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Food Security during the COVID-19 Pandemic: the Impact of a Rural Development Program and Neighbourhood Spillover Effect in the Solomon Islands

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Abstract

We examine differences in food security indicators between (rural development program) treated and untreated farmers in the Solomon Islands in the COVID-19 post-treatment period. Our findings show that treated farmers report significantly lower nutrition problems in the pandemic period. We as well consider that the project in its components (building local infrastructure, transmitting knowledge and competences and providing links and easier access to business partners) can produce positive spillovers in terms of externalities to control farmers in proportion to their geographical proximity to treatment farmers. Our findings are consistent with this hypothesis since the majority of treatment nutrition score outcomes are enhanced when controlling for spillover effects.

Keywords: rural development, nutrition.

JEL Codes: I31 (general welfare wellbeing); Q18 Agricultural Policy, Food Policy.

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1 Introduction

Global shocks such as the COVID-19 pandemic and the climate threat are dominant features of our times. Their impact on poverty indicators for low-income populations and the role that rural development programs can have in providing tools for the same populations to deal with these shocks is a crucial and underinvestigated research area.

Our paper provides a contribution to the issue by testing the effect of a rural development program on a sample of poor farmers in a small-scale island society such as the Solomon Islands in the Pacific. More specifically, we focus on the effects of the program on nutrition problems in the post-treatment COVID-19 period. Rural development programs carried on by international organizations such as IFAD can represent nowadays crucial opportunities for low income countries. The intervention can take the form of direct money injections such as cash transfers, for example, which have been increasingly adopted as means for poverty reduction and social protection strategies (Hanlon et al. 2010, Honorati et al. 2015), or microfinance programs (Quinones et al. 2014). Development programs can alternatively involve the development of local infrastructures and services (Blumenfeld et al. 2019), skill training (Alfonsi et al. 2017, Lachaud et al. 2018) or improvement of farmers access to export markets through fair trade initiatives (Maclellan 2016).

Solomon Islands are a particularly interesting target of rural development programs due to their low levels of education and economic development, as well as high exposure to natural disasters such as floods, droughts and tsunami (Leal Filho et al. 2020) and high dependence of local farmers on natural resources and support from governments and international organizations. Development programs carried on in these areas include intervention on international trade (Schep, 1997), local institutions and policies (Dinnen and Haley 2012), literacy (Singh 2001), gender inequalities (Lawless et al. 2017), food security (Cleasby et al. 2014, Hudson et al. 2017) and climate change (Neelim and Vecci 2013, Basel et al. 2020). The paper contributes originally to this literature since we analyse post-treatment effects of a rural development program on a target of very poor farmers in an extraordinary period such as the COVID-19 pandemic controlling for spillover effects. In this respect our findings provide evidence on how rural development programs can help beneficiaries to cope with nutrition problems in the interplay of environmental, social and pandemic shocks. Our main findings show that treated farmers, being targeted from the project as the poorest and more in need, have significantly lower nutrition problems in the post-treatment pandemic period. Results are confirmed and goodness of fit enhanced in the majority of cases when we account for spillover externalities proportional to geographical proximity of control to treatment farmers. Our two main findings are consistent with the fact that: i) the analysed rural development program empowers beneficiaries by strengthening their business partnerships along the product chain, improving access to market and product transformation and providing infrastructure and welfare support; ii) non treated farmers can partially benefit from these programs in proportion to their geographical proximity when such programs involve the provision of local public goods and create knowledge spillovers. Findings of our paper provide evidence and stimulus for policy suggestions in dealing with nutrition problems when local populations are hit by climate, economic and pandemic shocks as it has occurred in recent times and is unfortunately not unlikely to occur in the next future.

2 Description of the RDP II in the Solomon Islands

The Solomon Islands are part of the Small Island Developing States (SIDS) in the Pacific, a group of developing countries that share different economic, climate and social challenges. Crumpler and Bernoux (2020) identify the Pacific agro-ecosystems as the most vulnerable, followed by oceans and coastal zones. Among the affected sub-sectors, marine fisheries and crops are considered the most vulnerable to climate change (79 and 64 percent), followed by livestock and forestry. The totality of countries in the Pacific region report observed and/or expected climate-related impacts, vulnerability and risk in both social and agricultural systems. Indeed, most countries in the area suffer from health deterioration (93 percent), loss of productive infrastructure, assets and food insecurity, malnutrition, rural livelihoods and income loss (71 percent each) since social dimensions are strongly at risk under climate change (FAO, 2020). This is because some among the worst climate disasters of the past few decades occurred in Pacific island countries, which are exposed to damage from high speed winds and heavy rains for their geographical proximity to the Cyclone Belt. Due to these common characteristics the Pacific islands are facing in per capita terms the highest expected costs from disaster risk globally, a problem that is likely to be underestimated due to data gaps and lack of proper investigation. This is particularly the case of the Solomon Islands that are located near the tectonic boundary between the Australian and the Pacific plates, which makes the region seismically active, with high exposure to earthquakes, locally generated tsunamis and volcanic eruptions (Noy, 2016). In order to address these challenges at domestic level and with the support of international institutions the Alliance of Small Islands States participates to the Paris Agreement with the Nationally Determined Contributions representing the main national policy framework under the United Nations Framework Convention on Climate Change (UNFCCC). The United Nations through different organizations such as IFAD, FAO, UNDP and UN-Habitat, are widely committed to follow this path. Within this framework the Rural Development Program is a project of the International Fund for Agricultural Development which is part of IFAD 11, the set of interventions completed by the Organization in the period 2019-2021.[1]

