages magnify the impacts of both positive and negative price shocks. Positive price shocks stimulate production, employment and incomes throughout Kalangala. Negative shocks, on the other hand, have a disproportionately large negative impact on local incomes. Both positive and negative price shocks affect employment much more in non-palm-producing households than in palm-farmer or palm-worker households.

To the best of our knowledge, no prior research explores the general equilibrium (GE) impacts of cash crop promotion in poor economies. This study focuses on quantifying the full impact (direct and indirect) of a large-scale oil palm production and processing project in Kalangala. Using data collected from grower and non-grower households, we calibrate an *in silico* local economy-wide impact evaluation (LEWIE) simulation model to quantify the full impact of oil palm production on residents of Kalangala. The calibrated model reveals that each additional acre of mature oil palm adds UGX 2.2 million annually to the Kalangala economy (UGX 1.9 million if adjusted for inflation). Of this, UGX 800,000 (US$231, roughly 40 per cent of total benefits) goes to households that do not participate in oil palm production. An additional acre of oil palm creates 127 person-days of employment in Kalangala, 95.9 of which are in households that do not grow or work in oil palm. All sectors of the economy expand, with the exception of fishing. A 1 per cent (108.7 acre) expansion in oil palm plantations raises total cash income in Kalangala by UGX 242 million (US$70,000) and total real income by UGX 210.1 million (US$60,000). A 10 per cent increase in oil palm productivity increases total cash income in Kalangala by nearly UGX 5 billion annually, with nearly half of the income gain going to non-oil palm-producing households.

This analysis underlines the importance of using an economy-wide approach to evaluate the impacts of development programmes. The relative geographical isolation of Kalangala helps concentrate the local economy impacts of oil palm. Barriers to trade, including reliance on ferries and long transportation times, effectively trap a good proportion of the economic spillover impacts of palm development in Kalangala. Virtually all wages paid and most household purchases are within the local economy. This helps explain why the impacts on total Kalangala income far exceed the direct benefits of the project.

The rest of this paper is structured as follows: section 2 provides background on the oil palm project in Kalangala and summary statistics on the household and business surveys that were carried out to support this LEWIE. Section 3 lays the groundwork for the LEWIE model, and section 4 presents our simulation results. We conclude with a discussion of some policy implications of our findings in section 5.

2 Background

Kalangala district is located in southern central Uganda and comprises a series of islands situated on Lake Victoria. The estimated population in 2016 was 56,900 individuals, with the vast majority of residents located on Bugala Island, the largest island accounting for 63.2 per cent of total dry land in the district. Historically, the primary income-generating activities on the islands have consisted of fishing, tourism and agriculture.

In July 1998, Uganda's Ministry of Agriculture, Animal Industry and Fisheries, in collaboration with the International Fund for Agricultural Development (IFAD), launched the Vegetable Oil Development Project (VODP). The Kalangala oil palm development project, which is part of VODP, represents a prototype for projects to increase income and improve livelihoods of poor rural households in geographic areas suitable for oil palm development. One of the project's goals is to reduce Uganda's reliance on cooking oil imports; thus, the majority of processed palm oil goes to domestic markets. A predetermined formula sets farm gate prices of fresh fruit bunches (FFBs) based on the global price of palm oil.

Planting of palms started in 2005, and harvesting of palm fruit began approximately five years later. The project employs a vertically integrated processor-nucleus-estate-smallholder model. Since the inception of the oil palm project in 2005, in the form of a private–public partnership between the Government of Uganda and Bidco Uganda Limited (operating as Oil Palm Uganda Limited, or OPUL), cultivation of oil palm has steadily become a key economic activity in the district. Under the umbrella of the VDOP, promotion of oil palm production has been seen as a strategic effort to address high poverty rates and reduce Uganda's dependency on oil imports by increasing domestic production. At the time of the survey, roughly 10,000 hectares of palm oil had been planted, with 6,500 hectares operated by OPUL in the form of a nucleus estate.

As part of the project, the Government of Uganda and IFAD established the Kalangala Oil Palm Growers Trust (KOPGT), which enables farmers to access credit; current loans to smallholder growers total US$13 million. In addition to loans and extension services, KOPGT also acts as an intermediary between smallholders and OPUL by collecting FFBs from individual farmers and processing payments. As of 2017, the remaining 3,500 hectares belong to 1,800 individual smallholders who sell their FFBs to one of two local mills operated by OPUL.

Prior to the project, Kalangala was a relatively poor district in Uganda, with a population of around 40,000. The main island, Bugala, had been largely deforested to supply charcoal to the cities of Kampala and Entebbe. Kalangala affords a unique opportunity to quantify the direct and indirect impacts of introducing large-scale cash crop production into an extremely poor economy. Oil palm cultivation and processing were non-existent on Bugala Island in 1998. Between 2004 and 2017, palm largely reforested the island. Over the same period, residents of the island experienced transformative growth in income and infrastructure, as well as the inception of a nascent tourism industry. In the absence of other development fulcrums, it appears that the indirect income impacts of oil palm development rivalled or perhaps exceeded the direct impacts.

2.1 Survey background

The survey instrument was designed for resident households, OPUL employee households and businesses on Bugala Island in the Kalangala district of Uganda. The survey collected information on household demographics, income-generating activities (crops, oil palm, livestock, businesses, fishing and wage work) and detailed expenditure purchases, including information on the point of purchase. Further information on the oil palm estate and mill was gathered from administrative records.

During the data collection process, the enumeration team visited 18 randomly selected villages over a course of four weeks, from a total of 39 villages. Two of the selected villages were then used as pre-test sites, with their information omitted from the finalized sample. From each randomly selected village, a maximum of 40 households were then randomly chosen from two lists, one of oil palm growers and one of non-growers. Where a village had fewer than 20 oil palm-growing households, all oil palm households were approached for interviewing to ensure that a substantial number of oil palm-growing households appeared in our sample. While just over 10 per cent of households on the island participate in oil palm production, palm growers represent close to a third of households in our sample, due to our sampling strategy.

In addition to business information captured within the household surveys, a supplementary business survey was administered; information was collected on sales, employment and input purchases by business operation within and around villages. Business survey timing was staggered with that of the household survey to ensure no businesses were counted twice in our sample. Lacking a master list of businesses on Bugala Island, enumerators were instructed to survey all businesses that consented to the interview.[1] Administrative records from Kalangala Oil Palm Growers Trust (KOPGT) were merged with the survey data to obtain more detailed information regarding oil palm growers' sales and input usage.

The resulting sample contains 513 households, including 156 oil palm growers, 120 estate worker households and 244 non-oil palm-growing residents. Combining businesses from the household survey and the separate business survey, we obtained a total sample of 284 individual business operations, capturing a wide range of entrepreneurial activities on Bugala Island.

