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Who bears the burden of climate variability? A comparative analysis of the impact of weather conditions on inequality in Vietnam and Indonesia

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Who bears the burden of climate variability? A comparative analysis of the impact of weather conditions on inequality in Vietnam and Indonesia

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Abstract
Is climate variability regressive? One argument could be as follows: People living in areas with high risk of climate hazards usually correspond to the most disadvantaged populations. Due to existing structural inequalities, they have limited opportunities to cope with climate hazards and often fall into a spiral of further poverty and social exclusion. In this paper, we investigate whether climate variability indeed has a regressive effect in Vietnam and Indonesia where both climate variability and inequality have been increasing. We directly analyse the effect of annual and seasonal temperature on income and income inequality across years. We do so by looking at the Vietnamese and Indonesian populations as a whole and also investigating more in-depth how these impacts change for the most vulnerable and marginalised groups. Our results suggest that climate variability increases inequality and that its biggest burden is bore by existing vulnerable groups. In Indonesia, these groups are rural, farming, low educated, female headed households, whose income is significantly reduced because of changes in climate conditions. Similarly, in Vietnam, ethnic minorities, rural, farming, and agricultural households bear the biggest impact of climate variability. Interestingly, some households in Vietnam are able to completely offset short-term impact of climate variability, using remittances and transfer as an insurance, but our findings also show that their coping strategy does not withstand longer term impacts of persistent climate variability. Despite the remarkable efforts of the national governments in supporting most vulnerable and marginalised groups in the Vietnamese and Indonesian societies in the past decades, specific interventions are needed to address the needs of those who are still bearing the biggest burden of climate impacts to finally allow even the "last mile" groups to escape poverty and exclusion.

Keywords
Inequality; Climate variability; Indonesia; Vietnam.

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Résumé
Le changement climatique et la variabilité sont-ils régressifs? Un argument pourrait être le suivant : les personnes vivant dans une zone à haut risque de variabilité climatique correspondent généralement aux populations plus défavorisées qui, en raison des barrières socio-économiques structurelles et des inégalités existantes, ont des possibilités limitées d'améliorer leur bien-être et tombent souvent dans une spirale de pauvreté et d'exclusion sociale. Les aléas climatiques pourraient avoir donc des impacts disproportionnellement plus élevés sur ces personnes, avec une grande vulnérabilité et moindre de capacité à absorber et de se remettre de ces dommages. Dans cet article nous investigons si la variabilité climatique aurait effectivement un effet régressif dans deux des économies les plus dynamiques d'Asie du Sud-Est : le Vietnam et l'Indonésie. Dans ces pays la variabilité climatique et les inégalités se sont accrues. Nous analysons l'effet de la température annuelle et saisonnière sur les revenus et les inégalités de revenus au fil du temp. Nous examinons les populations vietnamiennes et indonésiennes dans leur ensemble et en étudions plus en profondeur comment ces impacts changent pour les groupes les plus vulnérables et marginalisés. Nos résultats suggèrent que la variabilité climatique aggrave les inégalités et que son plus gros fardeau est senti par les groupes vulnérables ou les groupes qui, en raison des barrières structurelles existantes, sont devenus de moins en moins capables de faire face aux aléas climatiques. En Indonésie, ces groupes sont des ménages ruraux, agricoles, peu scolarisés et dirigés par des femmes, dont revenus sont considérablement réduits en raison de changements des conditions climatiques. De même, au Vietnam les ménages ruraux et agricoles sont les plus touchés par la variabilité climatique. De plus, nos résultats montrent que les ménages des minorités ethniques sont en fait à la traîne du reste de la population au Vietnam. Il est intéressant de noter que certains ménages au Vietnam sont en mesure de compenser complètement l'impact à court terme de la variabilité climatique, en utilisant les envois de fonds et les transferts comme une assurance, mais nos résultats montrent également que leur stratégie d'adaptation ne résiste pas aux impacts à long terme de la variabilité climatique persistante. Malgré les efforts remarquables des gouvernements nationaux pour soutenir les groupes les plus vulnérables et marginalisés au Vietnam et en Indonésie au cours des dernières décennies, nous constatons que des interventions spécifiques sont nécessaires pour répondre aux besoins de ceux qui supportent encore le plus grand fardeau des impacts climatiques pour enfin permettre même aux groupes du « dernier kilomètre » d'échapper à la pauvreté et à l'exclusion.

Mots-clés
Inégalités, Variabilité climatique, Indonésie, Vietnam

Introduction

Climate change and variability in South East Asia (SEA) have been remarkable in the past 20 years. The Germanwatch, for example, estimates that half of SEA falls in the top 10 most affected areas by climate change in the past 20 years (Eckstein et al, 2019). Among these areas, Vietnam and Indonesia have experienced an increased incidence of extreme climate hazards and uncertainties.

In Vietnam, average surface temperatures have increased by 1 degree Celsius, over the last 40 years, with southern provinces of the Central Highlands and Central Coast provinces warming even more. Between the end of 2015 and early 2016, El Nino events caused extensive droughts and consequent reduction of groundwater availability in many provinces, especially in the Central Highlands (FAO, 2016). Mountainous areas in the northern regions are increasingly experiencing devastating floods and finally, with more than 70% of its population living in coastal areas and low-lying deltas, Vietnam is highly exposed to riverine and coastal flooding (Bangalore et al., 2018).

Similarly, about 40% of the population in Indonesia face high mortality risks due to multiple climate hazards, such as tsunami, floods, landslides, drought, and earthquakes (Leitmann, 2009). Climate change has increased the occurrence of droughts especially in southern islands, the severity of floods and cyclone intensity across the country, and sea-level rise effects in coastal areas (WB, 2014). Average temperatures have increased steadily in the past 40 years, within a range of 0.64 °C for 1960-2006 and 0.76 °C for 1985-2005, and by the 2060s it is expected to increase between 0.9°C and 2.2°C from 2012 levels (Karmalkar et al., 2012). Annual rainfalls have also increased (by 12% in the past 30 years). With an estimated further increase of 15% in the next 3 or 4 decades, wetter and drier seasons are expected especially for the regions south of the equator (including Java and Bali) (Climate Service Center, 2015).

The impact of climate variability is bound to be non-negligible in the SEA region. By the end of the 21st century, it is estimated that the region will lose about 11% of its GDP because of climate change (ADB, 2015). Empirical evidence suggests that the biggest losses will be faced by those sectors that rely more on climatic conditions, such as agriculture (First, 2019). Agriculture is, however, the biggest economic source of income for poorer people in SEA (Booth, 2019). In Vietnam, for instance, 96% of the poor population derives its livelihood from agriculture (Pimhidzai, 2018). Similarly, in Indonesia, most of the farming households live below the poverty line and heavily relies on agriculture for their subsistence (Bresciani and Valdes, 2007; Suryahadi and Hadiwidjaja, 2011). Therefore, climate-induced losses on crop and livestock productivity are expected to be regressive in nature as they can severely worsen the life of the poorest, further increasing economic inequality in these countries (Fisher et al, 2002; Hallegatte et al, 2014; Farbotko, 2020).

Other studies, however, suggest that agricultural is not the only sector that is and will be impacted by climate

variability. Dell et al (2009) and Hsiang (2010), for example, find that the effects of climate change are experienced very clearly also, and sometimes even more, by non-agricultural economic activities. There are two main channels for this effect: labour productivity and supply. For example, Graff Zivin and Neidell (2014) claim that the actual amount of work time was significantly reduced during warmer days and that the effect spans across different sectors. Moreover, Seppannen et al (2013) find that a 2% reduction in labour productivity is associated with temperature above 25 degrees Celsius. The rapid development of countries like Vietnam and Indonesia has also moved a lot of people out of farm activities to wage and non-farm employment. Some of these people are most marginalised and disadvantaged people, such as migrants. In Vietnam, for example, a significant number of poor women and ethnic minority migrants are often employed in construction activities as wage employees far away from their homes. Their living and working conditions are precarious and highly exposed to weather conditions. Therefore, the overall impact of climate variability on these sectors might also be non-negligible for the most disadvantaged part of the population.

Economic activities are only one pathway whereby the impact of climate could widen the gap between the poorest and the richest. There other factors that could increase exposure, vulnerability to, and capacity to cope with climate hazards, for instance remoteness, ethnicity and gender (Leichenko and Silva, 2014). Most poor and marginalised groups in both Indonesia and Vietnam, for instance, can often afford to live in less desirable areas. These areas are often remote, rural and with infrastructure that is less resilient to climate impacts. Furthermore, more than a third of the poor in Vietnam belongs to ethnic minorities (Pimhidzai, 2018). Scarce political representation, marginalisation and social norms often hinder the capacity of ethnic minorities to access a diversified set of productive assets, improve their current economic status and reduce their vulnerability to climate hazards (MDRI & Oxfam, 2020). Finally, women generally lack equal employment and social opportunities, as the existence of conservative social norms often relegate them to their traditional role in the households, such as chores and child-care (Lawler & Patel, 2012; Leichenko and Silva, 2014).

Due to lack of resources and opportunities, poorest and most marginalised groups are bound to be the most exposed and vulnerable to climate impacts (Silva, 2016). Societal and economic pressure renders these groups less able to make adequate investment choice to protect themselves from the impact of climate hazards while the lack of voice and representation in the political decision-making process and societal norms hinders their control over a more equal distribution of national resources and services (such as health, education, infrastructure and the judicial system).

This self-reinforcing relationship of unequal relations in roles, functions, decision rights, and opportunities is often referred as “structural inequality” (Dani and de Haan, 2008). Structural inequalities are the product of the interactions of discriminations based on gender, age, ethnicity, race, religion, culture, unequal access to basic services

and unequal opportunity for participation and choice. Several studies show how structural inequalities significantly reduce opportunities to escape poverty (Andrews and Leigh, 2009; Wilkinson and Pickett, 2009; Kerry et al., 2010; Dang et al., 2020). The interactions between rising inequality, lower social mobility and higher climate variability can further strengthen existing barriers that limit disadvantaged and marginalised groups ability to cope with and adapt to climate hazards1 (Beck, 2010).

Studies on the direct impact of climate change and variability on structural inequalities are limited, as the literature mostly focuses on the direct effects on poverty and treats inequality as a secondary and consequential issue (Leichenko and Silva, 2014). Poverty and inequality are, however, very distinct phenomena and often follow different patterns. Vietnam and Indonesia are perfect examples. These two countries are among the fastest-growing lower-middle-income countries in the region. Their effort in reducing poverty rates has been outstanding in the past decade and as of now about 10% and 5.8% of the population lives under the poverty line, respectively in Indonesia and Vietnam.

Despite these remarkable results, inequality has been steadily increasing (Gini coefficient +5% in Vietnam and 10% in Indonesia, 1990-2014) (UN, 2018). In Vietnam, inequality has widened even more in rural and remote areas, mostly populated by minority ethnic groups (Le and Booth, 2013; Nguyen et al., 2015; Bui et al., 2017; Nguyen et al., 2017; Nguyen and Nguyen, 2017). Indonesia has become the sixth country with the greatest wealth inequality in the world, with the four richest people in the country having more wealth than 100 million poor people, all together (Asra, 2000; Akita, 2002; Oxfam, 20172; Ananda and Pulungan, 2019).

Our major contribution in this paper is that we directly investigate the relationship between climate variability and drivers of structural inequalities using a within country approach. Understanding the direct relationship between structural inequality and climate variability will be of paramount importance for the policy development in Vietnam and Indonesia. Hence, although policies in both countries were designed to target and support low-income groups in coping with emergencies, they often have little relevance to the needs, rights and priorities of the most marginalised people. The lack of participation and voice the places of power has in the recent years worked in favour of the better-off and widened the gap between these and the most vulnerable, reducing even further their ability to face climatic challenges (Oxfam, 2017; Oxfam in Vietnam, 2015; Nguyen Tran Lam et al., 2016; Muhtadi and Warburton, 2020).

[1] Inequality is not all bad. Studies show that that some degree of inequality could provide the incentives for investments, human capital accumulation and future economic growth (Lazear and Rosen 1981; Barro 2000; Dabla-Norriet et al., 2015). Nonetheless, high level of sustained inequality can cause large social costs, reduced individuals' educational and occupational choices, increased resource misallocation and overall reducing economic growth (Stiglitz, 2012).

[2] https://www.oxfam.org/en/indonesia-even-it/inequality-indonesia-millions-kept-poverty.

Furthermore, a large majority of the previous studies analyse the relationship of climate and inequality across countries, with less attention to how different groups within each country are impacted by climate hazards (Acemoglu et al., 2001; Dell et al., 2009; Auffhammer et al., 2013). While it is important to discern differences at regional or global level, these studies fail to capture the main socio and economic barriers to climate responses. In this paper, we specifically analyse the impact of temperature and rainfall changes on the income and income inequality distribution. In addition to the average country effect, we also investigate whether this relationship changes due to selected drivers of structural inequalities, such as economic activities, gender, ethnicity and remoteness.

Finally, a technical contribution. To assess the linkages between social mobility and the impact of climate variability on inequality, we use a synthetic panel approach. We use Vietnam as a case study. Panel data are often regarded as ideal to estimate household level impacts of different nature. This is more so in the case of climate variability studies as one would ideally like to control for those specific households' features that could confound the results of the estimations across a long-time span. However, long, and large panel datasets are rare[3].

Synthetic panels approach (Dang and Lanjouw, 2013; Dang et al, 2019) provides a robust alternative to real panel data. We use this approach to test the relationship between mobility, income and income inequality for climate variability impacts and use Vietnam as a case study.

The rest of the paper is structured as follows: Section 1 describes data and methods; Section 3 discusses the results of the analysis and Section 4 concludes.

[3] VHLSS includes a rotating panel of communes and households, but only for a third of each round sample. Synthetic panels allow us to use all the data available, and not only the ones that are included in the panel.

I – Data and methods

We use five rounds of the regionally representative Indonesian Family Life Survey (IFLS) (1993/94, 1997, 2000, 2007, 2014/15) and nine rounds of the provincial, regional and national representative Vietnam Household Living Standard Survey (VHLSS), collected every two years from 2002 to 2018. Our sample include a panel of 4,909 HHs for Indonesia, for a total of 24,545 observation, and 99,723 households/repeated cross-section observations for Vietnam. Climate data sources are Climate Prediction Center (CPC) of the NOAA ESRL Physical Sciences Division (PSD) for daily min and max temperature and the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) for daily rainfalls amounts[4].

There are many methodological challenges that need to be accounted for when estimating the impact of weather on income and inequality. First, the lack of linearity of the relationship, which means that unusual variability in weather conditions do not have a uniform impact on the income response. For instance, it is reasonable to assume that 1-degrees temperature increase around the mean values of the temperature distribution will not have the same effect as a 1-degrees increase at the extreme ends of the distribution (colder or hotter temperatures) (Burke et al., 2015; Dell et al. ,2012; Skoufias et al.,2013; Schlenker and Roberts, 2009; Deryugina and Hsiang, 2017) and this effect might change significantly across seasons (Nurfolk, 2016). In this paper, we follow the Deryugina and Hsiang (2017) who use the number of temperature- and rainfall- days to control for non-linearity in the income and income inequality response function to climate. Climate variables are estimated on an annual and seasonal bases. This approach effectively controls for both non-linearity between climate, weather, and income and inequality responses and for within-year heterogeneity of impacts.

Another challenge in the analysis of the impact of weather on income and inequality is the existence of a significant heterogeneities across the units of analysis. Thus, it is reasonable to assume that weather variability does not have the same effect in all countries or across different groups in the population. Unobservable characteristics, such as contextual historical heritage and households' characteristics, as for example adaptive capacity or creativity (Acemoglu et al.,2001) might confound naïve estimations that do not control for specific fixed effects, as in Dell et al., (2009). Panel data are ideal in this context as they get rid of all location specific unobservable characteristics and they allow for a correct and unbiased comparisons across years of the income and inequality responses (Auffhammer et al, 2013; Dell et al.2012). When panel data are not available, multiple dimensions fixed effects might reduce the omitted variable bias in the estimation. We use panel data for Indonesia and for Vietnam we use multiple fixed effects dimensions to control for specific within-commune unobserved characteristics and households' unobservable characteristics.

[4] More details on the data can be found in the Appendix.

Following Deryugina and Hsiang (2017), we use the local random deviation of household income and provincial level Gini coefficients to estimate the marginal response to changes in weather, controlling for unobserved heterogenity for locations and households; for spatial auto-correlation across-locations; within-location auto-correlation and non-linear climate trends. We control for non-linearity of the impact of weather on income and inequality using annual within-communes/sub-district level variations in the distribution of daily temperatures. This approach allows us to estimate the marginal effect of a single day's temperature on end-of-year income, conditional on temperatures experienced during the rest of the year (Deschenes and Greenstone, 2011). Our empirical equation is the following:

$$Y_{it} = \mu_i + \theta_t + \sum_{h=1}^{H}[\sum_m[\beta^{mh}(T_{it}^m)^h + \gamma^{mh}(T_{it-1}^m)^h]] + \sum_m[\vartheta^n(P_{it}^g) + \varphi^n(P_{it-1}^g)] + \beta_{it}Z_{it} \qquad (1)$$

Where Y is the log of income per capita of household i in time t, or the provincial level Gini coefficient for province i in time t, and Z_{it} are selected household level characteristics, such as remoteness, gender, education, ethnicity[5], age of the head of the households, proportion of children and females in the household. We use year, θ_t , and commune (in the case of Vietnam) or household (in the case of Indonesia) fixed effects, μ_i. Location fixed effects controls for unobserved constant differences across location, such as elevation, and households, such as ability and entrepreneurship. Year fixed effects, on the other hand, control for common trends, such as trends in climate or technological innovations. Our main parameters of interest are β^{mh} and ϑ^n which show the impact of an increase of 1 day of certain temperature or rainfall bins on the growth of income per capita and income inequality at provincial level.

The model allows for non-linearity for each dimension of temperature and rainfalls. The dimensions are constructed as eight 3-degrees-temperature bins: 0-12; 12-15; 15-18; 18-21; 21-24; 24-27; 27-30 and more than 30 degrees Celsius6. Similarly, we constructed 8 rainfall bins based on the daily amount of rain experienced: 00-00 mm; 00:05 mm; 05-10 mm; 10-15 mm; 15-20; 20-25 mm; 25-50 mm and more than 50 mm. T_{it}^m and P_{it}^g are the number of days where the 24 hours temperature average and total rainfalls falls in the mth temperature bin and gth rainfall bin.

The average effect of daily weather in each of these bins can be identified if the number of days in each of the bins is assumed to be orthogonal to the other potential confounders in the model and conditional to other explanatory variables, so that the effect of, say, an additional 30 degrees Celsius day is estimated by comparing the commune (in the case of Vietnam) or the sub-district (in the case of Indonesia) to itself across the years when the number of days in the 30 degrees Celsius bin was different.

[5] We only add ethnicity as explanatory variables in the model for Vietnam as this feature has not been historically relevant for inequality in Indonesia.

[6] Deyugina and Hsiang (2017) use 17 bins for United States where the range of temperature is much higher than Vietnam and Indonesia, where the average temperatures is between 24 and 27 degrees Celsius. Therefore, we grouped the lowest bins into one, 0-12, and then created the following ones with a difference of 3 degrees, as in Deryugina and Hsiang (2017). For Indonesia, which has much average higher temperatures than Vietnam, very few days had temperature less than 18 degrees. Nonetheless, for comparison purposes, we kept the definition of the temperature bins for both countries.