The rural development program under inquiry is a five-year (2015-2019) nation-wide project that aims to improve basic infrastructure and services in rural areas and strengthen the linkages between smallholder farming households and markets in the Solomon Islands. It includes two main components: i) Component 1 focused on community infrastructure and services and aiming to retain and refine the community-driven development mechanisms developed during the program; ii) Component 2 focused on : i) building agricultural partnerships and support aiming to assist farming households to engage in productive partnerships with commercial enterprises, ii) reinforcing the capacity of the Ministry of Agriculture (MAL) to deliver its core functions of regulation, research and sector coordination, and iii) restoring the productive assets of households critically affected by the April 2014 flash floods.

2.1 Component 1: community infrastructure and services

The RDP II program placement is non-random as it is targeted to the poorest farmers and differs depending on the component project activities. The IFAD Rural Development Program invests in small infrastructures for local communities of the treated farmers such as community access roads, bridges, docks, water supply stations, community halls, classroom buildings, health

[1] More specifically, the program is part of the 15 percent of projects that the Organization chooses to carry out an ex-post impact assessment. Following IFAD's Development Effectiveness Framework (IFAD, 2016), in the RDP II Impact Assessment, scholars and researchers have demonstrated that the project had significant results on the progress toward achieving the Sustainable Development Goals (SDGs) in Solomon Islands, as well as the Pacific, in particular related to the Sustainable Development Goals SDG1 "no poverty", SDG2 "zero hunger" and SDG6 "clean water and sanitation" (Desa, 2016).The key outcome and impact indicators of interest in this project relate closely to the IFAD's Strategic Goal and Objectives (SOs): increased economic mobility (Goal), increased agricultural productive capacity (SO1), strengthened linkages between smallholder farmers and agricultural markets (SO2), and greater environmental sustainability and climate resilience (SO3).

centers and staff housing. This project component includes community development grants and community level support by Community Helpers and Technical Community Helpers who produce engineering and technical services.

Component 1 activities are implemented in all provinces of the Solomon Islands and are administered at the ward level. Each sub-project covers one or more villages within a ward. In Guadalcanal province, RDP II activities are implemented in 40 villages to repair or rebuild community infrastructures in the villages worst affected by the flash floods in April 2014. The process of identifying villages to receive funding for sub-projects follows a number of steps. Ward development committees (WDCs) asked each village to elicit their development priorities based on a ranking from 1 to 5. Then, WDCs selected two villages in each ward to receive funding for sub-projects from RDP II for activities according to their elicited priorities. The amount of funding provided to each sub-project is approximately 200,000 Solomon Islands (SI) dollars per village. Village members are expected to contribute in-kind assistance to sub-projects in the form of inputs, construction materials, and labor. The average value of the in-kind assistance contributed by each village is estimated at 30,000 SI dollars.

2.2 Component 2: agricultural partnerships and support

The second component project activities differ based on the type of commodities supported through agricultural partnerships. They aim to assist local farmers to engage in productive partnerships with commercial enterprises, to reinforce their market access by strengthening links with lead partners (providing also capacity building services) that ease the connection among the different stages of the product chain such as agricultural production, transformation, transport and sales. Component 2 activities are only implemented in eight of the nine provinces (excluding the Central province) and are administered broadly at the constituency (group of rural wards) level. Agricultural partnerships and support of RDP II provide grants to agribusinesses, or lead partners, to invest and expand their business activities. Lead partners source agricultural products from aggregators, or co-partners. Co-partners would then buy agricultural commodities directly from farmers at the village level and process them into agricultural products. The total number of agricultural partnerships supported by RDP II is 35. Figure 1 show in Table 1s The RDP II coverage area on the map of Solomon Islands is shown in Figure 1.