2.2 Household demographics and livelihood activities

This section presents a detailed description of the demographics and income-generating activities conducted by all island resident populations. Table 1 summarizes key household characteristics for local residents and oil palm-worker households. Local residents include palm and non-palm growers. Local residents, both growers and non-growers, actively participate in various production activities. Estate worker households tend to be employment oriented, working solely on the nucleus estate plantation.

1. A strategy of skipping every other business was initially implemented, but this proved infeasible for collection of a substantial sample as villages often did not have enough businesses. Enumerators were instructed to conduct the interview with minimal interruption to operations, ensuring a near-100 per cent consent rate.

Most of the Kalangala population (half of those in palm and non-palm households, 69 per cent of those in palm-worker households) was born outside of Kalangala. The majority of oil palm workers are migrants from other regions of Uganda (81.6 per cent) and reside in dormitories provided by the estate. Compared with residents, oil palm workers have smaller household sizes, younger heads of households and fewer dependants living under the same roof.[2] Estate worker households are relatively small, often comprising only immediate family, and their heads of household are significantly better educated. The difference in household head education is likely driven by the positive link between schooling and migration, well established in the development economics and migration literature (Taylor and Martin, 2001). This results in a positive selection effect on educational attainment of estate worker households.

The estimated household average annual expenditure (as a measure of permanent income) is UGX 11 million (US$3,200) for resident households and UGX 5.6 million (US$1,600) for oil palm workers. Owing to the smaller household sizes of palm workers, per capita expenditures are similar at UGX 3.3 million (US$960) and UGX 2.8 million (US$811) for residents and workers, respectively. Expenditures for both household types compare favourably with average income in Uganda, estimated to be US$630 in 2016 (World Bank, 2016).[3]

In comparison with oil palm workers, the livelihood activities of island residents are diverse. Roughly 10 per cent of residents are oil palm growers and two thirds participate in agricultural production and livestock rearing (Table 2). One in five fish or have local employment, and 40 per cent of resident households have some form of business activity. All of these shares are considerably lower for oil palm workers, who tend to focus on employment at the plantation and mill. Unsurprisingly, palm-worker households have little in the way of outside income and derive most of their income stream from wage work. Only 7 per cent grow their own oil palm, 13 per cent grow other crops, 15 per cent have livestock, 3 per cent fish and 9 per cent run a business (usually in/near the dormitories). In comparison, local residents have a substantially more diversified set of activities.

2. In the survey, we define individuals living under the same roof and eating together for at least six months in the past year as members of a household.

3. https://data.worldbank.org/country/uganda

Table 1. Demographics and expenditure

	Household size	Born in Kalangala	Head age	% female	Dependant ratio	Household head education	Annual exp (million UGX)	
							Total	Per capita
	Kalangala residents							
Mean	4.38	0.5	41.3	0.51	0.4	7.5	11.0	3.3
SD	(2.44)	(0.50)	(12.6)	(0.50)	(0.26)	(4.4)	(15.0)	(5.1)
N	391	1,713	391	1,713	391	391	391	391
	Estate worker households							
Mean	2.87	0.31	33.1	0.43	0.24	8.9	5.6	2.8
SD	(2.18)	(0.46)	(10.9)	(0.5)	(0.26)	(4.1)	(4.9)	(2.9)
N	120	344	120	344	120	120	120	120

Note: Dependants defined as those 16 years of age or younger. Source: 2017 Kalangala Survey.

Table 2. Proportion in livelihood activities

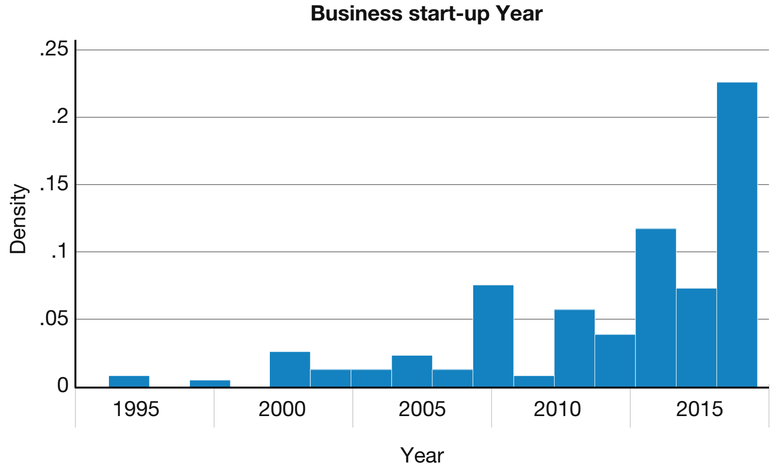
	Oil palm	Agriculture	Livestock	Fishing	Wage work	Business
	Local residents					
Mean	0.32	0.67	0.67	0.21	0.2	0.4
SD	(0.47)	(0.47)	(0.46)	(0.41)	(0.40)	(0.49)
N	391	391	391	391	391	391
	Estate worker households					
Mean	0.07	0.13	0.15	0.03	1	0.09
SD	(0.25)	(0.33)	(0.36)	(0.16)	(0.0)	(0.29)
N	120	120	120	120	120	120

Source: 2017 Kalangala Survey.

Of all Kalangala residents, 67 per cent own livestock, and these have an average herd value of UGX 1.66 million (Appendix A1). Stable wage employment opportunities are scarce in Kalangala, and only around 20 per cent of the population have some form of long-term wage work. However, those who do find work tend to work full-time; the average Kalangala resident who is employed works over nine months out of the year. Daily wages are estimated to be around UGX 7,500 (US$2) per day for residents and UGX 8,300 for oil palm workers.

Close to 40 per cent of resident households own or operate a small business, and entrepreneurial activities represent a substantial share of their incomes. However, the emergence of small businesses is a fairly recent phenomenon; Figure 1 details the distribution of start-up years for businesses captured in the survey process.

Figure 1. Bugala Island business formation by start-up year



Source: 2017 Kalangala Survey.

Few businesses were set up prior to the oil palm project, but business formation increased steeply after 2007 and especially after 2010. More than 40 per cent of businesses on Bugala Island were initiated after 2012, with the highest percentage (22 per cent) starting up in 2016. Part of this increase could be an artefact of high failure rates in the first few years of new businesses. We do not have information on business failure rates, and it is impossible to rule out this possibility without having matched panel data on businesses. Nevertheless, the trend in Figure 1 is consistent with an expansion in economic activity in the wake of oil palm development.

Appendix Figure A1 shows trends in both new business formation and the cumulative acreage of oil palm in our sample. Total oil palm acreage is nil prior to 2004, after which it rises gradually and then jumps sharply to 560 acres in 2010. The expansion tapers off after 2010, with a maximum just under 785 acres at the time of the survey in 2017. The rate of new business creation in the sample is less than 10 per year before the start of the oil palm development programme, but it increases sharply after that, rising to 49 in 2016, the year before the survey. The patterns in this figure are consistent with oil palm development providing a catalyst for new business development in Kalangala. The continuation of new business formation even after oil palm expansion tapers off suggests that this new activity may have set in motion a self-sustaining business development dynamic. Estimating the correlation between new business development and mature oil palm acreage (acreage in plantations five or more years old) shows that a 100-acre increase in mature oil palm plantations is associated with the creation of 1.2 new businesses in Kalangala (Appendix A1).