We exploit the small distortions in the distribution of daily weather conditions across years to estimate their impact on income and income inequality, while controlling for weather systematic patterns and their random variations in each location. Our direct focus is on contemporaneous effects of weather, defined as marginal effect of a single day's temperature on end-of-year income, conditional on temperatures experienced during the rest of the year (Deschenes and Greenstone, 2011[7]). Temperature and rainfall are, however, serially correlated. Therefore, we add lagged values of both temperature and rainfall to control for any potential effect of past temperature and rainfalls on current output[8]. Lagged weather variables are also included in the model to control for the temporal displacement of income and foresight of adaptive capacities across years.

In this model we assume constant marginal effects of adaptation efforts, captured by H. Therefore, we keep H=1. Some studies argue that, especially in developed economies, the contemporaneous net effect of weather variability on income might be negligible (e.g. Gallup, Sachs, and Mellinger, 1999; Nordhaus, 2006). This is because the direct, short-term effect on outputs, prices, and revenues, might be offset by adaptive and mitigation measures, national and household level defensive investments and effective risk transfer mechanisms. With the increasing penetration of crop risk insurance schemes and the remarkable climate adaptation and mitigation efforts in both Vietnam and Indonesia, we might expect a certain degrees of temporal displacement of wealth across years due to climate adaptation and mitigation.

Several studies have argued that annual measures of climate variability might hide intra-annual variation and specific impacts that timing of weather instability can generate (Hsiang, 2010; Mendelshon et al., 1994; Welch et al., 2010; Yang and Choi, 2007; Narloch, 2016). To test whether seasonality affects the relationship between weather and income in our analysis, we also estimate each temperature and rainfall bins for the dry (November to April) and wet (May to October) seasons.

Finally, we use standard errors that are clustered in two dimensions (Deryigina and Hsiang, 2017; Cameron et al., 2011) by year and location, communes for Vietnam and sub-districts for Indonesia. This allows to control for both spatial correlation across contemporary locations auto-correlation within locations. We also use population sampling weights. We use this model for each country, Vietnam, and Indonesia, separately, and estimate the average effect across the entire sample as well as across different dimensions of the structural inequalities that are prevalent in the two countries. A repeated cross-section model is used for Vietnam and a panel model for Indonesia. Summary statistics of the main explanatory variables can be found in Appendix 1 (table A1-A2).

[7] We decided to focus on temperature because temperature is highly correlated with rainfall, and therefore we only use rainfall to control for unexpected heterogeneity in the weather impact which is not accounted for by our temperature variables.

[8] We also estimated other model specifications, including polynomials (total annual rainfall squared) and variables that capture the deviation from the historical averages of temperature and rainfalls (coefficient of variation). However, our estimates do not change much. Therefore, we prefer following the Deryugina and Hsiang (2017) approach.

II – Results

2.1. Trends of economic and structural inequalities

Income disparities between the richest and poorest have widened through time in both Vietnam and Indonesia. Our data show that some households have been lacking behind, and their economic conditions have deteriorated in the past decades. These households are poor, often live in rural areas and have certain demographic characteristics that are usually associated with structural inequalities, such gender, ethnicity, education, and age of the household head. Nonetheless, peculiar discrepancies across the two countries can be noted.

In Vietnam, for instance, crop and overall agricultural income has grown much slower than non-farm and wage employment income (Figure 1, Panel A1). Furthermore, although positive, income growth for the poorest has been much slower than the rest of the population (Panel A2). Agricultural and rural households are significantly lacking behind, as their income has been lower than the average since 2002 and this gap has steadily widened (Panel A3). Our data also show that ethnicity of the head of the household is an important barrier for economic prosperity at household level (Panel A4). Thus, since 2002, ethnic minority households have experienced the lowest income growth in absolute and relative terms. Similarly, households whose head has low education (primary or lower) have also experienced a slow income growth, while female headed households or those households headed by older people are closer to the average growth since 2002. Interestingly, it seems that young households' heads have been struggling in catching up with other groups in terms of income growth, as their income has been consistently lower than other groups of households across time.

Income inequality at national and sub-national level has been relatively stable since 2002, with even a slight reduction noticeable in 2018 (Figure 1, Panel B1)[9]. The decomposition analysis of income inequality across sources of livelihoods shows that wage income accounts for most of the inequality in Vietnam (+ 49%) followed by non-farm income (31%) (Panel B2). Since 2002, the contribution of wage income to total inequality has consistently increased (+16% in 2018), while non-farm income contribution to inequality has reduced from 2002 to 2004 and increased ever since, although at a much lower rate than wage income. Agricultural income, which includes crop, livestock, fisheries, and forestry income, and other income (transfers, remittances, etc.) contribute very little to total inequality (11% and 9%, respectively) with a slight reduction since 2002 (5% and 6%, respectively).

Despite the relatively stable inequality levels at national level, inequality has, in fact, been increasing since 2002 mostly for those provinces where rural, poor, agricultural households are located and, even more, for those with the highest concentration of ethnic minority households. Thus, our data show that inequality increased in those regions more densely

[9] Consistently with official WB figures, expenditure inequality, on the other hand, has increased in the past years, although on a relatively small scale.

populated by ethnic minority, such as Northern mountainous regions and Central highlands[10]. In these regions, inequality increased by 12% and 14% since 2002, respectively. To understand whether these patterns are explained by difference between or within groups for each of the most vulnerable groups in Vietnam, we decomposed the Theil's L of the income per capita. Panel B3 of Figure 1 shows that since 2002, most of the total inequality can be explained by within-groups differences, except for education and ethnicity. For these households, between-groups inequality has increased. In line with previous literature (e.g. McCaig et al. 2015; Tuyen, 2016; Kompass et al., 2017; Pimhidzai, 2018), the largest increase in between inequality has occurred across ethnicities (Kinh vis-à-vis ethnic minorities).

In Indonesia, disparities between the richest and the poorest have also been progressively increasing since 1993, faster and wider than in Vietnam. Like Vietnam, though, household income is more and more sourced from non-farm wage employment and less from agricultural activities (Figure 2 – Panel A1). Poorest households have experienced the lowest income growth in the whole population, while richest groups have been become progressively richer and richer at a much faster rate(Panel A2), especially in the Sulawesi and Kalimantan regions where income per capita grew 58% more than in Java and 39% more than in Sumatra since 1993. Poor, agricultural and rural households have generally been lacking behind (Panel A3), especially in the Java region, where farming and poor households have also experienced a reduction of income since 2007. Similarly, female headed households and households where the head is old (more than 60 years old) or with low education (primary or lower) have experienced lower income growth than the average (Panel A4), at national as well as across different regions

Our data shows a consistent reduction of income inequality at national and provincial level since 1993[11], from above 70% to slightly less than 60% (Figure 2 – Panel B1). A spike in inequality occurred in concomitance to the financial crisis in 1997 but reduced significantly since 2000. The source of livelihoods and income that accounts mostly for the total inequality changed from 2000 to 2007 and overall, across all the years in the sample (Panel B2). While non-farm income accounted for about 40% to 50% of total inequality in 1993, 1997 and 2000, its contribution dropped to 14% in 2007 and slightly increased to 16% in 2014. In more recent years, the major source of inequality comes, instead, from other sources, such as remittances and transfers, and from non-farm wage income, both accounting for about 40% of total inequality, with a 18% increase since 1993 of the latter. Farm and farm labour income, on the other hand, do not contribute much to the total inequality. Like in

[10] Regional level figures can be found in the Appendix.

[11] WB estimates indicate an equalizing effect of the 1997 financial crisis and an increase in inequality in the last years of the Gini coefficient. Our data shows, instead, an increase of inequality following the crisis and consistent reduction of the national income inequality since 2000. There might be three main reasons for these discrepancies: 1) the dataset used in our analysis, IFLS, is representative at regional level and not at national level. WB, instead, uses SUSENAS datasets which are nationally representative. We did not use SUSENAS data as are not publicly available 2) Furthermore, our panel includes a selection of the households that have been followed in the 5 rounds of the IFLS data collection, located in 13 of the 27 Indonesian provinces.

Vietnam, total inequality is mostly explained by differences within groups. The only exception is for inequality across households with different level of education, for whom we notice a slight increase of the between-groups inequality since 1993 (Panel B3). provinces,

Remittances and other non-labour income transfers have significantly increased since 2000s in Indonesia, from 1.8 billion USD to 9.7 billion USD, according to WB estimates[12]. In our sample, the main recipients of transfers are middle aged widow, less educated, female headed households, with more dependents (children and adults in productive age) than households who do not receive any transfer. They are more likely to be poor and live in urban areas in the Sumatra region and their sources of livelihood are primarily non-labour and non-farm wage income.

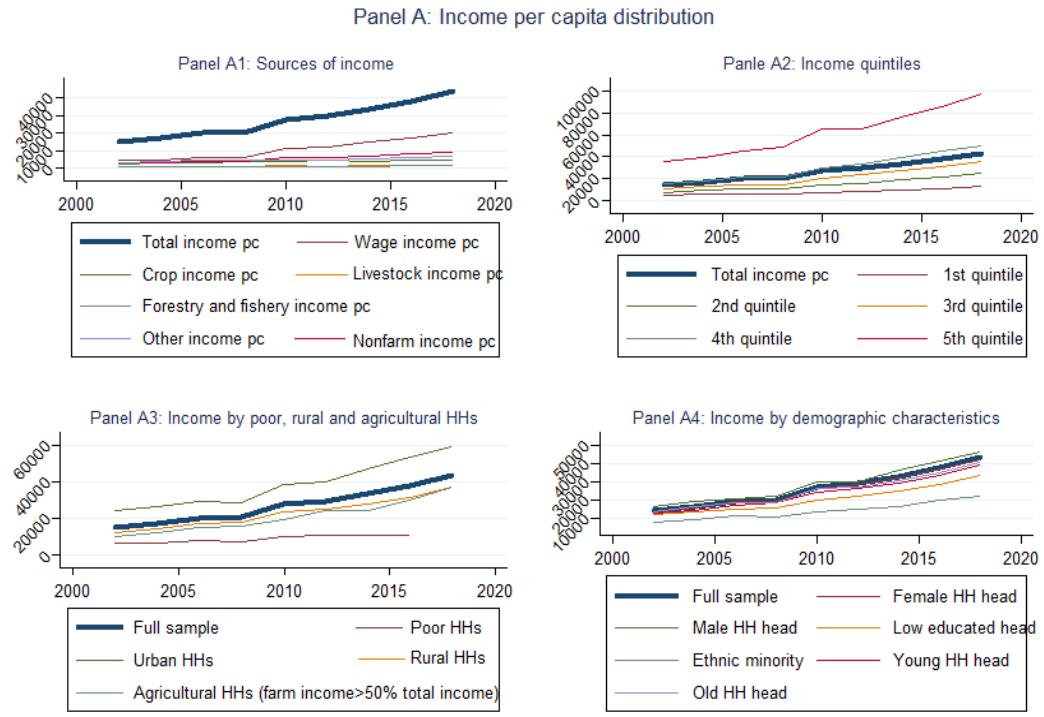
There exists evidence on migration patterns and lower and unequal employment opportunities that might explain why remittances, transfers and wage income have been the major contributors of inequality in Indonesia. Firstly, internal migration is a young people phenomenon. About 65% of the total migrant population are aged between 15 and 34. Most of them are single, more educated men, who look for better opportunities in the services sector, in urban areas in Java. Middle aged widows are, therefore, more likely to stay in their place of origin and receive remittances from their dependents, especially when poor, less educated and with more dependents (Sukamdi and Mujahid 2015). Women also have lower and unequal employment opportunities in Indonesia. In the past two decades, women labour market participation, and especially married or widows with more dependent children, has been consistently lower than international standards (Comola & de Mello, 2012; WB, 2018; Taniguchi and Tuwo, 2014; Cameron et al., 2019)[13]. Unemployment is, however, relatively "unaffordable" for poor households who often rely on the informal sector for otherwise inaccessible job opportunities. About 75% of the Indonesia's total female workforce is employed in the informal sector (WB, 2019), which pays lower salaries especially for low skilled workers and provides lower quality working environment than the formal sector. There also exists a significant gender wage pay gap in the formal sector, where women earn on average 30% less than men (Weni et al., 2019). Therefore, poor, and less educated women might face significant barriers in accessing equal earning opportunities than the rest of the population, both in the formal and informal sectors.

[12] Accessible here: https://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT?locations=ID&view=chart

[13] In Indonesia, 53% of women in productive age (15 years or above) participate in the labour market, while, in comparison, the corresponding rate in Vietnam is 73% (WB, 2018).

Figure 1: Annual average real income per capita, by income type (Panel A1), quintiles (Panel A2) and across selected demographic groups (Panel A3 & A4) from 2002 to 2018 in Vietnam. Panel B shows the distribution of the income Gini coefficient, at national and provincial level (B1) its decomposition sources of income (B2) and the GE0 Theil's L decomposition (B3).

Source: Authors' calculation using VHLSS (2002-2018)



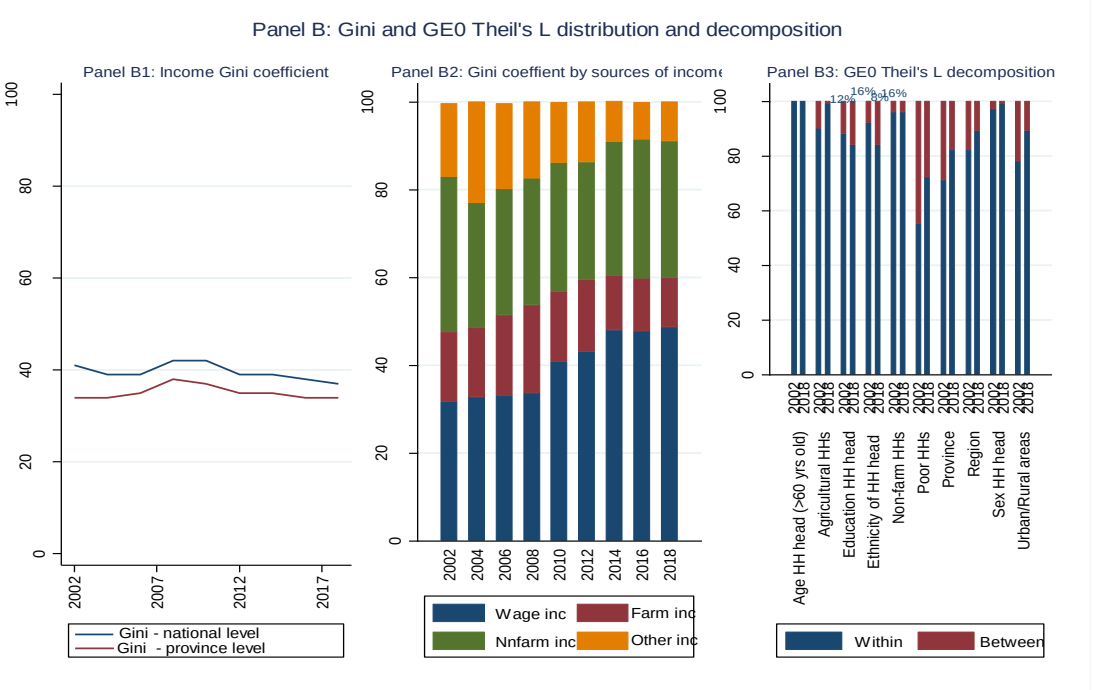
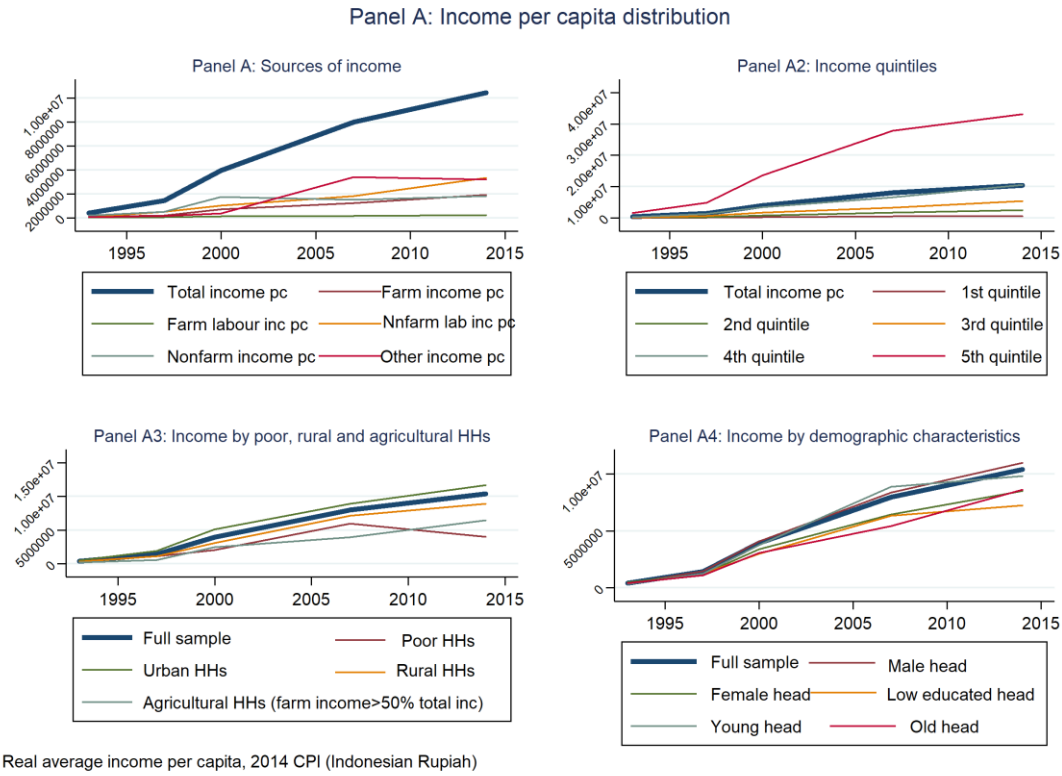
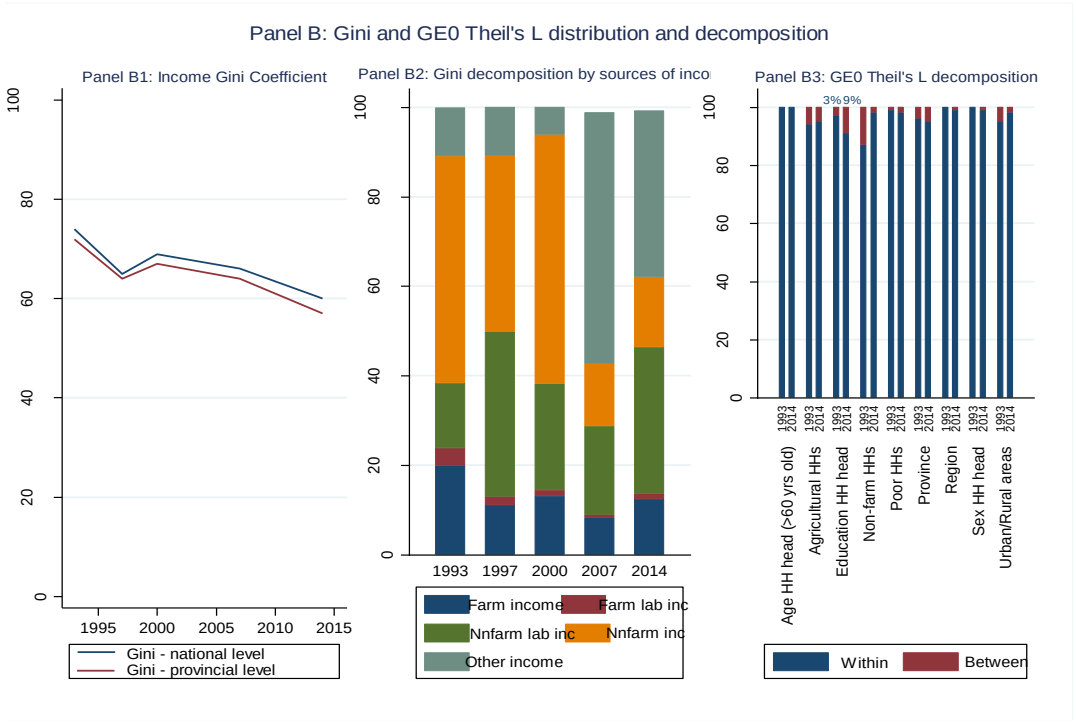


Figure 2: Annual average real income per capita, by income type (Panel A1), quintiles (Panel A2) and across selected demographic groups (Panel A3 & A4) from 1993 to 2014 in Indonesia. Panel B shows the distribution of the income Gini coefficient, at national and provincial level (B1) its decomposition sources of income (B2) and the GE0 Theil's L decomposition (B3).

