Facing climate change together? The role of collective variables in mediating CT effects on climate adaptation*

Job Market Paper

Filippo Grisolia†[1], Sara Dewachter[1], and Nathalie Holvoet[1]

[1]Institute of Development Policy, University of Antwerp

October 2023

Abstract

Surprisingly little (theoretical and) empirical literature exists on how cash transfer (CT) programs affect climate resilience and adaptation, notwithstanding the severity of the ongoing climate emergence, and the overlap in aims between social protection and climate policy. The existing sources claim that CTs can improve climate resilience by positively impacting its several dimensions, among which the social component plays a key role. In this context, the paper analyses, through a quasi-experimental difference-in-differences approach, the midline effects of a (universal) unconditional cash transfer conducted in rural Uganda, on adaptation to climate change and collective-level outcomes – operationalized as social capital, agency and collective action, and also underexplored.

The main finding was that the program did spur the adoption of (both preventive and absorptive) coping mechanisms against climate shocks. Nevertheless, interestingly, not only 'beneficial' strategies (such as savings and credit) but also 'mal-adaptation' practices – like selling productive assets and withdrawing children from school – were increasingly employed by recipients. Moreover, the study confirmed that CTs are able to yield positive effects on collective variables (even if agency was negatively impacted, in this case). Finally, through Causal Mediation Analysis, it was established that the rise in the utilization of beneficial coping mechanisms was in fact mediated and driven by the CT-led improvement in collective-level outcomes, whereas the latter did not significantly influence changes in the usage of adverse strategies.

Keywords: cash transfers, basic income, climate change, social capital, mediation analysis, Uganda

JEL-Codes: D60, I32, I38, O12, Q54, Q58

*Thanks to my PhD colleagues and to the participants to my CSB 2023 seminar series presentation for their feedback and suggestions. All errors are mine.

†Corresponding author. email: filippo.grisolia@uantwerpen.be

1 Introduction

Climate change possibly represents the biggest challenge of our time, posing existential threats to most people's livelihoods, but especially and disproportionately to the ones of marginalized individuals in poor Global South settings (IPCC, 2022). Communities exposed to severe climate hazards are, as a matter of fact, often incapable to adequately cope with the effects of disasters (Heltberg et al., 2015), given their limited adaptive capacity and resilience. Such condition creates vicious circles, perpetuating vulnerability, and ultimately making the attainment of poverty reduction and economic growth even more complicated (Asfaw et al., 2011). In this sense, the aims of social assistance and climate policy should, and do, legitimately overlap (Agrawal et al., 2020).

Their benefits also coincide, to a limited degree, as social protection can contribute to help recipients tackling climate change-related consequences (Heltberg et al., 2008) – even if its role should not be overestimated (Tenzing, 2020). It is argued that positive repercussions of social protection, in fact, include improvements in resilience to shocks, even when this is not an explicit objective of programs (Ulrichs et al., 2019). Social cash transfers (CTs) are, for instance, viewed as a resilience-building tool because, by providing a periodic and reliable safety net, they could enhance individuals' capacity to absorb the negative effects of climate-related shocks and stresses (Ulrichs et al., 2019). However, CTs' ability to build livelihoods and resilience against climate change is still poorly understood, as a natural reflection of the fact that few – when any – programs are designed to foster them (Béné, 2011; Johnson et al., 2013; Wood, 2011) . In fact, notwithstanding the magnitude of the ongoing climate emergence, the extensive use of cash transfers in countries' poverty reduction strategies – and the briefly discussed and potentially beneficial role of CTs in alleviating the consequences of climate change – social protection and climate change adaptation (CCA) have been evolving separately (Béné, 2011). Bringing these fields together has been identified as a key development challenge (Davies et al., 2013), partly addressed by the recent surge of the concept of 'Adaptive Social Protection' (ASP; Davies & Leavy, 2007), developed by exploring the linkages between social protection and climate change adaptation in the agricultural sector. While approaches such ASP, climate-smart and 'shock-responsive' social protection are gaining ground (Ulrichs et al., 2019), the related demand and supply is still insufficient (Costella et al., 2023).

As a consequence, a fundamental gap in the literature exists concerning CTs' repercussions on climate adaptation. On a theoretical level, if anything, scholars have been skeptical of transfers' ability to tackle patterns of poverty and environmental vulnerability, especially in the long run (Devereux & McGregor, 2014; Johnson et al., 2013; Johnson & Krishnamurthy, 2010). The empirical evidence is also surprisingly limited, considering the relatively vast amount of experimental knowledge that exists around CT effects on a variety of other outcomes, spanning labour supply, empowerment, and food security, amongst others (Bastagli et al., 2019; Kabeer

et al., 2012). Moreover, the few available investigations rarely analyze impacts on climate resilience directly, carrying the task out, instead, through the evaluation of effects on indicators associated with it, such as savings, consumption, asset ownership, and education (Agrawal et al., 2020).

This acknowledgment is easily explained by considering how vulnerability and resilience are often understood as highly dependent on and mediated by several different dimensions explicative of individual livelihoods' quality (Premand & Stoeffler, 2020; Sengupta & Costella, 2023). Among these, the social and collective aspect is assigned a prominent role by the literature, as numerous sources attribute a fundamental part of improvements in climate adaptation to enhancements in local social networks, levels of trust and collective action (Paul et al., 2016; Saptutyningsih et al., 2020; Yaméogo et al., 2018). In particular, social relations are seen as a crucial tool to spur long-term adaptive capacity, and therefore to unleash the transformative potential of CTs (Davies et al., 2013).

In this context, this study expands the available empirical evidence on cash transfer impacts on climate adaptation, on collective outcomes – operationalized as social capital, agency, and collective action, on which also just a few sources exist (Grisolia et al., 2021) – and the relationship between the two effect domains. To carry out the aforementioned exercise, the paper analyses the midline impacts of a universal unconditional CT program, initiated in 2022 in a rural Ugandan village, through the implementation of quasi-experimental difference-in-differences techniques (Gertler et al., 2016) and Causal Mediation Analysis (Charters et al., 2023; Pace et al., 2022). The latter tool was specifically employed to determine how much of the total CT-led effect – if any existed – on adaptive capacity to climate shocks could be attributed to (program impacts on) collective-level variables.

The rest of the article is structured as follows: Section 2 introduces the main concepts of interest to the paper, such as climate adaptation and collective-level outcomes, and their relations. Section 3 presents the study's methodology and the context of the analysed program. Section 4 discusses the results of the conducted impact evaluation and mediation analyses. Finally, Section 5 concludes and identifies key limitations and implications for further research.

2 Theoretical background

2.1 Cash transfers and climate resilience

Several theoretical sources put forward that social protection could represent an important tool in contributing to reduce the immediate consequences of climate disasters (Béné, 2011). This acknowledgement builds on the general consensus that social protection programs provide participants with improved resilience – seen as the ability to independently act against climate shocks and stresses (Ulrichs et al., 2019) – by reducing the levels of transitory and chronic

poverty caused by these events (Bagolle et al., 2023). According to Costella et al. (2023), there are four main pathways through which social protection could foster climate-resilient development: 1) by reducing overall climate vulnerability; 2) by responding to climate shocks; 3) by compensating for the negative impacts of climate change responses; and 4) by underpinning climate change adaptation and mitigation responses. However, the growing recognition of the need for a 'climate-proofed' social protection has been largely ignored by practitioners and policymakers (Bagolle et al., 2023; Béné, 2011; Heltberg et al., 2008; Siddiqi, 2011).

Even the emerging notion of ***Adaptive Social Protection*** (Davies & Leavy, 2007), integrating social protection, disaster risk reduction (DRR) and climate change adaptation (CCA) agendas (Davies et al., 2013), has mostly remained limited to the conceptual level, with very few programs actually incorporating these elements (Costella et al., 2023; C. Johnson et al., 2013; Wood, 2011). This is especially surprising when considering that, in light of the magnitude of the ongoing climate crisis, the designs and objectives of social assistance and climate policy need, by *force majeure*, to overlap (Agrawal et al., 2020; Coirolo et al., 2013), if longer-term chronic poverty and environmental vulnerability reduction – rather than short-term consumption alleviation – really represent their common goals (Agrawal et al., 2020).

The climate-tackling potential of social protection alone is not to be excessively emphasized, though: in order to ensure proper responses to climate change, it should in fact be coupled with pre-disaster mitigation and prevention measures, as well as post-disaster adaptation strategies (Coirolo et al., 2013; Tenzing, 2020). In this sense, the long-run 'transformative' role (Devereux & McGregor, 2014) of ASP in addressing the structural causes of vulnerability to climate change has not been harnessed by policymakers yet (Tenzing, 2020), and has been discussed with skepticism in the academic discourse (Johnson & Krishnamurthy, 2010; Tenzing, 2020). But although changes in transformative resilience are rare (Agrawal et al., 2020), social assistance and cash transfers have, for instance, confidently been linked to improvements in recipients' protective, preventive and promotive coping potential and strategies (Davies et al., 2013). Consequently, cash transfers could offer a particularly interesting adaptation option as, in comparison to other types of intervention, they are supported by a wider evidence base, yield substantial potential for scaling up, tend to gain local acceptance, and do not require a lot of climate-related information (Wood, 2011). Moreover, because of their guaranteed periodic design, they cater well to the context of climate change, characterized by severe uncertainty (Lawlor et al., 2015).