The high correlation between oil palm acreage and new business formation suggests that indirect impacts, or spillovers, should be taken into account when evaluating project benefits. Quantifying spillovers requires a local GE perspective. In theory, experiments could be designed to estimate income and production spillovers from development interventions. However, this is not possible for the Kalangala oil palm project, because there is no randomized treatment or control group for both beneficiaries and non-beneficiaries. Moreover, experiments provide reduced-form estimates of impacts. A structural approach is needed if one goal of this evaluation is to inform the design of complementary interventions to enhance project impacts (or counteract possible adverse impacts).

2.3 Land use and oil palm activity

There are two levels of land tenure status in Uganda. The first concerns the status of the land itself: officially registered land owned by an individual or organization (Mailo and freehold/leasehold), tenant rights land (known as Kibanja) or publicly owned land. Kibanja is informal, but in practice tenancy on private land is secure, with owners having to offer compensation when evicting residents from their land. The second level of tenure status concerns the ownership status of the individuals residing upon the land itself, and is broadly composed of mixed ownership (individual and family/communal ownership) and rental, including sharecropping arrangements.

Table 3 summarizes land ownership and land in oil palm production: 69 per cent of households own land, with an average holding of 3.51 acres; and 30 per cent of households grow oil palm on an average of 2.62 acres. The variation in oil palm acreage is high, with a standard deviation (7.41) nearly three times the mean acreage.

For households that participate in oil palm production, the average size of an oil palm plot is 5.58 acres (Table 4). This yielded an average of UGX 27,800 in output per acre over the three months prior to the survey, with a very high standard deviation (UGX 180,000). The average total sales value per oil palm farm was UGX 2.07 million over the three months prior to the survey. Of the acreage in oil palm, 23 per cent involves mixed cropping, usually with cassava.

Table 3. Land ownership and oil palm acreage in sample (household level)

	Land ownership	Landholding (acres)	Fraction of oil palm growers	Area in oil palm (acres)
Mean	0.69	3.51	0.3	2.62
SD	(0.46)	(8.22)	(0.46)	(7.41)
N	391	391	391	391

Source: 2017 Kalangala Survey.

Table 4. Oil palm summary statistics (plot level)

	Plot size (acres)	Yield (UGX/ acre)	% Spoiled	Sales value	Mixed cropping	Inputs (share of plots using…)	
						Pesticide	Fertilizer
	Kalangala residents						
Mean	5.58	27,800	0.045	2,070,000	0.23	0.45	0.73
SD	(7.63)	(180,000)	(0.13)	(5,030,000)	(0.42)	(0.5)	(0.45)
N	159	144	143	159	162	162	162

Source: 2017 Kalangala Survey.

Instances of intercropping are decreasing over time (Figure 2). Only 20 per cent of early (i.e. 2005) planters intercropped their palms. A significantly higher percentage of growers who began planting palm in the past year (40 per cent) intercropped. Most plots (73 per cent) have fertilizer applied, and just under half (45 per cent) are treated with pesticides.

Oil palm fruit yield per acre displays a quadratic trend over time (Figure 3), with yield peaking after around eight years. In the first two years of planting (i.e. palm planted between 2015 and 2017), palm fields net no significant yields as seedlings are still growing. Over time (moving leftward in the figure), yields increase and reach a maximum, when plants have reached maturity, at which point yields start to fall. The highest yields in our 2017 survey were from palms planted around 2009. Yields were lower on palms planted prior to that.

Figure 2. Intercropping and oil palm planting year

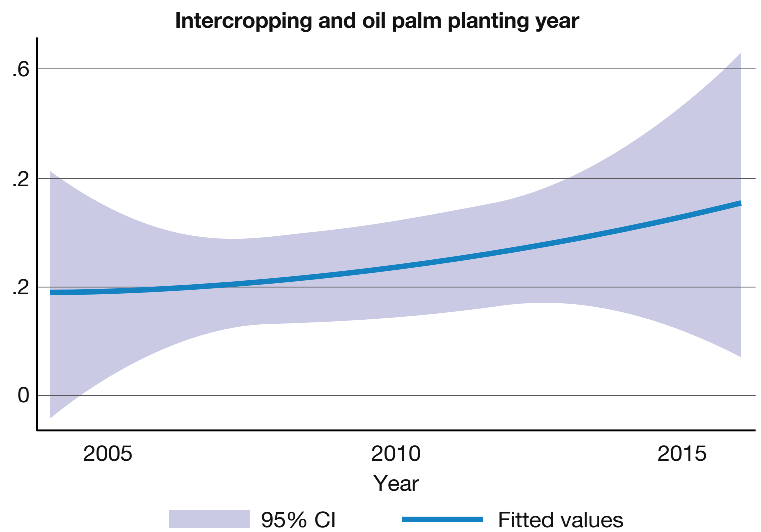
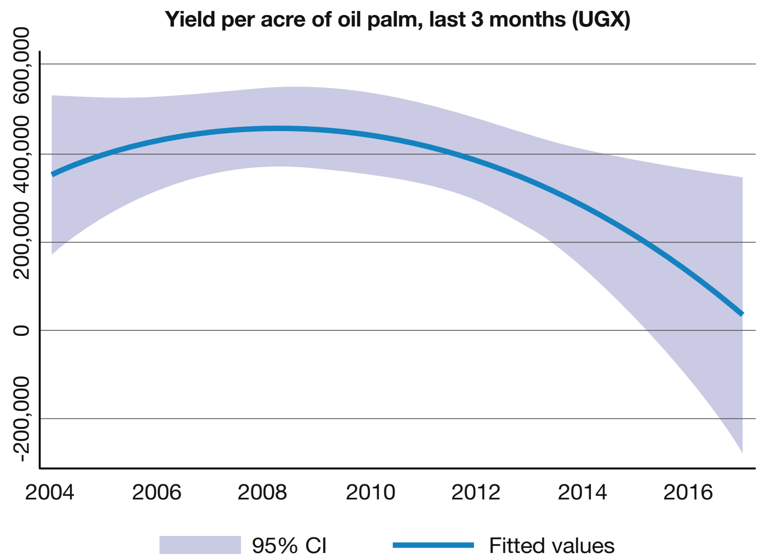


Figure 3. Yield per acre by planting year



Source: 2017 Kalangala Survey.

