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Does Land Certification Mitigate the Negative Impact of Weather Shocks? Evidence from Rural Ethiopia

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Abstract: This study examines the effects of weather shocks on household consumption and how the land registration and certification program facilitate coping strategies to mitigate the negative income shocks. Using the difference-in-differences (DID) approach and household panel data from Ethiopia, we find that weather shocks negatively affected household consumption expenditure. As expected, households are not able to protect themselves from weather shocks. However, the land certification program facilitated coping strategies (obtaining credit and receiving gifts and assistance from informal sources) to mitigate the negative effect on food consumption against weather shocks. This effect is only found among smaller landowners. Therefore, the program is pro-poor and beneficial for improving the welfare of poorer households and protecting vulnerable households from entering into poverty traps.

Keywords: land certification; weather shock; consumption expenditure; credit; Ethiopia

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1. Introduction

Weather shocks have an adverse effect on the income and consumption of households in both developed and developing countries. Due to limited insurance markets, the impact is more severe in developing countries [1–3] where many households are exposed to frequent shocks such as drought and flood which damage agricultural production and affect health conditions. This is more severe in areas where most households rely on rainfed agriculture where weather shocks have a negative effect on agricultural production and consumption. However, shocks can have also a deep-rooted and potentially long-term negative impact on household resources, particularly assets and livestock for coping with the short-term damage [1–4]. There is, therefore, room for improving policies to help these vulnerable people. In this light, the main function of this study is to test a potential coping strategy from the perspective of agricultural policy in a society where most households heavily depend on agriculture. Specifically, this study analyzes the role of a land certification program in mitigating the negative impact of weather shocks on consumption expenditure.

Many studies have investigated the impact of the shock on consumption; however, their findings are mixed. Some have identified a significant decrease in food and non-food consumption as a result of adverse shocks [1,4–6], while others have found that food consumption smoothens against shocks when food is produced by the household, income is generated through labor markets, and informal insurance strategies are available [2,7–12]. Existing literature and observations from the field suggest that the effect of shock mainly depends on the capacity of individuals to protect against it and the strength of their social network. Some of the most common coping strategies that served as insurance against covariate shocks are self-financing (using savings, obtaining credits, selling assets), assistance from others in their social networks, and government programs, such as food aid, food-for-work, and cash-for-work programs [3,4,6,13–15]. Existing informal risk-sharing mechanisms are complementary to formal insurance [15,16]. Accumulation of social capital

is one of the ways that one enhances the capacity to protect against shocks [4,17,18]. However, the effectiveness of using social capital as a coping mechanism differs based on the shared norms of the community in times of hardship [19].

In addition to the individual effort to cope with negative income shocks, technological innovations and policies can foster coping mechanisms. The introduction of mobile money transfer technology reduced transaction costs of sharing risks against idiosyncratic and covariate shocks, which allowed households with access to mobile money services to mitigate the negative impact [6,13,20–22]. The spread of microfinance institutions enhances access to credit, which prevents them from selling their assets and livestock to smoothen consumption at the time of shocks [3,23]. The cash transfer program had the effect of mitigating rainfall shocks on food consumption expenditure [24]. This suggests that other types of programs can enhance the functions of the credit market and facilitate other coping strategies to mitigate negative shocks. Given that impacts of climate changes on agricultural production become more serious year by year and farm households face riskier conditions and become more vulnerable to weather shocks [25–28], a way to enhance one's ability to cope with such temporal downturns is an important policy issue.

Land tends to be considered the main asset that can be used as collateral for obtaining formal credit [29]. In many developing countries, households do not own the land title of their farmland. Although they have the user right in customary and government land, it cannot be used as collateral. Currently, in Sub-Saharan African countries, land registration and certification programs have been introduced, which can help access credit when needed by using the certified land as collateral. Existing studies, however, do not always support that secured land tenure enhances access to credit [30]. Furthermore, there are no studies examining the role of a land certification program in mitigating the negative effects of weather shocks on household consumption through the acquisition of credits. Ajefu and Abiona [31] is closely related to this study that examines the effect of land tenure security status on household food security in Malawi. Although they found that tenure security plays a role in mitigating the negative effect of drought shock, whether tenure security facilitates a coping strategy or not was not investigated. Thus, to fill this research gap, we explore the role of land certification in consumption smoothing as a response to weather shocks and the mechanisms that can facilitate the role that land certification plays in serving as insurance against shocks.

We observe the case of Ethiopia because Ethiopia is one of the first countries in Africa where the land certification program was implemented. Furthermore, as in many other developing countries, many rural households are prone to weather shocks. Ethiopia's vulnerability is caused by frequent droughts, unexpected shocks, and diseases; epidemic diseases affect humans, crops, and livestock [32]. These unexpected shocks have a depleting effect on household income, which aggravates the level of poverty [1,5,33–35]. The findings of this study can be applicable to counties where land certification program is undergoing. We use two waves (2011 and 2015) of nationally representative panel household data from the Ethiopia Living Standards Measurement Study (LSMS). Following Jack and Suri and Ahmad and Cowan [6,36], our study employs a difference-in-differences approach with household fixed effects by utilizing the timing of the program and exposure to weather shocks. The findings suggest that weather shocks reduce food and non-food consumption. However, households with a land certificate managed to cope with the negative effect of a weather shock. Further analyses show that a land certification program can enhance access to credit when they were affected by weather shocks. The findings indicate that agricultural land policy reform not only has a direct effect on land investment and agricultural productivity [37,38], but can also be used to smoothen consumption by improving access to credit.

The remainder of the paper is organized as follows. Section 2 provides background and conceptual framework (Section 2.1 presents the Ethiopian land certification program; while Section 2.2 provides a conceptual framework). Section 3 presents data and descriptive

statistics (Section 3.1 provides data and variables, while Section 3.2 presents descriptive statistics). Section 4 presents estimation results. Section 5 presents the conclusion.