The mentioned "wider" evidence base is however not very large in the case of climate resilience impacts: as a result of the lack of attention to the issue, just a few of the available empirical proofs directly investigate CT effects – or impacts of any social protection program in general – on this outcome (Agrawal et al., 2020). A paper evaluating the impacts of the Zambia Child Grant Programme found, for instance, that the transfer enabled recipient households to better cope with climate shocks, by increasingly employing adaptive mechanisms which do

not increase the likelihood of falling into a poverty trap (Lawlor et al., 2015). Another study from Togo demonstrated that remittances can improve households' resilience, alongside their perception of exposure to climate risks (Sodokin & Nyatefe, 2021). On the other hand, the great majority of the existing knowledge pieces analyses CT effects on climate resilience in an indirect manner, by evaluating program impacts on proxies typically associated with the concept, like consumption, savings, asset ownership, education (Agrawal et al., 2020). Such approach reflects the commonly shared belief that cash transfers could foster resilience through mechanisms of savings facilitation, asset accumulation, and income smoothing (Premand & Stoeffler, 2020). It is the case, for example, of an investigation of *Familias en Acción* in Colombia, which concluded that the program did not yield any significant effect on vulnerability to climate change, operationalized as an index – comprising wealth, health, access to information, access to basic facilities, financial vulnerability, resilience to natural disasters, and nutrition (Arena et al., 2023). Similarly, a study from Ethiopia suggested that the PSNP had not enabled smallholders to diversify income sources in such a way to stimulate climate adaptation (Weldegebriel & Prowse, 2013). Other studies actually find that CTs can improve resilience to climate, by spurring income diversification in Nicaragua (Macours et al., 2012), or income security and savings in Niger (Premand & Stoeffler, 2020). In summary, much of the available evidence is only suggestive of eventual cash transfer beneficial impacts on climate resilience and adaptation.

2.2 Climate adaptation: preventive and absorptive measures

This paper looks at resilience by focusing on cash transfers' impacts on ***climate adaptation***, adopting an ASP-inspired definition, whereby adaptation is described as a mix of: "*disaster risk management focusing on preventing, mitigating and preparing to deal with shocks, and adaptive change management that aims to modify behaviors and practices over the medium-to long-term*" (Asfaw et al., 2011, p. 2). Coherently, then, the study maintained this distinction, by asking interviewees to indicate which kinds of coping mechanisms they resorted to, both as a way to anticipate, and to react to the consequences of climate shocks. This is relevant for the purposes of this work because, according to the theoretical literature, both tasks can be facilitated by cash transfers (Agrawal et al., 2020; Ulrichs et al., 2019): the 3As frameworks actually posits that CTs can benefit recipients' ***anticipatory*** (pre-; being better prepared for the eventuality of shocks), ***absorptive*** (post-; cope with stresses while and after they occur) and *adaptive* (transformative; adapting to long-term climate risks) capacity (Bahadur et al., 2015). Hence, greater (at least anticipatory and absorptive) capacities are likely to result from CT-derived strengthening of resilience , even if the obtained impacts clearly depend on a variety of factors, including prior wellbeing levels and the nature of experienced climate hazards (Agrawal et al., 2020).

In this case, the list of inquired mechanisms was drafted on the basis of a literature review

of the most typically adopted climate adaptation techniques in Sub-Saharan Africa (Asfaw et al., 2011; Heltberg et al., 2015; Yaméogo et al., 2018), (rural) Uganda (Helgeson et al., 2013; Hisali et al., 2011) and even in the specific region in which the CT of interest is conducted (Berman et al., 2015; Okonya et al., 2013). An additional differentiation (see *Table 1*) was also introduced to distinguish between '***mal-adaptation***' strategies (Schipper, 2020), and the ones generally perceived as positive, or at least more nuanced (Lawlor et al., 2015). Mal-adaptation techniques activities which provide a temporary relief from the consequences of climate change but that, in the longer-term, may activate vicious circles, and ultimately trap households into poverty (Barrett et al., 2006; Helgeson et al., 2013). In this sense, selling productive assets or livestock is typically seen as the most significant driver of poverty traps, but other adverse and harmful coping strategies comprise those which reduce households' human capital investment, such as withdrawing children from school, and sending them to work (Helgeson et al., 2013; Lawlor et al., 2015).

As already briefly mentioned, for all of the selected strategies – regardless of their beneficial or adverse nature – it was inquired whether they had been employed in anticipation, absorption of climate consequences, or both. Among these, the adoption of agricultural practices, considered a beneficial strategy, was further investigated, by asking respondents to indicate which exact agricultural tasks they had been carrying out – including changing planting dates, diversifying crops, and increasing the use of fertilizers and/or pesticides (Asfaw et al., 2011; Okonya et al., 2013; Yaméogo et al., 2018). The latter choice was driven by the acknowledgment that resorting to such practices – either as ex-ante or ex-post solutions – could return hints and insights around the possibility of increases in CT recipients' adaptive capacity to climate change (Bahadur et al., 2015).

2.3 The collective/social aspect of climate adaptation

As already briefly mentioned, resilience is often measured through associated proxies (Agrawal et al., 2020; Premand & Stoeffler, 2020) and understood as the sum of several different components and dimensions of one's livelihood (Sengupta & Costella, 2023). According to the GIZ multidimensional resilience index (Welle et al., 2014), for instance, adaptive capacity can be strengthened by enhancing the five main dimensions of vulnerability, namely the social, ecological, economic, physical and institutional ones (Sengupta & Costella, 2023). In this sense, the social domain represents a main driver of transformative long-term improvements in adaptation to climate change (Welle et al., 2014). Adaptation is in fact recognized as a dynamic social process, whereby a society's ability to adapt is partially determined by its capacity to act collectively (Adger, 2003). Collective action is considered crucial in driving numerous decisions related to the management of natural resources, and social networks play a major role in adaptation, with networking social capital sometimes even regarded as a potential substi-

tute of government (Adger, 2003). When facing environmental threats, poor households may indeed have to draw upon social capital (among other forms of capital) to cope, especially in the absence of strong higher-level institutions (Paul et al., 2016). For instance, social networks bear the potential to affect farmers' attitudes about climate change (Nam et al., 2012), to enrich their adaptation knowledge (Fankhauser et al., 1999), and to improve their ability to estimate climate-derived risks (Kane & Shogren, 2000). Consequently, beneficial investments in social networks and relations – such as the instalment of a cash transfer program (Asfaw et al., 2011) – could contribute to strengthening recipients' resilience to a number of climate hazards (Agrawal et al., 2020). However, the effectiveness of social capital is dependent on the local level of available resources and possessed knowledge of solutions against environmental stresses (Paul et al., 2016).

Empirical research has proven that social capital can facilitate adaptation: several sources have demonstrated, as a matter of fact, that the social component is a key driver of poor communities' climate resilience. A study from Ethiopia determined that trust influenced the extent of individual contributions to public adaptation goods (Paul et al., 2016). Another paper from Indonesia showed that farmers' willingness to participate in the process of climate change adaptation was positively correlated with trust, community engagement and personal relations (Saptutyningsih et al., 2020). Lastly, evidence from Burkina Faso showed that social capital affected the choice, the number, and the degree of effective implementation of adopted adaptation techniques (Yaméogo et al., 2018).

This article evaluates CT impacts on ***collective (or 'social') outcomes*** – and the extent to which they mediate effects on climate adaptation – by conceptualizing them as repercussions on *social capital*, *agency* and *collective action*. Despite a rising interest, the number of existing empirical proofs on the topic is scarce, although pointing to positive cash transfer impacts on these domains (Grisolia et al., 2021). As already seen, proxies of social capital (Paul et al., 2016; Yaméogo et al., 2018) and collective action (Adger, 2003; Saptutyningsih et al., 2020) can spur adaptation. Investigating agency's role is also necessary because social capital – regarded as a critical factor in sustainable development (Garbarino & Holland, 2009) – is in itself not sufficient to spur the collective action processes which lead to improved climate adaptation patterns, sometimes described as private or local public goods (Hasson et al., 2010; Khan & Munira, 2021). Alongside beneficial social capital changes, in fact, enhancements in (influential) actors' agency are also indispensable (Krishna, 2002). This study's analytical framework is therefore depicted in *Figure 1*, highlighting the expected theory of change, beyond CT effects at the individual- and household-levels (Bastagli et al., 2019), reaching better climate adaptation through beneficial impacts on collective outcomes.