2.4 Emergence of the tourism industry

Recent expansion of the tourism industry in Kalangala district is at least partially driven by large infrastructure investments. Construction and operations of a local solar power-plant, together with improved power lines, cell service, ferry services and road conditions have helped create the environment for increased tourism activity on the island. The advent of tourism has had a substantial effect on local businesses. No dedicated hotels existed on the island prior to the early 2000s, whereas in 2015, roughly a fifth of tax revenue in Kalangala district came from tourism (Kalangala Tourism Board, 2015).[4]

An auxiliary survey of visitors going to and from the island via ferry provides us with some insight into the current magnitude of tourism activity. Visitors travelling to Bugala Island via one of two ferries (currently the only way to travel to the island) were asked to take a short survey on the purpose of their visit and their expenditures while on the island. Table 5 displays key summary statistics from the survey.

Just under half of the surveyed visitors cited tourism as the primary purpose of their visit and 23 per cent were international tourists, primarily from Europe (Germany and Sweden are major source countries). The average length of stay was three days. Tourists and non-tourists have an estimated daily expenditure of around UGX 0.26 million and UGX 0.22 million, respectively, or a total of UGX 0.62 million of on-island expenditures per visitor-trip. The majority of expenditures went to local services: 61 per cent went to housing (e.g. hotels and guestrooms) followed by food expenditures at 30 per cent.

In addition to expenditure statistics, the visitor questionnaire also asked a hypothetical question: "Would you have visited the island had there not been any resorts, paved roads or 24-hour electricity?" (these conditions characterized Bugala Island in the early 2000s) and 80 per cent responded negatively. Although it is hypothetical, this question provides insight into the importance of infrastructure development related to the oil palm project as a promoter of tourism development on the island.

Table 5. Kalangala tourist survey summary

	Tourism	International	Days stayed	Daily expenditure (UGX)		Hypothetical
				Tourist	Non-tourist	
Mean	0.44	0.23	3.0	264,000	221,000	0.2
SD	(0.50)	(0.43)	(3.1)	(250,000)	(411,000)	(0.41)
N	98	98	79	41	38	98

Source: 2017 Kalangala Tourist Survey.
Note: Discrepancies in sample size are due to respondents who did not provide information.

4. https://www.monitor.co.ug/News/National/Tourists-shun-Kalangala-sites/688334-2678516-13b430cz/index.html

3 LEWIE model calibration

The LEWIE offers a viable alternative assessment by simulating project impacts on incomes and welfare of project beneficiaries as well as non-beneficiaries, local production activities, employment and other outcomes of interest and constructing confidence intervals around simulated impacts. The LEWIE models were constructed from an econometric analysis of micro-survey data. In Kalangala, where the required microdata do not currently exist, this required carrying out surveys of a random sample of households and businesses.

3.1 LEWIE methodology

The Kalangala oil palm LEWIE was designed to evaluate the impact of oil palm production on incomes, welfare and production activities of project beneficiaries (the oil palm-farmer households) as well as non-beneficiaries on Bugala Island. Design of the Kalangala oil palm LEWIE was based on the general LEWIE modelling approach in Taylor and Filipski (2014).

To calibrate the LEWIE model, we first carried out econometric analysis of the survey data to construct separate models of project beneficiary households (i.e. the palm-growing households directly "treated" by the project) and non-beneficiary households (non-palm-growing households). Non-beneficiaries are not to be confused with control households in a conventional experiment. In an experimental analysis, control households, like beneficiaries, are eligible for the treatment, but they do not receive it because they reside in control sites. In our analysis, the non-beneficiaries are part of the island economy treated by the project, but they are ineligible to receive the treatment because they are not (or have not become) palm growers. We draw from a rich tradition in development economics of using survey data to construct agricultural household models (e.g. Singh et al., 1986; Taylor and Adelman, 2003).

Once we constructed separate models of beneficiary and non-beneficiary households, we combined them into a model of the whole Bugala Island economy. For this, we drew from another rich tradition in development economics – applied general-equilibrium modelling. Computable general equilibrium models are usually built for country economies using aggregate data. The LEWIE is unique in using general equilibrium methods to integrate micro household models into models of local economies, in the present case, the Kalangala LEWIE model.

3.2 Household and activity taxonomies

A practical household and activity taxonomy is needed to carry out simulations and compare outcomes across beneficiary and non-beneficiary household groups as well as across production activities. Groupings should reflect the characteristics of households and activities as well as the priorities of the evaluation. Project impact evaluation requires at least two groups: the treated group (in the present case, the palm growers who are beneficiaries of the project) and the non-treated group (households that do not grow palm and de facto are ineligible for the programme). In practice, the LEWIE model may include multiple treated as well as non-treated household groups and many different production activities. However, there must be sufficient data to estimate production and expenditure parameters for each group.

Our household taxonomy for the LEWIE model included three household groups: oil palm-cultivating households, palm-worker households and all other households on the island. The LEWIE methodology requires defining production activities in ways that are likely to reflect similar production technologies and/or interests of the study. Each household group may participate in one or more of these production activities, and may also purchase output (or implicitly purchase output from itself, in the case of subsistence production) from each of the activities. Our classification reflects the oil palm focus of the study. The activities include oil palm, other crop activities, livestock production, fishing, retail and other non-crop activities (which include services and non-crop production, including food processing). The nucleus estate and mill play a central role in the Kalangala economy as well as in the oil palm project. We gave each its own production activity account in the model. The nucleus estate produces oil palm fruit, hiring labour from households on Bugala Island and making other expenditures that may create linkages in the local economy. The mill processes fruit from the estate plantation as well as fruit purchased from small farmers who are beneficiaries of the project, sending the crude oil off-island.

3.3 Estimation of model parameters

We estimated the model parameters econometrically, using microdata from our surveys of households and businesses on Bugala Island. On the consumption side, we assumed linear expenditure functions of a Stone–Geary form without a minimum subsistence constraint, implying Cobb–Douglas utility. For each of the three aforementioned household categories, a set of expenditure regressions helped estimate marginal expenditure shares for crops, livestock, fishing and local business. We estimated a separate system of demand equations for each household group, yielding the group-specific marginal budget shares shown in Appendix Table A2. Table A2 shows that the households spend the largest share of their marginal income on retail and other non-agricultural activities, followed by crops, livestock and fishing. More than 80 per cent of household expenditures are in Kalangala.

On the production side, econometric estimation always requires making some assumptions about functional forms. Cobb–Douglas production functions are by far the most widely used in economics to represent technological relationships between inputs and outputs. They allow for non-linearities, including diminishing marginal returns to inputs, and they can be estimated with the data from our household and business surveys.

Table 6 reports the production function estimates. The parameter on each factor represents the elasticity of output with respect to the factor. This elasticity is also the factor's share in the activity's total value-added. Labour value-added shares range from 0.14 (crops, retail and other production) to 0.56 in small-scale livestock activities. The highest capital share (0.27) is in the production of livestock and livestock products (it corresponds to the animal stock itself). Land value-added shares are high in oil palm (0.54) and other crops (0.77). Purchased input shares in value-added are high for retail (0.68) and non-agricultural production (0.72) but relatively low in agricultural and livestock production.

