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What works for rural incomes under climate variability? Evidence from rural Vietnam

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HIGHLIGHTS

- Examine the impact of two interventions on rural incomes in a climate vulnerable region of Vietnam.
- Difference-in-Differences is used to compare roads only (RO) vs. roads and agro-extension services (RA).
- Income increases are similar across conditions, but sectoral income gains differ.
- Households from RO diversify into wage jobs; those from RA improve agricultural incomes.
- Pathways to climate resilience in rural area are responsive to type of intervention.

Abstract

Climate stress can have significant negative impact on agricultural productivity and rural incomes. Yet we know little about interventions that support rural incomes and their pathways in areas vulnerable to climate change. Using data from an aid program, we use Difference-in-Differences analysis to compare two interventions across some of the poorest villages in Vietnam that also suffer extreme rainfall variability. Villages either received improvements to roads only (RO) or roads and agricultural extension services (RA). Income gains across the interventions are similar, but sectoral gains differ: RO households experience an increase in wage incomes and RA households in agricultural incomes. Findings indicate that rural households are responsive to type of intervention when adapting to climate change.

Keywords: rural incomes, roads, agricultural extension services, climate change, aid-effectiveness, Vietnam

1. Introduction

Climate variability critically affects agricultural productivity and rural incomes (Chavas et al., 2019). It adds uncertainty to risks already faced by food producers, especially smallholders (FAO, 2016). From the perspective of poverty alleviation and food security, building resilience to climate variability is key (Hallegatte et al., 2016). Localized climate smart practices are seen to increase farm and non-farm incomes (Teklewold et al., 2019). Yet, little is known about interventions that are effective in building climate resilience at scale.

This represents a significant gap in knowledge, exacerbated by the lack of real-world data. Our study constitutes a first step towards addressing this shortcoming. We use a unique dataset from an aid program in the Lao Cai province of Vietnam that faces extreme rainfall variability. Program villages either received improvements to roads only or roads plus a package of

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agricultural extension services. We use Difference-in-Differences analysis to compare the impact of the two interventions. Our results show that household real incomes increase comparably across both conditions, but those receiving roads only experience an increase in wage incomes (and a fall in farm incomes), while those receiving additional extension-services experience an increase in agricultural incomes. Exploring pathways behind observed differences suggests that rural households are responsive to type of intervention when adapting to climate variability. Intervention type is a significant consideration for policy makers targeting specific climate resilient outcomes.

Our paper relates to various branches of literature on rural development and climate change. Closely related are studies that find improved rural roads benefit cultivating smallholders via better access to input and produce markets (Qin and Zhang, 2016; Aggarwal, 2018; Berg et al., 2018). Our results indicate that under climate variability, this result is unlikely to hold. Instead, smallholders are likely to adapt to climate-induced uncertainties by diversifying their livelihoods and moving away from agriculture into wage labouring. Recent evidence on smallholders' response to climate variability supports these results (Chuang, 2019). The other branch of literature our paper relates to investigate the impact of 'green revolution' type of interventions, including better inputs, improved technology and finance. A clear role for fertilisers and better seeds has been established globally, especially in areas of deteriorated land conditions (Mcarthur and Mccord, 2017). Comparable results are reported for Philippines (Villano et al., 2015); India (Birthal et al., 2015); Vietnam (Luan and Bauer, 2016); Ethiopia (Michler and Josephson, 2017) and Bangladesh (Hossain et al., 2019). Dercon et al., (2009) find that improved roads and access to extension-services collectively result in lower rates of poverty in rural Ethiopia. These results are not incompatible with our findings, which indicate that under climate uncertainties, improving agriculture production will necessitate investing in resource intensive extension-services.

Remainder of the paper is organized as follows: Section 2 outlines the empirical strategy, Section 3 describes our data, Section 4 presents the results and Section 5 concludes.

2. Empirical strategy

We test the impact of the two program conditions on rural incomes and on sectoral incomes using Difference-in-Differences (DID) Ordinary Least-Squares Regression estimations and T-tests for equality between treatments. Following Imbens and Wooldridge, (2009), we first conduct DID regressions for all outcome variables without including any covariates and then add the covariates to the models and re-run the regressions. By examining R^2 values, we chose the models that explained the greatest amount of variance for further analysis. We examine the magnitude and direction of the coefficients for interventions x time interactions, which combined with T-tests, allows us to compare the effects of interventions against each other. Findings were interpreted to be significant when $p<0.05$. All analyses were intent-to-treat, i.e., households were analyzed regardless of service used in their intervention condition.