Source: Authors' calculation using IFLS data (1993-2014)

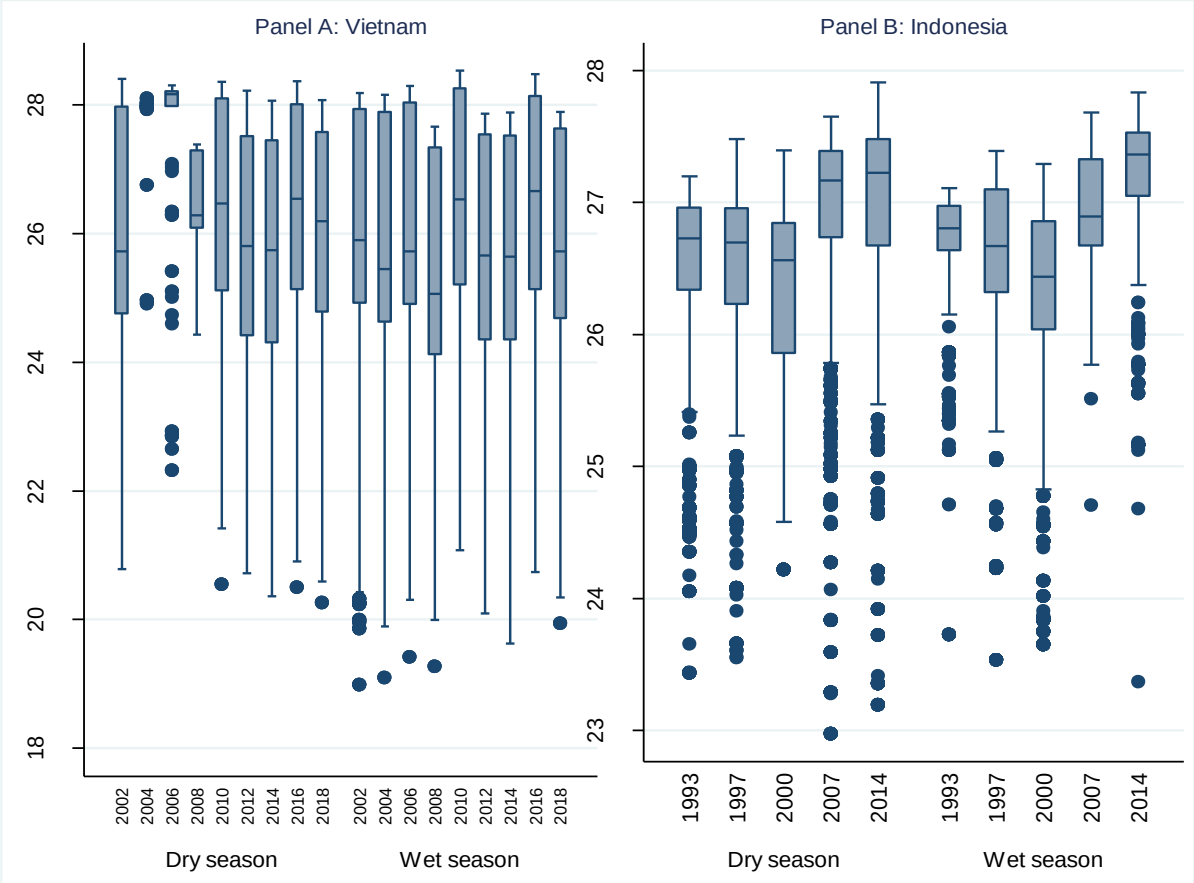




2.2. Trends in climate variability

Average temperatures and total rainfalls have been varying significantly across time. Our data show that temperature patterns in Vietnam have become increasingly more diverse since 2002, especially during the main dry season (November to April). This is at the exception of the years 2004 and 2006 when communes have experienced similar average temperature in the year In Indonesia, we observe higher temperature variability than in Vietnam, more so during the dry season, for lower temperature level and higher rainfall amounts[14] (Figure 3).

Figure 3: Average temperature in Vietnamese communes (Panel A) and Indonesian sub-districts (Panel B) during dry and wet seasons in the past 12 months.
Source: Authors estimation using CPC-NOAA ESRL (temperature).



[14] In both Vietnam and Indonesia, precipitations do also vary significantly across years. In Vietnam, rainfall variability increased since 2010.

Average measures of weather conditions can, however, hide differences in variability at different temperatures and rainfall levels. In Vietnam, both during the dry and wet season, most of the days in the year have temperatures ranging between 21 and 30 degrees on average. The highest variability is at the lowest extreme of the distribution (00-12 degrees) and between 21 and 27 degrees, especially since the 2010s. The highest temperature bins (27-30 and more than 30) show the biggest variations. For example, in 2008 temperatures

were in very few occasions higher than 30 degrees on average. The year 2010, on the other hand, was an extremely hot year, with more than 80 days of average temperature above 30 degrees in some parts of Vietnam. In 2012 this number dropped to a quarter of what was in 2010 to increase then steadily, but slowly, till 2016 and drop again in 2018[15].

In Indonesia, we do not observe any days in the lowest temperature bins (0-12; 12-15 and for most years 15-18). Interestingly though, since 2007 more and more households have experienced days with temperature less than 21 degrees and more than 27 degrees, especially during the dry season. The highest variation is, however, for days with temperature between 21 and 24 degrees, less so in the year 2000, but otherwise consistently varied, again, more in the dry season that in the wet season. Within the most common temperature bin (24-27 degrees), the number of days were quite consistent in 1993 and 1997 but started decreasing since the 2000, with more fluctuation during the wet season. The number of days in the 27-30 degrees bin has been increasing since 2000 confirming the increasing temperature trends observed overall in the country [16] [17].

[15] Rain patterns have also been volatile in Vietnam. The number of no rain days have been quite varied within the years but overall, we do not observe unusual trends. On the other hand, at higher amount of rainfalls (above 14 mm) we observe a much higher variation and occurrence of unusual rainfalls in both wet and dry season. Like the temperature trends, variability in rainfall seems to have increased since 2010, confirming the high correlation between these two variables.

[16] Rainfalls have also been erratic since 1993. The number of days within each rainfall bin varies significantly across years. More variation is observed at the tails of the distribution, with more unusual observations for the number of days where rainfall have been more than 50 mm a day. In addition, whilst the number of no rain days fluctuates across years, the overall picture shows an increase in wetter days, especially since 2000.

[17] Additional figures on the distribution of temperature and rain days in Vietnam and Indonesia can be found in Figure A1 and A2 in the Appendix.

Table 1 : Number of temperature and rainfall days from 2002 to 2018 in Vietnam (Panel A) and from 1993 to 2014 in Indonesia (Panel B).
Source: Authors estimation using; CPC-NOAA ESRL (temperature); CHIRPS (rainfall)

Panel A: Vietnam										
		2002	**2004**	**2006**	**2008**	**2010**	**2012**	**2014**	**2016**	**2018**
Variable	Description	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Temperature 00-12 °C	Total number of days in the past 12 months when temperature was between 0 °C and 12 °C	0	0	0	1	0	0	1	2	1
Temperature 12-15 °C	Total number of days in the past 12 months when temperature was between 12 °C and 15 °C	2	6	3	10	2	6	9	4	6
Temperature 15-18 °C	Total number of days in the past 12 months when temperature was between 15 °C and 18 °C	16	11	15	14	12	20	13	13	11
Temperature 18-21 °C	Total number of days in the past 12 months when temperature was between 18 °C and 21 °C	26	26	25	24	22	22	26	23	26
Temperature 21-24 °C	Total number of days in the past 12 months when temperature was between 21 °C and 24 °C	37	43	37	47	37	38	43	30	40
Temperature 24-27 °C	Total number of days in the past 12 months when temperature was between 24 °C and 27 °C	87	93	82	105	101	108	97	83	92
Temperature 27-30 °C	Total number of days in the past 12 months when temperature was between 27 °C and 30 °C	178	164	181	153	150	161	151	176	174
Temperature >30 °C	Total number of days in the past 12 months when temperature was 30 °C or higher	21	23	22	11	43	11	24	36	17
	N	**27720**	**8521**	**8532**	**8503**	**9354**	**9354**	**9342**	**9320**	**9077**

Panel B: Indonesia						
		1993	**1997**	**2000**	**2007**	**2014**
Variable	Description	Mean	Mean	Mean	Mean	Mean
Temperature 00-12 °C	Total number of days in the past 12 months when temperature was between 0 °C and 12 °C	0	0	0	0	0
Temperature 12-15 °C	Total number of days in the past 12 months when temperature was between 12 °C and 15 °C	0	0	0	0	0
Temperature 15-18 °C	Total number of days in the past 12 months when temperature was between 15 °C and 18 °C	0	0	0	0	0
Temperature 18-21 °C	Total number of days in the past 12 months when temperature was between 18 °C and 21 °C	0	0	0	0	0
Temperature 21-24 °C	Total number of days in the past 12 months when temperature was between 21 °C and 24 °C	7	8	8	7	5
Temperature 24-27 °C	Total number of days in the past 12 months when temperature was between 24 °C and 27 °C	246	236	167	173	155
Temperature 27-30 °C	Total number of days in the past 12 months when temperature was between 27 °C and 30 °C	112	121	53	185	205
Temperature >30 °C	Total number of days in the past 12 months when temperature was 30 °C or higher	1	1	1	1	1
	N	**4909**	**4909**	**4909**	**4909**	**4909**

III – Income and income inequality sensitivity to contemporaneous weather trends

Using a non-parametric approach, we explored the relationship between weather variability, income, measured as household level income per capita, and income inequality, measured as the Gini coefficient. We use average annual temperature of the past 12 months to compare contemporaneous weather, income, and income inequality.

Our data show that the correlation between weather conditions, income and inequality is non-linear (Figure 4). We observe an overall positive correlation between average yearly temperature and household level income per capita in both Vietnam and Indonesia (Panel A & C). In Vietnam, however, household income decreases when the average annual temperature goes above 28 degrees Celsius. This negative impact seems to be mostly experienced in Central Highlands. This region has historically been one of the most sensitive to the El Nino effects since 1982. The drought even in 2003, for instance, caused a 25% reduction in the coffee production and earnings. The more recent drough in 2015 has also resulted in significant crop damage, yield decline and serious water shortage in this region (CCAFS 2016). In Indonesia, income increases mostly at temperature higher than 26 degrees Celsius mark. In Sumatra and Kalimantan and Suwalesi (other) we also observe a reduction of income between 24 and 26 and 22 and 24 degrees Celsius, respectively, but a sharp increase of income at higher temperature. Like in Vietnam, these regions have been very sensitive to the El Niño–Southern Oscillation (ENSO). The recent drought event in 2016 in Sumatra[18], while the increased incidence of cyclones and forest fires in Kalimantan and Suwalesi in the past decades, also associated with the ENSO, have severely affected the agricultural sector of these regions (UNDP 2013). Our results show that, indeed, farm income reduces significantly with changing weather conditions in both Vietnam and Indonesia (Figure 5). Non-farm income, instead, tends to increase with temperature consistently across both countries. Similarly, non-farm wage income is positively correlated with the increase of temperature, although in Vietnam we find a point of inflection when temperatures go beyond 28 degrees Celsius, where this income reduces on average.

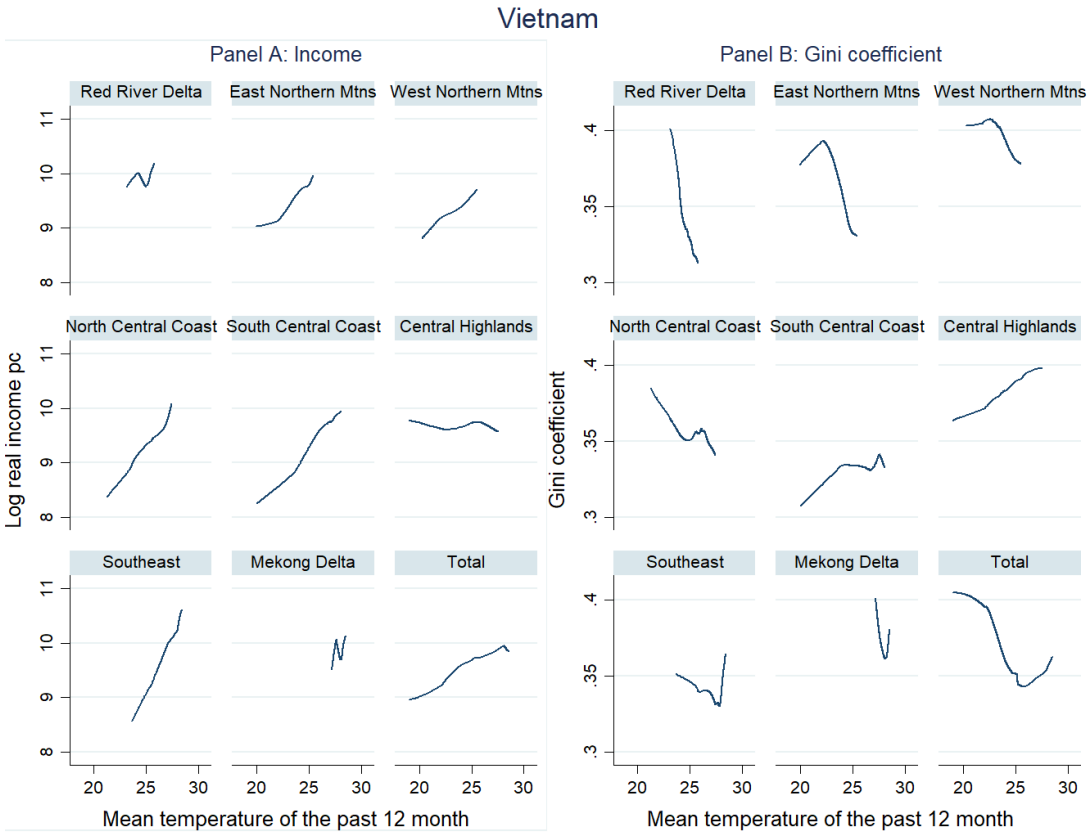
Our parametric estimations also show that weather conditions might worsen income inequality in certain areas of Vietnam and Indonesia (Figure 4, Panel B). More specifically, when average temperature increases beyond 26 degrees Celsius, the Gini coefficient in Vietnam tends to increase.This inequality enhancing effect is not observed for all the regions, but only for the the regions most vulnerable to El Nino events, such as Central Highlands, Southeast and Mekong Delta. In Indonesia, on the other hand, we find that climate variability is negatively correlated with the Gini coefficient. Thus, for temperature higher than 27 degrees Celsius, the Gini coefficient drops significantly in all regions but Sumatra, where the Gini coefficient actually increases.

[18] https://coopcoffees.coop/the-impact-of-climate-change-in-sumatra/

We investigated this relationship further across the main economic and demographic drivers of structural inequality to see whether the correlation between income, income inequality and weather variability differs across selected most vulnerable groups in Vietnam and Indonesia (Figures5,6,7). Figure 6 shows that, in Vietnam, the correlation between weather and household income changes significantly across different type of households. More specifically, household income decreases with contemporaneous temperature only in the case of rural, mostly agricultural households, female headed household and those households whose head is relatively young of age (<40 years old) or relatively old (>60 years). For other selected vulnerable groups, the correlation is, instead, positive. In Indonesia, on the other hand, we observe a positive correlation between household income and temperature across all the selected most vulnerable groups.

Finally, the analysis of the correlation of weather and income inequality across vulnerable groups confirms that weather conditions might exacerbate existing inequalities (Figure 7). This is specifically in the case of Vietnam where for temperature higher than 26 degrees Celsius, income inequality increases for all the vulnerable groups considered in this analysis. We also find that changes in weather conditions might have an equalising effect in Indonesia at the higher end of the distribution but an inequality-enhancing effect at lower ends. Thus, the Gini coefficient reduces for temperature higher than 27 degrees Celsius, but it is stable or increases for temperature lower than 26 degrees.

Figure 4: Non-parametric estimation of the correlation between average annual temperature, household income per capita (Panel A & C) and the provincial level Gini coefficient (Panel B & D) in Vietnam and Indonesia.
Source: VHLSS 2002-2018 (Vietnam); IFLS 1993-2014 (Indonesia); CPC-NOAA ESRL (temperature).



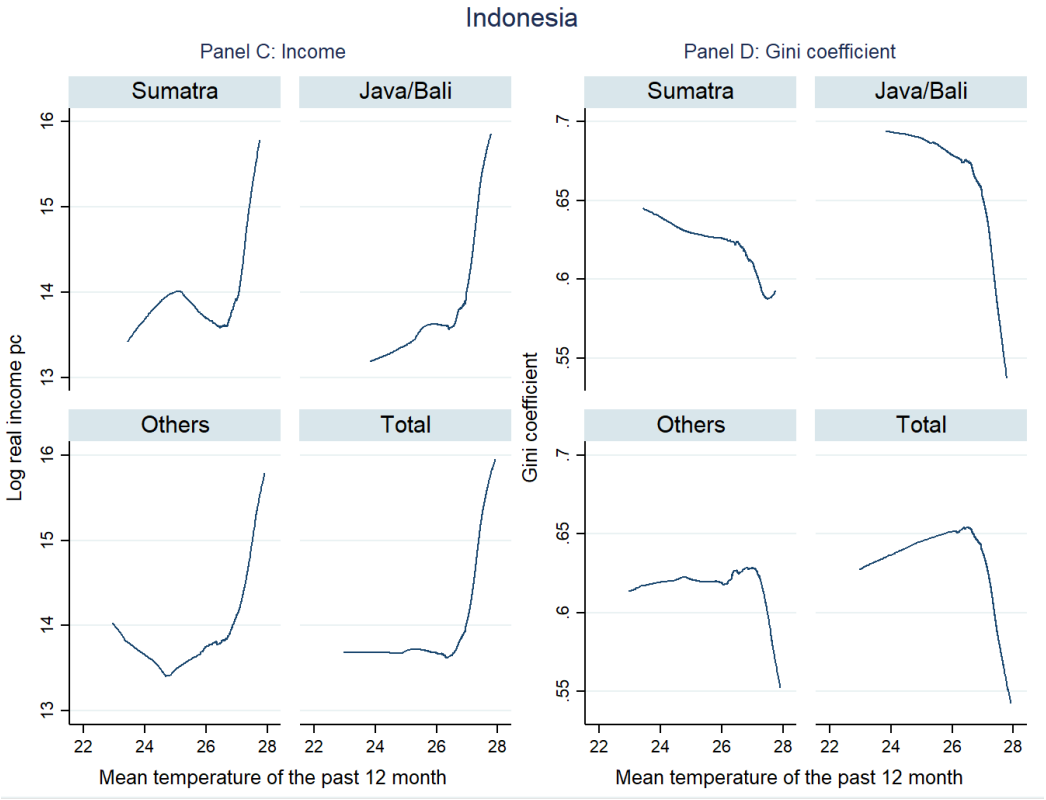


Figure 5: Non-parametric estimation of the correlation between average weather conditions and farm, non-farm and wage income in Vietnam and Indonesia.
Source: Authors' estimations using VHLSS 2002-2018 (Vietnam); IFLS 1993-2014 (Indonesia); CPC-NOAA ESRL (temperature).