2. Background and Conceptual Framework

2.1. Ethiopian Land Certification Program

In Ethiopia, the land is state-owned and usufruct rights are given to households. In rural areas, farmland had occasionally been reallocated by the government. In 2003, the Ethiopian land certification program began to enhance agricultural productivity by securing land tenure [39,40]. Under this program, the usufruct rights of the plots were registered under the names of current users. Public meetings were held in villages to inform people about the program, and the local-level administration and certification were done by a land use and administration committee (LAC), while certificates were issued by the district offices.

LAC and current users as well as their neighbors made an agreement by resolving the land border conflict with the neighbors and then completed measuring and registering the plots for each household. Although the program was meant to cover all households, some did not receive land certificates. This is mainly owing to the capacity limitations of woreda administration staff, shortages of forms, transportation problems, shortage of certificates at hand, and a seasonal-based certification process [37,39–41].

The land registration and certification process were implemented in a decentralized approach at a regional level, as the mandate for the land policy was given to regions by the federal proclamation in 1997. As a result, the implementation process varies in different entities. In the Tigray region, where the land certification program was started in 1998, only the household head's name was stated on the certificate, while in other regions such as Amhara, Oromia, and SNNP certificates were issued in the names of both head and spouse (joint certification). This difference in registration with and without a spouse's name has had a differential impact on intra-household resource allocation and the bargaining power of spouses. Bezabih et al. [42] found a gender-heterogeneous effect of land certification on productivity. The marginal productivity of land certification is higher for female-headed households compared with male-headed households. Muchomba [43] assessed the impact of land certification issued for only household heads in Tigray and land certification issued jointly for household heads and spouses in the regions of Amhara, Oromia, and SNNP. The findings show that joint land certification increased health consumption and home-grown food consumption and decreased expenses of education compared with the certification issued only to the household head. Hence, empowering women through providing a joint certification has a positive impact on the income of the household. Even under joint certification, there is a slight difference: in the Oromia region, only the household head's photo was attached to the certificate, while in the Amhara and South regions both the head and the spouse's photos were attached. In the Amhara region, supervision was undertaken more closely by the woreda survey team and land administration team to monitor how the land registration and certification process was implemented in comparison with the other regions. Written materials provided to LAC also vary: the limited copies of the land policy proclamation were provided in the Tigray region, while posters were provided in the Amhara region, though there were some delays. In the Oromia region, both posters and proclamations were given, while no written material was used in the SNNP region due to a lack of common language to be used in the region. As a fee for obtaining a land certificate, households in the Amhara region paid nothing, while households in the SNNP, the Tigray, and the Oromia region paid 2 birr, 3-birr, and 5 birr, respectively; with an exchange rate of 1 USD = 8.78 birr, referencing the exchange rate of 2006. In addition, households living in remote areas have to account for an extra cost of transportation to travel to the office. Moreover, the costs of land certification also vary across regions. For instance, in the Amhara region, due to the engagement of the woreda survey team and land administration team in monitoring the land certification process, the cost of the land certification process is higher than in the other regions [39].

In the Ethiopian context, farmers cannot sell or mortgage plots of land and land certification provides them with land use rights. However, farm households with a land certificate might have a better chance to use their land as a guarantee for informal credit. This is because land certification reduces land border disputes [44], which in turn enhances land transferability [37–39]. Hence, a farm household with a land certificate can rent out their land with more confidence even in a country where there is frequent land redistribution and risk of land expropriation [45]. Moreover, land certification enables farm households to reduce their mistrust of the state, which was prompted by the existence of frequent land redistribution. Land certification also increased interpersonal mutual trust within the community [46], allowing its members to help each other when faced with any hardship. Bezabih et al. [46] examined that improving land tenure security creates a trust of an individual over government and non-government institutions; it also increased cooperative behavior in the society through the increased trust of an individual over other individuals. Moreover, land certification improved agricultural productivity by increasing the engagement and effort of farm households on their land [47]. Agricultural income improved when households exerted their efforts towards their farm activities. However, sometimes even exerting similar efforts may not increase agricultural income for a variety of reasons. In this situation, their effort can create a cooperative behavior through borrowing as a credit from households that have higher agricultural income [48]. Therefore, a program providing a formal land certificate can bring about trust within the society, which activates an informal credit market.

2.2. Conceptual Framework

The standard microeconomic theory where households maximize lifetime utility indicates that households try to smoothen consumption over time regardless of income fluctuations [49]. Consumption smoothing can be realized when households share resources within an insurance network. However, in the real setting, the network size varies for each household, and transaction costs in sharing resources are high [6]. Thus, households attempt to implement coping strategies to mitigate the negative impact of shocks. In addition, households attempt to smoothen income by implementing ex-ante strategies to reduce negative income shocks by diversifying activities. Farm households that mainly depend on rainfed agriculture suffer from income fluctuation by weather shocks. As explained in the previous subsection, land certification can reduce transaction costs in sharing resources in many ways.

Formalization of land rights by registering and certifying land increases tenure security, which gives the incentive to make long-term investments [40,50–55] and activates land rental markets [39,56]. Both result in higher farm productivity through technological change and efficient resource use [37–39]. Moreover, land certification adds additional value to land by allowing the owner to use the land as collateral to obtain credit. Theoretically, it is believed that land certificates can be used as collateral, which increases access to credit. However, in existing studies conducted in developing countries, empirical evidence is lacking. This could be due to the lack of a system in formal financial institutions that evaluate rural farmland and the prohibitively high transaction costs. However, as access to informal credit, the land certificate can be attractive enough to be used as collateral for them to provide credits, although it has not been studied whether the program that enhanced tenure security enables access to credit to mitigate the negative impact of shocks.