3 Research hypotheses

As mentioned above, the IFAD Rural Development Program (Component 1) invests in small infrastructures for local communities of the treated farmers. This project component includes community development grants and community level support by Community Helpers and Technical Community Helpers who produce engineering and technical services. While grants tend to have limited temporary effects, the community level support of experts tends to increase know-how and capabilities of treated farmers over time. As described above the overall strategy of the intervention is based on priorities elicited by village members also aiming to address consequences of the 2014 flash flood shock. The second component of the program (Component 2) reinforces market access of local farmers by strengthening links with lead partners (providing as well capacity building services to farmers) that ease the connection among the different stages of the product chain such as agricultural production, transformation, transport and sales. This component includes access to the Agriculture Supplemental Equity Facility scheme that finances projects with growth potential where 20 percent of costs are borne by the farmer, 60 percent by the bank and 20 percent by a project grant. This means significantly subsidised access to bank loans for treated farmers.

Our research hypothesis is that the direct and indirect effects of actions from Components 1 and 2 (investment in infrastructure, capacity building, reinforced access to the agricultural product chain and intervention to address the 2014 flash flood shock) reduce the likelihood of nutrition problems that can arise when respondent households are hit by climate and pandemic shocks. The rationale is that improved community infrastructure (see section 2.2 and especially improved water supply stations and access to community halls and, in general. community infrastructure and relationships) and capacity building helps treated households to absorb shocks and avoid situations in which some of their members can suffer from food shortage (component 1). At the same time improved access to markets and strengthened links with business partners along the product chain raise the market value generated by crops and therefore can generate additional financial resources that can be used to face economic shocks that can lead to nutrition problems (Component 2).

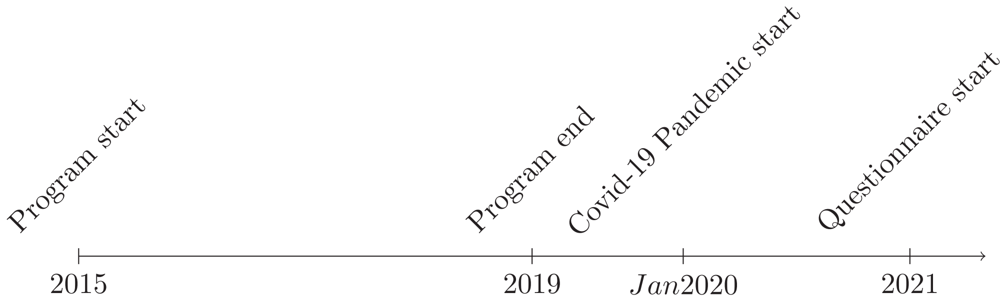
H01: The rural development program significantly improves nutrition outcomes of treated farmers.

As explained in section 2.1 the rural development program is composed of two parts. The first relates to community infrastructure and services and the second to agricultural partnership and support. Some elements of the treatment such as grants are clearly private goods but others involve public good and externality characteristics where geographical proximity can help untreated farmers to capture part of its benefits. These factors can reduce impact differences between treated and control farmers thereby making project impact less visible. More specifically in the first case (program component one) the creation and implementation of small infrastructures for local communities of the treated farmers (community access roads, bridges, docks, water supply stations, community halls, classroom buildings, health centers and staff housing) are likely to be enjoyed also by control farmers in proportion to their geographical proximity to treated farmers in their public good components (evident in case of community access roads and bridges). About the remaining infrastructure (especially docks and water supply stations) limited access and excludability can reduce this effect, without eliminating it at all. It is in fact reasonable to believe that geographical proximity implies closer links between treatment and control farmers thereby reducing excludability. About component 2, assistance for engaging in productive partnership and strengthening links with local partners to increase market access is also an activity that can be shared in part by control farmers by assuming that geographical proximity implies closer links, higher probability of business partnerships and the possibility of getting benefit from the improved relationships of treated farmers. In addition to it, the project transmits with both components knowledge and competences that can spill over to control farmers always proportionally to their geographical distance and, more in general, higher purchasing power of treated farmers can create economic benefits to neighbouring households in proportion to their geographical proximity.

H02: The impact of the rural development program on nutrition outcomes is enhanced when controlling for spillover effects.

4 Descriptive findings

The legend of the variables used in the empirical analysis is in Table 1 while descriptive statistics of our sample are provided in Table 2. The survey is performed during the COVID-19 pandemics (July-October 2021) and after the end of the program.



Descriptive findings on the variables used in the empirical analysis show that education levels are extremely low among respondents since 16.5 percent of household heads have zero education, while 51 percent only elementary school education. Around 85 percent of head household respondents are married and only 9.7 percent of them are female. The average number of household members is 5.5, of whom 3.3 in working age. Around 33 percent of respondents are members of a formal agricultural farmer association.