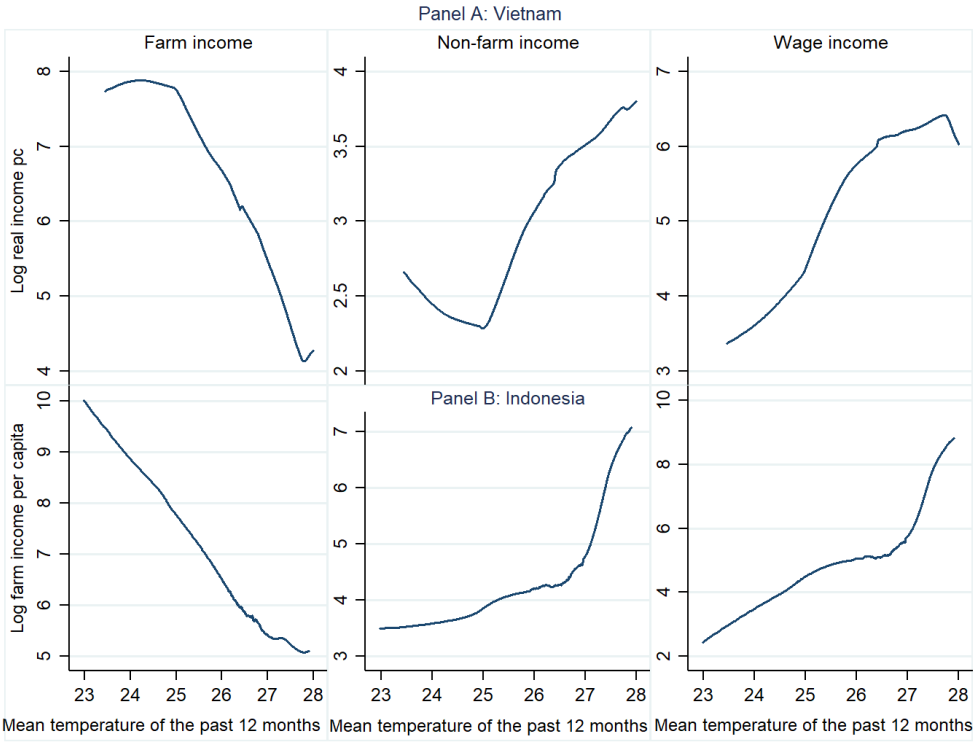


Figure 6: Non-parametric estimation of the correlation between average weather conditions (average temperature per year in panel A, and total rainfall per year in panel B) and log of income per capita in Vietnam and Indonesia.
Source: Authors' estimations using VHLSS 2002-2018 (Vietnam);
IFLS 1993-2014 (Indonesia); CPC-NOAA ESRL (temperature); CHIRPS (rainfall).

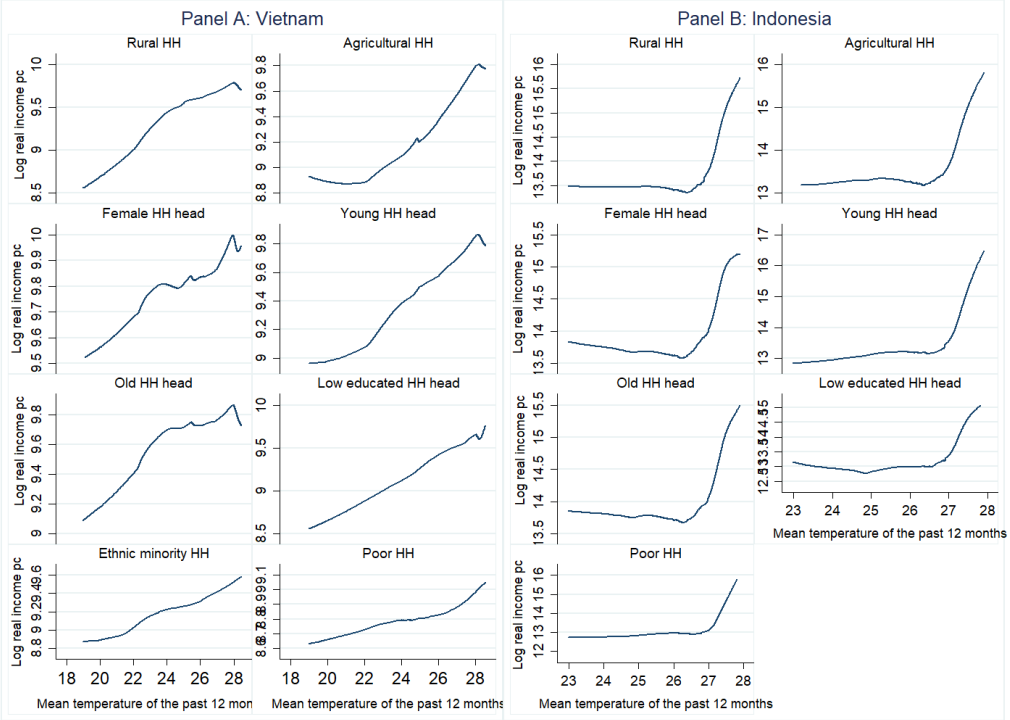
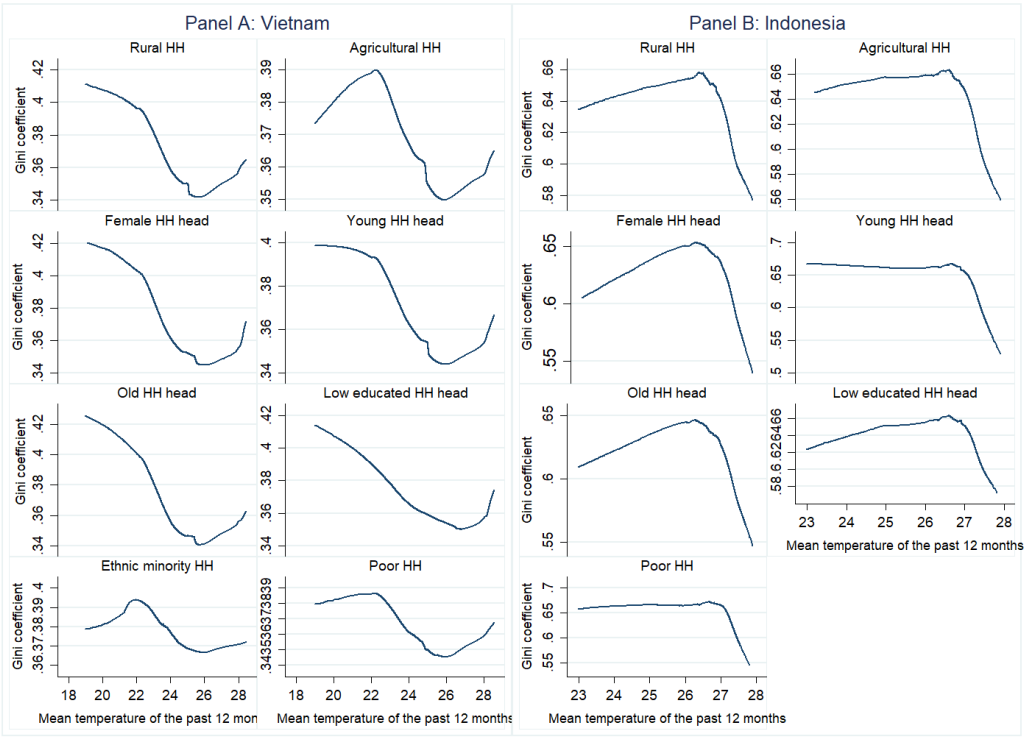


Figure 7: Non-parametric estimation of the correlation between average weather conditions and Gini coefficient in Vietnam and Indonesia.
Source: Authors' estimations using VHLSS 2002-2018 (Vietnam);
IFLS 1993-2014 (Indonesia); CPC-NOAA ESRL (temperature)



IV – Accounting for non-linearity and heterogeneity of impacts

The non-parametric analysis confirms that there exists a non-linear relationship between weather and income as different levels of temperature affect income and inequality in different ways. It also shows that poor, rural, agricultural, and most marginalised households might be bearing a bigger burden of changing weather conditions. However, these results only show the direct correlation of weather, income and inequality without considering other factors that could affect this relationship. We now present the results of the analysis which controls for, household and community level characteristics, heterogeneities of impacts and non-linearity between weather, income and inequality.

4.1. Income sensitivity to annual and seasonal weather variability

Our results show that variability of contemporary temperatures has a positive effect on income in Vietnam. Namely, an increase of a single day's temperature generates more total household income per capita in the same year (table A3). The positive effect is even more pronounced for agricultural, female headed households, and households with a young household head (Table A4). For these households, the largest increase in income occurs when temperature increase beyond the highest levels (>30 degrees Celsius). These results contradict findings of previous literature that argue that climate and weather variability should have a negative impact on income (e.g. Deryugina and Hsiang, 2017; Dell et al., 2012; and specifically for Vietnam, Narlock, 2016; Espagne and De Laubier-Longuet, 2019). There exists, however, a number of authors who challenge this claim, and argue that the observed negative association of warming climate conditions and income is, in fact, causal. These authors claim that omitted variables, such as social and political institutions, play a prominent role in mitigating or exacerbating the effect of climate and weather on income, which can in same case be negligible or positive (e.g. Gallup, Sachs, and Mellinger, 1999; Acemoglu, Johnson, and Robinson, 2002; Easterly and Levine, 2003; Nordhaus, 2006). These studies, though, mainly present evidence from the developed world where household level risk mitigating and insurance schemes, coupled with government driven defensive investments, can offset the overall negative impact of changing climate on prices and outputs in the short term (Deryugina and Hsiang, 2014).

Vietnam is not a developed country, yet, and as such we would not expect that households would be able to fully offset the negative impact of climate variability on income as in wealthy economies. It is, however, plausible that changes in weather conditions might push households to leverage extra income in the short term in the form of transfers or remittances to be used as insurance for current and future climate hazards (Yang and Choi, 2007). These strategies might be especially used by those households who rely mostly on weather conditions for their livelihood, such as farming households, or the most exposed and vulnerable to climate hazards. In our sample, it is the most vulnerable groups (ethnic minorities, rural and female headed households, households with young, old, and

less educated heads) who receive, on average, a significantly higher amount of transfers than other households in the country, in the form of generic and disaster related allowances.

To test whether receiving transfers might affect the impact of climate variability on income, we estimate our models with the addition of a variable that capture the receipt of allowances, including international and domestic remittances and other disaster related allowances. The results of this analysis show that transfers and remittances might be used as insurance by the most vulnerable and farming households (Table A5). For these households, the contemporaneous effect of climate variability on farm income is not significant. When controlling for transfers and remittances, this effect becomes negative for rural and ethnic minorities households, suggesting that, indeed, these households might be using transfers to cope with short term climatic shocks. Similar solutions might not play as well for the non-farm sectors, especially for poor, female and less educated households, who, instead, experience a significant reduction in this source of income with increase in climate variability in the same year and this impact does not change when we control for transfers. Coping capacity of Vietnamese households, however, seem to mostly focus on the short term. Our results show that the effect of changing of temperatures' days in the previous year on income persists in the current year. This holds for the entire population, for agricultural households, as well as for the most vulnerable households, such as poor households and for ethnic minority who experience a negative impact of lagged temperature on current farm income.

In Indonesia, our findings are mostly in line with the studies that postulate a negative, contemporaneous, effect of changing weather on income (such as Deryugina and Hsiang, 2001 and 2017; Dell et al., 2012). We find that the highest effect on total income is at the extreme ends of the temperature distributions, below 18 degrees Celsius and above 30 degrees Celsius (Table A6). Furthermore, agricultural households experience a significant reduction of total income with any change in temperature in the current year. Among different sources of livelihood, it is the farm income that reduces quite systematically for changes in contemporaneous weather conditions. Poor, low educated and those households who mostly rely on agriculture for their livelihood are the ones who are the most affected, especially for temperature lower than 18 degrees Celsius and higher than 24 degrees Celsius. We also find that non-farm income for rural and female headed households and wage income for household headed by older people reduce with changes in weather condition, which confirms the argument that climate impacts do not occur exclusively for agricultural activities (e.g. Dell et al., 2009; Hsiang, 2010)[19].

To test whether seasonality affects the relationship between weather and income in our analysis, we also estimate the impact of seasonal climate variability on income, across type of income source and other households' demographic characteristics. The results of this analysis confirm that the effect of climate variability is mostly positive in Vietnam, especially for agricultural households during the wet season (May to October) who

[19] Also for Indonesia we estimate our models which control for transfers and remittances (Table A8). We find, however, that the results are consistent with the main model and therefore are not discussed here.

experience an increase in the total income and wage non-farm income (Table A 9). The only exception is for farm income in the dry season, which reduces with temperature variability when households are headed by old people (> 60 years old). For all the other incomes and demographic drivers of structural inequality, the contemporary results are either non-significant or positive (Table A10). Like in the previous estimates, we test whether the receipt of transfers affects households' coping capacity differently during wet and dry season. We find that transfers and remittances play a mitigating role of the impact of climate variability on income especially in the dry season and especially for farming households, who may use these sources of income as insurance during periods of high climate uncertainty (Table A11). However, as in the analysis of the impact of annual climate variability, we find that these coping strategies are effective solely in the short term. Specifically, we find that during the dry season (November to April) the effect of the increase of the number of hot days (>30 degrees Celsius) in the previous year has a consistent negative effect on total household income, farm income and wage non-farm income, and that these effects are more pronounces for agricultural and poor households. During the wet season, instead, the effect of weather condition of the previous year reduces total income and wage non-farm income for rural, less educated households and those belonging to ethnic minorities (Table A10) [20].

In Indonesia, we find that changes in temperature consistently reduce total and non-farm income for poor households during the dry and wet seasons (Table A12). Among household demographic characteristics, the age of the household head seems to exacerbate the impact of climate variability for households whose head is young (<40 years old) or old (>60 years old), with some differences across livelihood sources (Table A13). Some studies suggest that older people can adapt slower and less efficiently to climate and weather variations than other vulnerable groups (e.g. Maguza-Tempo, 2017; Mango et al., 2018). This lower overall coping capacity of older households is confirmed in our results, as climate variability significantly reduces the total income of these households. Disaggregating by livelihood sources, though, shows that older households might be able to cope or offset the negative impact of climate variability on farm and wage income in the short term. In Indonesia, older people are less likely to migrate to find better employment opportunities and more likely to receive transfers from young members of the households as migration, in Indonesia, is mostly young phenomenon (Sukamdi and Mujahid 2015). Like in Vietnam, it is plausible that these households might use remittances and other transfers as an insurance during periods of higher climate variability (Yang and Choi, 2007). In our sample, however, older people are not the only recipients of transfers and remittances. We find that middle aged widow, less educated, female headed households, with more dependents (children and adults in productive age) receive a significantly higher amount of non-labour income than other households in the sample. They are more likely to be poor and live in urban areas in the Sumatra region and their sources of livelihood are primarily non-labour and non-farm wage income. Opportunities to find better employment in more developed areas of the country tend to favour single, unmarried men (Sukamdi and Mujahid 2015). Young, low skilled, married households' heads, with more dependents have also lower chances of improving their livelihood through migration. This is particularly true

[20] These effects do not change when controlling for transfers.

in the case of women, who due to their traditional roles in the childcare might not be able to pursue their careers and may become recipients of remittances sent by a migrant husband or relative.

We test whether the positive effect of climate variability is linked to the use of remittances and transfers as insurance and we find that our results remain mostly unchanged across different demographic groups, except for rural and female headed households (Table A14). For these households, farm income and non-farm income, respectively, reduce because of climate variability suggesting that also in Indonesia, like in Vietnam, coping strategies using transfers and remittances as insurance in periods of climate variability might be used[21]. Longer term impacts of climate variability are, however, not managed as well, especially for those households who are engaged in non-farm activities during the dry season and total income for agricultural households in the wet season, also suggesting that foresight in coping capacities and interventions is limited.

4.2. Income inequality sensitivity to annual and seasonal weather variability

In this section we present the results of the analysis of the impact of annual and seasonal climate variability on the provincial level income Gini coefficient. Our results show that annual climate variability has a consistent inequality-increasing effect in Vietnam (Table A15). This effect is relatively more pronounced for those provinces where mostly agricultural households and ethnic minorities are located and especially at the highest end of the temperature distribution (>30 degrees Celsius). Similarly, in provinces where poor, rural, mostly agricultural, low educated households and those headed by a young head, income inequality also worsens for temperature changes below 18 degrees Celsius. Seasonal climate variability, on the other hand, has a mostly equalising effect across different groups in Vietnam (Table A16). This is exclusively observed for an increase in the number temperature days around the average levels (21-24 degrees Celsius) and during the wet season for all the groups selected for the analysis. For more remote provinces and those where households with a young head are located, instead, this equalising effect is observed for all changes in temperatures above 21 degrees Celsius[22].

In Indonesia, our results show inequality increases consistently for climate variability at the extreme ends of the distribution (temperature lower than 18 degrees Celsius and higher than 27 degrees Celsius). The inequality enhancing effect is larger in the case of provinces where poor households and households headed by older people are located. However, changes in temperature days around the average values (24-30 degrees Celsius) reduce provincial inequality (Table A19 & 20). Climate variability during the wet season also tends to decrease income inequality, especially for temperature above 30 degrees Celsius.

[21] Remoteness also seems to affect the contemporaneous income response of the Indonesian households. Thus, for rural households, seasonal climate variability tends to increase their income in both the dry and wet seasons, but this effect is exclusively observed for non-farm wage activities, such as those related for example to services and other professional activities.

[22] We test the role of transfers in the impact of annual and seasonal climate variability on income inequality and the results do not change (Table A17 & 18).