In our case, social capital was operationalized by resorting to proxies reflecting the categorization of the World Bank Social Capital Assessment Tool (SOCAT; Grootaert & Van Bastelar, 2002), which distinguishes between the structural (e.g., networks and inclusion patterns) and

cognitive (trust and solidarity) dimensions of the concept (see *Table 2*). The adopted definition of agency mainly concerned its perceived efficacy (Harvey, 2002; Onyx & Bullen, 2000) aspects, together with life satisfaction (Emirbayer & Mische, 1998; Valli et al., 2019) and individual demand for services. Finally, collective action was investigated, in an economic perspective (Olson, 1965), through its indicators of collective investment and demand for services.

3 Methodology

3.1 Setting and data collection

This article investigates the preliminary impacts of a universal unconditional mobile cash transfer (UCT) program which started in September 2022, with expected end date in September 2024. Likewise other CT experiments previously conducted by the program's implementing body, a foreign non-profit organization, the project consists – for a fixed period of two years – of a monthly monetary transfer to all adult inhabitants of a rural Western Uganda village. Children are also indirect beneficiaries of half of the amount destined to adults, through additional transfers given to their mothers . The consequent 'full' universality of the program – even if limited to the village scale – together with its unconditionality, individuality, in-cash and periodic nature, explains why it is labelled as a Universal Basic Income (UBI) pilot (Gentilini et al., 2020). In this sense, alongside GiveDirectly transfers, it should be regarded as one of the few true UBI experiments implemented not only in Sub-Saharan Africa, but even worldwide (Stanford Basic Income Lab, n.d.). The transferred amount was determined with the aim to significantly improve recipients' living standards, while still not allowing them to make a decent living just on the premises of the UBI. The individual CT, set to 30 percent of the local lower-income households' average income (Davala et al., 2015), would in fact not enable participants to completely give up labour.

The treatment and control villages were selected on the basis of a combination of geographical, economic, and sociodemographic criteria. In addition, the search was informed, guided and limited to regions severely affected by climate hazards, such as floods and drought. Residents of both villages, situated in the climate-affected district of Kasese (Berman et al., 2015; Okonya et al., 2013), were so far interviewed twice: in 2022, just before the start of the program in the CT village (baseline stage), and in 2023, roughly one year into the project (midline). Future rounds are also forecasted, in order to validate and integrate the midline findings.

3.2 Empirical strategy

3.2.1 Total CT impacts

Given the relatively low number of observations of the study, alongside the absence of a randomized targeting and allocation process, it could not be ensured that the two analyzed groups would be statistically identical. As a consequence, pursuing experimental RCT as an effect estimation method would have not been meaningful (Gertler et al., 2016). A quasi-experimental difference-in-differences (DiD) procedure was followed instead, in view of its numerous advantages, including its intuitiveness and relaxation of the hypothesis on conditional exogeneity of with-and-without comparisons (Stock & Watson, 2020). In this context, because of the lack of pre-baseline data, it was not possible to check for the validity of the *equal trends* assumption (Gertler et al., 2016), posing a limitation to the reliability and validity of the study findings which should be acknowledged. Even though simple DiD regressions already provide unbiased estimations of the average treatment effect (ATE), the precision of models was improved through the inclusion of individual-level characteristics as control variables (Stock & Watson, 2020). As a result, the model used for carrying out the analysis is summarized by the following *Equation (1)*:

$$Y_{it} = \beta_0 + \beta_1 T_{it} + \beta_2 CT_{it} + \beta_3 CT * T_{it} + \beta_4^T lnd_covariate_{it} + \epsilon_{it} \quad (1)$$

where: Y_{it} is a proxy of climate adaptation or collective-level outcomes for individual i at time t; T is the time dummy, distinguishing between baseline (equaling 0) and midline (1) data; CT is an indicator which equals 1 if individual i is a program recipient, and 0 otherwise; $Ind_covariate$ is a vector of the considered individual covariates. Clustered standard errors were used for the estimations. The observed DiD findings were also complemented with a few qualitative insights, with the objective of shedding additional light on their causal pathways and contingent drivers.

3.2.2 Direct and mediated impacts

Afterwards, in order to determine whether eventual program effects on climate adaptation were mediated by its causal impacts on collective-level outcomes, then, Causal Mediation Analysis (Baron & Kenny, 1986; Imai et al., 2010) was employed. Such technique was only applied a few times to the impact evaluation of cash transfer programs. For instance, it was used to verify that the nutritional outcome benefits of the *Red de Protección Social* program in Nicaragua were highly dependent on health check-ups and dietary diversity (Charters et al., 2023). Another study concluded that a considerable share of the Zimbabwe Harmonized Social Cash Transfer effects on food security and nutrition were mediated by and attributable to agricultural activities (Pace et al., 2022). This approach disentangles the causal mediation effects from the total treatment impact, by distinguishing between indirect – or 'mediated' –

effects, channeled by the intermediate variable under analysis, and direct consequences, fostered by all the other channels (Imai et al., 2010). A visual clarification of this differentiation is provided by *Figure 2*.

In this context, the formulation of a hypothesis, the so-called '*sequential ignorability*' assumption, is necessary before identifying the causal mediation impacts (Imai et al., 2011). The assumption is composed of two successive hypotheses:

1 The 'ignorability' of the treatment assignment, namely its *statistical independence from outcomes of interest and mediators*, given the observed pre-treatment confounders. Because of the universality of the CT under analysis, and the consequent lack of a randomization process, this assumption could possibly be deemed not meaningful. Nevertheless, notwithstanding the detected baseline imbalance – elucidated in *subsection 4.1* – treatment ignorability plausibly holds, in this case, by reason of the application of DiD under the *equal trends* assumption (Ho et al., 2007);

2 The *exogeneity of the mediators with respect to the final outcomes*. In light of the absence of any strong theoretical proposition – although likely, at least for what concerns agency – that climate adaptation influences collective-level variables, the possibility of reverse causality was discarded, concluding that this assumption would also be fulfilled.

When both parts of the ignorability assumption hold, the average causal direct effect and the mediation effect can be estimated through successively running *Equations (2) and (3)*:

$$Mediator_{it} = \alpha_0 + \alpha_1 T_{it} + \alpha_2 CT_{it} + \alpha_3 CT * T_{it} + \alpha_4^T lnd_covariate_{it} + \epsilon_{it} \tag{2}$$

$$Y_{it} = \gamma_0 + \gamma_1 T_{it} + \gamma_2 CT_{it} + \gamma_3 CT * T_{it} + \gamma_4^T lnd_covariate_{it} + \gamma_5 Mediator_{it} + \epsilon_{it} \tag{3}$$

whereby γ_3 represents the direct program effect, controlling for the mediator variables and for covariates; and $\alpha_3 * \gamma_5$ is the mediation effect, computed as the product of the CT impact on the mediator (α_3), and of the partial effect of the mediator on the final outcome (γ_5), controlling for the same confounding factors.

4 Results

4.1 Summary statistics and baseline balance

In order to verify the comparability at baseline of the two groups under analysis, a statistical check through t-tests was performed on several individual- and household-level characteristics, and on the proxies of climate resilience and adaptation and of collective variables investigated by this paper (see *Table 3*).

No statistically significant differences were, for instance, detected on most of the *covariates* included in the regressions (age group, gender and leadership status), with the exception of education, which was higher, on average, in the treatment village. Other proxies, possibly informing a *multidimensional poverty assessment* of groups, were also taken into consideration while determining the comparability of the clusters. It could be possible to conclude, then, that at baseline the CT village had lower access to safe water sources, and was more frequently subject to food insecurity. On the other hand, control households were more likely to host a chronically ill person. No other significant discrepancies were found, as the two groups were statistically comparable on household size, sanitation, spending patterns, labour, incomes, savings and land ownership.

In terms of climate hazards, the two clusters were starting from a similar (severe) situation, with just around 7 percent of each village's respondents not having experienced a major crop failure during the previous year. Livestock loss rates were also very high for both, but the difference was, once again, not statistically significant. Nevertheless, control individuals were much more confident about their (perceived) *resilience to climate shocks* – at least in terms of material/financial means and social support networks – than their treatment counterparts. As a matter of fact, at baseline, the control group was comparatively more able to anticipate the consequences of environmental stresses, by employing more 'preventive' measures than the CT cluster. However, it should be pointed out that this was largely due to a more frequent use, by the counterfactual group, of 'adverse' preventive mechanisms, such as selling productive assets, or withdrawing children from school. In turn, treatment households were more reliant on ex-post 'absorptive' techniques, both beneficial (e.g., saving) and harmful (once again, selling productive assets or livestock). Lastly, no statistical difference was detected concerning the number of adopted agricultural coping mechanisms – considered a beneficial tool – either in prevention or as a reaction to a hazard.

Even less balance was found in terms of *collective-level variables*. Treatment individuals were, for instance, less likely to be actively engaging in organizations (such as saving groups, water user committees, or other civil society institutions), but on average more involved in the community (60 percent against 47 percent of the control group) with higher rates of social inclusion. No significant discrepancy, on the other hand, was measured on overall social relations, or on the size of social networks. Cognitive social capital was more developed inside the control village, regarding interpersonal and institutional trust alike – but solidarity patterns were similar among groups. Interestingly, agency was significantly higher in the CT village, at least for what concerns perceived efficacy proxies, but statistically lower in terms of life satisfaction and individual demand for services. Finally, even though frequencies of getting together with others to raise issues of common concern – an indicator of collective action – were comparable, the control group invested less money in public goods than the treatment village, at baseline.