Farmers' income sources include sales from agricultural output (cocoa and coconut) and fishing, wage and income from self-employment plus government transfers, remittances and other private transfers. Average gross crop income per capita in the sample is 11,678 in local currency units corresponding to a standard of living of (around) 1.44 dollars per day (1.51 in PPP). This value is quite below the average living standard reported for the Solomon islands (2.61 dollar per day in PPP in 2020) for two reasons. First, the COVID-19 shock had a negative effect on the standard of living observed during our survey. Second, the IFAD program targets the poorest farmers.

We can adjust that living standard by adding the value of self-consumption of coconut and fish where corresponding household values are calculated at market prices. We compute them based on the share of production that is not sold in the market and on the average crop price in the village where the farmers sell their crops and the total production in kilograms. By doing so we find that production not sold and consumed directly in the household has a market value corresponding to at least 10 percent of total household income (including crops, wages and transfers). Table 3 panel A shows that treatment and control groups are balanced in terms of socio-demographic characteristics since there are no significant differences between the two groups in terms of variables such as age, education, share of female household heads, marital status. Household size and number of household members in working age have a negligible difference. As well, the subjective reported level of household wellbeing is not significantly different between treatment and control group at the beginning of the project. However, as implicitly driven from the construction of the program addressing the needs of the poorest our treatment sample has significantly lower values for land size and total gross income.

4.1 Nutrition outcomes in treatment and control group

With regard to our outcome variables treated farmers report in the post treatment COVID-19 period significantly better nutrition scores than the control group in spite of the observed significantly smaller land size and total gross income (Table 3). More specifically, the share of household heads declaring that during the last year in the COVID-19 period there was a time when someone in the household was hungry but could not eat because there was not enough money or food resources is half the share reporting the same problem among control households (6 against 12 percent). Consistently, the share of households declaring that some of their members remained without eating a whole day was 5 percent in the treatment against 8.5 percent in the control group. Households declaring that some members run out of food were 8 percent in the treatment group against 15 percent in the control group. Respondents saying some of them had eaten less than they thought in the same time interval were 14.5 against 30 percent in the control group, while households who skipped meals were 15.7 percent in the treatment versus 25.1 percent in the control group. The share of households worried about not having enough food at some time in the last year was 36 percent in the treatment versus 47.6 percent in the control sample. In section 7 we will test using the propensity score approach whether the observed nutrition differences between treatment and control group are robust to the inclusion of other factors affecting nutrition outcomes and to the matching approach that looks at paired differences between couples of treatment and control households having the closest possible selection characteristics in order to simulate random selection.

4.2 Propensity score matching and average treatment effect

In order to test our first research hypothesis (Ho1) in Table 5 we estimate the average treatment effect that is, the causal effect of the rural development project on our food security variables. In doing so, we follow the standard approach of estimating the average treatment effect with two matching methodologies: the propensity score and the nearest-neighbour. More specifically we estimate the following model:

$$\begin{aligned} Nutrition_{i,j,k,l} &= \alpha_0 + \alpha_1 Treat_{i,j,k,l} + \alpha_2 Age_{i,j,k,l} + \alpha_3 FemaleHead_{i,j,k,l} \\ &+ \alpha_4 Education\ Years_{i,j,k} + \eta_j + \epsilon_{i,j,k,l} \end{aligned}$$

where the dependent variable is the given nutrition outcome for the i-th farmer living in province j, ward k and village l, Treat is a (0/1) dummy taking value one if the household belongs to the treatment group, Age is household head age, Education Years are her/his schooling years and η_j are province fixed effects.

Our findings show that the the share of households worried about not having enough food is reduced by around 18 percent from a baseline of 55.7 percent and the share of those declaring they skipped meals is reduced by 10.5 percent by the treatment against a baseline of 28.5 percent. The effect on households declaring they ate less than they thought is a reduction of 13.8 percent on a baseline of 25.8 percent (Table 5, column 1). As well our findings show that the treatment significantly affects households declaring that: i) they run out of food because of lack of money or other resources (8.3 percent less in the treatment group on a sample baseline of 15.9 percent households declaring such problems); ii) during the last year there was a time when anyone in the household was hungry but did not eat because there was not enough money or food resources (7.1 percent less in the treatment group); iii) skipped a meal because there was not enough money or other resources to get food (10.5 percent less in the treatment group); iv) had at least one household member that could not eat for a whole day (4.9 percent less in the treatment group).