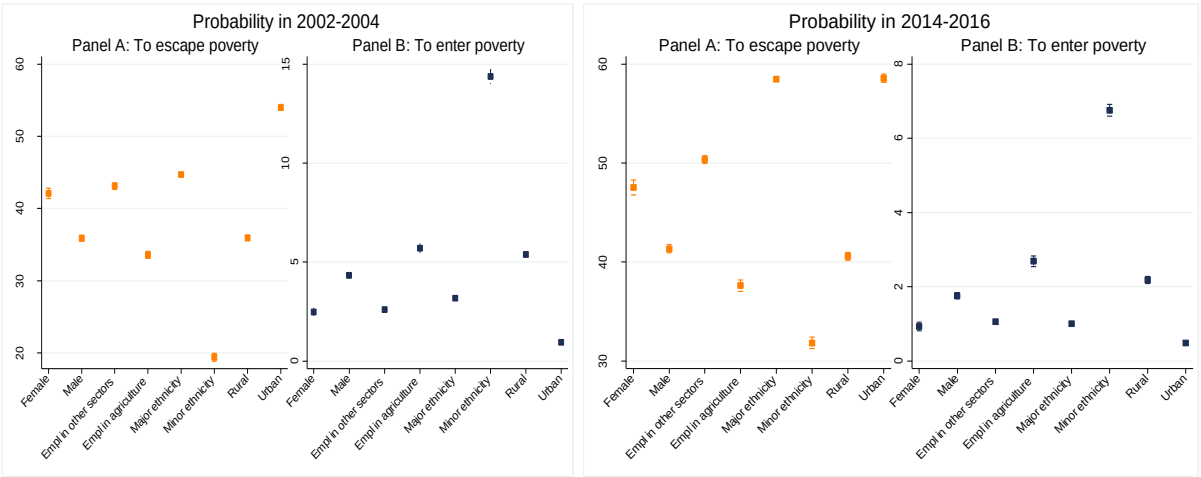
During the dry season, any change in temperature days reduces inequality exclusively for those provinces where mostly agricultural households are located, whereas in provinces with a lower level of education increases in temperature tend to also increase inequality in this season[23].

[23] Like for the analysis of Vietnam, these results do not change when controlling for transfers (Table A21 & 22)

V – Poverty mobility, drivers of structural inequality and climate variability in Vietnam

The results presented thus far show that certain groups in the population do suffer more than others of the impact of climate variability. Despite some discrepancies across seasons, our results suggest that remoteness, type of economic activity (agriculture), poverty and ethnicity seem to exacerbate the negative effect of climate variability. Vietnam is one of the fastest growing economies in SEA and poverty reduction achievements have been extraordinary, which suggests that social mobility in the past years has been particularly high, allowing people to escape poverty through time. Nonetheless, inequality has not been reducing as steadily as poverty rates, while weather abnormalities have increased in the past decades. In this section, we use Vietnam as a case study to assess whether the relationship between inequality and climate variability affects the ability of households to escape poverty. We do so by investigating whether there is correlation between poverty mobility, climate variability and observable characteristics linked to structural inequality. For this analysis, we use a synthetic panel approach. Synthetic panels have widely been recognized as robust alternative to panel data to study poverty mobility (Dang et al., 2019). Synthetic panel analysis allows to re-construct household panel data using pure cross-sectional data and controlling for house time-invariant characteristics[24]. The main advantage of this approach is to provide similar benefits of panel data when these do not exist, as in the case of Vietnam. We follow Dang and Lanjouw (2013) approach to study the relationship between mobility and inequality for climate change impacts25.

Figure 8: Probability to escape and to enter poverty in Vietnam across demographic and economic groups, synthetic panel analysis of Vietnamese households 2002-2016.
Source: Authors estimation using VHLSS data from 2002 to 2016.



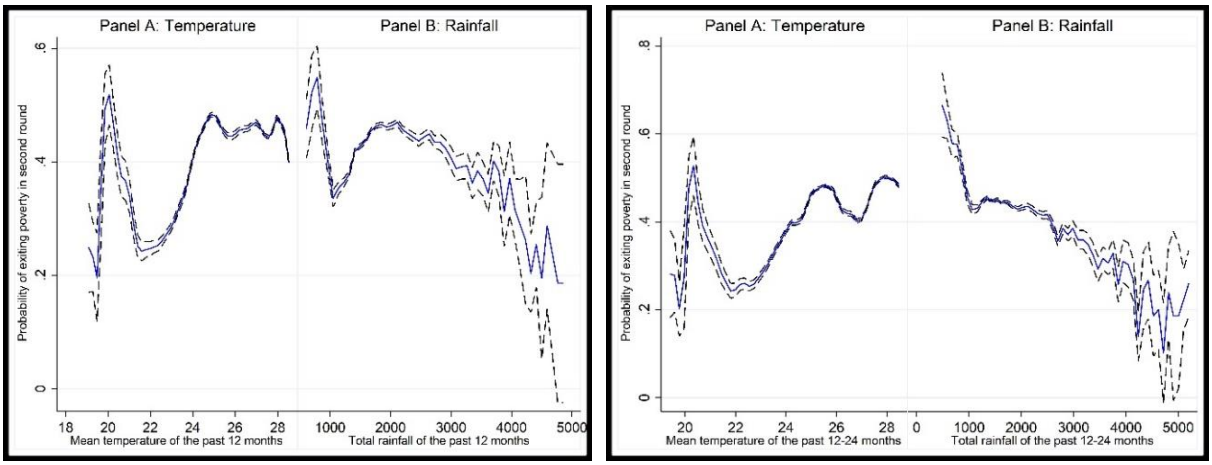
[24] The main assumption of this approach is that that the underlying population being sampled in survey rounds 1 and 2 are identical such that their time-invariant characteristics remain the same over time.

[25] A more comprehensive presentation of the synthetic panel analysis can be found in Appendix 2.

Figure 8 shows the results of the correlation between upward and downward poverty mobility, respectively, and structural inequalities for Vietnam. The data confirms our previous finding in that structural inequality's drivers, such as type of economic activities, remoteness and ethnicity are significantly associated with a lower probability to escape poverty and increase poverty immobility. Thus, rural, agricultural, and ethnic minority households have a much lower probability to move out of poverty and a much higher likelihood to become poor across all the rounds of VHLSS. Interestingly, female headed households seem to have higher chances of upward poverty mobility than male households, although the difference is not likely to be significant.

Figure 9 shows the correlation between upward poverty mobility of the past 12 and 24 months, respectively, and average annual temperature and rainfall patterns. As in our previous analysis, contemporaneous correlation between upward poverty mobility and temperature is non-linear and positive. A negative relationship is, instead, found between rainfall and the probability to escape poverty. These results are consistent for current and lagged value of weather variables (Figure 28).

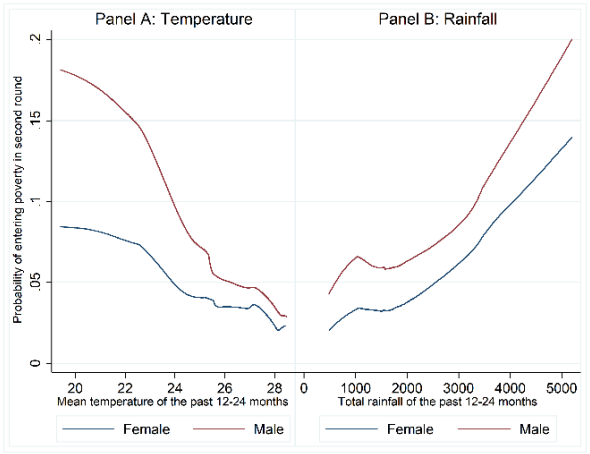
Figure 9: Correlation between contemporaneous (left panel) and lagged (12 months before – right panel) average weather and (conditional) probability (at household level) a poor household in the first period becomes non-poor in the second period.
Source: Authors estimation using VHLSS data from 2002 to 2016

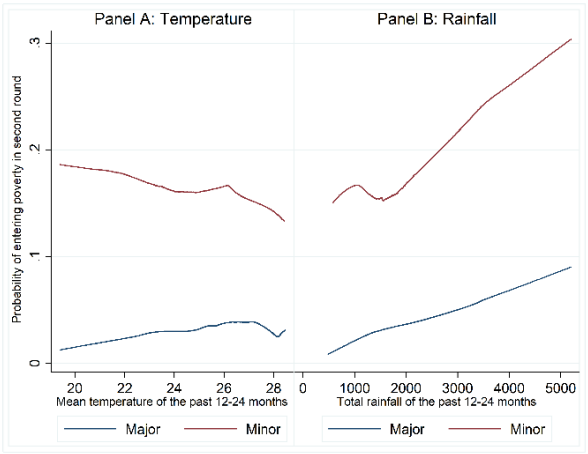


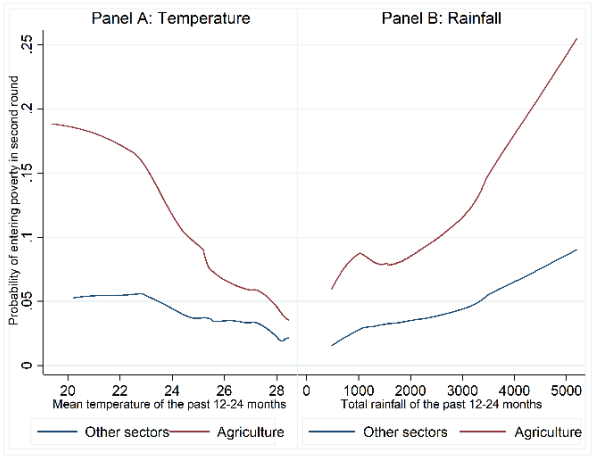
Finally, figure 10 show the interaction between climate variability and demographic characteristics linked to structural inequalities that are correlated with the probability of becoming poor. The overall findings confirm puzzling results for Vietnam, especially for temperature variability. The analysis shows that there exists a negative relationship between increase in temperature and the probability to enter poverty for female headed households, rural, agricultural, and ethnic minority households. For the latter type of households, the figure also shows that between 24- and 26-degrees downward poverty mobility is, in fact, positively associated with temperature increase. On the other hand, we find that higher rainfalls (above 1000 mm) do increase the probability to enter poverty consistently across the different groups (female headed households, rural, agricultural and ethnic minority households).

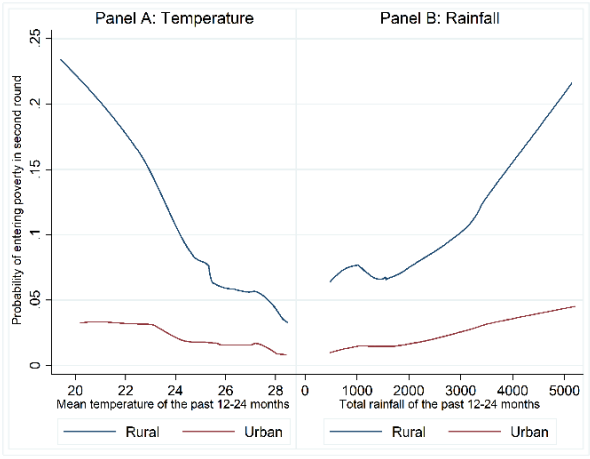
Overall, these results suggest that there exists a heterogeneity of poverty mobility across the sample, and that poor, rural, agricultural and ethnic minority households are more likely to become poor or escape poverty across time.

Figure 10: Correlation between weather of the past 12 months and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period, by gender of household head (top left), ethnicity (top right), economic activity (bottom left) and remoteness (bottom right).
Source: Authors' estimation using VHLSS data from 2002 to 2016.









Conclusions

The past few decades have seen an extraordinary increase of variability in climate conditions, especially in tropical countries, where each year an increased number of typhoons, floods, droughts are disrupting the life of entire populations. The ability of people to respond to these new hazards may diverge signficantly due to the existence of socio-economic and structural inequalities that might further constrain opportunities to improve their wellbeing. The impact of climate variability might enhance these existing inequalities and force "the last mile" groups into a spiral of further poverty and social exclusion.

In this paper we investigated the impact of the so-called "environment-inequality nexus" in two of the fastest growing economies in South-East Asia, Vietnam and Indonesia. In these countries both climate variability and inequality have been increasing (Le and Booth, 2013; Nguyen et al., 2015; Bui et al., 2017; Nguyen et al., 2017; Nguyen and Nguyen, 2017; Asra, 2000; Akita, 2002; Oxfam, 2017[26]; Ananda and Pulungan, 2019). We directly analyse the effect of annual and seasonal temperature on income and income inequality across years. We do so by looking at the Vietnamese and Indonesian populations as a whole and also investigating more in-depth how these impacts change for the most vulnerable and marginalised groups.

Our results show that the effect of climate variability is regressive as income decreases and income inequality increases with changing in climatic conditions in both Vietnam and Indonesia. Our results show that the "last mile" groups, poor, rural and agricultural households and minorities, bear the biggest burden of climate variability, forcing them in a spiral of poverty and social exclusion. Among different sources of income, our findings show that farm income is negatively correlated with increase in temperature especially in Indonesia, especially during dry seasons, which is in line with previous findings (e.g. Fisher et al, 2002; Hallegatte et al, 2014; First, 2019; Farbotko, 2020). Our analysis also shows that in both Vietnam and Indonesia non-farm economic sectors suffer the increase of climate instability (as in Dell et al., 2009; Hsiang, 2010; Graff Zivin and Neidell, 2014; Seppannen et al., 2013). The most affected areas are those that have been historically more vulnerable to the El Nino events, such as Sumatra, Kalimantan and Sulawesi in Indonesia and Southeast, Central Highlands and Mekang Delta in Vietnam.

Country specific differences can be noted. For instance, in Vietnam we find that changes in weather conditions has a positive effect on the income of the same year. Some authors claim that climate uncertainties might push households to leverage extra income in the short term in the form of transfers or remittances which are then used as insurance for current and future climate hazards (Yang and Choi, 2007). These strategies might be especially used by those households who rely mostly on weather conditions for their livelihood, such as farming households, or the most exposed and vulnerable to climate hazards. Our analysis confirms this claim and it shows that rural and ethnic minority and

[26] https://www.oxfam.org/en/indonesia-even-it/inequality-indonesia-millions-kept-poverty.

farming households might be using transfers to cope with short term climatic shocks. Coping capacity of Vietnamese households, however, seem to mostly focus on the short term as our results show that the effect of changing of temperatures' days in the previous year on income persists in the current year.In Indonesia, on the other hand, we find that these coping strategies might apply to poor, younger and older, female headed and low educated households, who are the biggest receipients of transfers and remittances. Migration, in Indonesia, is mostly a young phenomenon, which tends to favour single, unmarried men (Sukamdi and Mujahid 2015). Like for Vietnam, we find that, controlling for the receipt of transfers and remittances, farm income and non-farm income, respectively, reduce because of climate variability, suggesting that this coping capacity might be effective in the short term. Longer term impacts of climate variability are, however, not managed as well, also suggesting that foresight in coping capacities and interventions is limited. Finally, our analysis confirms the highest exposure and vulnerability of ethnic minorities to changes in weather conditions in Vietnam. The marginalisation and vulnerability of ethnic minority has been extensively documented (e.g. Bruun, 2012; McElwee, 2015; Son and Kingsbury, 2020) and our study confirms the need to design ad-hoc solutions for these groups in light of increasing climate impacts.

In the past decade, policies in both Vietnam and Indonesia were designed to target and support low-income groups in coping with emergencies, they often had little relevance to the needs, rights and priorities of the poorest people. The lack of participation and voice of the most marginalised in the places of power has in the recent years worked in favour of the better-off and widened the gap between those and the poorest, reducing even further their ability to face climatic challenges (Oxfam, 2017; Oxfam in Vietnam, 2015; Nguyen Tran Lam et al., 2016; Muhtadi and Warburton, 2020). Developing specific measures to help rural and agricultural households coping, adapting and mitigating the annual and season impacts of the increasing climate instability will be paramount in these countries. Specific attention should also be given to those groups, such as ethnic minorities and younger or older households, who have found to bear the biggest burden of climate variability.

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Appendix - 1

Sources of data

The socio-economic data used in this analysis were drawn from the Indonesian Family Life Survey (IFLS) and the Vietnam Household Living Standard Survey (VHLSS). The IFLS (RAND) is a publicly available longitudinal survey that is representative of about 83% of the Indonesia population at regional level, with a total sample of 30,000 people located in 13 out of the 27 provinces in the country. It is one of the richest datasets available in Indonesia and it has been collected since 1993, covering information at individual, household and community level for several topics. Currently, five rounds have been collected: 1993/94, 1997, 2000, 2007, 2014/15. For our main analysis, we selected only those households that have been interviewed in all the 5 rounds. Therefore, our final sample includes a balanced panel of 4909 households (HHs) across each IFLS round, for a total of 24,545 HHs.

The Vietnam Household Living Standard Survey (VHLSS) is a provincial, regional and national representative survey, collected every two years since the beginning of the 1990s. The latest round dates to 2018. To ensure comparability and consistency across surveys we selected a subsample of datasets for this analysis, starting from 2002. This is because questionnaires and sampling design were substantially different before the 2002 round and dropping previous rounds ensures that we are not adding unnecessary biases in the analysis. Our final sample is composed of a total of 99,723 households/repeated cross-section observations, across 9 VHLSS rounds.

Climate data was retrieved using different sources. Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) data are an excellent source of rainfall frequency data, which are collected at a very high resolution (5 km) from 1981 up to now, but less so for temperature, for which data were collected for a limited amount of time (from 2010 onwards). For temperature data, we, therefore, opted for Climate Prediction Center (CPC) of the NOAA ESRL Physical Sciences Division (PSD), which provides temperature frequency data since 1979 to 2018[27]. We used minimum and maximum daily temperature and amount of daily rain in mm. Our final sample of climate data included on average 3,285 observations for each of the commune (Vietnam) and sub-district (Indonesia).

[27] The CPC datasets is slightly coarser than the CHIRPS data. Its resolution is 50 km. To extract commune (in the case of Vietnam) and sub-district (in the case of Indonesia) level temperature data, we have developed a downscaling process by mean of elevation data at 5 km.