The linkages created by production activities in Kalangala depend on the production functions as well as whether inputs are purchased on- or off-island. Table 7 summarizes the shares of inputs each activity purchases on and off Bugala Island. The first row in this table shows that the on-island input demand relative to total revenue is highest for livestock (0.65) and non-agricultural activities (excluding retail, 0.60). It is slightly lower (0.53) in agriculture, reflecting the demand for fertilizer, seed and other intermediate inputs purchased off-island. It is lowest (0.46) for retail, because most goods on store shelves come from off-island sources. Fishing uses almost no purchased inputs from off-island, so its local input share (not shown) is close to 1.0.

Table 6. Cobb–Douglas production functions

Variables	Agricultural production			Fishing	Business	
	Oil palm	Crops	Livestock		Retail	Other
Labor	0.41	0.14	0.56	0.33	0.14	0.14
se	(0.17)	(0.05)	(0.08)	(0.10)	(0.08)	(0.05)
Land	0.54	0.77	0.07	0.67	-	-
se	(0.16)	(0.05)	(0.03)	(0.10)	-	-
Inputs	0.05	0.10	0.10	-	0.68	0.72
se	(0.03)	(0.03)	(0.05)	-	(0.10)	(0.07)
Capital		-	0.27	-	0.17	0.14
se		-	(0.06)	-	(0.07)	(0.08)
Constant	2.5	11.5	7.7	1.7	7.0	8.0
se	(1.9)	(0.35)	(0.78)	(1.17)	(1.08)	(0.89)
N	98	129	248	53	114	129

Note: All variables transformed using inverse hyperbolic sine transform. White's robust standard errors in parentheses. Labour, inputs and capital measured in value (UGX); land measured in acres. Regressions constrained to have constant returns to scale.
Source: Authors' estimates using survey data.

Table 7. On- and off-island input purchases as share of activity gross revenue

Input shares		Ag	Livestock	Retail	Non-ag
On-island	Mean	0.528	0.65	0.461	0.601
	SD	0.374	0.317	0.352	0.382
Off-island	Mean	0.472	0.35	0.539	0.399
	SD	0.374	0.317	0.352	0.382

Source: 2017 Kalangala Survey.

Estimating income spillovers from palm production is a key objective of the LEWIE analysis. Income spillovers depend not only on the share of income spent in Kalangala, but also on which goods and services households spend their income on, as well as where these activities, in turn, obtain inputs. Real income multipliers also depend on the local supply response to increases in demand, which influences prices and thus the purchasing power of cash in Kalangala. The more elastic the response, the larger the real-income impact and the smaller the inflationary impact. If households' budget share on goods and services from a given activity – say, retail – is large, but the activity spends a large share of its revenue on inputs obtained off-island, the impact on island income might be limited. On the other hand, large budget shares combined with high on-island activity input shares can translate into large island income multipliers.

Supply elasticities depend, in part, on the elasticity of factor input supplies. Labour is an important input for all activities. Very few reliable estimates of labour-supply elasticities exist in the development economics literature, and these elasticities are not estimable from cross-section data. We assume an elastic labour-supply in Kalangala. We believe this assumption is justified for two reasons. First, the Kalangala economy, like that of the rest of Uganda, is characterized by high unemployment. This implies that additional workers can readily be induced to supply their labour as the labour demand expands. Second, most of the population on Bugala Island was born outside of Kalangala. This implies a very open demographic system that can readily bring new workers to the island as the demand for labour increases. A high labour-supply elasticity keeps wage increases in check as the local demand for labour rises. The Kalangala labour market adjusts to changes in labour demand via the supply of workers rather than through wage changes.

4 Results

The calibrated model was used to simulate the island-wide impacts of (1) an additional acre in oil palm production, (2) a 1 per cent increase (equivalent to 108.7 additional acres of mature oil palm) in the total amount of land in oil palm production, (3)–(4) a 1 per cent increase or decrease, respectively, in the farm gate price per FFB of oil palm fruit and (5) a 10 per cent increase in total factor productivity in oil palm production. Table 8 shows impacts on total nominal (cash) income and real income (Bugala Island GDP), the income of each household group (including households that do not grow oil palm) and total sales in each production activity. For simulations (2)–(5), Table 9 presents average per-household impacts.[5] The simulation results appear in columns (1)–(5) in Table 8 and (2)–(5) in Table 9. In both tables, the top panel describes the simulation. In Table 8, the second panel reports impacts on total income, the third, impacts on income by household group, and the bottom panel, impacts on production and employment. All impacts are in millions of UGX, except for employment, which is in person-days. Standard errors generated using the Monte Carlo method in Taylor and Filipski (2014) appear in parentheses underneath total income impacts.

4.1 Impact of additional acreage in oil palm

Columns (1) and (2) report impacts of an additional acre and a 1 per cent increase in acreage of mature (fruit-bearing) oil palm. The direct impact of increasing oil palm acreage is to increase production of oil palm fruit; a 1-acre expansion increases the value of oil palm output by UGX 1.77 million annually (see bottom panel of Table 8). This creates new income for palm-cultivating households while increasing the demand for labour and other inputs. Employment in oil palm rises by approximately 31 additional worker-days (13 in palm-cultivating households and 18 in oil palm-worker households; see bottom panel of Table 8). Higher wage labour demand transmits impacts to wage-labourer households. Rising income in palm-producer and wage-labourer households stimulates the local demand for goods and services, as these households spend their cash. Production to satisfy this demand creates new demand for labour and other inputs across the spectrum of production activities, and this unleashes multiple new rounds of income, demand and production gains, creating production and income spillovers.

Once this process settles into a new equilibrium, all production sectors on the island expand as a result of the new acreage in oil palm. The largest production impact is on the retail sector, whose sales increase by UGX 660,000. This is not surprising given the large share of household budgets spent on retail (see Appendix Table A2). Other non-agricultural production also expands significantly by UGX 490,000. Bugala Island's agricultural and livestock outputs each rise by UGX 70,000.

5. We do not report average per-household impacts of simulation (1), because the impact of an additional acre in oil palm, spread across the island's 16,791 households, logically is small.

Fish output drops slightly, as fishing (a declining activity, given overfishing of Lake Victoria) must compete with other activities for inputs, particularly labour. The LEWIE simulations show that increasing oil palm by 1 acre reduces fishing income (production effects) by UGX 0.01 million, or 10,000 Ugandan shillings, annually. As a comparison, empirical estimates (Appendix Table A4) show that increasing the acreage of oil palm by 1 acre decreases the probability of a fisherman participating in fishing by roughly one percentage point. Assuming most fishermen fish six months out of the year, the empirically estimated reduction in fishing income is UGX 14,400, slightly higher than the 10,000 Ugandan shillings estimate from the LEWIE model. However, such a calculation using empirical estimates does not take into account daily costs of fishing (e.g. bait, tackle, gas), and thus is likely to slightly overstate losses from a reduction in fishing activities.