5 Accounting for spillover effects

Program evaluation studies involve the computation of the effects of some kind of treatment received by comparing one or more outcomes between two groups of treated and untreated (control) observations. In this type of research, several fundamental assumptions such as the conditional independence assumption, for instance, are made. Among them, the no-interaction assumption - called "SUTVA"[2]or the "individualistic treatment response" (Manski, 2013) - predicts that "the treatment received by one unit does not affect other units' outcome" (Cox 1958). This assumption is one of the most criticized (Rosenbaum, 2007, Angrist, 2014) given that, in many cases, ignoring peer effects may result in biased estimates of treatment effects (TE). In our case, given the specific characteristics of the treatment described above and in our research hypothesis, we believe that ignoring "externality effects" can lead to biased estimates of the effect of the rural development program. To account for the problem, we follow Cerulli (2017) and include spillover effects in our estimates. In order to do so the SUTVA is relaxed under specific conditions allowing neighborhood-correlated effects to be considered in the evaluation. Specifically, the difference in outcome (the treatment effect) calculated between treated and untreated units is weighted through a matrix associating their geographical distance for each Treated-Untreated pair. In this way we obtain that, if a control unit is located close to a treated unit, the associated weight will be lower and vice versa. The approach followed implies that we expect that a control household who did not receive the treatment, but is close to one that received it, will still partly benefit of the treatment through neighborhood effects (related to the local public good and knowledge spillover components of the treatment as explained in our research hypothesis). A related consequence of this approach is that a control unit, if distant and more isolated will weigh more in our final estimate, as we expect that it could have benefited less from any spillover effects. More specifically, following Cerulli (2017), we proceed with the following steps:

- we build a NxN row-normalized weighting matrix $\Omega = [\omega_{ij}]$ measuring geographical distance between the generic unit i (untreated) and unit j (treated).

[2]Stable Unit Treatment Value Assumption (see among others on this point Rubin, 1980 and 1986; Angrist et al. (1996)

- using OLS, we fit a regression model of y_i, getting for treated units:

$$y_{1i} = \mu_1 + x_i\beta_i + e_{1i}$$

  and for control units:

$$y_{0i} = \mu_0 + x_i\beta_0 + \gamma \sum_{j=1}^{N_1} \omega_{ij} y_{1j} + e_{0i}$$

- we obtain $\hat{\beta}_0, \hat{\gamma}, \hat{\beta}_1$ and replace them into the formula of ATE with neighborhood interactions to compute Treatment Effects.

$$ATE = E(y_{1i} - y_{0i}) = \mu + E\Big\{x_i\delta - \Big(\sum_{j=1}^{N_1} \omega_{ij} x_j\Big)\gamma\beta_1 - e_i\Big\}$$

In short, unit i's neighborhood effect takes the form of a weighted mean of the outcomes of treated units and that this "neighbourhood spillover" effect has an impact only on unit i's outcome when this unit is untreated. Untreated unit i's outcome is a function of its own idiosyncratic characteristics (x_i), the weighted outcomes of treated units multiplied by a sensitivity parameter γ, and a standard error term.

Our findings show that the impact of the treatment on nutrition scores is in general magnified when we take into account spillovers proxied by the geographical proximity of control to treatment farmers. More specifically, the reduction of households worried about not having enough food to eat because of lack of money or other resources is enhanced moving from 17.8 to 18.8 percent when accounting for spillovers externalities, of those who ate less food than they wanted from 13.8 to 15.7 percent, of households running out of food from 8.3 to 10.6 percent, of those being hungry but did not eat from 7.1 to 10.9 percent, of households having at least one member that could not eat for whole day from 4.9 to 7.3 percent (Table 5, column 2). In some cases, controlling for spillover effects reduces the magnitude of the score, as it is the case for households skipping meals for lack of money or other resources in the treatment group moving from 10.1 to 10.5 percent. For households worried about unhealthy food we have that the coefficient becomes not significant, while for nutrition 3 (few food), the result obtained with nearest neighbour matching is confirmed when we control for spillovers.

More in general, our results show that average treatment effects calculated accounting for geographical distance are mostly consistent with those obtained with the matching estimator. As explained above the rationale for our findings on the enhanced effect of the treatment when controlling for spillovers is both cognitive and operational. On the first point, geographical proximity implies that knowledge and skills learned with the treatment (i.e. competences on more productive farming practices and food storage) can spill over and be transmitted more easily from treatment to control farmers. On the second point control farmers living closer to treatment farmers are more likely to enjoy local public goods generated by the treatment in terms of local infrastructures. The actual impact of the project is therefore likely to be downward biased when not accounting for spillover effects.

In order to control whether our findings are robust we perform our estimates by using an extended specification adding to the four time invariant controls (age, years of education, gender and province). Our findings are robust and consistent with our base model (Table 6). In Table 7, we report estimates using the nearest neighbourhood matching and the OLS spillover matrix both for the base model and for the model augmented with additional covariates when baseline (2015) subjective wellbeing is added among regressors. Our main findings are again robust to these changes.

6 Discussion

Findings related to the improved nutrition performance of the interviewed households belonging to the treatment group during the COVID-19 period are consistent with what expected in our research hypotheses based on the characteristics of the rural development program and on their focus on building infrastructure, providing technical assistance to improve production and farm management practices and enhancing market access of farmer with stronger links with lead intermediaries.