First, we estimate how much weather shocks affect consumption. The effect of weather shock on per capita consumption expenditure is estimated by the following model:

$$Cons_{hvt} = \alpha_0 + \alpha_1 S_{vt} + \alpha_4 X_{hvt} + \theta_h + (\theta_V \times \gamma_t) + \varepsilon_{hvt}, \quad (1)$$

where $Cons_{hvt}$ is the per capita consumption expenditure for household h in village v in period t; S_{vt} is the adverse weather shock variable in village v in period t; X_{hvt} is a vector of household-level covariates; θ_h is the household fixed effects to control for unobserved time-invariant household characteristics; $(\theta_V \times \gamma_t)$ is a set of village-by-time dummies

that control for time-variant village-level heterogeneity; ε_{ht} is the error term, and α is a coefficient to be estimated. Standard errors are clustered at the village level. In this model, α_1 is the net impacts of weather shocks on consumption as we do not consider coping strategies. To examine in further detail which consumption items were most affected by the shocks, we estimate the same model with different dependent variables, such as food consumption, non-food consumption, and education expenditure instead of total consumption expenditure.

Second, we examine the effect of the land certification program on consumption when facing weather shocks through coping strategies. We add an interaction term between weather shock and coping strategy to Equation (1) where the coping strategy of interest is land certification. Following Jack and Suri and Ahmad and Cowan [6,36], we apply the difference-in-differences (DID) approach by including household fixed effects to examine how the land certification program helps households against shocks. Jack and Suri [6] used a simple difference-in-differences approach to examine the role of mobile transfer technology on risk sharing against self-reported income shocks by comparing the consumption of mobile transfer technology users and nonusers. During the survey, the households were asked to report unexpected shocks among the lists of potential shocks that they experienced. Even though they used a self-reported income shock, they considered only unexpected self-reported covariate and idiosyncratic shocks; additionally, they examined that the self-reported shocks are not systematically correlated with a household-level variable. To support this idea, they also examined that the expansion of mobile technology agents is not correlated with observable characteristics, and performed a falsification test using data collected prior to the introduction of mobile technology. We estimate the following equation:

$$Cons_{hvt} = \alpha_0 + \alpha_1 S_{vt} + \alpha_2 C_{vt} + \alpha_3 S_{vt} \times C_{vt} + \alpha_4 X_{hvt} + \theta_h + (\theta_w \times \gamma_t) + \varepsilon_{hvt}, \quad (2)$$

where C_{vt} takes 1 if a household is located in a village with a land certification program and $(S_{vt} \times C_{vt})$ is an interaction term between shock and land certification. The coefficient of interest, α_3, identifies how much land certification programs help households recover from the negative effects of weather shocks. If $\alpha_1 + \alpha_3 = 0$, we cannot reject the null hypothesis that households who received the land certification program are fully insured.

Third, we examine the effect of the land certification program on potential mechanisms to mitigate the negative effect of weather shocks on consumption. Specifically, we test which mechanisms are facilitated by the program. Potential mechanisms are credit obtained from formal and informal institutions; gifts received from friends, relatives, or formal/informal institutions; assistance received in the form of food or cash for work; land rental fees received, and asset sales. Following [36], we apply the same strategy as above, and the following equation is estimated:

$$M_{hvt} = \alpha_0 + \alpha_1 S_{vt} + \alpha_2 C_{vt} + \alpha_3 S_{vt} \times C_{vt} + \alpha_4 X_{hvt} + \theta_h + (\theta_w \times \gamma_t) + \varepsilon_{hvt}, \quad (3)$$

where M_{hvt} is an indicator variable taking 1 if a household took coping strategies, and 0 otherwise. The coefficient α_3 measures if land certification programs facilitate coping mechanisms in facing adverse weather shocks. Land rights secured by the certification program are expected to activate the land rental market and use land as collateral for obtaining credit. If the program enhances mutual trust throughout the insurance network, the gifts and in-kind transfers can be increased by the program. As food-for-work and cash-for-work program is a government program and has no relationship with land tenure security, we do not expect that the land certification program enhances access to such programs as a coping strategy. There is no clear prediction of whether the land certification program facilities asset sales as a coping mechanism.

3. Data and Descriptive Statistics

3.1. Data and Variables

This study uses a panel dataset from the Ethiopian Socioeconomic Survey (ESS) collected in 2011/12, and 2015/16, a collaborative project between the Central Statistics

Agency (CSA) of Ethiopia and the World Bank Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) project. The sample households were selected using two-stage probability sampling. In the first stage, 333 enumeration areas (EAs) which are equivalent to villages were randomly selected from the sample of an Annual Agricultural Sample Survey (AgSS). Therefore, the population included households in rural and small-town areas. In the second stage, 12 households were randomly selected in each EA [57]. However, 137 households were excluded from the database of the 2011 survey sample due to the wrong calculation of consumption expenditures and a wrongly reported value of consumption. Thus, we obtained a balanced panel of 7398 households for two wave surveys with an attrition of about 7.4%.

The ESS contained comprehensive village- and household-level data. Our main outcome variables are annual per capita food consumption expenditure, annual per capita non-food consumption expenditure, annual per capita education expenditure, and annual per capita total consumption expenditure (Per capita education expenditure is defined as the total education expenditure per school age (used from age 6 to 18) while per capita food and non-food consumption expenditure are divided by the number of household members). To adjust for inflation, we used a price index provided in the data set. They considered a regional spatial price index from the Ministry of Finance and Economics Development (MoFED) of Ethiopia that was calculated from the Household Consumption and Expenditure Survey (HCEI). A set of indicator variables used as a mitigating mechanism used by households are: borrowing money from formal/informal institutions as a credit; receiving assistance and gifts from friends and relatives; receiving food-for-work or cash-for-work programs from the government and development partners of the government; selling assets, and receiving a land rental fee from renting out land in the last 12 months. Obtaining credit is defined as a member of the household borrowing cash or inputting on credit from someone outside the household or from an institution for business or farming purposes over the past 12 months.

The main policy variable is an indicator variable if a village received a land certification program by year t. In the 2011 and 2015 surveys, households were asked whether they had land certificates and, if so, when they received them. We found that 39.1% of the sample households had land certificates in 2011 and before, and the proportion of households who received land certification increased to 53.3% by 2015. As explained in Section 2.1, the land certification program was not demand-driven by households. Due to administrative reasons, not all the households received a land certificate at the same time. Even so, we cannot eliminate the possibility that those who needed the land certificate for using it as collateral received the certificate earlier than those who did not. Hence, to reduce a bias by using a household-level variable if a household received a land certificate, we construct and use a village-level variable taking unity if a household lives in a village where more than 40% of households had received the land certificate at the time t. For the robustness checks, we provided the results with an alternative threshold of treatment of 40%.