Total wage income on the island rises by UGX 960,000, which translates into approximately 127 worker-days at the prevailing daily wage of UGX 7,552. Most of this total employment impact (96 worker-days) is in households that do not produce oil palm.

The additional acre in oil palm increases total island income by considerably more than the increase in value of oil palm production. Cash income increases by UGX 2.23 million per additional acre in mature oil palm plantings. Higher demand has a slight inflationary effect, reducing the purchasing power of cash. Adjusting for inflation, the increase in total real income is UGX 1.93 million.

Table 8. LEWIE model results

Impacts on total income (annual in million UGX)					
	Increase oil palm land by 1 acre	**Increase oil palm land by 1% of total acreage**	**Price of oil palm FFB rises by 1%**	**Price of oil palm FFB drops by 1%**	**TFP goes up by 10%**
Description of simulated impact	Increase total oil palm land by UGX 0.89 million, which is the monetized value of an acre (in rental rates, annual)	Increase total oil palm land by 1% (108.7 acres, monetized value = UGX 97.14 million)	Increase output price by 1% (for oil palm only)	Reduce output price by 1% (for oil palm only)	Increase total factor productivity by 10% (for oil palm only)
Change in island income					
Nominal income (cash)	2.23	242.05	472.20	-466.73	4,975.49
Real income (GDP of local economy)	1.93	210.16	409.94	-405.43	4,307.07
Standard error	(0.59)	(63.65)	(126.66)	(120.49)	(1,593.50)
Confidence interval: 5% Lower bound	1.30	141.19	274.33	-594.79	2,785.82
Confidence interval: 5% Upper bound	2.85	309.58	606.39	-273.36	6,600.83

Change in household incomes (real)					
Oil palm	1.02	110.36	215.10	-213.10	2,241.62
Standard error	(.06)	(7.02)	(14.46)	(12.83)	(228.22)
Non-oil palm	.80	87.49	170.81	-168.61	1,810.84
Standard error	(.45)	(48.71)	(96.51)	(92.58)	(1,176.51)
Palm worker	.11	12.31	24.03	-23.72	254.61
Standard error	(.07)	(7.96)	(15.75)	(15.15)	(189.48)
Production effects (in monetary value)					
Local crops	.07	7.81	15.22	-15.09	158.11
Standard error	(.02)	(2.43)	(4.82)	(4.64)	(57.45)
Local meat	.07	7.42	14.48	-14.31	152.53
Standard error	(.03)	(3.03)	(6.00)	(5.76)	(72.24)
Fish	-.01	-.93	-1.82	1.80	-18.95
Standard error	(.00)	(.54)	(1.06)	(1.03)	(12.09)
Oil palm	1.77	192.73	185.73	-185.10	3,960.58
Standard error	(.53)	(57.93)	(114.19)	(110.63)	(1,464.99)
Local retail	.66	72.20	140.84	-139.28	1,480.19
Standard error	(.20)	(21.42)	(42.62)	(40.53)	(538.06)
Local services	.49	53.67	104.72	-103.51	1,102.94
Standard error	(.18)	(19.19)	(38.09)	(36.40)	(470.39)
Employment (person-days)					
All households	127.0	13,815.1	26,973.9	-26,618.6	286,378.2
Standard error	(74.1)	(8,036.6)	(15,921.6)	(15,271.4)	(194,580.2)
Oil palm	13.0	1,407.0	2,747.3	-2,711.1	29,166.5
Standard error	(7.9)	(818.5)	(1,622.0)	(1,555.8)	(19,817.2)
Non-oil palm	95.8	10,456.4	20,416.1	-20,147.2	216,759.3
Standard error	(55.6)	(6,082.8)	(12,051.1)	(11,558.5)	(147,277.5)
Estate worker	18.1	1,951.5	3,810.4	-3,760.2	40,452.4
Standard error	(10.5)	(1,135.2)	(2,248.4)	(2,157.0)	(27,485.4)

Source: Authors' estimates using survey data.

Not surprisingly, the largest income gain goes to palm-producing households. They benefit both directly, by cultivating slightly more land, and indirectly by receiving some of the income spillovers resulting from increased economic activity on the island. (For example, some palm-producing households have members who own non-palm businesses or work for others who do.) Their real income rises by UGX 1.02 million per additional acre in oil palm. Nevertheless, real income in households that do not cultivate palm increases by UGX 800,000, and oil palm-worker household incomes increase by UGX 110,000. These numbers reflect the considerable income spillovers that oil palm production creates in Kalangala. We find that the increase in oil palm acreage has a negative impact on total fishing activity (a reduction in fishing income of around UGX 10,000), but it stimulates cropping and livestock activities. Rising demand for consumption goods (in this case, crops and livestock products) indicates substantial increases in island residents' purchasing power via direct and spillover effects of oil palm production.

A 1 per cent increase in mature oil palm acreage (simulation 2) has impacts that are similar to those from the 1-acre increase, but they are scaled up considerably (a 1 per cent increase is equivalent to 108.7 additional acres in mature oil palm). Total real income in Kalangala rises by UGX 210 million. Table 9 reveals that the 1 per cent expansion in oil palm increases household income in Kalangala by an average of UGX 14,415 (cash) and 12,516 (real). (The average household income effects in Table 9 are the total income effects spread evenly across Bugala Island's 16,791 households.)

Table 9. Per-household income impacts (annual in UGX)

	Increasing oil palm land by 1%	Price of oil palm FFB rises by 1%	Price of oil palm FFB drops by 1%	Total factor productivity goes up by 10%
Description of simulated impact	Increase total oil palm land by 1% (108.7 acres, monetized value = UGX 97.14 million)	Increase output price by 1% (for oil palm only)	Reduce output price by 1% (for oil palm only)	Increase total factor productivity by 10% (for oil palm only)
Change in total income per household				
All households, nominal (cash)	14,415.19	28,122.29	-27,796.60	296,318.60
All households, real (GDP of local economy)	12,516.37	24,414.55	-24,145.86	256,510.81
Real income change by household group				
Oil palm	61,311.32	119,499.8	-118,389.0	1,245,344.0
Standard error	(3,899.85)	(8,033.33)	(7,127.78)	(126,788.9)
Non-oil palm	6,734.98	13,148.60	-12,978.96	139,392.16
Standard error	(3,749.52)	(7,428.99)	(7,126.47)	(90,563.47)
Estate worker	6,153.93	12,015.72	-11,861.55	127,305.11
Standard error	(3,979.61)	(7,875.00)	(7,575.00)	(94,740.00)

Source: Authors' estimates using survey data.