Our impact evaluation approach has obvious limits driven by data availability. The control group has been created ex post and we have survey responses only in the post-treatment COVID-19 period, while not in the pre-treatment and immediate post-treatment (2015 and 2020) time spells. What we observe is a difference in nutrition outcomes between treatment and control group in the post treatment COVID-19 period and we must exclude that the observed finding is due to something different than the rural development project. For this reason we control for other drivers that can have affected nutrition scores and try to limit as much as we can selection bias with a propensity score approach. Based on our results and on these considerations it is highly implausible that differences in nutrition outcomes in the COVID-19 period between treatment and control group could correspond to time invariant pre-existing differences between the two groups observable also in the pre-treatment period, especially if we consider that the IFAD program targets the poorest. If we acknowledge that the different nutrition performance is something specific of the COVID-19 period the propensity score approach also leads us to exclude that factors different from the treatment can explain it.

We of course acknowledge that the creation of a randomized experiment to select treatment and control group before the project would have been the first best for scientific purposes to evaluate the impact of the program. However in presence of intervention on very poor targets this approach can have ethical limits as it implies that we have to sacrifice intervention for part of beneficiaries in high need. This is the reason why the IFAD approach has chosen in this case and in a small geographical area such as that of the Solomon Island project to address the poorest. To our knowledge the ex post evaluation trying to match as much as possible treatment and control groups based on their characteristics is the best we can do given the strategy chosen by IFAD.

7 Conclusion

The current scenario of strong interdependence among environmental, social and pandemic shocks urges empirical research on how these shocks affect the most exposed and fragile segments of the world population and on policies that can be designed to increase their resilience and adaptation. Our empirical analysis aims to provide an original contribution in this direction by investigating the post-treatment effects during the COVID-19 pandemics of a rural development program on a very poor segment of the population in a small scale island society in the Pacific islands. Our findings show that treated households have significantly better nutrition performance than the control group during the post-treatment pandemic period. We as well consider that due to program characteristics the treatment is highly likely to produce positive externalities also on control farmers in proportion to their geographical proximity presumably presumably due to access to the public goods of local infrastructure built or improved by the program and to spillovers of knowledge, competences and business relationships. Our findings support this hypothesis since most of our findings are reinforced when controlling for spillover effects.

Our findings stimulate direction for future research and implementation of future development projects. Our argument is that the true impact of rural development programs such as that analysed in our paper should be evaluated accounting for spillover externalities to avoid that observed outcomes are downward biased. The presence of a significantly higher impact when controlling for them should lead to consider two additional effects of the program often neglected by standard approaches. The first is the difference between the impact on treated farmers with and without accounting for spillover externalities, the second is the partial impact on control farmers due to the same externalities.

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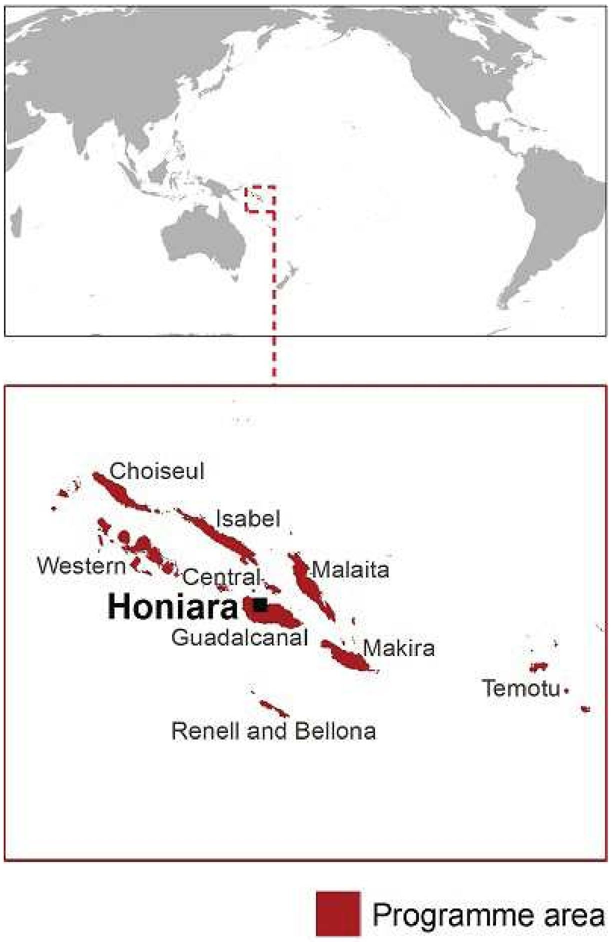
8 Figures