The implementation of a difference-in-differences technique is able, nevertheless, to address

these balance issues, ensuring a correct and consistent estimation of program impacts, under the equal trends assumption (Gertler et al., 2016; Stock & Watson, 2020).

4.2 Total CT effects

4.2.1 Impacts on climate resilience and adaptation

Despite not having yielded significant impacts on major crop failure or livestock loss, during the first implementation year, the cash transfer proved to have already very positively affected recipients' ***perceived extent of being able to cope*** with shocks (*Table 4*), on all three considered dimensions (material/financial means, capacity/knowledge/skills and social support network). Statistically significant (at 1 percent) rises of at least 1.7 points (out of 10) were in fact registered on all indicators.

At the same time, at midline the CT had spurred participants' capacity to employ ***preventive strategies*** against expected climate change repercussions (*Table 5*). The simultaneous statistically significant decrease in the usage of ***absorptive mechanisms*** could be seen as a positive outcome, derived from an enhanced potential to anticipate shocks, rather than only being able to react to them after their surge, or as they occur. Nevertheless, it should be pointed out that the recourse to both beneficial and detrimental preventive strategies had risen at midline, with the latter driving most of the overall positive effect on anticipatory techniques. As a matter of fact, while the employment of more nuanced tactics – such as planning to migrate – had increased, the same conclusion could be reached concerning deleterious activities like reducing expenditures and food consumption, or selling productive assets and/or livestock. This finding is especially surprising when considering that, on a theoretical level, the transfer should have allowed recipients to build and maintain the necessary savings and financial capital to deal with shocks, without having to rely on mal-adaptation strategies that could damage their human capital investment, in the long run. A first qualitative explanatory hint could be represented by the increase in (expensive) preventive crop diversification patterns enabled in the treatment village by the CT, which, by failing to already adequately compensate for the consequences of flood and drought episodes, may have ultimately led program participants to resort to harmful practices to anticipate future disasters. Nevertheless, supplementary qualitative evidence could contribute to clarify such surprising – albeit just preliminary – findings. Among beneficial practices, an increase in preventive agricultural strategies – albeit statistically insignificant, with the exception of crops diversification – was indeed recorded. At the same time, in line with the overall decrease in the employment of ex-post mechanisms, absorptive agricultural practices significantly reduced. Therefore, no clear sign of an enhancement in households' adaptive capacity could be retrieved, as it could be expected from a mere preliminary analysis of findings. For details on impacts on each individual preventive, absorptive, and agricultural strategy, respectively see *Tables 11, 12 and 13* in the Appendix.

4.2.2 Impacts on collective-level outcomes

First, concerning ***structural social capital***, mixed results were found. Whereas a strong (of roughly one point, on a scale from 1 to 10) and statistically significant improvement in overall social relations was detected – alongside an increase in the size of recipients' social support networks – the CT also seemed to have caused a very significant worsening in the individual feeling of inclusion inside the community (*Table 6*). Other observed impacts, like the growth in organizational membership, and the decline in community participation, were not significant from a statistical point of view.

Cognitive social capital was instead more clearly positively impacted by the program. In fact, interpersonal trust significantly increased both in terms of generic trust in others, and of confidence in fellow villagers in taking care of one's premises (*Table 7*). Trust in institutions also benefitted from the inception of the CT, even though not always in a statistically significant manner. The detected slight decrease in solidarity patterns was also not significant. Finally, in an unsurprising way, to be possibly attributed to the cash transfer, trust in NGOs increased very robustly.

On the other hand, overall CT effects on ***agency*** were unexpectedly detrimental (*Table 8*). As a matter of fact, treatment coefficients for all four considered aspects of one's perceived efficacy were negative, even though it should be taken into consideration that only one of them (related to the power to take important decisions) was statistically significant. Consequently, the effect on the computed overall agency index was surely negative, but insignificant. At the same time, extremely positive and significant impacts on other agency dimensions, namely life satisfaction and individual demand for services (operationalized as the frequency of contacts with local duty bearers to complain about their services) were observed. Future qualitative analysis could shed additional light on these observed changes.

Finally, the CT yielded mixed impacts on ***collective action*** (*Table 9*). While the frequency of getting together with others to raise an issue of common concern – an indicator of collective demand for services – significantly increased, monetary investment into collective projects declined, even if in a not statistically proofed manner.

4.3 Indirect CT effects: Mediation analysis

Table 10 presents the results of the performed Causal Mediation analyses, disentangling the contribution of program impacts on collective variables from the total CT effect on climate adaptation, both in terms of preventive and of absorptive coping mechanisms.

In order to build a reliable single mediator, representative of collective-level outcomes, a Principal Component Analysis (PCA) was performed, encapsulating indicators of structural (membership in organizations, overall social relations, social support network's size) and cognitive social capital (trust in others, solidarity patterns), agency (its total index) and collective

action (collective demand for services). The obtained variable's first component, explaining around 24 percent of the sample's variance and with an eigenvalue higher than 1 , was kept as an index of collective dimensions. Subsequently, following the two-stage process outlined by Imai et al. (2010), a regression on the mediator was conducted before regressing the main outcomes of interest on the mediator, and ultimately computing the mediation effects.

Concerning ***climate change prevention***, the analysis returned the finding that collective-level outcomes contributed to as much as 17 percent of the total program impact on the usage of beneficial coping mechanisms. At the same time, interestingly, the collective-mediated effect on adverse prevention strategies was much lower (around 6 percent of the total impact) and, more importantly, was not statistically significant. Therefore, it could be concluded that social capital, agency and collective action positively and greatly contributed to the adoption of favourable climate-anticipating tactics, whereas their role in spurring harmful prevention techniques was not significant, meaning that other factors – to be further investigated – must have driven the latter increase.

With regard to ***climate change absorption***, the CT effect on collective-level outcomes proved to have partially counteracted the overall negative program impact on all total, beneficial and adverse strategies. Nevertheless, the mediation coefficient was only significant in the case of advantageous absorptive techniques, and amounting to 22.5 percent of the total effect. Consequently, it could be affirmed that collective and social outcomes contribute to (or, at least, diminish the magnitude of the overall reduction in) beneficial climate adaptation mechanisms, either in prevention (which should be preferred) or absorption of the consequences of climate change-derived shocks.

5 Discussion

This study contributed to enlarge the scarce available evidence concerning cash transfer programs' impacts on climate adaptation, collective-level outcomes, and their interactions.

The main finding of the investigation was that, as claimed by related theoretical sources (Béné, 2011; Costella et al., 2023; Davies et al., 2013), CTs can indeed enhance climate adaptation, by spurring the adoption of 'beneficial' prevention mechanisms, rather than ex-post 'absorptive' ones (Lawlor et al., 2015; Schipper, 2020). The empirically observed simultaneous increase in 'adverse'/'mal-adaptation' (Schipper, 2020) strategies should be further investigated through qualitative evidence, but it might be attributable to the detected negative program impacts on agency, the only collective-level outcome that was overall negatively affected by the CT, so far. As a matter of fact, the paper also confirmed that collective variables can benefit from cash transfer interventions, by individuating clearly positive and statistically significant program effects, especially on cognitive social capital proxies. Nevertheless, it should be pointed out that the presented findings derive from midline data, therefore only constituting

preliminary insights into the repercussions of the analyzed program, to be complemented by future rounds of data collection.

Moreover, it was empirically proved that the collective dimension plays a fundamental role in improving climate adaptation, by fostering the adoption of beneficial preventive mechanisms, and by counteracting eventual reductions in the adoption of positive absorptive techniques. It was also determined that, in this case, social capital, agency and collective action did not contribute – in a statistically significant manner, to the detected CT-led increases in the usage of adverse anticipatory strategies, such as selling productive assets and/or livestock. Further research efforts should then be devoted at understanding which other mediators or contingent factors and events could have driven the augmented recourse – that should have, at least on a theoretical level, been deterred by the CT – to such detrimental tools, bearing the potential to trap households into poverty (Helgeson et al., 2013; Lawlor et al., 2015).

Albeit preliminary in nature, the results of this analysis could inform the drafting of some implications for policy-making. In particular, it is advocated for a scaling up of Adaptive Social Protection (Davies & Leavy, 2007): policy-makers and practitioners cannot afford to further ignore the necessary and long-due 'climate-proofing' process of social protection programs (Béné, 2011). Implementing organizations should, in fact, take the resilience-building potential of cash transfer (and UBI) programs into account, when designing them. In this sense, cash transfers represent an especially interesting and potentially efficient intervention type, given their periodicity, scalability and flexibility, amongst other advantageous characteristics (Bagolle et al., 2023; Kuriakose et al., 2013; Wood, 2011). Moreover, not only integrating DRR and CCA agendas, but also 'collective/social' perspectives, into program design and implementation is crucial to build long-term adaptive capacity to climate change (Béné, 2011; Davies et al., 2013; Ulrichs et al., 2019). In fact, even if there was yet no indication of the activation of enhanced adaptive capacity – measured through changes in beneficial agricultural practices – in the context of this paper, investments in social networks may strengthen resilience to a variety of climate disasters (Agrawal et al., 2020; Bezabih et al., 2013).