Impacts of oil palm price shocks

While generating income for Kalangala households, oil palm production exposes producers as well as the Kalangala economy as a whole to swings in market prices for oil palm fruit. Market linkages transmit the impacts of palm-fruit price shocks throughout the island economy. They magnify the benefits from positive price shocks, but also the adverse effects of negative shocks. They are considerably larger than the impacts of a 1-acre increase in palm area, because a change in the farm gate FFB price affects the profitability of every acre in oil palm.

The FFB price change directly affects palm producers. As their incomes change, so do their expenditures on goods and services sold by other households on the island. Palm producers also may alter their demand for labour and other inputs. Changes in palm households' consumption and input demands transmit the impacts of the price shock throughout the Kalangala economy.

A 1 per cent price increase raises the value of oil palm fruit production by UGX 185.7 million. This results in a UGX 472 million increase in the island's total nominal income and a UGX 410 million increase in real income. These translate into average cash and real income gains per household of UGX 28,122 and UGX 24,415, respectively.

The positive price shock stimulates production in all sectors except fishing – Kalangala retail sales rise by UGX 141 million; crop and livestock production increase by UGX 15 and 14 million, respectively; and other production increases by UGX 105 million. Total employment rises by just under 27,000 person-days. Most of the employment gain (20,416) is in non-palm-producing households.

Simulations on price reductions for FFBs highlight the vulnerability of the entire island economy to market price shocks. The impacts of a 1 per cent decrease in FFB price are similar in magnitude to the impacts of a 1 per cent price increase, but negative. The value of oil palm fruit production falls by UGX 185.1 million. This results in a UGX 467 million decrease in total cash income and a UGX 405 million drop in real income, equivalent to average cash and real-income losses per household of UGX 27,797 and UGX 24,146, respectively. A formula used to determine farm gate prices ties local FFB purchase prices to global market prices. Sharp and continuous declines in world palm oil prices would likely result in even larger losses should households currently growing oil palm reduce their acreage or stop cultivation altogether. Persistent low prices for FFBs are likely to act as a disincentive for non-palm growers to adopt. A negative FFB price shock causes a contraction in all production sectors except fish. Island retail sales fall by UGX 139 million; crop and livestock production fall by UGX 15 and UGX 14 million, respectively; and other production decreases by UGX 103 million. Total employment decreases by 26,619 person-days, with most of the employment loss (20,147 person-days) in non-palm-producing households.

4.2 Impacts of increased productivity on oil palm plantations

Productivity on Bugala Island's small-scale palm plantations is significantly lower than on the OPUL estate plantation, and Figure 3 showed a decline in productivity over time. Declining productivity potentially has adverse effects on the island economy as well as on the livelihoods of palm farmers. We simulated the island economy-wide impact of a 10 per cent increase in oil palm productivity for smallholder farmers. The findings appear in column (5) of Table 7 and column (4) of Table 8.

Increased productivity impacts palm households directly, by increasing FFB output. This boosts profits from palm cultivation while increasing palm farmers' demand for labour and other inputs. The bottom panel of Table 7 shows that employment increases by 29,167 person-days in oil palm households and by 40,452 in palm-worker households. Higher wage labour demand transmits impacts to wage-labourer households. Rising income in palm-producer and wage-labourer households stimulates demand for goods and services, as these households spend their cash. Production to satisfy this demand creates new demand for labour and other inputs across the spectrum of production activities, and this unleashes multiple new rounds of income, demand and production gains, creating production and income spillovers. Total employment increases by 286,378 person-days, considerably more than the employment gains in palm-grower and palm-worker households.

As markets transmit the influences of higher palm productivity through the economy, all sectors expand. Total output value rises by UGX 158 million in crops, UGX 153 million in livestock, UGX 1.5 billion in retail and UGX 1.1 billion in other production activities.

The 10 per cent increase in palm productivity raises total cash income on Bugala Island by UGX 4.97 million. Adjusting for inflation, real income increases by UGX 4.3 billion. Non-oil palm-producing households gain nearly as much in real income (UGX 1.8 billion) as palm-farming households (UGX 2.2 billion). Palm-worker households also benefit from higher productivity on oil palm plantations (UGX 255 million). Averaged across all of the island's 16,791 households, the 10 per cent increase in palm productivity raises income by UGX 296.3 million (UGX 256.5 million in real terms).

5 Conclusions

Our analysis of survey data and LEWIE simulations reveal the importance of oil palm cultivation not only for palm farmers but for the Kalangala economy as a whole. As oil palm acreage expands, so does palm farmers' demand for labour and other inputs. Payments to workers spread benefits to palm-worker households. As profits increase in palm-farmer households and wages rise in worker households, these households increase expenditures on goods and services supplied by other households and businesses on Kalangala's main island of Bugala. Market linkages spread the benefits of oil palm production through the entire island economy. Our simulations offer insight into how the Kalangala economy has grown in tandem with oil palm expansion, and why there is a high correlation between acreage in oil palm and new business formation.

Increases in oil palm acreage, oil palm productivity or FFB prices benefit palm-farmer and -worker households. But our simulations show that the impact on total island income is substantially greater than the impact on oil palm-farmer and -worker households. Each additional acre of mature oil palm adds UGX 2.2 million annually to the Bugala Island economy (UGX 1.9 million if adjusted for inflation). Of this, UGX 800,000 goes to households that do not participate in oil palm production. An additional acre of oil palm creates 127 person-days of employment, 95.9 of which are in households that do not grow or work with oil palm. All sectors of the economy expand, with the exception of fishing, which appears to compete with oil palm for island labour. A 1 per cent (108.7 acre) expansion in oil palm plantations raises total cash income on the island by UGX 242 million and total real income by UGX 210.1 million.

Our simulations suggest that interventions that raise productivity on oil palm plantations and insure palm farmers against price shocks could provide large benefits for palm farmers and workers as well as for the entire Kalangala economy. Average productivity is low on small-scale palm plantations, and it appears to be declining over time. Based on our simulations, a 10 per cent increase in oil palm productivity would raise total cash income on Kalangala's Bugala Island by nearly UGX 5 billion annually. Non-oil palm-producing households would capture nearly half of this income gain, and all production sectors except fishing would expand. A 10 per cent increase in palm productivity would add more than 286,000 person-days of new employment to the island economy, of which nearly 217,000 would be in non-palm-producing households.

Palm households' livelihoods are intimately linked to global oil palm prices, and so is the livelihood of the Kalangala economy as a whole. Our simulations show that when oil palm fruit price shocks hit producers, the effects ripple through the entire island economy. Negative FFB price shocks reduce employment much more in non-palm-producing households than in palm-farmer or -worker households. This finding suggests that measures to protect small-scale palm farmers from adverse price shocks would create benefits for non-palm households. For example, an intervention that provides palm farmers with insurance against FFB price shocks would also insure the Kalangala economy as a whole. Adjustments to the pricing formula of FFBs (e.g. implementing a price floor) could be an alternative strategy to ensure sustainability of oil palm production and mitigate adverse local economy effects of price reductions in the global market for palm oil.