Figure 1: RDP II Project areas on the map of Solomon Islands



Notes: The figure shows the area of the Solomon Islands where the RDP II Project was implemented by IFAD. Our study is focused on only three Provinces: Guadalcanal, Makira-Ulawa, Malaita

9 Tables

Table 1: Variable Legend

Dependent Variables	
NUTRITION DUMMIES:	(0/1) dummies where the respondent answered to the question: "During last year, was there a time when anyone in your household...
Nutrition 1: worried about food	... were worried about not having enough food to eat because of lack of money or other resources?
Nutrition 2: unhealthy food	... were unable to eat healthy and nutritious/preferred foods because of a lack of money or other resources?
Nutrition 3: few food	... ate only a few kinds of foods because of a lack of money or other resources?
Nutrition 4: skipped meals	... had to skip a meal because there was not enough money or other resources to get food?
Nutrition 5: ate less food than wanted	... ate less than you thought you should because of a lack of money or other resources?
Nutrition 6: run out of food	... ran out of food because of a lack of money or other resources?
Nutrition 7: hungry	... were hungry but did not eat because there was not enough money or other resources for food?
Nutrition 8: didn't eat for a whole day	... went without eating for a whole day because of a lack of money or other resources?
Independent Variables, Controls	
Treat	0/1 dummy for control and treatment status (1=treated).
HH Size	Number of household members.
Female Headed	0/1 dummy for female household head.
Married	0/1 dummy for married status.
Education Years	Total number of respondent's education years.
Age	Age of respondent
Work HH	Household members in working age (15-64)
Gross Crop Income	Gross yearly household income from crops in LCU.
Agricultural Ass.	0/1 dummy for membership of agricultural societies.
Area Cultivated	Land size of the household in HA.
Motorboat	Household members in working age.
Wheel Barrow	Household members in working age.
Thatch Roof	0/1 dummy if the main material of the roof of the main dwelling is made of thatch.
Thatch Wall	0/1 dummy if the main material of the walls of the main dwelling is made of thatch, leaves, reed bamboo, poles.
Province	Guadalcanal, Malaita and Makira/Ulawa.

Table 2: Summary statistics

Dependent Variables					
Nutrition 1: worried about food	41 %	0.5	0	1	1239
Nutrition 2: unhealthy food	47 %	0.5	0	1	1239
Nutrition 3: few food	51.7 %	0.5	0	1	1239
Nutrition 4: skipped meals	20.3 %	0.4	0	1	1239
Nutrition 5: ate less food than wanted	19.5 %	0.4	0	1	1239
Nutrition 6: run out of food	11 %	0.31	0	1	1239
Nutrition 7: hungry	9.2 %	0.3	0	1	1239
Nutrition 8: didn't eat for a whole day	6.9 %	0.25	0	1	1239
Independent Variables, Controls					
Treat	53 %	0.5	0	1	1239
Household Size	5.5	2.2	1	14	1239
Female Headed	9.7%	0.3	0	1	1239
Married	84.8 %	0.4	0	1	1239
Education Years	7.5	4.9	0	19	1239
Age	46.6	12.8	17	90	1239
Work HH	3.4	1.7	0	11	1239
Gross Crop Income in $	1.44	4.23	0	59.21	1239
Agricultural Ass. Member	32.4%	0.47	0	1	1239
Area Cultivated	5.4	82.5	0	2500	1239
Motorboat	7.4%	0.3	0	1	1239
Wheel Barrow	2%	0.4	0	1	1239
Thatch Roof	4%	0.5	0	1	1239
Thatch Wall	3%	0.4	0	1	1239

Table 3: Nutrition dummies by treatment

Nutrition dummies	TREATMENT	CONTROL
Nutrition 1: worried about food	46.7%	35.5%
Nutrition 2: unhealthy food	45.2%	48.7%
Nutrition 3: few food	47.3%	55.7%
Nutrition 4: skipped meals	25.1%	16%
Nutrition 5: ate less food than wanted	24.9%	14.6%
Nutrition 6: run out of food	14.9%	7.5%
Nutrition 7: hungry	12.5%	6.2%
Nutrition 8: didn't eat for a whole day	8.8%	5.2%

Notes: Average nutrition statistics by treatment.