The weather shock variable employed for this study is self-reported by the households if households were affected by at least one of the severe weather shocks such as droughts, floods, and landslides during the last 12 months of the survey. Although this is a self-reported measure, it is not correlated with household characteristics such as education and assets, which ensures that this variable does not suffer from serious self-report bias. This is because the dataset does not contain GPS coordinates of the village location. Due to the lack of objective rainfall data, we construct a village-level weather shock variable taking one if 70% or more of the sample households living in the village are exposed to weather shock. As a robustness check, we also used a self-reported household-level weather shock.

Our model specification has two concerns that need to be dealt with: (1) the endogeneity of shocks because the shock variable is self-reported, and (2) the endogeneity of land certification because not all the households with the program received land certificates. Regarding the first concern, we test if land certification and other household covariates

affect weather shocks or not. Following Jack and Suri and Ahmad and Cowan [6,36], we run the following model using the household-level shock variable as a dependent variable:

$$S_{hvt} = \alpha_0 + \alpha_1 C_{vt} + \alpha_1 X_{hvt} + \theta_h + (\theta_w \times \gamma_t) + \varepsilon_{hvt}. \quad (4)$$

As reported in column 1 of Table 1, there is no evidence that a land certification program and other household variables affect weather shocks.

Table 1. Correlation between land certification and natural shocks.

	Weather Shock	Certification
Certification	0.029	
	(0.019)	
Natural Shock		0.025
		(0.016)
Age of household head	0.001	−0.002 **
	(0.001)	(0.001)
Literacy of household head	−0.027	−0.028
	(0.022)	(0.02)
Household size	0.006	0.009 *
	(0.005)	(0.005)
Land size in ha	−0.025	−0.091
	(0.031)	(0.16)
Household FE	Yes	Yes
Year x Woreda	Yes	Yes
Number of Observations	7374	7374
R-squared	0.619	0.752

Column 1 shows the estimation results of Equation (4). Standard errors are reported in parentheses. **, and * indicate significance at the 5%, and 10% critical level.

In terms of the second concern, we test if households who have a land certificate and those who do not have the certificate differ by the status of the shocks. By using the household-level certificate variable, we estimate the following model:

$$C_{hvt} = \alpha_0 + \alpha_1 S_{vt} + \alpha_1 X_{hvt} + \theta_h + (\theta_w \times \gamma_t) + \varepsilon_{hvt}. \quad (5)$$

As shown in column 2 of Table 1, the shock status and other household characteristics are not correlated with the characteristics of the owner of the certificate. Moreover, the land certification process in Ethiopia was implemented using a top-down approach and the program was initiated from a federal-level administration to the village level (a lower unit of administration). The implementation of the program was determined based on non-economic criteria [37,39,41,43].

3.2. Descriptive Statistics

Table 2 shows the descriptive statistics of exposure to shocks, consumption expenditure, and mitigating measures using two-year pooled data for total sample households and across each region. Four main categories of regional representations are considered in Table 1 (Tigray, Amhara, Oromo, and SNNP). The share of households who received land certification differs across regions, which ranges from 72.3% in Tigray to 57.6% in Oromia. This may be partly because of the difference in the year when the land certification program was first introduced. Regarding the exposure to shocks, it shows that 24.2% of the total sample households were affected by weather shocks, out of which 22.4% are mainly affected by drought; 2.2% are affected by flood and 0.4% are affected by landslides. The top mitigation mechanisms against the negative effect of weather shock are accessing formal/informal credit and receiving gifts from friends and relatives. When we examine the data across regions, the percentage of households who did not use mitigation methods is higher in SNNP (which can be computed by reducing the ratio

of other regions from 1: $1 - 0.217 - 0.152 - 0.024 - 0.046 = 0.561$) and lower in Tigray ($1 - 0.217 - 0.152 - 0.024 - 0.046 = 0.4$). There is also a difference across regions in their consumption expenditure, with the highest per capita consumption expenditure in Oromia and the lowest per capita consumption expenditure in the Amhara region. Given the heterogeneity across regions, we examine the role of the land certification program as insurance separately for each major region and test if the role varies from region to region based on differences in their regional land certification process and experiences.

Table 2. Mean value of main variables across regions.

	All	TIGRAY	AMHARA	OROMIA	SNNP
=1 Natural Shock	0.242	0.272	0.188	0.173	0.227
	[0.429]	[0.016]	[0.010]	[0.010]	[0.010]
=1 drought	0.224	0.258	0.163	0.160	0.201
	[0.417]	[0.016]	[0.009]	[0.010]	[0.009]
=1 flood	0.022	0.024	0.028	0.011	0.032
	[0.145]	[0.006]	[0.004]	[0.003]	[0.004]
=1 land slide	0.004	0.000	0.004	0.003	0.007
	[0.066]	[0.000]	[0.002]	[0.001]	[0.002]
Sum of drought, flood and land slide	0.25	0.282	0.194	0.174	0.240
	[0.451]	[0.017]	[0.010]	[0.010]	[0.011]
=1 HH received certification	0.612	0.723	0.657	0.576	0.628
	[0.487]	[0.016]	[0.012]	[0.013]	[0.011]
log Food per capita	8.882	8.924	8.740	9.023	8.796
	[0.682]	[0.023]	[0.016]	[0.016]	[0.017]
log Nonfood per capita	7.178	7.297	7.045	7.269	7.063
	[1.121]	[0.034]	[0.032]	[0.029]	[0.026]
log Educ per capita	2.852	2.932	2.536	3.130	2.983
	[2.329]	[0.080]	[0.055]	[0.063]	[0.053]
log Cons per capita	9.124	9.173	8.999	9.253	9.037
	[0.658]	[0.021]	[0.016]	[0.016]	[0.017]
=1 Obtained credit	0.235	0.307	0.275	0.235	0.217
	[0.424]	[0.017]	[0.011]	[0.011]	[0.010]
=1 received gifts from others	0.171	0.216	0.158	0.163	0.152
	[0.376]	[0.015]	[0.009]	[0.010]	[0.008]
=1 received food/cash for work	0.037	0.053	0.040	0.028	0.024
	[0.188]	[0.008]	[0.005]	[0.004]	[0.004]
=1 selling asset	0.025	0.024	0.009	0.026	0.046
	[0.156]	[0.006]	[0.002]	[0.004]	[0.005]
Number of observations	7398	776	1606	1488	1878

The figures in brackets represent the standard deviations.