Nevertheless, as already mentioned, the potential role of social protection – and of its benefits – should not be exaggerated (Coirolo et al., 2013; Tenzing, 2020). Social protection should only be intended as an accompanying tool to more structural climate mitigation and adaptation interventions, including livelihood enhancement and the creation of disaster risk management and climate policy institutions (Kuriakose et al., 2013).

Before concluding, it is necessary to acknowledge the limitations of the study, with the main deriving from the impossibility to verify the validity of the equal trends assumption (Gertler et al., 2016), given the lack, in our dataset, of pre-baseline measurements and of variables not affected – at least theoretically – by the inception of the CT program (Pace et al., 2022). Finally, practical reasons informed the choice of stringent (and not exhaustive) definitions of climate adaptation and collective-level outcomes.

References

Adger, W. N. (2003). Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography, 79*(4), 387–404.

Agrawal, A., Kaur, N., Shakya, C., & Norton, A. (2020). Social assistance programs and climate resilience: Reducing vulnerability through cash transfers. *Current Opinion in Environmental Sustainability, 44*, 113–123.

Arena, M., Guasti, A., & Hussein, H. (2023). Can conditional cash transfers reduce vulnerability to climate change? *Climate Policy, 23*(4), 462–476.

Asfaw, S., Davis, B., & Dewbre, J. (2011). *Cash transfer programs in Sub-Saharan Africa: Measuring the impact on climate change adaptation.* In 4th meeting of the Wye City Group on Statistics on Rural Development and Agriculture Household Income, Rio de Janeiro, Brazil (pp. 9-11).

Bagolle, A., Costella, C., & Goyeneche, L. (2023). *Social Protection and Climate Change: How Can We Protect the Most Vulnerable Households Against New Climate Threats?* Policy Brief N° IDB-PB-00375. Washington, DC: Inter-American Development Bank.

Bahadur, A., Peters, K., Wilkinson, E., Pichon, F., & Tanner, T. (2015). *The 3As: Tracking resilience across BRACED.* BRACED Knowledge Manager Working Paper. London: Overseas Development Institute (ODI).

Baron, R. M., & Kenny, D. A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research. Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. Scopus.

Barrett, C. B., Carter, M. R., & Little, P. D. (2006). Understanding and reducing persistent poverty in Africa: Introduction to a special issue. *The Journal of Development Studies, 42*(2), 167–177.

Bastagli, F., Hagen-Zanker, J., Harman, L., Barca, V., Sturge, G., & Schmidt, T. (2019). The Impact of Cash Transfers: A Review of the Evidence from Low- and Middle-income Countries. *Journal of Social Policy, 48*(3), 569–594.

Béné, C. (2011). Social Protection and Climate Change. *IDS Bulletin, 42*(6), 67–70.

Berman, R. J., Quinn, C. H., & Paavola, J. (2015). Identifying drivers of household coping strategies to multiple climatic hazards in Western Uganda: Implications for adapting to future climate change. *Climate and Development, 7*(1), 71–84.

Bezabih, M., Beyene, A. D., & Borga, L. (2013). Social Capital, climate change and soil

conservation investment: Panel data evidence from the Highlands of Ethiopia. *Centre Clim. Change Econ. Policy, 135*, 1–31. Scopus.

Charters, T. J., Kaufman, J. S., & Nandi, A. (2023). A Causal Mediation Analysis for Investigating the Effect of a Randomized Cash-Transfer Program in Nicaragua. *American Journal of Epidemiology, 192*(1), 111–121.

Coirolo, C., Commins, S., Haque, I., & Pierce, G. (2013). Climate Change and Social Protection in Bangladesh: Are Existing Programmes Able to Address the Impacts of Climate Change? *Development Policy Review, 31*(s2), o74–o90.

Costella, C., van Aalst, M., Georgiadou, Y., Slater, R., Reilly, R., McCord, A., Holmes, R., Ammoun, J., & Barca, V. (2023). Can social protection tackle emerging risks from climate change, and how? A framework and a critical review. *Climate Risk Management, 40*, 100501.

Davala, S., Jhabvala, R., Standing, G., & Mehta, S. K. (2015). *Basic income: A transformative policy for India*. London: Bloomsbury Publishing.

Davies, M., Béné, C., Arnall, A., Tanner, T., Newsham, A., & Coirolo, C. (2013). Promoting Resilient Livelihoods through Adaptive Social Protection: Lessons from 124 programmes in South Asia. *Development Policy Review, 31*(1), 27–58.

Davies, M., & Leavy, J. (2007). *Connecting social protection and climate change adaptation*. IDS in Focus 2.3. Brighton, UK: Institute of Development Studies.

Devereux, S., & McGregor, J. A. (2014). Transforming Social Protection: Human Wellbeing and Social Justice. *The European Journal of Development Research, 26*(3), 296–310.

Emirbayer, M., & Mische, A. (1998). What Is Agency? *American Journal of Sociology, 103*(4), 962–1023.

Fankhauser, S., Smith, J. B., & Tol, R. S. J. (1999). Weathering climate change: Some simple rules to guide adaptation decisions. *Ecological Economics, 30*(1), 67–78.

Garbarino, S., & Holland, J. (2009). *Quantitative and qualitative methods in impact evaluation and measuring results*. Discussion Paper. Birmingham, UK: University of Birmingham.

Gentilini, U., Grosh, M., Rigolini, J., & Yemtsov, R. (2020). *Exploring universal basic income: A guide to navigating concepts, evidence, and practices*. World Bank Publications. Washington, DC: World Bank.

Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B., & Vermeersch, C. M. J. (2016). *Impact evaluation in practice*. World Bank Publications. Washington, DC: World Bank.

Grisolia, F., Dewachter, S., & Holvoet, N. (2021). *Shifting the focus? From individual to*

collective-level effects of cash transfers. A systematic review of the impacts on social capital [Manuscript submitted for publication]. Institute of Development Policy (IOB), University of Antwerp.

Grootaert, C., & Van Bastelar, T. (2002). *Understanding and Measuring Social Capital: A Multidisciplinary Tool for Practitioners.* Directions in Development. Washington, DC: World Bank.

Harvey, D. L. (2002). Agency and Community: A Critical Realist Paradigm. *Journal for the Theory of Social Behaviour*, 32(2), 163–194.

Hasson, R., Löfgren, Å., & Visser, M. (2010). Climate change in a public goods game: Investment decision in mitigation versus adaptation. *Ecological Economics, 70*(2), 331–338.

Helgeson, J. F., Dietz, S., & Hochrainer-Stigler, S. (2013). Vulnerability to Weather Disasters: The Choice of Coping Strategies in Rural Uganda. *Ecology and Society, 18*(2).

Heltberg, R., Jorgensen, S. L., & Siegel, P. B. (2008). *Climate change: Challenges for social protection in Africa.* In Social Protection for the Poorest in Africa Conference.

Heltberg, R., Oviedo, A. M., & Talukdar, F. (2015). What do Household Surveys Really Tell Us about Risk, Shocks, and Risk Management in the Developing World? *The Journal of Development Studies, 51*(3), 209–225.

Hisali, E., Birungi, P., & Buyinza, F. (2011). Adaptation to climate change in Uganda: Evidence from micro level data. *Global Environmental Change, 21*(4), 1245–1261.

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2007). Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference. *Political Analysis, 15*(3), 199–236.

Imai, K., Keele, L., & Tingley, D. (2010). A general approach to causal mediation analysis. *Psychological Methods, 15*(4), 309–334.

Imai, K., Keele, L., Tingley, D., & Yamamoto, T. (2011). Unpacking the black box of causality: Learning about causal mechanisms from experimental and observational studies. *American Political Science Review, 105*(4), 765–789. Scopus.

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK and New York, NY: Cambridge University Press.

Johnson, C. A., & Krishnamurthy, K. (2010). Dealing with displacement: Can "social protection" facilitate long-term adaptation to climate change? *Global Environmental Change, 20*(4),

648–655.

Johnson, C., Bansha Dulal, H., Prowse, M., Krishnamurthy, K., & Mitchell, T. (2013). Social Protection and Climate Change: Emerging Issues for Research, Policy and Practice. *Development Policy Review, 31*(s2), o2–o18.

Kabeer, N., Piza, C., & Taylor, L. (2012). *What are the economic impacts of conditional cash transfer programs? A systematic review of the evidence.* Technical report. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Kane, S., & Shogren, J. F. (2000). Linking Adaptation and Mitigation in Climate Change Policy. *Climatic Change, 45*(1), 75–102.