Selected summary statistics

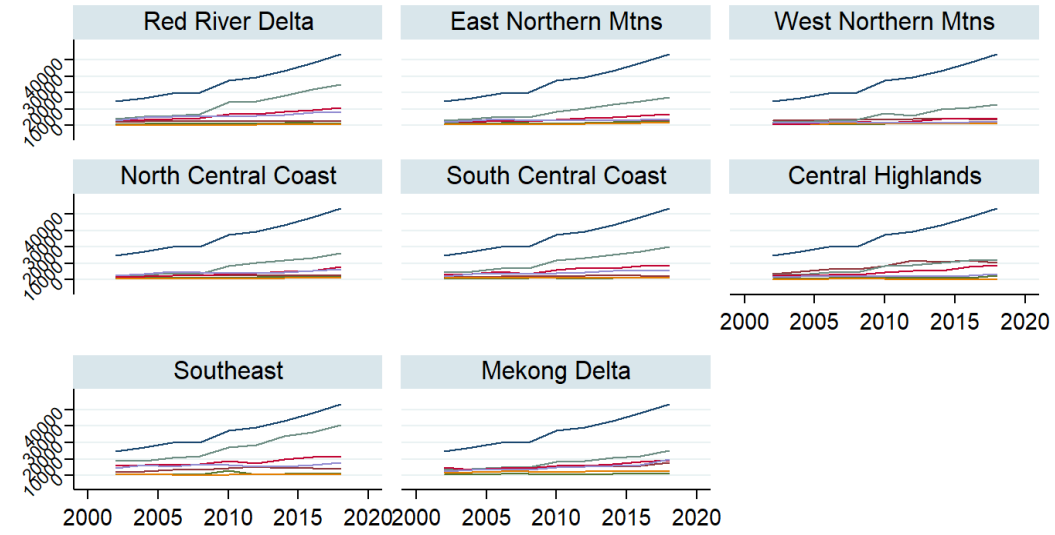
Table A1: Summary statistics of household level explanatory variables - Vietnam, VHLSS 2002 - 2018

Variable	Description	2002	2004	2006	2008	2010	2012	2014	2016	2018
Sex head	1=male; 0=female	0.79	0.78	0.78	0.78	0.78	0.78	0.77	0.78	0.78
Age	Age of head of household in years	48	49	49	50	48	49	51	51	51
Ethnic minority	1= if household is member of an ethnic minority; 0 otherwise	0.12	0.13	0.13	0.13	0.14	0.15	0.14	0.16	0.16
Children	Proportion of < 15 years old, % of total household members	29	27	24	23	24	23	23	24	24
Female members	Proportion of female in the household, % of total household members	50	50	51	51	51	51	51	51	51
HH size	Number of household members	5.09	5.01	4.86	4.76	4.48	4.47	4.44	4.44	4.39
Urban	1=urban; 0=rural	0.23	0.25	0.26	0.27	0.30	0.30	0.34	0.32	0.31
Education of household head										
< Primary	HH head with education or lower than primary education, %	32	30	28	26	26	25	24	24	22
Primary	HH head with primary education, %	24	24	24	25	25	25	25	24	24
Lower-secondary	HH head with lower-secondary education, %	26	24	26	26	24	25	26	26	26
Upper-secondary	HH head with upper secondary education, %	8	7	7	8	7	8	9	9	9
Technical degree	HH head with technical degree, %	6	10	10	12	11	11	10	9	10
Post-secondary	HH head with post-secondary education, %	4	4	5	5	7	6	7	8	8
	N	27720	8521	8532	8503	9354	9354	9342	9320	9077

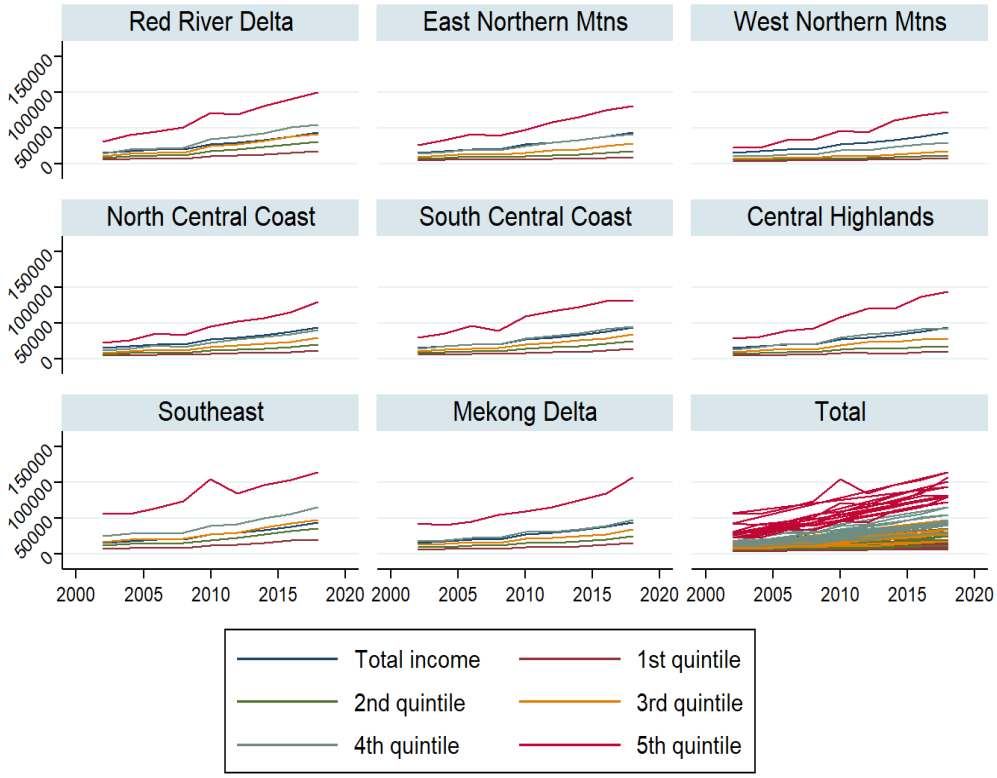
Table A2: Summary statistics of household level explanatory variables - Indonesia, IFLS 1993-2014

Variable	Description		1993	1997	2000	2007	2014
Sex head	1=male; 0=female		0.86	0.83	0.84	0.81	0.79
Age	Age of head of household in years		45	47	49	52	55
Children	Proportion of < 15 years old, % of total household members		31	30	28	21	18
Female members	Proportion of female in the household, % of total household members		52	53	52	53	54
HH size	Number of household members		4	4	4	4	4
Urban	1=urban; 0=rural		0	0	0	0	0
Education of household head							
< Primary	Proportion of households' heads with no education or lower than primary education, %		23	22	17	15	13
Primary	Proportion of households' heads with primary education, %		54	54	53	52	48
Lower- and upper-secondary	Proportion of households' heads with lower-secondary education, %		23	24	25	27	31
Post-secondary	Proportion of households' heads with post-secondary education, %		0.0	0.0	4.8	6.2	7.3
		N	4909	4909	4909	4909	4909

Figure A1: Distribution of income across different livelihood sources and quintiles in Vietnamese regions.
Source: Authors estimations using VHLSS (2002-2018)



2018 CPI



2018 CPI

Figure A2: Gini coefficient in Vietnamese regions.
Source: Authors estimations using VHLSS (2002-2018)

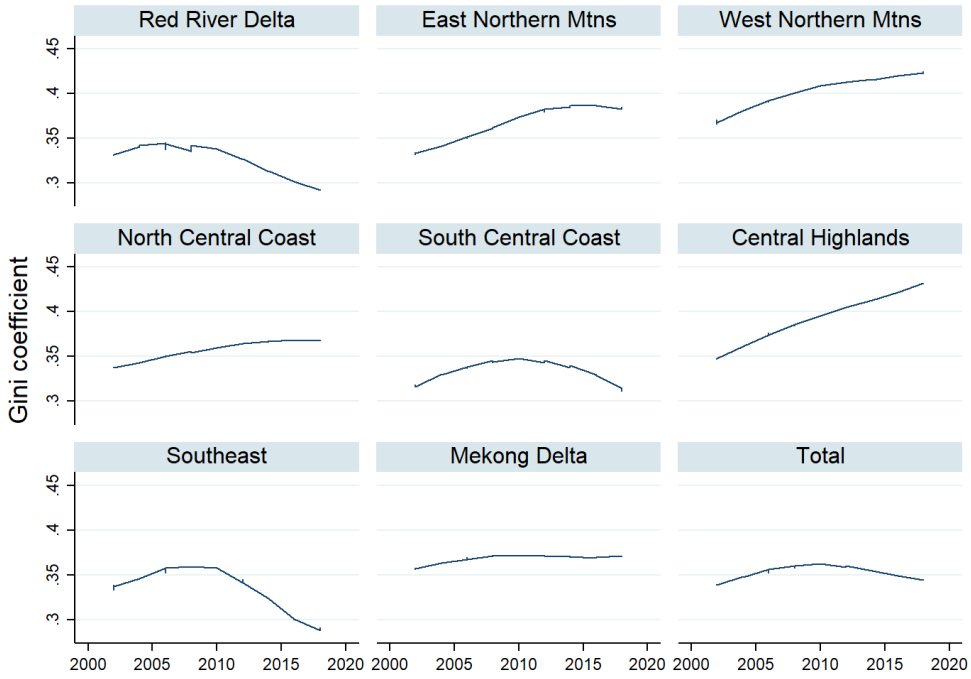
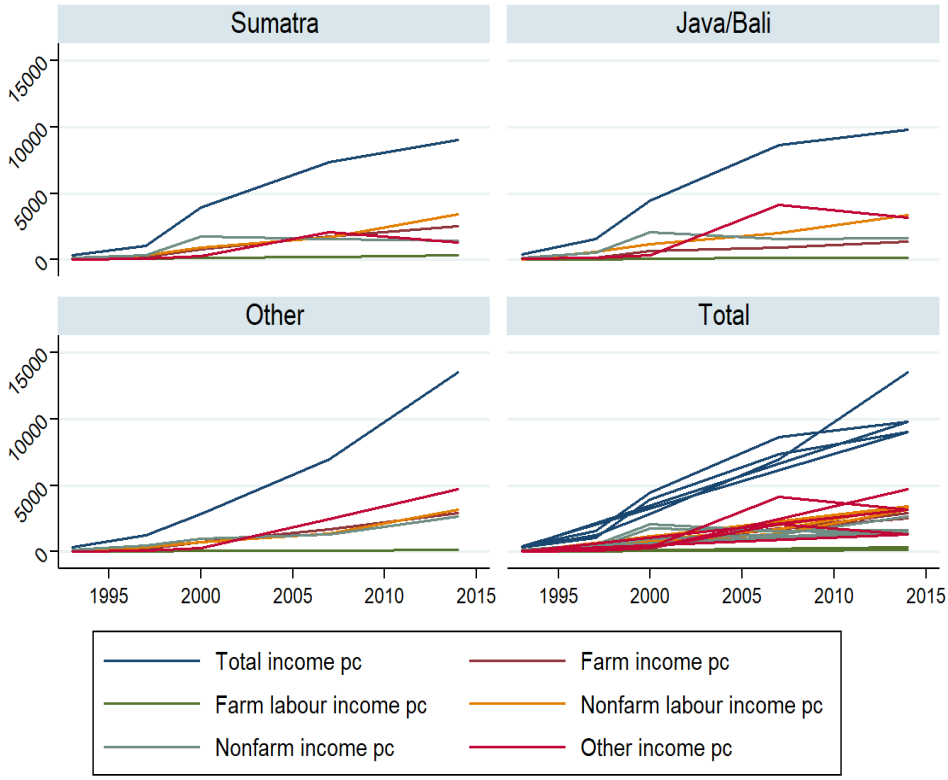
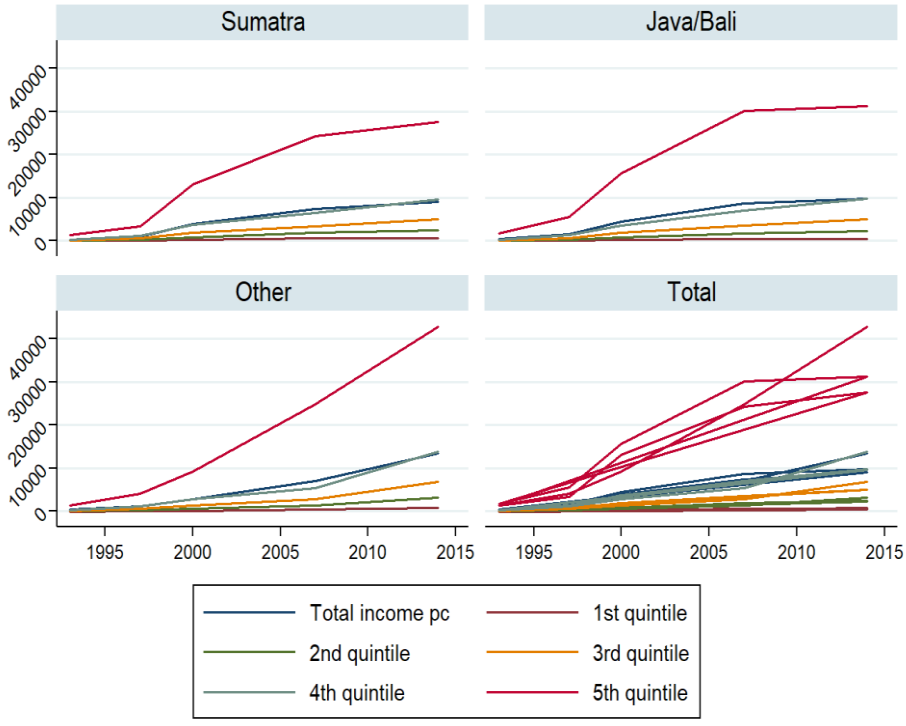


Figure A3: Distribution of income across different sources of livelihoods and quintiles in regions in Indonesia.
Source: Authors estimations using IFLS (1003-2014)



Indonesian Rupees (thousand, CPI 2014)



Indonesian Rupees (thousand, CPI 2014)

Figure A3: Gini coefficient in Indonesian regions.
Source: Authors estimations using IFLS (1993-2014)

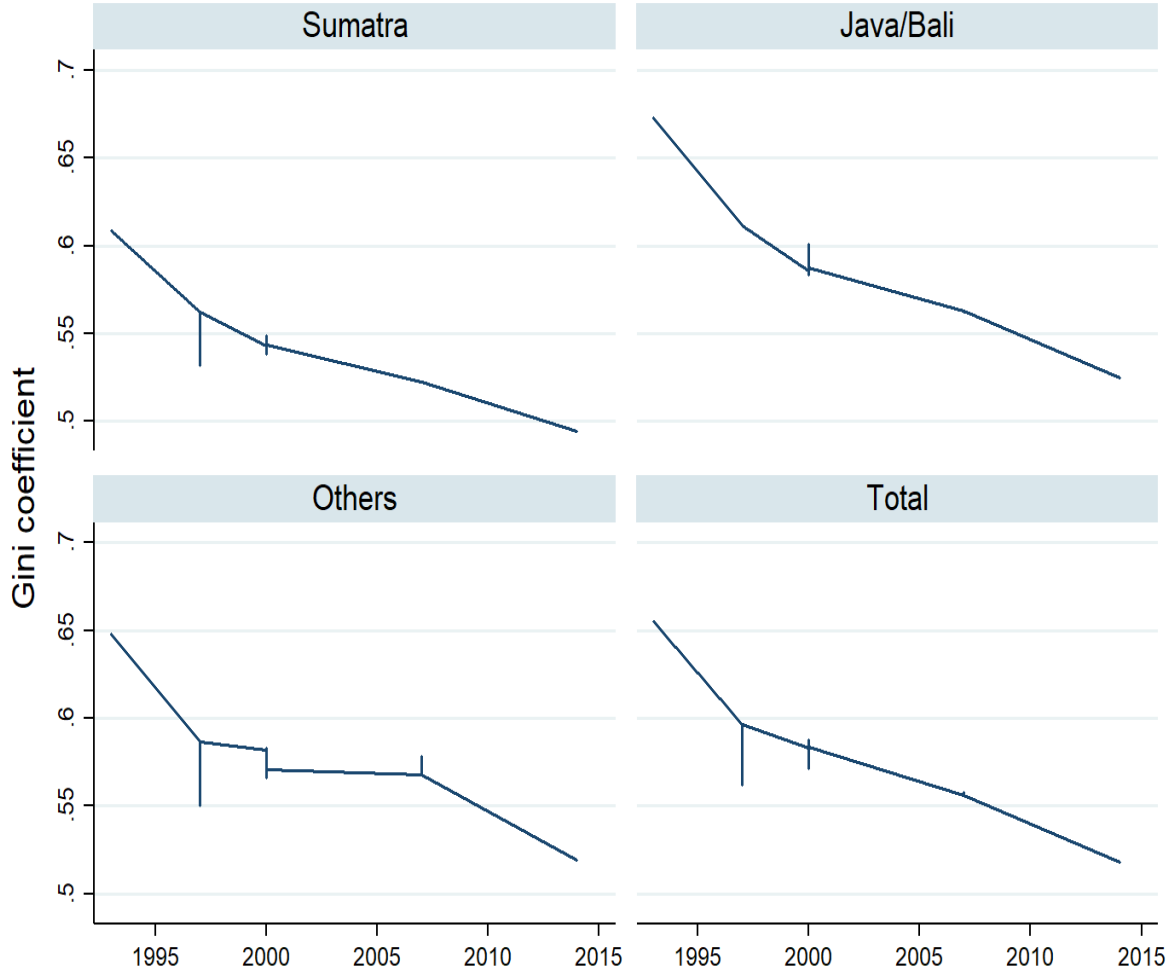
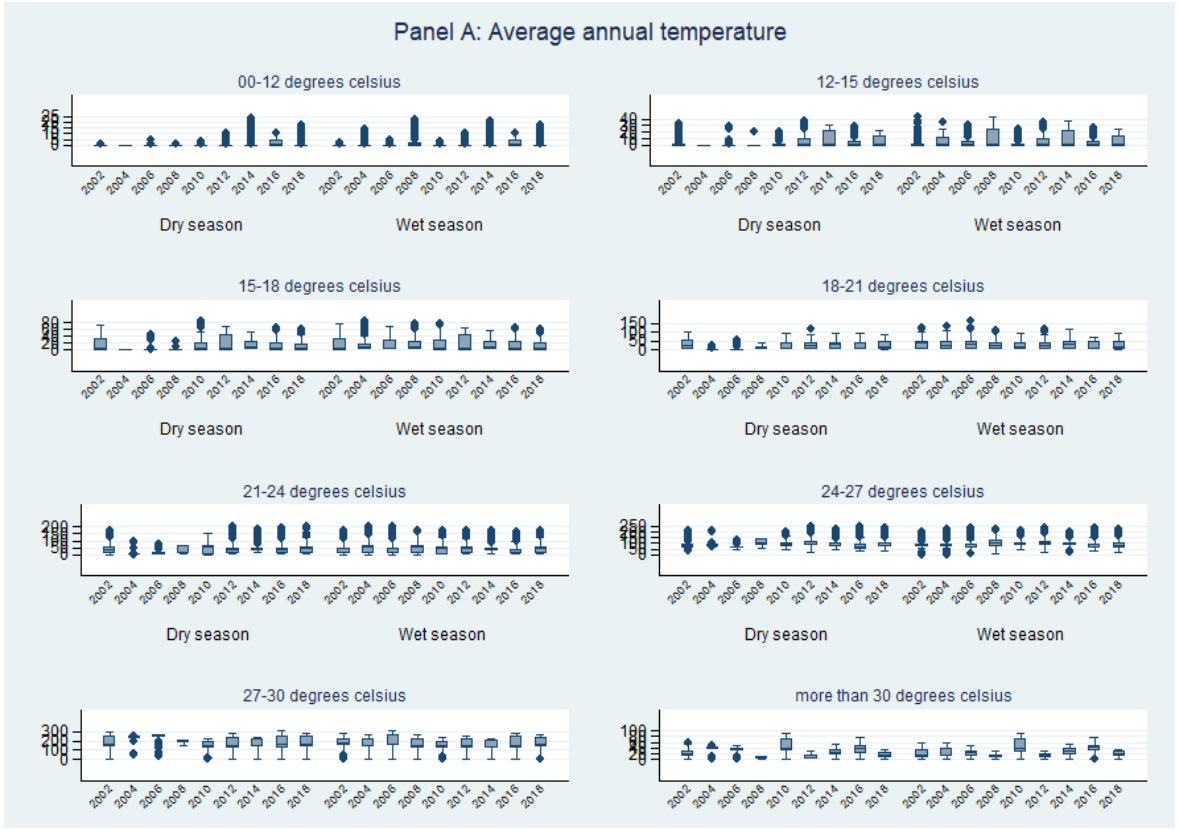