Table 3 shows the descriptive statistics separately by shock status if households were affected by natural shocks in the last 12 months. We pooled two-year data. There is a statistical difference in consumption expenditure and mitigation measures between households that were and were not exposed to natural shocks. Households who were affected have a lower value for consumption expenditure than those who were not. Compared to households who did not experience any shocks, those who did receive more gifts from friends and relatives, as well as more assistance in the form of food/cash for work, mitigate the negative effect of shocks on consumption. However, no differences were found in the number of asset sales between households that were and were not affected by natural shocks.

Table 3. Differences in consumption and coping mechanisms by natural shocks (pooled data).

	Natural Shock	**No Natural Shock**	**Difference**
log Food exp per capita	8.858 [0.016]	8.889 [0.009]	−0.031 *
log Nonfood exp per capita	6.988 [0.027]	7.239 [0.015]	−0.251 ***
log Educ exp per capita	2.735 [0.053]	2.890 [0.031]	−0.155 **
log Cons exp per capita	9.066 [0.015]	9.143 [0.009]	−0.077 ***
=1 Obtained credit	0.242 [0.010]	0.232 [0.006]	0.010
=1 Received gifts from others	0.201 [0.009]	0.161 [0.005]	0.039 ***
=1 Received food/cash for work	0.079 [0.006]	0.023 [0.002]	0.057 ***
=1 Sold asset	0.023 [0.004]	0.026 [0.002]	−0.003
Observation	1794	5604	
	Natural Shock	No Natural Shock	Difference
log Food exp per capita	8.858 [0.016]	8.889 [0.009]	−0.031 *
log Nonfood exp per capita	6.988 [0.027]	7.239 [0.015]	−0.251 ***
log Educ exp per capita	2.735 [0.053]	2.890 [0.031]	−0.155 **
log Cons exp per capita	9.066 [0.015]	9.143 [0.009]	−0.077 ***
=1 Obtained credit	0.242 [0.010]	0.232 [0.006]	0.010
=1 Received gifts from others	0.201 [0.009]	0.161 [0.005]	0.039 ***
=1 Received food/cash for work	0.079 [0.006]	0.023 [0.002]	0.057 ***
=1 Sold asset	0.023 [0.004]	0.026 [0.002]	−0.003
Observation	1794	5604	

The figures in brackets represent the standard deviations. The values displayed for the t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level.

In Table 4, we compare the four groups categorized by both exposure to natural shocks and the land certification program. Group (1) consists of households that were affected by natural shocks and did not receive land certification. Group (2) consists of households who were affected by natural shocks and received land certification. Group (3) consists of households that were not affected by natural shocks and received land certification. Group (4) consists of households that were not affected by natural shocks and did not receive land certification. By comparing households who did not and did receive land certification given a natural shock (columns 1 and 2, respectively), we can see that, on average, consumption expenditure is greater for those that received land certification than for those who did not when households were affected by natural shocks. As expected, the share of households that obtained credit is higher for households that received land certification than those that did not. Next, we compare two groups of households that received land certification, but only one was exposed to natural shocks (columns 2 and 3). Within the group of households that received that land certification, we did not observe much difference in food consumption and education expenditures between the group of households who were exposed to natural shocks and those who were not. However, there was a significant difference in non-food consumption expenditure between these groups when they were affected by natural shocks compared with those who were not. In contrast, a higher share of households with land certification obtained credit, gifts, and assistance when they were affected by natural shocks than when they were not. Lastly, we compare households without land certification who were affected by natural shocks with those who were not (columns 1 and 4, respectively). Like the second comparison, natural shocks affected the consumption of both groups, and the difference is in the credits obtained. The likelihood of obtaining credit did not increase for the households without land certification when they were affected by natural shocks, which suggests that land certificates make it easier for households to obtain credits.

Table 4. Differences in consumption and coping mechanisms by certification.

	Natural Shock without Cert	Natural Shock with Cert	No Natural Shock with Cert	No Natural Shock without Cert	Difference	Difference	Difference
Variable	(1)	(2)	(3)	(4)	(1)-(2)	(3)-(2)	(4)-(1)
log Food per capita	8.755 [0.031]	8.903 [0.018]	8.897 [0.012]	8.879 [0.015]	−0.148 ***	−0.006	0.124 ***
log Nonfood per capita	6.746 [0.055]	7.093 [0.030]	7.270 [0.019]	7.194 [0.023]	−0.347 ***	0.177 ***	0.447 ***
log Educ per capita	2.250 [0.093]	2.945 [0.063]	3.023 [0.042]	2.703 [0.048]	−0.695 ***	0.078	0.452 ***
log Cons per capita	8.954 [0.031]	9.114 [0.017]	9.155 [0.011]	9.127 [0.014]	−0.160 ***	0.040 *	0.173 ***
=1 Obtained credit	0.196 [0.017]	0.263 [0.012]	0.236 [0.007]	0.225 [0.009]	−0.067 ***	−0.026 *	0.029
=1 Received gifts from others	0.205 [0.017]	0.199 [0.011]	0.145 [0.006]	0.182 [0.008]	0.006	−0.054 ***	−0.022
=1 Received food/cash for work	0.067 [0.011]	0.085 [0.008]	0.020 [0.002]	0.027 [0.003]	0.010	0.003	−0.039 ***
=1 Sold asset	0.030 [0.007]	0.020 [0.004]	0.023 [0.003]	0.029 [0.003]			−0.001
No. of Observations	542	1252	3267	2325			

The figures in brackets represent the standard deviations. The values displayed for the t-tests are the differences in the means across the groups. *** and * indicate significance at the 1%, and 10% critical level.