Table 4: Balanced properties

	TREATMENT	CONTROL	Diff. (T-C)	S.E.	Obs.	T-stat
Household Size	5.5	5.2	0.3**	(0.126)	1239	2.13
Female Headed	0.1	0.1	0	(0.017)	1239	1.28
Married	0.8	0.8	0	(0.020)	1239	0.05
Education Years	7.8	7.4	0.4	(0.279)	1239	1.47
Age	46	47	-1	(0.727)	1239	-0.92
Subjective Wellbeing in 2015	4.7	4.6	0.1	(0.101)	1239	1.17

Notes: Results from t-test between the means of the two groups. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Estimation Results: Nearest Neighbor Matching and OLS Spillover Matrix - baseline covariates

VARIABLE	ATE NN Matching	ATE Spillover Matrix	N. of obs.
Nutrition 1: worried	-0.178***	-0.188***	1239
	(0.040)	(0.033)	
Nutrition 2: unhealthy food	-0.116***	0.038	1239
	(0.035)	(0.034)	
Nutrition 3: few food	-0.055	0.028	1239
	(0.038)	(0.034)	
Nutrition 4: skipped meals	-0.105***	-0.101***	1239
	(0.030)	(0.027)	
Nutrition 5: ate less food than wanted	-0.138***	-0.157***	1239
	(0.031)	(0.027)	
Nutrition 6: run out of food	-0.083***	-0.106***	1239
	(0.031)	(0.021)	
Nutrition 7: hungry	-0.071***	-0.109***	1239
	(0.027)	(0.019)	
Nutrition 8: didn't eat for a whole day	-0.049**	-0.073***	1239
	(0.025)	(0.017)	

Notes: Results from ATE estimation. Treatment effects were calculated using a propensity score matching regression and a spillover matrix regression. The dependent variables are (0/1) dummies for nutrition problems related to economic reasons. Controls include: female headed household, education years, age, province. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimation Results: Nearest Neighbor Matching and OLS Spillover Matrix - additional covariates

VARIABLE	ATE NN Matching	ATE Spillover Matrix	N. of obs.
Nutrition 1: worried	-0.139***	-0.245***	1239
	(0.036)	(0.035)	
Nutrition 2: unhealthy food	0.009	-0.008	1239
	(0.040)	(0.037)	
Nutrition 3: few food	0.054	0.017	1239
	(0.040)	(0.037)	
Nutrition 4: skipped meals	-0.108***	-0.120***	1239
	(0.035)	(0.030)	
Nutrition 5: ate less food than wanted	-0.115***	-0.173***	1239
	(0.033)	(0.029)	
Nutrition 6: run out of food	-0.073**	-0.116***	1239
	(0.028)	(0.023)	
Nutrition 7: hungry	-0.057**	-0.104***	1239
	(0.027)	(0.021)	
Nutrition 8: didn't eat for a whole day	-0.040	-0.079***	1239
	(0.027)	(0.019)	

Notes: Results from ATE estimation. Treatment effects were calculated using a propensity score matching regression and a spillover matrix regression. The dependent variables are (0/1) dummies for nutrition problems related to economic reasons. Controls include : female headed household, education years, age, province, household size, married household head, household members working, agricultural association member, total area cultivated, motorboat, wheelbarrow, thatch roof, thatch wall, crop income. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 7: ATE with Subjective Wellbeing in 2015 as control

	(1) Nutrition 1	(2) Nutrition 2	(3) Nutrition 3	(4) Nutrition 4	(5) Nutrition 5	(6) Nutrition 6	(7) Nutrition 7	(8) Nutrition 8
BASE COVARIATES								
ATE NN MATCHING	-0.171***	-0.116***	-0.044	-0.119***	-0.162***	-0.084***	-0.079***	-0.064***
	(0.037)	(0.036)	(0.041)	(0.031)	(0.032)	(0.031)	(0.027)	(0.023)
ATE SPILLOVER	-0.184***	0.031	0.023	-0.098***	-0.156***	-0.108***	-0.109***	-0.074***
	(0.033)	(0.033)	(0.034)	(0.027)	(0.027)	(0.021)	(0.019)	(0.017)
ADDITIONAL COVARIATES								
ATE NN MATCHING	-0.128***	0.017	0.050	-0.114***	-0.129***	-0.084***	-0.062**	-0.044*
	(0.035)	(0.039)	(0.040)	(0.034)	(0.031)	(0.029)	(0.027)	(0.025)
ATE SPILLOVER	-0.237***	-0.021	0.009	-0.118***	-0.171***	-0.118***	-0.107***	-0.081***
	(0.035)	(0.036)	(0.037)	(0.030)	(0.029)	(0.023)	(0.021)	(0.019)
Observations	1239	1239	1239	1239	1239	1239	1239	1239

Notes: Results from ATE estimation. Treatment effects were calculated using a propensity score matching regression and a spillover matrix regression. The dependent variables are (0/1) dummies for nutrition problems related to economic reasons. BASE COVARIATES include : female headed household, education years, age, province and subjective wellbeing in 2015; ADDITIONAL include also household size, married household head, household members working, agricultural association member, total area cultivated, motorboat, wheelbarrow, thatch roof, thatch wall, crop income and subjective wellbeing in 2015.

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