Figure A4: Distribution of days per year in temperature (panel A) and rainfall bins (panel B) between 2002 2018 across Vietnamese communes.
Source: Authors' estimation using CPC-NOAA ESRL (temperature) and CHIRPS (rainfall) data



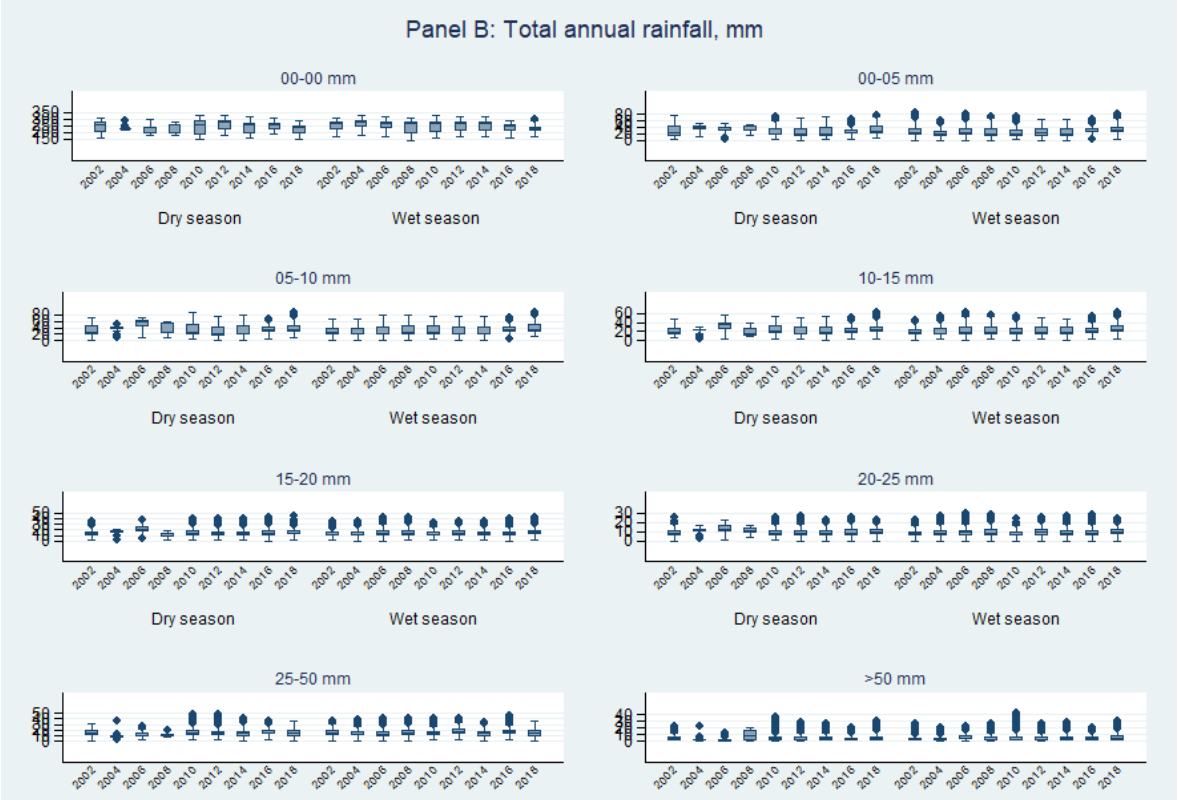


Figure A5: Distribution of days per year in temperature (panel A) and rainfall bins (panel B) between 1993 and 2014 across Indonesian sub-districts.
Source: Authors' estimation using CPC-NOAA ESRL (temperature) and CHIRPS (rainfall) data

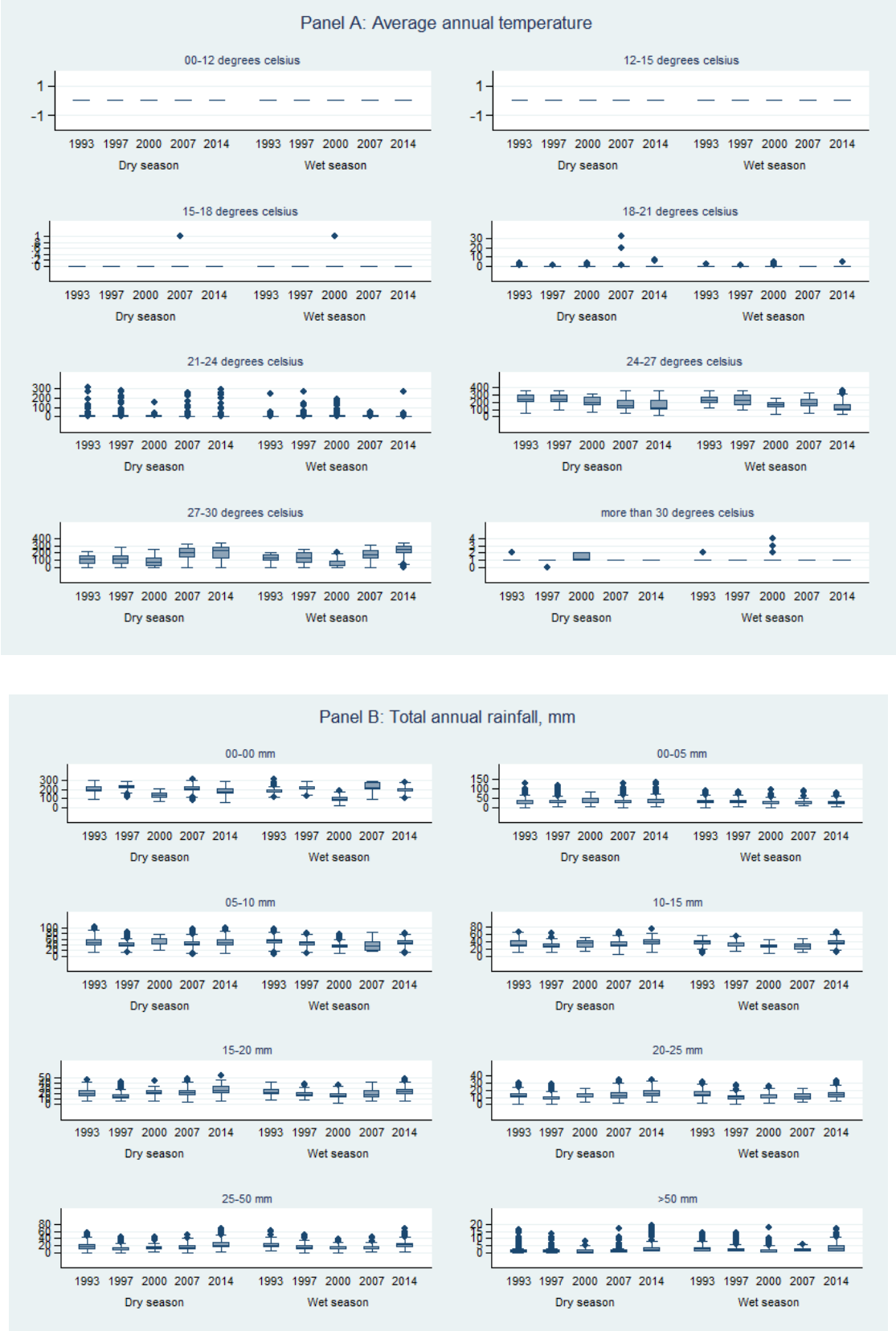


Table A3: Estimated effect of climate variability on household income per capita (total, farm, non-farm and wage income in Vietnam. Selected results. (VHLSS 2002-2018).

Vietnam	Total income per capita			Farm income			Non-farm income			Wage income		
	All	Poor	Agricultural HH	All	Poor	Agricultural HH	All	Poor	Agricultural HH	All	Poor	Agricultural HH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln crop income pc	Ln crop income pc	Ln crop income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc
tembin00_12	-0.0028	-0.0104	**-0.0138****	0.0003	0.0139**	-0.0158	-0.0009	-0.0013	-0.0068	**0.0163***	0.0002	-0.0015
	(0.002)	(0.006)	(0.004)	(0.008)	(0.005)	(0.011)	(0.004)	(0.004)	(0.008)	(0.008)	(0.006)	(0.009)
tembin12_15	0.0003	0.0014	0.0002	0.0024	0.0038	0.0038	0.0017	0.0030	**0.0059****	0.0022	0.0003	-0.0031
	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.003)
tembin15_18	-0.0016	-0.0004	0.0000	0.0001	0.0015	0.0011	0.0004	-0.0015	0.0013	-0.0024	0.0026	0.0021
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)
tembin21_24	0.0009	0.0022	**0.0029*****	0.0010	-0.0008	-0.0006	-0.0009	**-0.0031****	0.0014	0.0006	**0.0045***	-0.0002
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
tembin24_27	0.0014	0.0005	**0.0025*****	0.0014	-0.0003	-0.0010	0.0001	**-0.0035***	0.0012	0.0004	0.0013	0.0010
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)
tembin27_30	**0.0015****	0.0006	**0.0019****	0.0007	-0.0011	-0.0018	0.0001	-0.0042	0.0017	0.0001	0.0013	0.0007
	(0.000)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)	(0.003)	(0.002)
tembin30_40	**0.0036*****	0.0001	**0.0032****	0.0005	-0.0045	-0.0017	-0.0007	**-0.0067***	0.0013	0.0022	0.0046	0.0028
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.005)	(0.003)
tembin00_12_lag	0.0030	0.0080	-0.0010	-0.0114	0.0065	-0.0141	-0.0078	-0.0087	-0.0066	-0.0087	-0.0094	-0.0012
	(0.005)	(0.007)	(0.009)	(0.010)	(0.006)	(0.010)	(0.010)	(0.007)	(0.022)	(0.011)	(0.013)	(0.012)
tembin12_15_lag	0.0020	0.0022	-0.0051	0.0004	0.0045	0.0010	0.0034	0.0022	0.0001	0.0033	-0.0062	0.0059
	(0.001)	(0.002)	(0.003)	(0.003)	(0.006)	(0.003)	(0.002)	(0.002)	(0.012)	(0.002)	(0.005)	(0.004)
tembin15_18_lag	0.0014	0.0017	0.0020	-0.0008	**0.0063***	**0.0069****	-0.0006	-0.0013	-0.0022	0.0004	-0.0025	-0.0008
	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)
tembin21_24_lag	**-0.0015***	-0.0006	0.0006	-0.0015	0.0004	**-0.0024*****	0.0001	-0.0009	0.0002	**-0.0028***	0.0052	-0.0007
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
tembin24_27_lag	**-0.0010****	**-0.0014****	-0.0003	-0.0010	-0.0005	**0.0034*****	-0.0006	-0.0003	-0.0006	-0.0024	0.0046	0.0016
	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
tembin27_30_lag	**-0.0011***	**0.0024*****	0.0004	-0.0006	0.0009	**-0.0038****	-0.0010	-0.0001	0.0011	**-0.0029***	0.0051	0.0015
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
tembin30_40_lag	-0.0002	**-0.0017***	0.0009	0.0007	-0.0003	-0.0022	-0.0004	0.0003	0.0012	-0.0011	0.0071	0.0051
	(0.001)	(0.001)	(0.002)	(0.001)	(0.005)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.004)	(0.005)
Rain and rain lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region, commune and year clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	9.8462***	9.6031***	9.6890***	2.9732***	4.2278***	6.4360***	1.9075**	1.7701	-1.0087	6.7203***	3.1177	1.8919
	(0.330)	(0.376)	(0.337)	(0.468)	(0.201)	(1.188)	(0.690)	(1.152)	(0.905)	(0.937)	(2.046)	(1.659)
Observations	99,670	26,290	14,304	99,675	26,291	14,309	99,675	26,291	14,309	99,675	26,291	14,309
R-squared	0.602	0.779	0.712	0.500	0.565	0.789	0.210	0.378	0.367	0.305	0.447	0.369

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A4: Estimated effect of climate variability on household income per capita of selected most marginalised groups in the population in Vietnam. Selected results. (VHLSS 2002-2018).

	Total income				Farm income		Non-farm income			Wage non-farm income	
	Rural	Female HH head	Ethnic minority	Young HH head	Rural	Ethnic minority	Rural	Female HH head	Head with low education	Rural	Old HH head
	(1)	(2)	(3)	(3)	(4)	(5)	(6)	(7)	(8)	(11)	(12)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln crop income pc	Ln crop income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln wage income pc	Ln wage income pc
tembin00_12	-0.0042	-0.0059	-0.0033	**-0.0092****	0.0025	-0.0158	0.0018	0.0122	0.0029	0.0130	**0.0511****
	(0.002)	(0.005)	(0.003)	(0.003)	(0.010)	(0.011)	(0.005)	(0.011)	(0.007)	(0.007)	(0.021)
tembin12_15	0.0015	0.0003	-0.0006	-0.0003	**0.0056****	0.0038	0.0021	0.0048	0.0033	0.0016	0.0030
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.006)	(0.002)	(0.002)	(0.006)
tembin15_18	-0.0013	-0.0018	-0.0007	-0.0015	-0.0001	0.0011	0.0017	0.0011	0.0014	-0.0026	**-0.0083***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)	(0.003)	(0.002)	(0.002)	(0.004)
tembin21_24	0.0004	0.0024	0.0003	0.0017	0.0009	-0.0006	-0.0008	-0.0010	-0.0011	0.0001	-0.0058
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)	(0.007)
tembin24_27	0.0005	**0.0037****	-0.0001	**0.0025***	0.0006	-0.0010	-0.0011	0.0007	-0.0017	0.0008	0.0017
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.006)
tembin27_30	0.0005	**0.0035****	-0.0002	**0.0024***	-0.0008	-0.0018	-0.0012	-0.0004	**-0.0023****	0.0003	0.0027
	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.006)
tembin30_40	**0.0019****	**0.0058*****	0.0005	**0.0050****	-0.0014	-0.0017	-0.0028	**-0.0059***	**-0.0058****	0.0030	0.0058
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.006)
tembin00_12_lag	-0.0015	0.0085	0.0031	0.0014	-0.0113	-0.0141	-0.0016	0.0237	0.0011	-0.0148	-0.0322
	(0.006)	(0.009)	(0.003)	(0.006)	(0.009)	(0.010)	(0.013)	(0.027)	(0.016)	(0.009)	(0.022)
tembin12_15_lag	0.0017	0.0019	-0.0011	0.0024	0.0009	0.0010	0.0021	0.0006	0.0016	**0.0051***	0.0051
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.002)	(0.005)
tembin15_18_lag	0.0012	0.0032	0.0021	**0.0029****	-0.0013	**0.0069****	0.0018	0.0055	0.0022	-0.0006	**-0.0101***
	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.005)
tembin21_24_lag	-0.0013	-0.0002	-0.0004	-0.0018	-0.0024	**-0.0024*****	-0.0005	0.0024	-0.0013	**-0.0032****	**-0.0139****
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.006)
tembin24_27_lag	**-0.0011***	-0.0007	-0.0017	-0.0012	-0.0021	**-0.0034*****	-0.0014	-0.0046	**-0.0036*****	-0.0013	-0.0086
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.005)
tembin27_30_lag	-0.0011	-0.0005	-0.0021	-0.0017	-0.0018	**-0.0038****	-0.0018	-0.0058	**-0.0040*****	-0.0017	-0.0039
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.006)
tembin30_40_lag	0.0002	0.0001	0.0019	-0.0005	-0.0007	-0.0022	-0.0011	-0.0057	**-0.0042****	-0.0003	-0.0018
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.004)	(0.002)	(0.001)	(0.005)
Rain and rain lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region, commune and year clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	10.5381***	8.6509***	10.9847***	9.4563***	4.6887***	6.4360***	2.4545**	3.8125*	3.4608***	5.9159***	6.8863
	(0.486)	(0.351)	(0.820)	(0.620)	(0.808)	(1.188)	(0.755)	(1.934)	(0.686)	(0.022)	(3.824)
Observations	73,509	23,935	14,982	29,084	73,509	14,309	73,509	23,936	51,257	73,509	22,579
R-squared	0.540	0.667	0.616	0.732	0.409	0.789	0.208	0.357	0.289	0.272	0.440

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5: Summary table of the changes in the coefficient of interest when controlling for transfers received by the households in Vietnam.
Source: Authors' calculation using VHLSS data (2002-2018)

Panel A: Transfer dummy

Annual	Total income	Transfer variable	Crop income	Transfer variable	Wage income	Transfer variable
All	no difference	negative	no difference	positive	no difference	not significant
Mostly Agricultural	no difference	not significant	no difference	not significant	no difference	not significant
Rural	no difference	negative	**negative**	positive	not significant	not significant
Young head	not significant	not significant	no difference	not significant	no difference	not significant
Old head	no difference	not significant	no difference	not significant	no difference	negative
Low education	positive	not significant	not significant	not significant	not significant	not significant[28]
Female head	no difference	not significant	no difference	not significant	no difference	not significant
Ethnic minority	no difference	not significant	**negative**	not significant	no difference	not significant
Poor	no difference	not significant	no difference	not significant	negative	not significant

Panel B: Log of real value of transfers received

Annual	Total income	Transfer variable	Crop income	Transfer variable	Wage income	Transfer variable
All	no difference	not significant	no difference	positive	no difference	not significant
Mostly Agricultural	no difference	not significant	no difference	not significant	no difference	not significant
Rural	no difference	negative	negative	positive	not significant	not significant
Young head	no difference	not significant	no difference	not significant	no difference	not significant
Old head	no difference	not significant	no difference	not significant	no difference	negative
Low education	no difference	not significant	not significant/negative	not significant	no difference	not significant
Female head	no difference	not significant	no difference	not significant	no difference	not significant
Ethnic minority	no difference	not significant	no difference	not significant	no difference	not significant
Poor	no difference	not significant	no difference	not significant	no difference	not significant

[28] The CPC datasets is slightly coarser than the CHIRPS data. Its resolution is 50 km. To extract commune (in the case of Vietnam) and sub-district (in the case of Indonesia) level temperature data, we have developed a downscaling process by mean of elevation data at 5 km.