4. Results

4.1. Effect of Weather Shocks on Consumption Expenditure

Table 5 shows the results from Equation (1). Column 1 shows that natural shocks significantly reduced household food consumption expenditure by 6%, while column 2 shows a decrease of 12.1% in non-food consumption expenditures when households were affected by weather shocks. On average, per capita consumption expenditure decreased by 6.6% because of weather shocks. The results are consistent with those of other studies [4,6,58]. Furthermore, education expenditure was negatively affected by weather shocks by 17.2%.

Table 5. Effect of shocks on consumption expenditure.

	Log (Per Capita Food Consumption Exp)	Log (Per Capita Non-Food Consumption Expenditure)	Log (Per Capita Education Expenditure)	Log (Per Capita Total Consumption Exp)
Weather shocks	−0.060 ** (0.03)	−0.121 *** (0.043)	−0.172 * (0.096)	−0.066 ** (0.027)
Household FE	Yes	Yes	Yes	Yes
Year x Woreda	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Rwolf2 FWER *p*-value	0.2151	0.0040	0.0040	0.5418
No. of Observations	7398	7398	7398	7398
R-squared	0.671	0.737	0.757	0.709

Other controls include the literacy level of household head, household head age, number of household members, and land size. Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level.

4.2. Role of Land Certification Program in Consumption Smoothing

In the previous subsection, we found a negative impact of the weather shock on consumption expenditure. Now, we examine if the land certification program facilitates risk sharing to mitigate the negative effect of weather shocks on per capita consumption expenditure (Equation (2)). The estimation results are found in Table 6. Column 1 shows that weather shocks decrease the food consumption of households in villages without land certification programs by 25.1%. However, for households in villages with the land certification program, weather shocks increased their per capita food consumption expenditure by only 1.1% (−0.251 + 0.262). Although the magnitude is small, a joint test (Wald

test *p*-value) for a sum of the coefficients indicates that it is significantly different from zero. Hence, households in villages with a land certification program were able to protect themselves against such shocks. This finding is consistent with Porter [2] which found that idiosyncratic shocks in Ethiopia have a positive impact on consumption. In terms of other expenditures, the coefficient of the interaction term between certification and shock is positive. However, the mitigating effect of the land certification is not large enough to smoothen the consumption when affected by the shock.

Table 6. Role of land certification on mitigating against shock.

	Log (Per Capita Food Consumption Expenditure)	**Log (Per Capita Non-Food Consumption Expenditure)**	**Log (Per Capita Education Expenditure)**	**Log (Per Capita Total Consumption Expenditure)**
Certification x Shock	0.262 ***	0.175 *	0.167	0.200 ***
	(0.07)	(0.095)	(0.171)	(0.067)
Certification	0.018	0.017	−0.259 ***	0.011
	(0.028)	(0.04)	(0.095)	(0.025)
Shock	−0.251 ***	−0.277 ***	−0.314 *	−0.213 ***
	(0.068)	(0.092)	(0.162)	(0.065)
Household FE	Yes	Yes	Yes	Yes
Year x Woreda	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Certification x Shock + Shock	0.011	−0.122	−0.157	−0.013
Wald test (*p*-value)	(0.0007)	(0.0019)	(0.0940)	(0.0044)
No. of Observations	7374	7374	7374	7374
R-squared	0.66	0.731	0.752	0.701

Other controls include the literacy level of household head, household head age, number of household members, and land size. Wald test (*p*-value): joint test of an interaction variable with shock. Standard errors are reported in parentheses. *** and * indicate significance at the 1%, and 10% critical level.

4.3. Coping Mechanisms

In the previous subsection, we saw that households in villages with the land certification program managed to avoid the negative effect of weather shocks on food consumption, unlike those without. In this subsection, we report the results of the mechanisms.

Table 7 shows the effect of the land certification program on the likelihood of obtaining credit, receiving gifts, receiving assistance in the form of food-for-work or cash-for-work programs, selling assets, and renting out land via fixed rental contracts. Column 1 suggests that the land certification program increased their probability of obtaining credit when they were affected by weather shocks. The joint test also shows that sum of the effect of shock and interaction with certification is significantly different from zero. This implies that land certificates can help to access credit when households are affected by weather shocks.

Column 2 in Table 7 reports the results on the probability of receiving gifts/assistance from friends and relatives when faced with weather shocks. Unlike our expectations, households that were affected by weather shocks are less likely to receive gifts. However, the effect of shocks is different for those who have a land certification program, and land certificates increase the probability that households who were affected by weather shocks receive gifts from others. In Ethiopia, it is common for people to share what they have with their neighbors and social formal/informal networks when someone faces hardship [12]. Receiving gifts from friends and relatives could constitute helping someone in the time of hardship. Another implication is that giving a gift may also depend on creating cooperative behavior with the receiver of the gifts to use at a time of need. Hence, someone with land tenure security can be more trusted and likely to receive gifts when they become affected by the shock.

Table 7. Coping mechanisms against weather shocks.

	=1 Obtained Credit from Others	=1 Received Gifts from Others	=1 Received Food for Work or Cash for Work	=1 Sold Assets	=1 Rented Out Land Via Fixed Rental Contract
Certification x Shock	0.142 ***	0.131 ***	−0.012	−0.013	0.007
	(0.043)	(0.04)	(0.024)	(0.016)	(0.016)
Certification	0.008	−0.009	−0.006	0.003	−0.007
	(0.019)	(0.017)	(0.008)	(0.007)	(0.01)
Shock	−0.049	−0.141***	0.068 ***	0.018	−0.021
	(0.042)	(0.039)	(0.022)	(0.014)	(0.015)
Household FE	Yes	Yes	Yes	Yes	Yes
Year x Woreda	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Certification x Shock + Shock	0.093	−0.01	0.056	0.005	−0.14
Wald test (*p*-value)	0.0000	0.0016	0.0000	0.4186	0.1109
No. of Observations	7374	7374	7308	7374	5910
R-squared	0.569	0.599	0.541	0.532	0.567

Other controls include the literacy level of household head, household head age, number of household members, and land size. Wald test (*p*-value): joint test of an interaction variable with shock. Standard errors are reported in parentheses. *** indicate significance at the 1% critical level.