This analysis underlines the importance of using an economy-wide approach to evaluate the impacts of development programmes. It reveals that oil palm cultivation creates large production, income and employment spillovers. By ignoring these spillovers, we miss many or even most of the income and employment impacts of oil palm production. Production, employment and income spillovers offer an explanation for the rapid expansion of the Kalangala economy following the introduction of oil palm. They also raise concerns about the Kalangala economy's sensitivity to oil palm fruit price shocks and declining productivity of palm plantations. A local-economy impact evaluation approach can be a basis for designing interventions that benefit small-scale oil palm farmers, workers and the entire economy of which they are part.

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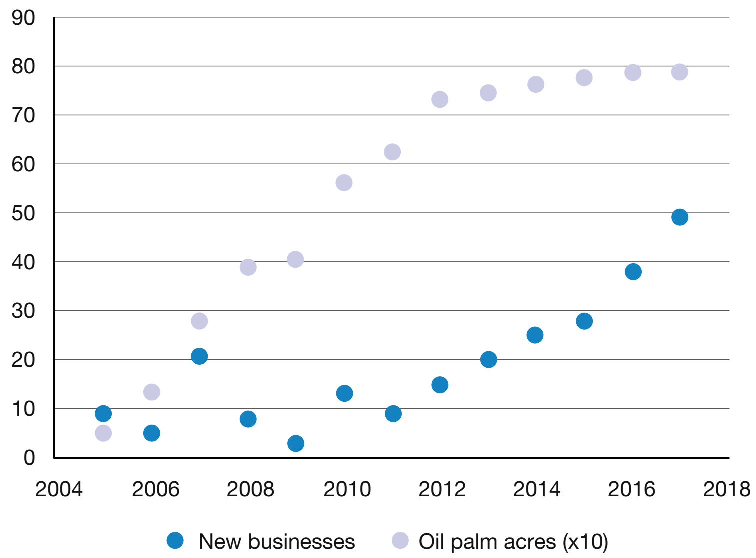
Appendix

Table A1. Livestock holdings and transactions for Kalangala residents (annual 2017)

		Livestock value*	Livestock purchases^	
	Livestock growers		% purchased on island	% from other HHs
Mean	0.62	1,657,000	0.96	0.73
SD	(0.49)	2,600,000	(0.20)	(0.45)
N	391	242	144	144

* Livestock value calculated for households with positive livestock holdings
^ Table only displays percentage on island and percentage from HHs conditional on a transaction occurring
Source: 2017 Kalangala survey

Figure A1. Correlation between mature palm acreage and new businesses



Source: Constructed by authors using survey data.

We used an autoregressive distributed lag model to estimate the correlation between new business development and mature oil palm acreage (i.e. acreage in plantations five or more years old). The results (not shown) reveal that, other things being equal, a 100-acre increase in mature oil palm plantations is associated with the creation of 1.2 new businesses in Kalangala ($t = 2.78$). Controlling for mature palm acreage, there is not a significant relationship between new business development at times t and $t - 1$. Total palm acreage (including plantations that do not yet yield fruit) does not have a statistically significant relationship with new business development – only mature palm acreage does. It appears that, in order to simulate business growth, plantations have to be of productive age – just as one would expect..

Table A2: Marginal expenditure share regressions

		Oil palm-growing households	Non-grower households	Oil palm-worker households
Crops	**coeff.**	0.083	0.055	0.128
	SE	0.016	0.010	0.015
Livestock	**coeff.**	0.019	0.046	0.072
	SE	0.006	0.008	0.010
Fish	**coeff.**	0.244	0.197	0.214
	SE	0.039	0.020	0.041
Retail	**coeff.**	0.324	0.269	0.240
	SE	0.033	0.016	0.025
Service	**coeff.**	0.125	0.260	0.163
	SE	0.027	0.013	0.020
Total exp share on island		0.794	0.826	0.817

Source: Authors' estimates using survey data.

Fishing and palm production

Despite increased regulation of equipment and practices at the time of survey, fishing remains an important income-generating activity for many residents. In recent years, several packing and shipping centres have opened in Kalangala, purchasing from local fishermen and exporting the catch, creating a relatively stable buyer for their output. Table A3 summarizes key statistics for fishing. Fishing is a lucrative (though risky) endeavour and is performed almost entirely by males. While the average monthly earnings are substantial, there is a lot of uncertainty in earnings due to the nature of the activity. The average fisherman makes just under UGX 1.8 million monthly, selling over 70 per cent of his catch. Start-up costs for fishing can be high because the average asset value of fishing equipment is over UGX 17 million, and nets and boats require constant maintenance, further adding to this cost.

Table A3: Fishing income and assets

	Catch value (monthly, UGX)	Proportion sold	Asset value (UGX)
Mean	1,778,000	0.71	17,200,000
SD	(4,700,000)	(0.28)	(70,000,000)
N	51	43	51

Source: 2017 Kalangala Survey.

In addition to their current conditions, the survey also records retroactive recall data at the individual level for historical fishing activity, dating back to 2003 (before the introduction of oil palm in Kalangala). Enumerators were instructed to guide recall for fishing activities in both the extensive (whether a fisherman did any commercial fishing in a given year) and intensive margin (whether a fisherman fished for more than three months commercially in that year). Statistical estimates show a significant correlation between fishing and oil palm growing: the likelihood of an individual participating in fishing activities is 28.1 per cent lower once households begin to harvest from oil palm groves (four years after planting; see Table A4). While we find a strong negative correlation between the probability that a fisherman fishes in a given year and owning a (harvestable) oil palm plot, the size of the plot does not strongly influence the probability of fishing. Fishing households that own a mature oil palm plot reduce their fishing activities by 19 per cent, controlling for the size of the plot, while each additional acre further reduces the probability of fishing by 1 per cent per acre. Fishing households that participate in oil palm production reduce their fishing activities, even when plot sizes are limited.

Limitations to retroactive recall data include recall error and a potentially selective sample (i.e. fishermen who switched to other activities and left Kalangala are not captured in the survey).

Table A4: Fishing activity and oil palm

	Baseline model	Baseline model 2
Age	0.030***	0.030***
	(0.002)	(0.002)
Oil palm	0.012	
	(0.041)	
Mature oil palm	-0.286***	-0.281***
	(0.047)	-0.044
Cons	-0.116*	-0.120*
	(0.065)	(0.064)
R2	0.15	0.15
N	97	97

*Dependent variable is dummy variable for fishing in a given year. Oil palm variable takes the value of 1 should the household have an oil palm plot in a given year, 0 otherwise. Mature oil palm takes the value of 1 should a household have a harvestable plot of oil palm (4+ years post-planting) in a given year and 0 otherwise. Robust standard errors in parentheses.
Source: Authors' estimates using survey data.

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