3. Data and Descriptive Analysis

Data

Our data is from the Lao Cai Happiness Program (LCHP), an aid intervention for rural Vietnam funded by South Korea and implemented from Dec-2015 to Dec-2017. Situated in the

mountainous Northwest region, Lao Cai is one of the poorest provinces of Vietnam, facing extreme rainfall variability (Fig. A.1). Based on a basket of poverty and deprivation indicators, 172 villages from 26 communes across three districts were selected (KOICA, 2018). Of these, 164 received improvements to roads only (RO) while 8 received roads plus a comprehensive package of agricultural extension services (RA). Program placement reflects evidence that poorer communes in Vietnam benefit more from roads and extension-services due to lower levels of initial market development (Mu and van de Walle, 2011; Luan and Bauer, 2016). Further, choice of extension-services was guided by community interactions, which matters for their acceptability and success (Ragasa and Mazunda, 2018).

Impact evaluation of LCHP was facilitated by a household survey across the program conditions. Using stratified random sampling, 377 RO households and 208 RA households were selected. Sample size calculations provided for 95% confidence level and 0.05 alpha. **Fig. 1** depicts the study flow, including the interventions and assessments relevant to this analysis.

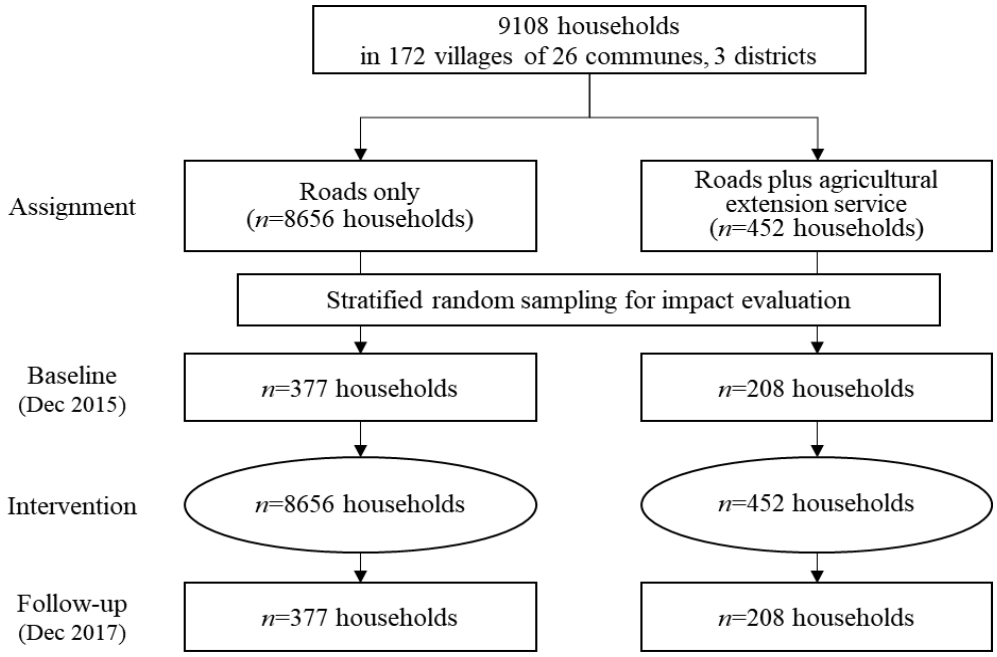

Fig. 1. CONSORT diagram detailing study flow of all relevant aspects and conditions of LCHP.

Baseline statistics

Table 1 reports baseline scores on covariates and outcome variables stratified by program condition. Scores indicate that the randomization strategy has been effective with no differences between conditions in household socio-economic characteristics and outcome variables. Over 90% of the households are male-headed with very low literacy levels. Land ownership is small and fragmented, distributed across difficult hilly terrain. With incomes around 35% of the average for rural Vietnam, program households are extremely poor (GSO, 2015). The main sources of wage income are construction, manufacturing and large-scale tea-farms. Income from wage work and agriculture are equally important, suggesting that livelihood diversification into non-farm activities is a crucial coping strategy in face of rainfall variability.