Column 3 reports the mitigating mechanism in the form of receiving government programs (food-for-work or cash-for-work programs). Households who were affected by weather shocks are likely to receive an increased number of programs. This may be because these programs tend to be provided in drought-prone areas by the government and development partners. As expected, there is no evidence that a land certification program increases such likelihood when affected by shocks.

Column 4 shows the results of another coping mechanism—the sale of one's own assets. There is no evidence that weather shock increases the probability of selling assets. Since the dependent variable is a dummy variable, we cannot rule out the possibility that the number of assets sold increased by weather shocks (the intensive margin) and the effect of weather shocks on asset sales varies by land certificate. At least for the extensive margin, there is no evidence that a land certification program makes a difference.

Column 5 reports the result of testing if renting out land via a fixed rental contract can be facilitated by the land certification program as a mitigating mechanism against weather shock. Unlike the expectation, there is no precisely estimated zero impact that households with land certification programs are more likely to rent out land when facing weather shocks. This may be because there is no demand for renting land in the middle of cropping season after weather shocks hit and neighbors are also adversely affected. However, households may be able to find tenants when they had idiosyncratic shocks such as the sickness of the household head. Thus, the land certification program can be effective as a mitigation mechanism against idiosyncratic shocks.

4.4. Heterogeneity Analysis

In the previous sections, we found a negative impact of the weather shock on consumption expenditure, and the land certification program facilitated coping mechanisms such as obtaining credits and gifts to mitigate the effect of weather shocks. In this section, we investigate if there are heterogeneous effects of the land certification program on consumption smoothing against shocks by land size (households owning larger than median land size, 0.89 hectares).

We examine the heterogenous treatment effect of land certification by estimating separately for smaller vs. larger landowners. The estimation results are shown in Table 8. Columns 1–4 show an estimation result for larger landowners while columns 5–8 show that for smaller landowners. The effect of the land certification program is contrasting between smaller and larger landowners. The land certification program increased food and total consumption expenditure among smaller landowners while it increased non-food

consumption expenditure among larger landowners. Similar to the average impact shown in Table 6, smaller landowners in villages with a land certification program were able to protect themselves on food consumption against weather shocks. Furthermore, total consumption expenditure did not decrease among smaller landowners.

Table 8. Heterogeneity based on land size.

	Owning Larger Land Size				Owning Smaller Land Size			
	Log (Pc Food Cons Exp)	**Log (Pc Non-Food Cons Exp)**	**Log (Pc Education Exp)**	**Log (Pc Total Cons Exp)**	**Log (Pc Food Cons Exp)**	**Log (Pc Non-Food Cons Exp)**	**Log (Pc Education Exp)**	**Log (Pc Total Cons Exp)**
Certification x Shock	−0.008	0.317 **	0.246	0.017	0.488 ***	0.091	0.131	0.358 ***
	(0.11)	(0.137)	(0.24)	(0.104)	(0.094)	(0.137)	(0.252)	(0.092)
Certification	0.056	0.094 *	−0.239 *	0.046	0.028	−0.022	−0.227	0.019
	(0.039)	0(.049)	(0.136)	(0.035)	(0.041)	(0.067)	(0.139)	(0.037)
Shock	−0.025	−0.438 ***	−0.461 *	−0.06	−0.428 ***	−0.165	−0.238	−0.335 ***
	(0.107)	(0.131)	(0.236)	(0.101)	(0.091)	(0.131)	(0.234)	(0.089)
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year x Woreda	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cert x Shock + Shock	−0.033	−0.121	−0.251	0.11	0.06	−0.074	−0.107	0.023
Wald test (*p*-value)	0.7489	0.0008	0.0896	0.4968	0.0000	0.3035	0.5244	0.0005
No. of Observations	3600	3600	3600	3600	3772	3772	3772	3772
R-squared	0.64	0.696	0.738	0.663	0.685	0.752	0.761	0.731

Other controls include the literacy level of household head, household head age, number of household members, and land size. Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level.

As reported in Table 9, the heterogenous effect of the land certification program on coping mechanisms against weather shock also differs by land size. For households owning larger land, the certification program helps not to sell assets when they are affected by weather shocks. Although there is no evidence that the land certification program activated credit for larger landowners, the land certification program facilitated access to credit and assistance from relatives and friends for smaller landowners.

Table 9. Mechanisms for heterogeneity based on land size.

	Owning Larger Land Size					Owning Smaller Land Size				
	Obtained Credit	**Received Gifts**	**Received Food/Cash for Work**	**Sold Assets**	**Rented Out in Fixed Rental**	**Obtained Credit**	**Received Gifts**	**Received Food/Cash for Work**	**Sold Assets**	**Rented Out in Fixed Rental**
Certification x Shock	0.094	0.076	0.007	−0.047 **	0.034	0.213 ***	0.160 ***	−0.018	0.008	−0.016
	(0.068)	(0.057)	(0.029)	(0.02)	(0.027)	(0.056)	(0.057)	(0.036)	(0.02)	(0.021)
Certification	0.027	−0.006	0.001	−0.01	−0.025 **	−0.028	−0.017	−0.007	0.010	0.014
	(0.03)	(0.021)	(0.013)	(0.011)	(0.012)	(0.027)	(0.027)	(0.012)	(0.01)	(0.016)
Shock	−0.033	−0.062	0.061 **	0.053 ***	−0.048 *	−0.081	−0.178 ***	0.065 **	−0.002	−0.004
	(0.069)	(0.057)	(0.028)	(0.018)	(0.028)	(0.052)	(0.055)	(0.033)	(0.02)	(0.016)
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year x Woreda	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cert x Shock + Shock	0.061	0.014	0.068	0.006	−0.014	0.132	−0.018	0.047	0.006	−0.020
Wald test (*p*-value)	0.1413	0.4043	0.0024	0.0102	0.1405	0.0000	0.0051	0.0082	0.8557	0.3607
No. of Observations	3600	3600	3574	3600	3316	3772	3772	3732	3772	2592
R-squared	0.576	0.604	0.562	0.539	0.584	0.57	0.598	0.547	0.549	0.558

Other controls include the literacy level of household head, household head age, number of household members, and land size. Wald test (*p*-value): joint test of an interaction variable with shock. Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level.