Khan, M. R., & Munira, S. (2021). Climate change adaptation as a global public good: Implications for financing. *Climatic Change, 167*(3), 50.

Krishna, A. (2002). *Active social capital. Tracing the roots of development and democracy.* New York, NY: Columbia University Press.

Kuriakose, A. T., Heltberg, R., Wiseman, W., Costella, C., Cipryk, R., & Cornelius, S. (2013). Climate-Responsive Social Protection. *Development Policy Review, 31*(s2), o19–o34.

Lawlor, K., Handa, S., & Seidenfeld, D. (2015). *Cash Transfers and Climate-resilient Development. Evidence from Zambia's Child Grant Programme.* Innocenti Working Paper No.2015-03, UNICEF Office of Research, Florence.

Macours, K., Premand, P., & Vakis, R. (2012). *Transfers, diversification and household risk strategies: Experimental evidence with lessons for climate change adaptation.* Policy Research Working Paper No. 6053. Washington, DC: World Bank.

Nam, W.-H., Choi, J.-Y., Yoo, S.-H., & Jang, M.-W. (2012). A decision support system for agricultural drought management using risk assessment. *Paddy and Water Environment, 10*(3), 197–207.

Okonya, J., Syndikus, K., & Kroschel, J. (2013). Farmers' Perception of and Coping Strategies to Climate Change: Evidence From Six Agro-Ecological Zones of Uganda. *Journal of Agricultural Science, 5*(8), Article 8.

Olson, M. (1965). *The logic of collective action: Public goods and the theory of groups.* Cambridge, MA: Harvard University Press.

Onyx, J., & Bullen, P. (2000). Measuring Social Capital in Five Communities. *The Journal of Applied Behavioral Science, 36*(1), 23–42.

Pace, N., Sebastian, A., Daidone, S., Prifti, E., & Davis, B. (2022). Mediation analysis of the

impact of the Zimbabwe Harmonized Social Cash Transfer Programme on food security and nutrition. *Food Policy, 106*, 102190.

Paul, C. J., Weinthal, E. S., Bellemare, M. F., & Jeuland, M. A. (2016). Social capital, trust, and adaptation to climate change: Evidence from rural Ethiopia. *Global Environmental Change, 36*, 124–138.

Premand, P., & Stoeffler, Q. (2020). *Do cash transfers foster resilience? Evidence from rural Niger*. Policy Research Working Paper No. 9473. Washington, DC: World Bank.

Saptutyningsih, E., Diswandi, D., & Jaung, W. (2020). Does social capital matter in climate change adaptation? A lesson from agricultural sector in Yogyakarta, Indonesia. *Land Use Policy, 95*, 104189.

Schipper, E. L. F. (2020). Maladaptation: When Adaptation to Climate Change Goes Very Wrong. *One Earth, 3*(4), 409–414.

Sengupta, S., & Costella, C. (2023). A framework to assess the role of social cash transfers in building adaptive capacity for climate resilience. *Journal of Integrative Environmental Sciences, 20*(1), 2218472.

Siddiqi, A. (2011). Supporting the working but vulnerable: Linkages between social protection and climate change. *Climate and Development, 3*(3), 209–227.

Sodokin, K., & Nyatefe, V. (2021). Cash transfers, climate shocks vulnerability and households' resilience in Togo. *Discover Sustainability, 2*(1), 3.

Stanford Basic Income Lab. (n.d.). *Global Map of Basic Income Experiments*. Stanford Basic Income Lab. https://basicincome.stanford.edu/experiments-map/

Stock, J. H., & Watson, M. W. (2020). *Introduction to Econometrics*, 4th edition. Pearson Education.

Tenzing, J. D. (2020). Integrating social protection and climate change adaptation: A review. *WIREs Climate Change, 11*(2), e626.

Ulrichs, M., Slater, R., & Costella, C. (2019). Building resilience to climate risks through social protection: From individualised models to systemic transformation. *Disasters, 43*(S3), S368–S387.

Valli, E., Peterman, A., & Hidrobo, M. (2019). Economic Transfers and Social Cohesion in a Refugee-Hosting Setting. *The Journal of Development Studies, 55*(sup1), 128–146.

Weldegebriel, Z. B., & Prowse, M. (2013). Climate-Change Adaptation in Ethiopia: To What Extent Does Social Protection Influence Livelihood Diversification? *Development Policy Re-*

view, 31(s2), o35–o56.

Welle, T., Witting, M., Birkmann, J., & Brossmann, M. (2014). *Assessing and monitoring climate resilience: From the theoretical considerations to practically applicable tools.* A discussion paper. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Wood, R. G. (2011). Is there a Role for Cash Transfers in Climate Change Adaptation? *IDS Bulletin, 42*(6), 79–85.

Yaméogo, T. B., Fonta, W. M., & Wünscher, T. (2018). Can Social Capital influence Smallholder Farmers' Climate-Change Adaptation Decisions? Evidence from Three Semi-Arid Communities in Burkina Faso, West Africa. *Social Sciences, 7*(3), Article 3.

Table 1: Adopted anticipatory/preventive, absorptive and adaptive coping mechanisms

Type	Anticipatory/absorptive	Adaptive
Beneficial/nuanced	Agricultural practices	Agricultural practices
	Informal credit and/or assistance	
	Formal credit and/or assistance	
	Saving	
	Working more	
	Planning to migrate	
Adverse ('mal-adaptation')	Reducing food consumption	
	Reducing expenditures	
	Selling productive assets and/or livestock	
	Sending children to work	
	Withdrawing children from school	
	Sending children to live elsewhere	

Table 2: Operationalization of the collective outcomes of interest

Outcomes (and components)		Main adopted indicators
Social capital	Structural	Membership in organizations, community participation, frequency of property crimes, social inclusion, social relations, social networks
	Cognitive	Interpersonal and institutional trust, solidarity, trust in NGOs
Agency		Perceived efficacy, life satisfaction, individual demand for services
Collective action		Collective demand for services, collective investment

Table 3: Baseline balance check with t-tests, by treatment status

	Control			*Treatment*				
Variable	N	Mean	Std. Error	N	Mean	Std. Error	Difference in Means	P-value
Individual and household characteristics								
Age group	172	2.023	0.787	101	2.000	0.787	0.023	0.813
Gender	172	1.500	0.501	101	1.505	0.502	-0.005	0.937
Holding leadership/bureaucratic position	172	0.058	0.235	101	0.069	0.255	-0.011	0.713
Educational level group	172	1.977	0.764	101	2.317	0.615	-0.340	0.000***
Household size	172	5.645	2.590	101	5.743	3.104	-0.097	0.781
Number of rooms in the HH	170	3.376	1.161	101	3.238	0.981	0.139	0.314
Safety of the water consumed in the HH	168	0.208	0.407	100	0.060	0.239	0.148	0.001***
Sanitation service used by the HH	172	3.052	0.487	101	3.020	0.199	0.033	0.522
Number of spending categories money is spent on	157	5.541	2.308	91	5.286	2.330	0.256	0.402
Any person chronically ill in the HH	166	0.145	0.353	99	0.051	0.220	0.094	0.017**
Frequency of not having a varied diet (last 6 months)	169	3.041	0.941	99	3.273	1.058	-0.231	0.064*
Avg. hours/week worked on agricultural activities	148	30.851	24.956	89	33.157	30.678	-2.306	0.528
Avg. hours/week worked on non-agricultural activities	97	11.515	23.194	62	10.613	22.981	0.903	0.810
Average weekly agricultural income	168	2.423	1.404	96	2.521	1.429	-0.098	0.587
Average weekly non-agricultural income	155	1.503	0.942	91	1.407	0.894	0.097	0.429
Total value of HH savings	158	2.297	1.541	100	2.420	1.565	-0.123	0.536
Acres of land owned	133	0.945	2.811	75	0.718	1.065	0.227	0.502
Climate resilience and adaptation								
No major (at least 50%) crop failure (last year)	172	0.070	0.255	101	0.069	0.255	0.000	0.988
No major (at least 50%) livestock loss (last year)	172	0.163	0.370	101	0.109	0.313	0.054	0.220
Resilience: necessary material/financial means	143	4.664	1.971	88	4.170	1.895	0.494	0.061*
Resilience: necessary capacity/knowledge/skills	121	4.355	2.980	78	3.705	2.380	0.650	0.106
Resilience: necessary social support network	138	4.254	2.033	90	3.722	1.690	0.531	0.040**
No. prevention strategies (last year)	137	3.102	3.061	77	2.208	2.489	0.894	0.029**
No. beneficial prevention strategies (last year)	137	1.613	1.601	77	1.455	1.391	0.159	0.467
No. adverse prevention strategies (last year)	137	1.489	1.659	77	0.753	1.329	0.736	0.001***
No. absorption strategies (last year)	142	2.739	2.953	81	3.568	3.915	-0.828	0.075*
No. beneficial absorption strategies (last year)	142	1.430	1.518	81	1.765	1.698	-0.336	0.129
No. adverse absorption strategies (last year)	142	1.310	1.608	811	1.802	2.390	-0.493	0.067*
No. agricultural prevention strategies (last year)	137	0.248	0.838	78	0.103	0.524	0.146	0.167
No. agricultural absorption strategies (last year)	142	1.634	2.214	83	1.916	2.349	-0.282	0.368
Collective-level outcomes								
Membership in organizations' total score	169	5.485	1.075	100	4.920	1.535	0.565	0.000***
Community participation of HH members	169	0.473	0.501	101	0.604	0.492	-0.131	0.037**
Frequency of undergoing property crime (last year)	171	1.409	0.749	99	1.384	0.752	0.026	0.787
Social inclusion: I feel accepted	156	3.551	0.821	93	3.817	0.441	-0.266	0.004***
Overall rating: social relations	147	4.469	2.175	97	4.227	1.874	0.243	0.369
Social support network's size	172	1.453	0.999	101	1.376	1.199	0.077	0.567
Material support/risk-sharing network's size	172	0.837	0.897	101	0.861	0.990	-0.024	0.836
Trust in others	134	0.261	0.441	85	0.212	0.411	0.049	0.407
I trust my neighbour to take care of my home/field	150	3.307	0.969	87	2.908	0.996	0.399	0.002***
Institutional trust: politicians represent my interests	149	2.960	1.150	85	2.435	1.170	0.524	0.000***
Institutional trust: I trust the government	144	3.083	1.119	91	2.615	1.298	0.468	0.003***
Solidarity: someone available to help me, in need	158	3.487	0.746	94	3.426	0.726	0.062	0.521
Trust in NGOs: NGOs are here to help and support	109	3.073	1.200	80	2.638	1.380	0.436	0.021**
Agency: my life is determined by my own actions	146	3.404	1.041	94	3.872	0.335	-0.468	0.000***
Agency: I am capable of protecting my interests	150	3.380	1.053	94	3.819	0.463	-0.439	0.000***
Agency: I can define and act on my goals	154	3.351	1.032	94	3.819	0.414	-0.468	0.000***
Agency: I have the power to take important decisions	147	3.293	1.068	91	3.813	0.492	-0.521	0.000***
Agency total index	157	3.191	1.364	95	3.884	0.409	-0.693	0.000***
Overall rating: life satisfaction	160	5.181	2.215	101	4.733	1.708	0.449	0.083*
Frequency of contacting duty bearers (last year)	164	2.829	2.261	98	2.235	1.722	0.595	0.025**
Frequency of getting together to raise issue (last year)	168	1.893	1.262	100	1.900	1.124	-0.007	0.962
Collective investment: contribution of money	96	0.531	0.502	67	0.687	0.467	-0.155	0.047**