Table 1
Baseline scores on covariates, outcomes and analysis of variance between conditions

	Total (n=585)	RO (n=377)	RA (n=208)	*t*-test
Household Characteristics				
Household size	4.98^ (1.641)	4.94 (1.616)	5.05 (1.686)	-0.738
Gender of household head (*0=female, 1=male*)	0.92 (0.274)	0.91 (0.290)	0.93 (0.242)	-1.347
Land owned (*in acres*)	2.32 (2.842)	2.24 (2.960)	2.45 (2.616)	-0.884
Education of head (*0=none to 5=higher education*)	0.96 (1.160)	1.01 (1.193)	0.87 (1.093)	1.493
Administrative District				
Bac Ha	0.33 (0.471)	0.38 (0.485)	0.25 (0.434)	3.304***
Si Ma Cai	0.30 (0.458)	0.33 (0.469)	0.25 (0.434)	1.975**
Muong Khuong	0.36 (0.482)	0.29 (0.456)	0.50 (0.501)	-4.900***
Outcome variables				
Total annual household income~	34.88 (46.084)	34.78 (49.484)	35.06 (39.290)	-0.075
Agricultural income	17.18 (32.903)	16.27 (37.930)	18.83 (20.901)	-1.050
Wage income	17.69 (31.677)	18.50 (32.463)	16.23 (30.222)	0.848

Notes: ^Mean and SD in parenthesis; *** p<0.01; ** p<0.05
~ Income reported in million VND per annum

4. Results

Roads, agricultural extension services and climate variability

Table 2 reports the follow-up scores for income variables. Comparing these against baseline incomes from Table 1 shows that household real incomes have increased by 15% post-LCHP. Comparing across program conditions, we find that real income gains are comparable across households in RO and RA villages (row (1), Table 2).

Breaking down total income into its sectoral components reveals that sources of gain are entirely different across the program conditions. At follow-up, agricultural income was significantly greater for the RA group (row (2), Table 2), but income from laboring was greater for the RO group (row (3), Table 2)). Comparing these against baseline incomes from Table 1 we find that for the households in RO, agricultural incomes fell by 19% but wage incomes increased by 46%. For households in RA, the gain is mainly from agricultural income that increased by 27% with a small fall in wage incomes.

These comparisons foreshadow the formal DID results summarized in Table 3. DID coefficients clearly show that agricultural incomes improved significantly for the households in RA villages that received the extension-services, in addition to improved roads. Households in RO villages that received only improved roads intensified livelihood diversification already observed at baseline. Full regression models, including covariates, are available in Table A.1.

Resilience pathways

The LCHP interventions helped both groups improve their incomes under climate variability but their pathways to resilience were entirely different. The program years were marked by longer precipitation than the 30 year average (Fig. A.1), which badly affected the productivity of the major regional crops: rice and maize. In response, households in RO villages diversify their incomes by moving out of agriculture into wage jobs. Improved roads meant they now had better access to non-farm opportunities that were too far and inaccessible earlier. Chuang (2019) finds similar results for smallholders facing rainfall variability in India. This suggests that the earlier findings that improved roads have a positive impact on agricultural incomes (Qin and Zhang, 2016; Aggarwal, 2018), are unlikely to hold in conditions of climate variability.

Households in RA villages had access to extension-services in addition to improved roads. This largely mitigated uncertainties associated with rainfall variability and enabled them to continue investing in improved agricultural practices. Despite falling productivity in the region, RA villages experienced per hectare productivity gains of 13.4% and 14.4% for rice and maize respectively over the program period (KOICA, 2018). There is also evidence on crop diversification, with cultivating households sowing premium crops like pumpkin, cabbage and potato. Supporting these results, Pan et al., (2018) find that a large-scale agricultural extension program in Uganda helped achieve improved food diversity. Our results indicate that if improving agriculture production under climate uncertainties is the target then more resource intensive extension programs will be necessary. From the perspective of food security, this may even be critical (UN, 2019).

Table 2
Follow-up scores on outcomes and analysis of variance

Annual household incomes˜	Total (n=585)	RO (n=377)	RA (n=208)	t-test
(1) Total income	40.08 (50.776)	40.13 (54.957)	39.98 (42.283)	0.038
(2) Agricultural income	16.97 (25.976)	13.09 (25.115)	23.97 (26.109)	-4.889***
(3) Wage income	23.11 (42.022)	27.02 (46.022)	16.00 (34.493)	3.370***

Notes: ^Mean and SD in parenthesis; t-test: *** p<0.01; ** p<0.05;
˜ Inflation adjusted income in million VND per annum (inflation data from World Bank, 2018).