4.5. Robustness Checks

In this section, we provide further analyses for robustness checks. The first one is on the weather shock variable. In the main specifications, we used village-level weather shock to decrease possible self-reporting bias. As a robustness check, we also used a self-reported household-level weather shock. The results are provided in Tables S1 and S2 (see supplementary). Though the magnitudes of the coefficients are smaller than the ones obtained in Tables 6 and 7, the results are similar qualitatively. The land certification program helped recover from negative income shocks by enhancing access to credit and gifts.

The second analysis is also on the weather shock variable. In the main specifications, we combined the three main types of shocks (drought, flood, and landslides) and considered households affected by weather shock if at least one of these types occurred. As drought, flood, and landslides can have different impacts, we constructed three different shock variables and estimated the same models. As shown in Tables S3 and S4 (see supplementary), drought decreased per capita food consumption by 11.5%. However, the land certification program mitigated the negative effect, and the effect of drought shock on food consumption expenditure was only 1%. This small impact was explained by the fact that the land certification program facilitated coping strategies of receiving credit and gifts. For other types of shocks (floods and landslides), there is no evidence that the land certification has a mitigating effect when households faced floods and landslides. Hence, the effect of the land certification that we found in Table 6 can be mainly explained by drought, and land certification can protect households from the severe effect of drought on food consumption.

The third analysis is on the land certification variable. This variable was constructed from a household-level variable and we set an arbitrary threshold of 40% of households within the village. For robustness checks, we changed the threshold to 35% and 45%. The results are found in Tables S5–S8 (see supplementary). At the 35% threshold, the findings do not change. At the 45% threshold, obtaining credit is no longer a coping strategy that was facilitated by the land certification program but renting out land became an effective coping strategy.

The last analysis is also on the land certification variable. Although the program was not demand-driven, villages that have higher social capital could have received the program earlier than the other villages. If so, this variable is a proxy of social capital. To test this possibility, we constructed a membership in a local association (i.e., Iddir) as a proxy measure of social capital and included it as one of the independent variables in Equation (3). As shown in Tables S9 and S10 (see supplementary), we confirmed that the results remain the same.

5. Conclusions

This study analyzes two-year LSMS household-level panel data to estimate the effect of Ethiopia's land registration and certification program on mitigating the negative effects of weather shocks. Following Jack and Suri and Ahmad and Cowan [6,36], we adopted a DID approach, including household fixed effects, to elucidate the role of the land certification program in facilitating coping strategies to mitigate the negative effect on consumption against shocks. We found that weather shocks reduced household consumption expenditure, which is expected because of limited access to the insurance market. However, the land certification program could manage to partially recover from decreased consumption expenditures as a response to weather shocks largely through obtaining credit from their own social networks and credit markets. Land certification improves land tenure security and, in turn, creates trust among people and institutions [46,47]. Therefore, strengthening land tenure security by land certification can help smoothen consumption. This study provided empirical evidence that the enhancement of land property rights enhances access to credit markets.

Our study also provides heterogeneous treatment effects of the land certification program on facilitating coping mechanisms against weather shock across land sizes (smaller or larger land owners). We found that for smaller landowners, the land certification program

helped them increase food consumption in response to weather shocks through obtaining credit and receiving gifts, while for larger landowners, we did not find a mitigating effect of the program. Therefore, the program is pro-poor and beneficial for improving the welfare of poorer households and protecting vulnerable households from entering into poverty traps.

The land certification program became a pro-poor agricultural program as it changed the livelihood of the small landholder and young household heads who likely lack assets and wealth to rely on. Providing formal land property rights in the form of land certification is becoming an effective way to reduce the negative impact of weather shock on consumption expenditure. Therefore, policymakers need to upgrade the value of land certification that enables them to formally use it to access credit. However, there is a need for promoting the program carefully. In each country, the land tenure system is different. It is documented that land was taken away by elites during the process and the program provoked serious land disputes [59–63]. It is critical, therefore, that policymakers design and implement land registration programs appropriately.

The paper has a few limitations. First, food consumption is measured by the last week's consumption while the shock is measured in the last 12 months before the interview. We cannot tell when the shock occurred. The impact of shock can be smaller when it occurred a long time before the interview and larger when it did during a critical time of agricultural production. Second, this study lacks objective rainfall data to measure weather shock as the village location is confidential in the dataset. Since it is a self-reported and binary variable, we cannot derive the estimated impact for a certain threshold of rainfall shortage. These points persist for future studies.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su141912549/s1, Table S1: Role of land certification on mitigating against shock (HH self-reported shocks); Table S2: Coping mechanisms against natural shocks (HH self-reported shocks); Table S3: Role of land certification for each type of natural shocks on consumption; Table S4: Coping mechanisms against combined and each type of natural shocks; Table S5: Role of land certification on consumption expenditure with alternative threshold. (35% of households as threshold); Table S6: Effect of land certification on the mechanisms. (35% of households as threshold); Table S7: Role of land certification on consumption expenditure with alternative threshold. (45% of households as threshold); Table S8: Effect of land certification on the mechanisms (45% of households as threshold); Table S9: Role of land certification on mitigating against shock controlling for Social Capital (Enumeration Area shocks); Table S10: Coping mechanisms against natural shocks controlling for Social Capital (Enumeration Area shocks).

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