Notes: Mean difference test with clustered standard errors. *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels.

Table 4: Difference-in-differences: total CT impact estimates on crop/livestock loss and climate resilience

	(1)	(2)	(3)	(4)	(5)
			Perceived climate resilience		
	No major (at least 50%) crop failure (last year)	No major (at least 50%) livestock loss (last year)	Material/financial means	Capacity/ knowledge/ skills	Social support network
CT*T	-0.040	0.057	1.702***	1.708***	1.973***
CT	0.006	-0.029	-0.584**	-0.728*	-0.569**
T	0.039	0.433***	-2.042***	-0.915***	-0.430*
Constant	0.189**	0.351***	4.221***	4.713***	3.618***
Observations	572	572	478	455	492
R-squared	0.014	0.240	0.163	0.063	0.073

Notes: *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels. Clustered robust standard errors. All regressions control for individual age group, gender, educational level group and leadership/bureaucratic position status.

Table 5: Difference-in-differences: total CT impact estimates on climate adaptation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	No. prevention (pre) strategies (last year)			No. absorption (post) strategies (last year)			No. agricultural strategies (last year)	
	Total	Beneficial	Adverse	Total	Beneficial	Adverse	Prevention	Absorption
CT*T	2.096***	0.674**	1.422***	-1.300**	-0.500	-0.800**	0.345	-1.065***
CT	-0.945**	-0.202	-0.743***	0.768	0.320	0.448	-0.165*	0.254
T	-0.213	0.423**	-0.636***	3.466***	1.708***	1.757***	1.487***	1.035***
Constant	1.757**	0.934**	0.823**	1.929**	1.273***	0.656	-0.100	1.265**
Observations	422	422	422	497	497	497	439	501
R-squared	0.083	0.090	0.091	0.188	0.188	0.152	0.325	0.040

Notes: *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels. Clustered robust standard errors. All regressions control for individual age group, gender, educational level group and leadership/bureaucratic position status.

Table 6: Difference-in-differences: total CT impact estimates on structural social capital

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						Social networks' sizes	
	Membership in organizations' total score	Community participation of HH members	Frequency of undergoing property crime (last year)	Social inclusion: I feel accepted	Overall rating: social relations	Social support	Material support/risk-sharing
CT*T	0.164	-0.020	-0.176	-0.381***	0.911**	0.383*	-0.088
CT	-0.522***	0.118*	-0.081	0.255***	-0.290	-0.110	-0.019
T	-0.265**	0.378***	0.499***	0.346***	1.413***	0.491***	0.739***
Constant	6.340***	0.335***	0.757***	3.465***	3.894***	1.143***	0.581**
Observations	565	565	561	547	527	572	572
R-squared	0.132	0.217	0.077	0.059	0.144	0.104	0.163

Notes: *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels. Clustered robust standard errors. All regressions control for individual age group, gender, educational level group and leadership/bureaucratic position status.

Table 7: Difference-in-differences: total CT impact estimates on cognitive social capital

	(1)	(2)	(3)	(4)	(5)	(6)
	Interpersonal trust		Institutional trust			
	Trust in others	I trust my neighbour to take care of my home/field	Politicians represent my interests	I trust the government	Solidarity: someone available to help me, in case of need	Trust in NGOs: NGOs are here to help and support
CT*T	0.185**	0.417**	0.513**	0.206	-0.025	0.855***
CT	-0.045	-0.390***	-0.499***	-0.469***	-0.070	-0.439**
T	-0.046	0.193*	0.225	0.102	0.299***	0.078
Constant	0.226*	3.273***	2.969***	2.852***	3.490***	3.268***
Observations	510	531	529	527	550	470
R-squared	0.023	0.062	0.065	0.051	0.049	0.081

Notes: *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels. Clustered robust standard errors. All regressions control for individual age group, gender, educational level group and leadership/bureaucratic position status.

Table 8: Difference-in-differences: total CT impact estimates on agency

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Agency: perceived efficacy						
	My life is determined by my own actions	I am capable of protecting my interests	I can define and act on my goals	I have the power to take important decisions	Agency total index	Overall rating: life satisfaction	Frequency of contacting duty bearers (last year)
CT*T	-0.193	-0.114	-0.183	-0.320**	-0.259	2.285***	0.806***
CT	0.458***	0.425***	0.434***	0.513***	0.652***	-0.569**	-0.610**
T	-0.040	-0.021	0.022	0.133	-0.023	0.275	-1.443***
Constant	3.260***	3.369***	3.152***	3.347***	2.865***	4.376***	1.829***
Observations	536	541	543	532	549	547	556
R-squared	0.053	0.060	0.059	0.055	0.065	0.150	0.173

Notes: *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels. Clustered robust standard errors. All regressions control for individual age group, gender, educational level group and leadership/bureaucratic position status.

Table 9: Difference-in-differences: total CT impact estimates on collective agency

	(1) Frequency of getting together with others to raise issue (last year)	(2) Collective investment: contribution of money
CT*T	0.544**	-0.110
CT	-0.003	0.127*
T	0.730***	0.009
Constant	1.357***	0.049
Observations	564	462
R-squared	0.249	0.049

Notes: *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels. Clustered robust standard errors. All regressions control for individual age group, gender, educational level group and leadership/bureaucratic position status.

Table 10: Causal Mediation Analysis on climate adaptation. Mediator: collective-level variables PCA index (SI assumption holds)

	No. prevention (pre) strategies (last year)				No. absorption (post) strategies (last year)			
	Regression on mediator:	Regression on main outcome:			Regression on mediator:	Regression on main outcome:		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Collective-level PCA index	Total no.	No. Beneficial	No. Adverse	Collective-level PCA index	Total no.	No. Beneficial	No. Adverse
Collective-level PCA index		0.333***	0.200***	0.133*		0.203	0.154**	0.049
CT*T	0.909***	2.759***	0.911***	1.848***	0.754***	-1.302*	-0.532	-0.770*
CT	-0.293	-1.705***	-0.513**	-1.192***	-0.196	0.417	0.167	0.250
T	0.672***	-1.615***	-0.305	-1.311***	0.632***	2.323***	1.103***	1.220***
Constant	-0.777**	2.998***	1.599***	1.399***	-0.995**	3.538***	2.121***	1.417**
Observations	333	333	333	333	400	400	400	400
R-squared	0.296	0.128	0.083	0.163	0.232	0.106	0.109	0.081
Mediation effect		0.308**	0.185**	0.123		0.155	0.118*	0.037
Direct effect		2.749***	0.905***	1.842***		-1.315	-0.538	-0.777
Total effect		3.057***	1.090***	1.965***		-1.160	-0.421	-0.741
% of mediated effect		10.1%***	17.1%**	6.3%***		-12.4%	-22.5%	-4.7%

Notes: *, ** and *** respectively indicate statistical significance at the 10%, 5% and 1% levels. Clustered robust standard errors. All regressions control for individual age group, gender, educational level group and leadership/bureaucratic position status.