Table 3
Summary of DID coefficients between RA vs. RO interventions

	Coefficients
Total Income	-0.146
Agricultural income	8.375***
Wage income	-8.510**

Note: *** p<0.01; ** p<0.05.

5. Conclusion

This paper demonstrates that in rural areas facing climate variability, improving roads is likely to help households adapt by diversifying into non-farm wage work, but to improve agricultural incomes and productivity, direct support for this activity will be necessary.

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Appendix

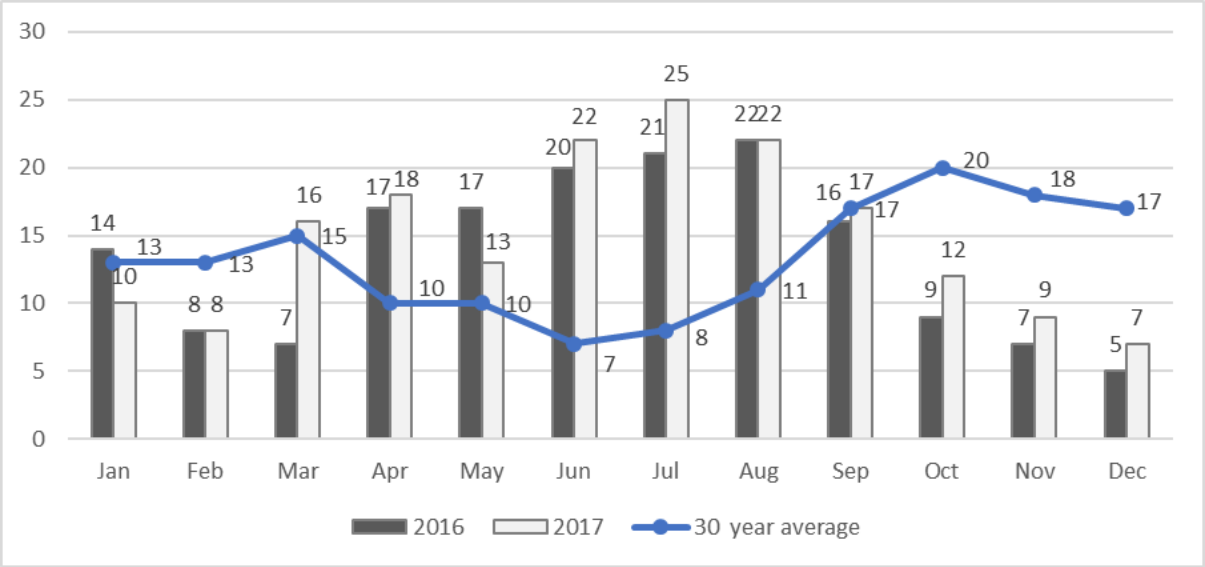

Fig. A.2. Number of precipitation days in Lao Cai province in Vietnam

Table A. 1
Difference in Differences Ordinary Least-Squares Regression Results Including Covariates

	Annual household income		
	Total income	Agricultural income	Wage income
time	5.630	-3.481	9.097***
(0=baseline, 1=follow-up)	(3.458)	(2.130)	(2.693)
intervention	1.325	1.660	-0.337
(0=RO, 1=RA)	(4.149)	(2.555)	(3.098)
intervention x time	-0.146	8.375***	-8.510**
	(5.792)	(3.566)	(4.325)
household size	3.381***	1.531***	1.851***
	(0.894)	(0.550)	(0.668)
household head sex	-16.756***	6.970**	-23.730***
	(5.572)	(3.431)	(4.161)
household head education	8.776***	0.293	8.475***
	(1.245)	(0.766)	(0.929)
Bac Ha district	-1.458	-0.112	-1.347
	(3.400)	(2.144)	(2.539)
Si Ma Cai district	-2.576	-7.180***	4.590*
	(3.502)	(2.156)	(2.615)
Constant	25.736	4.468	21.279***
	(7.200)	(4.433)	(5.376)
R^2	0.052	0.036	0.105

Notes: Standard Errors in parentheses. *** p<0.01; ** p<0.05; * p<0.1