Figure 1: Analytical framework of the study

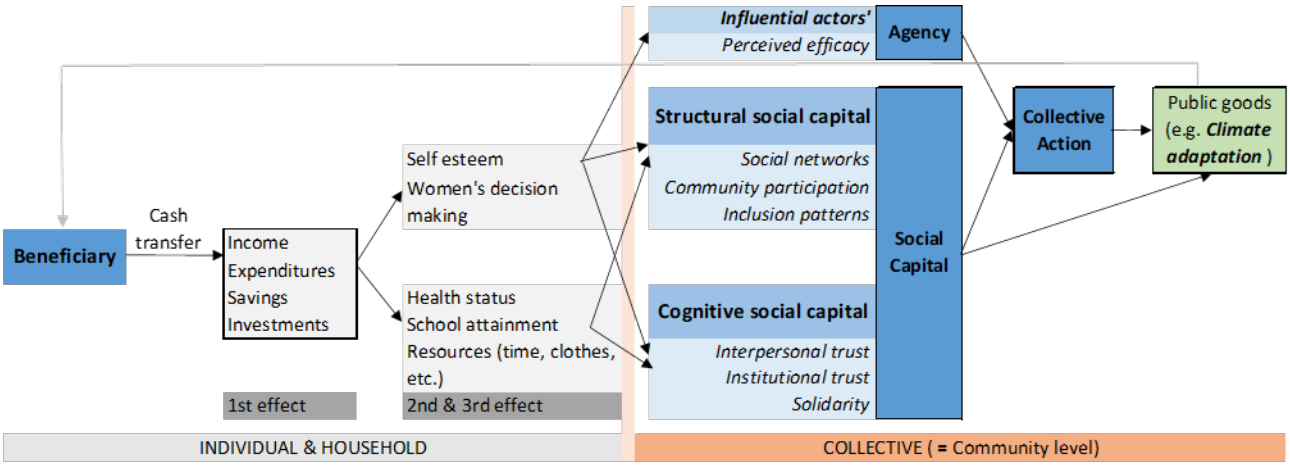
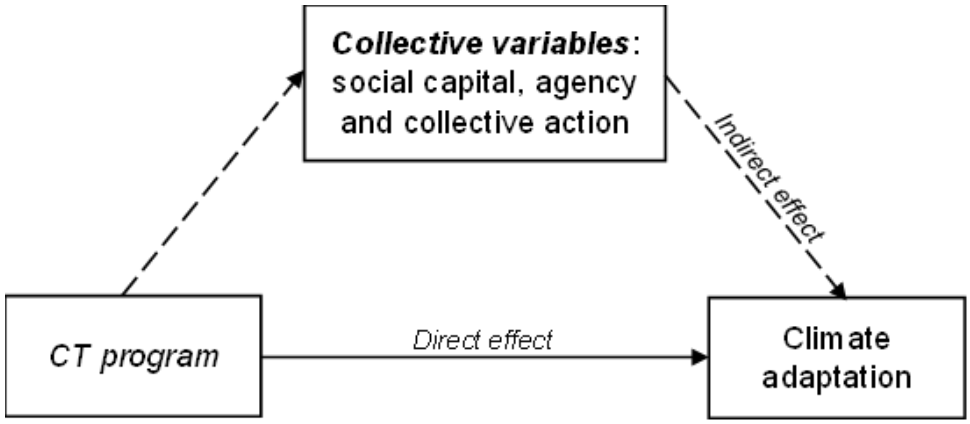


Figure 2: Mediation process (adapted from Pace et al., 2022)



Appendix

Table 11: Difference-in-differences: total CT impact estimates on climate provision (detail by mechanism)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Beneficial preventive strategies (last year)						**Adverse preventive strategies (last year)**							
	Agricultural practices	Informal credit and/or assistance	Formal credit and/or assistance	Saving	Working more	Planning to migrate	Reducing expenditures	Reducing food consumption	Selling productive assets and/or livestock	Sending children to work	Withdrawing children from school	Sending children to live elsewhere	None	Other
CT*T	0.137*	0.038	0.087	0.100	0.053	0.259***	0.344***	0.163**	0.301***	0.163**	0.234***	0.216***	0.019	0.037
CT	-0.084**	0.045	0.045	-0.035	-0.027	-0.146**	-0.059	-0.076*	-0.179***	-0.130**	-0.164***	-0.135**	-0.064	-0.026
T	0.552***	-0.185***	-0.305***	0.340***	0.285***	-0.264***	0.121**	0.072	-0.068	-0.218***	-0.283***	-0.259***	-0.466***	-0.053***
Constant	-0.088	0.415***	0.373***	-0.071	0.156	0.149	0.167	0.183	0.028	0.067	0.177*	0.201*	0.810***	0.022
Observations	422	422	422	422	422	422	422	422	422	422	422	422	422	422
R-squared	0.406	0.036	0.089	0.176	0.122	0.081	0.188	0.080	0.046	0.068	0.099	0.072	0.316	0.028

Notes: *, ** and *** respectively indicate statistical significance at the 10, 5 and 1 percent levels. MDM = Mahalanobis Distance Matching; CEM = Coarsened Exact Matching. (Robust) standard errors in brackets, number of observations in squared parentheses. $^{+}$ follow-up-only variable.

Table 12: Difference-in-differences: total CT impact estimates on climate absorption (detail by mechanism)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Beneficial absorptive strategies (last year)						**Adverse absorptive strategies (last year)**							
	Agricultural practices	Informal credit and/or assistance	Formal credit and/or assistance	Saving	Working more	Planning to migrate	Reducing expenditures	Reducing food consumption	Selling productive assets and/or livestock	Sending children to work	Withdrawing children from school	Sending children to live elsewhere	None	Other
CT*T	-0.254***	-0.151**	-0.060	0.056	-0.038	-0.053	-0.122	-0.099	-0.294***	-0.088	-0.089	-0.108	-0.116	0.068
CT	0.045	0.003	0.026	0.100	-0.002	0.147**	-0.017	-0.011	0.167***	0.081	0.089	0.138**	0.113*	-0.040
T	0.343***	0.658***	0.398***	0.024	0.148**	0.137***	0.386***	0.407***	0.426***	0.173***	0.191***	0.174***	-0.470***	-0.153***
Constant	0.347**	-0.009	0.261**	0.318**	0.444***	-0.087	0.283**	0.182	0.297**	0.011	-0.054	-0.063	0.621***	0.072
Observations	497	497	497	497	497	497	497	497	497	497	497	497	497	497
R-squared	0.079	0.380	0.174	0.032	0.027	0.053	0.123	0.150	0.130	0.056	0.064	0.052	0.325	0.075

Notes: *, ** and *** respectively indicate statistical significance at the 10, 5 and 1 percent levels. MDM = Mahalanobis Distance Matching; CEM = Coarsened Exact Matching. (Robust) standard errors in brackets, number of observations in squared parentheses. $^{+}$ follow-up-only variable.

Table 13: Difference-in-differences: total CT impact estimates on agricultural climate adaptation (detail by mechanism)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Agricultural preventive strategies (last year)						**Agricultural absorptive strategies (last year)**					
	Agricultural practices	Diversifying crops	Using Soil and Water Conservation techniques	Increasing application of pesticides/fertilizers	Planting trees	Other	Agricultural practices	Diversifying crops	Using Soil and Water Conservation techniques	Increasing application of pesticides/fertilizers	Planting trees	Other
CT*T	0.103	0.200***	0.052	-0.068	0.058	-0.017	-0.202**	-0.226**	-0.223**	-0.301***	-0.115	-0.084
CT	-0.059*	-0.045*	0.008	-0.010	-0.060**	0.001	0.047	0.023	0.058	0.082	0.044	0.083
T	0.451***	0.287***	0.340***	0.294***	0.116***	0.035*	0.236***	0.219***	0.245***	0.298***	0.038	-0.243***
Constant	-0.040	0.038	0.002	-0.101	0.002	0.031	0.288**	0.350***	0.234*	0.109	0.283**	0.169**
Observations	439	439	439	439	439	439	501	501	501	501	501	501
501												
R-squared	0.294	0.221	0.205	0.150	0.053	0.036	0.038	0.038	0.040	0.064	0.015	0.174

Notes: *, ** and *** respectively indicate statistical significance at the 10, 5 and 1 percent levels. MDM = Mahalanobis Distance Matching; CEM = Coarsened Exact Matching. (Robust) standard errors in brackets, number of observations in squared parentheses. $^{+}$ follow-up-only variable.