Table A6: Estimated effect of climate variability on household income per capita (total, farm, non-farm and wage income) in Indonesia. Selected results. (IFLS 1993-2014)

Indonesia	Total income			Farm income			Non-farm income			Wage income		
	All	Poor	Agricultural HH	All	Poor	Agricultural HH	All	Poor	Agricultural HH	All	Poor	Agricultural HH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln farm income pc	Ln non-farm income	Ln non-farm income	Ln non-farm income	Ln wage income	Ln wage income	Ln wage income
tembin15_18	**-0.7430*** **	**-0.9267*** **	**-0.3168** **	**-0.6268***	-1.3646	-0.8352	**-2.0491*** **	-0.3966	**-0.7183***	**-0.6423***	0.4832	**-0.6952** **
	-0.133	-0.26	-0.141	(0.365)	(1.132)	(0.520)	(0.444)	(0.887)	(0.412)	(0.335)	(1.105)	(0.335)
tembin21_24	**-0.0042***	-0.0008	**-0.0057** **	**-0.0202***	-0.0079	-0.0042	-0.0089	-0.0104	-0.0102	0.0143	0.0180	-0.0057
	-0.002	-0.004	-0.003	(0.011)	(0.014)	(0.013)	(0.008)	(0.012)	(0.010)	(0.010)	(0.013)	(0.008)
tembin24_27	-0.0032	-0.0017	**-0.0069*** **	**-0.0245*** **	**-0.0260** **	**-0.0259*** **	-0.0059	-0.0082	-0.0061	0.0073	0.0103	-0.0062
	-0.002	-0.003	-0.002	(0.008)	(0.011)	(0.010)	(0.007)	(0.011)	(0.008)	(0.008)	(0.011)	(0.008)
tembin27_30	**-0.0044** **	-0.0031	**-0.0058** **	**-0.0260*** **	**-0.0252*** **	**-0.0254*** **	-0.0103	-0.0082	-0.0039	0.0020	0.0040	-0.0100
	-0.002	-0.003	-0.002	(0.007)	(0.009)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)	(0.011)	(0.007)
tembin30_40	-0.0472	-0.0636	**-0.2077** **	0.1025	-0.1264	0.0196	0.1083	0.2403	0.1088	**-0.5646** **	0.0566	0.1205
	-0.099	-0.122	-0.096	(0.219)	(0.268)	(0.363)	(0.322)	(0.406)	(0.318)	(0.236)	(0.307)	(0.189)
tembin15_18_lag	0.8172***	0.4179	-0.0675	0.7573	2.3833*	2.0978*	2.7485***	1.2285	-0.7733	2.8400**	0.1220	-0.6039
	-0.248	-0.325	-0.336	(0.973)	(1.422)	(1.154)	(1.054)	(1.664)	(1.010)	(1.237)	(1.140)	(0.495)
tembin21_24_lag	-0.0161	0.0144	0.0064	-0.2633*	-0.3966*	-0.0223	-0.0133	-0.0870	-0.1761	-0.0093	0.0971	0.0444
	-0.044	-0.046	-0.049	(0.134)	(0.222)	(0.186)	(0.104)	(0.244)	(0.178)	(0.093)	(0.117)	(0.153)
tembin24_27_lag	-0.0145	0.0188	0.0067	-0.2405*	-0.3533	-0.0065	-0.0054	-0.0723	-0.1715	0.0010	0.0988	0.0386
	-0.043	-0.045	-0.049	(0.132)	(0.218)	(0.184)	(0.100)	(0.242)	(0.176)	(0.090)	(0.113)	(0.148)
tembin27_30_lag	-0.014	0.0208	0.005	-0.2409*	-0.3518	-0.0080	0.0057	-0.0692	-0.1733	0.0040	0.1065	0.0381
	-0.043	-0.045	-0.049	(0.132)	(0.218)	(0.184)	(0.100)	(0.242)	(0.176)	(0.090)	(0.113)	(0.148)
tembin30_40_lag	0.0428	0.0837	0.068	-0.1369	-0.4478	0.2210	0.0565	-0.1450	-0.0927	0.2052	0.4526*	0.1365
	-0.061	-0.088	-0.094	(0.180)	(0.325)	(0.312)	(0.185)	(0.335)	(0.247)	(0.188)	(0.254)	(0.218)
Rain current and lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	16.3099	3.958	11.1842	88.3613*	134.7996*	9.5693	1.6538	27.9296	62.7266	-3.4988	-44.7937	-14.5953
	-15.652	-16.432	-17.984	(48.661)	(80.091)	(67.644)	(36.806)	(88.777)	(64.007)	(32.947)	(41.206)	(54.750)
Observations	22,639	10,908	6,119	24,545	12,245	8,025	24,545	12,245	8,025	24,545	12,245	8,025
R-squared	0.445	0.386	0.661	0.088	0.092	0.304	0.079	0.058	0.066	0.185	0.162	0.070
Number of hhid_n	4,909	4,647	2,432	4,909	4,766	3,455	4,909	4,766	3,455	4,909	4,766	3,455

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A7: Estimated effect of climate variability on household income per capita of selected most marginalised groupsin the population in Indonesia. Selected results. (IFLS 1993-2014).

Indonesia	Total income				Farm income			Non-farm income		Wage non-farm income		
	Rural	Female HH head	Head with low education	Old HH head	Rural	Female HH head	Head with low education	Rural	Female HH head	Rural	Female HH head	Old HH head
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln farm income pc	Ln non-farm income pc	Ln non-farm income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc
tembin15_18	**-0.6730*** **	**-1.1365*** **	**-0.7861***	**-1.1801*** **	-0.5238	-0.9355	-0.7633	-0.6966	**-3.2293*** **	-0.5203	**-1.5963*** **	**-1.7301*** **
	-0.157	-0.321	-0.427	-0.211	(0.464)	(0.977)	(1.163)	(0.519)	(1.060)	(0.343)	(0.772)	(0.811)
tembin21_24	-0.0037	-0.0037	-0.0002	-0.0065	-0.0059	-0.0217	-0.0343	**-0.0397*** **	**-0.0441** **	0.0171	0.0105	-0.0078
	-0.003	-0.007	-0.009	-0.005	(0.014)	(0.019)	(0.024)	(0.010)	(0.021)	(0.012)	(0.021)	(0.019)
tembin24_27	-0.0032	-0.0037	0.0003	-0.0052	-0.0153	-0.0097	**-0.0387***	**-0.0315*** **	**-0.0247***	0.0099	0.0028	**-0.0292** **
	-0.003	-0.005	-0.008	-0.004	(0.011)	(0.015)	(0.020)	(0.007)	(0.014)	(0.010)	(0.014)	(0.014)
tembin27_30	-0.0042	-0.0039	-0.0009	**-0.0083***	**-0.0177***	-0.0154	**-0.0406** **	**-0.0235*** **	-0.0240	0.0084	-0.0009	**-0.0315** **
	-0.003	-0.006	-0.008	-0.005	(0.010)	(0.015)	(0.017)	(0.009)	(0.015)	(0.010)	(0.015)	(0.015)
tembin30_40	0.0248	0.1852	-0.2206	-0.0307	0.0809	0.2616	-0.2502	0.5878	-0.0537	-0.0844	-0.7684	-0.1466
	-0.151	-0.207	-0.255	-0.164	(0.313)	(0.437)	(0.454)	(0.486)	(0.660)	(0.297)	(0.548)	(0.495)
tembin15_18_lag	0.9266*	0.9569	0.6939	1.7000***	0.7807	-2.8492	-0.0206	2.3616	-2.5056	3.7307***	9.8508***	12.8452***
	-0.546	-0.649	-1.531	-0.591	(1.614)	(2.109)	(3.189)	(1.678)	(1.677)	(1.384)	(1.839)	(2.140)
tembin21_24_lag	-0.0319	0.0054	-0.2347	-0.0431	**-0.4180***	**-0.4679***	-0.1153	-0.2111	0.1532	0.0618	0.0625	0.8618**
	-0.104	-0.066	-0.27	-0.101	(0.244)	(0.245)	(0.447)	(0.254)	(0.197)	(0.180)	(0.290)	(0.353)
tembin24_27_lag	-0.0304	0.0069	-0.2233	-0.0382	-0.3926	**-0.4397***	-0.0882	-0.1858	0.1426	0.0678	0.0645	0.8622**
	-0.103	-0.066	-0.264	-0.099	(0.242)	(0.240)	(0.438)	(0.256)	(0.185)	(0.177)	(0.283)	(0.342)
tembin27_30_lag	-0.0299	0.0062	-0.2235	-0.0376	-0.3920	**-0.4417***	-0.0901	-0.1722	0.1449	0.0680	0.0635	0.8552**
	-0.103	-0.066	-0.264	-0.099	(0.242)	(0.240)	(0.439)	(0.255)	(0.185)	(0.178)	(0.283)	(0.343)
tembin30_40_lag	0.0916	0.1142	-0.1666	0.0977	-0.1658	-0.0429	0.2844	-0.2630	0.1735	0.3049	0.1988	0.5329
	-0.121	-0.132	-0.294	-0.132	(0.298)	(0.430)	(0.579)	(0.313)	(0.374)	(0.271)	(0.402)	(0.450)
Rain current and lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	23.3492	13.5669	94.6612	29.7192	143.2995	157.2517*	41.5009	68.5708	-50.0433	-28.4607	-16.0153	-309.9650**
	-37.542	-24.585	-95.393	-36.24	(88.828)	(88.671)	(160.366)	(65.143)	(68.775)	(65.124)	(104.579)	(125.834)
Observations	12,433	3,963	4,029	5,727	13,468	4,292	4,494	13,468	4,292	13,468	4,292	6,157
R-squared	0.444	0.285	0.329	0.228	0.114	0.065	0.086	0.064	0.054	0.150	0.122	0.092
Number of hhid_n	3,010	1,791	1,695	2,693	3,027	1,841	1,760	3,027	1,841	3,027	1,841	2,740

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3: Summary table of the changes in the coefficient of interest when controlling for transfers (dummy variable – Panel A, and log real value in Panel B) received by the households in Indonesia.
Source: Authors' calculation using IFLS data (1993-2014)

Panel A: Transfer dummy

Annual	Total income	Transfer variable	Crop income	Transfer variable	Non-farm income	Transfer variable	Wage income	Transfer variable
All	no difference	not significant	no difference	positive	no difference	not significant	no difference	not significant
Mostly Agricultural	no difference	not significant	no difference	positive	no difference	positive	no difference	positive
Rural	no difference	positive	no difference	positive	no difference	positive	no difference	not significant
Young	no difference	negative	no difference	not significant	no difference	not significant	no difference	not significant
Old	no difference	not significant	no difference	not significant	no difference	not significant	no difference	not significant
Low education	no difference	not significant	no difference	not significant	no difference	not significant	no difference	not significant
Female head	no difference	not significant	no difference	not significant	negative	not significant	no difference	not significant
Poor	no difference	not significant	no difference	positive	no difference	not significant	no difference	not significant

Panel B: Log real value of transfers received

Annual	Total income	Transfer variable	Crop income	Transfer variable	Non-farm income	Allowance	Wage income	Transfer variable
All	no difference	positive	no difference	positive	no difference	positive	no difference	not significant
Mostly Agricultural	no difference	positive	no difference	positive	no difference	positive	no difference	positive
Rural	no difference	positive	no difference	positive	no difference	positive	no difference	not significant
Young	no difference	positive	no difference	not significant	no difference	not significant	no difference	not significant
Old	no difference	positive	no difference	not significant	no difference	not significant	no difference	not significant
Low education	no difference	positive	no difference	not significant	no difference	not significant	no difference	not significant
Female head	no difference	positive	no difference	positive	negative	not significant	no difference	not significant
Poor	no difference	positive	no difference	positive	no difference	not significant	no difference	not significant

Table A9: Estimated effect of *seasonal* climate variability on household income per capita (total, farm, non-farm and wage income) in Vietnam. Selected results. (VHLSS 2002-2018).

Vietnam	Total income			Farm income			Non-farm income			Wage non-farm income		
	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln farm income pc	Ln non-farm income	Ln non-farm income	Ln non-farm income	Ln wage income	Ln wage income	Ln wage income
tembin00_12_y_lag_dry	0.0016	-0.0008	-0.0093	-0.0057	0.0145	-0.0046	-0.0024	-0.0217*	-0.0015	-0.0138	-0.0061	-0.0247
	(0.007)	(0.005)	(0.007)	(0.010)	(0.010)	(0.010)	(0.013)	(0.010)	(0.023)	(0.014)	(0.017)	(0.018)
tembin12_15_y_lag_dry	-0.0015	-0.0028	-0.0085*	-0.0019	-0.0068	-0.0012	0.0076**	0.0043	0.0035	-0.0021	-0.0020	0.0028
	(0.002)	(0.004)	(0.004)	(0.003)	(0.007)	(0.004)	(0.003)	(0.005)	(0.012)	(0.003)	(0.009)	(0.005)
tembin15_18_y_lag_dry	-0.0010	-0.0018	-0.0025	0.0006	0.0008	0.0031	0.0004	0.0001	-0.0044	-0.0009	0.0038	-0.0043
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.007)	(0.005)
tembin21_24_y_lag_dry	-0.0004	-0.0030**	-0.0003	-0.0017	0.0036	-0.0021	-0.0000	-0.0034*	0.0006	-0.0019	0.0066	0.0020
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)
tembin24_27_y_lag_dry	0.0004	-0.0017	-0.0000	-0.0018	0.0012	**-0.0054****	-0.0010	-0.0045	-0.0002	-0.0006	0.0056	0.0052*
	(0.001)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.006)	(0.002)
tembin27_30_y_lag_dry	0.0004	-0.0019	0.0020	-0.0026	0.0080	-0.0047	-0.0035	-0.0061	0.0005	0.0006	0.0057	0.0082**
	(0.002)	(0.002)	(0.003)	(0.002)	(0.005)	(0.003)	(0.004)	(0.004)	(0.002)	(0.003)	(0.007)	(0.003)
tembin30_40_y_lag_dry	0.0036	-0.0017	0.0039	0.0035	0.0027	-0.0085	-0.0022	-0.0096	0.0032	0.0059	0.0082	0.0059
	(0.003)	(0.004)	(0.006)	(0.004)	(0.011)	(0.009)	(0.005)	(0.007)	(0.008)	(0.008)	(0.012)	(0.010)
tembin00_12_y_lag_wet	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin12_15_y_lag_wet	-0.0502	0.2219	0.0889	0.3100	0.6685	0.0801	0.1044	0.4141	-0.0008	-0.2982	-0.7414	0.0901
	(0.174)	(0.231)	(0.297)	(0.518)	(0.401)	(0.334)	(0.633)	(0.407)	(0.249)	(0.431)	(0.772)	(0.621)
tembin15_18_y_lag_wet	-0.0208	-0.0118	-0.0022	0.0293	-0.0752	0.0564	-0.0331	-0.0014	-0.0248	0.0205	-0.0584	0.0318
	(0.033)	(0.029)	(0.029)	(0.030)	(0.049)	(0.089)	(0.099)	(0.053)	(0.049)	(0.056)	(0.061)	(0.052)
tembin21_24_y_lag_wet	**0.0091*****	0.0116	**0.0235*****	0.0012	0.0044	0.0194	0.0036	0.0099	0.0050	0.0050	0.0008	**0.0182****
	(0.002)	(0.008)	(0.005)	(0.007)	(0.009)	(0.012)	(0.004)	(0.010)	(0.003)	(0.005)	(0.012)	(0.007)
tembin24_27_y_lag_wet	**0.0080*****	0.0078	**0.0219*****	-0.0013	-0.0051	0.0207	-0.0000	0.0037	0.0022	-0.0006	-0.0033	**0.0236****
	(0.002)	(0.007)	(0.004)	(0.007)	(0.004)	(0.011)	(0.003)	(0.009)	(0.002)	(0.005)	(0.005)	(0.007)
tembin27_30_y_lag_wet	**0.0068****	0.0074	**0.0207*****	-0.0007	-0.0044	0.0212	-0.0016	0.0042	0.0006	-0.0029	-0.0016	**0.0240****
	(0.002)	(0.007)	(0.005)	(0.007)	(0.004)	(0.012)	(0.003)	(0.010)	(0.003)	(0.006)	(0.005)	(0.006)
tembin30_40_y_lag_wet	**0.0076****	0.0077	**0.0177***	0.0006	-0.0050	0.0236	-0.0016	-0.0018	0.0014	-0.0021	0.0018	**0.0269***
	(0.003)	(0.008)	(0.007)	(0.007)	(0.004)	(0.013)	(0.005)	(0.010)	(0.006)	(0.008)	(0.008)	(0.011)
tembin00_12_y_lag2_dry	-0.0002	0.0063	**-0.0160****	0.0146*	0.0061	-0.0042	0.0058	0.0032	-0.0008	0.0008	-0.0048	**-0.0364*****
	(0.005)	(0.006)	(0.007)	(0.006)	(0.010)	(0.007)	(0.011)	(0.007)	(0.010)	(0.009)	(0.009)	(0.009)
tembin12_15_y_lag2_dry	0.0032	0.0020	**-0.0056***	0.0002	0.0001	-0.0064	0.0021	0.0019	-0.0012	0.0037	0.0041	**-0.0102***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.004)	(0.003)	(0.005)	(0.005)	(0.003)	(0.009)	(0.005)
tembin15_18_y_lag2_dry	0.0016	0.0017	-0.0018	0.0026	-0.0024	0.0011	-0.0009	0.0005	-0.0025	**0.0062*****	0.0036	**-0.0037***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
tembin21_24_y_lag2_dry	-0.0014*	0.0007	0.0000	0.0034	-0.0015	-0.0030	0.0011	-0.0027	-0.0016	**-0.0030***	-0.0019	-0.0033
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.006)	(0.003)
tembin24_27_y_lag2_dry	-0.0021	0.0011	0.0001	0.0009	-0.0040	-0.0034	0.0004	-0.0020	-0.0019	-0.0028	-0.0062	0.0000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.006)	(0.003)
tembin27_30_y_lag2_dry	-0.0021	0.0009	0.0035	0.0036	0.0006	-0.0002	0.0017	-0.0013	0.0014	-0.0029	-0.0071	-0.0052
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.010)	(0.004)
tembin30_40_y_lag2_dry	**-0.0070****	**-0.0047****	**-0.0046***	0.0007	**-0.0121***	-0.0055	0.0023	0.0055	-0.0020	-0.0019	-0.0058	-0.0056
	(0.002)	(0.002)	(0.002)	(0.003)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)
tembin00_12_y_lag2_wet	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin12_15_y_lag2_wet	-0.0322	-0.1664	0.1417	-0.6430	-0.3650	0.2673	-0.0843	0.0196	-0.0372	**0.9920****	0.1110	**1.0553****
	(0.083)	(0.150)	(0.196)	(0.444)	(0.317)	(0.281)	(0.391)	(0.264)	(0.190)	(0.324)	(0.399)	(0.306)
tembin15_18_y_lag2_wet	-0.0106	-0.0040	0.0240	-0.0004	0.0118	-0.0121	0.0516	0.0685*	0.0246	-0.0350	-0.0662	-0.0119
	(0.021)	(0.022)	(0.033)	(0.032)	(0.041)	(0.070)	(0.050)	(0.032)	(0.034)	(0.045)	(0.080)	(0.052)
tembin21_24_y_lag2_wet	-0.0030	-0.0016	-0.0089	-0.0012	0.0104	**-0.0153*****	0.0083	-0.0049	-0.0072	-0.0092	**-0.0389****	**-0.0319****
	(0.003)	(0.002)	(0.005)	(0.006)	(0.012)	(0.004)	(0.005)	(0.008)	(0.006)	(0.012)	(0.013)	(0.010)
tembin24_27_y_lag2_wet	-0.0029	-0.0033	**-0.0095***	-0.0008	0.0105	**-0.0152*****	0.0111**	-0.0026	-0.0057	-0.0124	**-0.0373****	**0.0340*****
	(0.003)	(0.003)	(0.005)	(0.007)	(0.011)	(0.004)	(0.004)	(0.008)	(0.004)	(0.011)	(0.013)	(0.009)
tembin27_30_y_lag2_wet	-0.0031	-0.0053	**-0.0088***	-0.0006	0.0087	**-0.0125****	0.0127*	-0.0002	-0.0049	-0.0129	**-0.0363****	**0.0355*****
	(0.003)	(0.003)	(0.004)	(0.007)	(0.009)	(0.005)	(0.005)	(0.007)	(0.005)	(0.010)	(0.013)	(0.009)
tembin30_40_y_lag2_wet	-0.0019	-0.0043	-0.0047	0.0000	0.0169	-0.0019	0.0132*	0.0003	-0.0018	-0.0130	**-0.0372****	**0.0346*****
	(0.003)	(0.004)	(0.005)	(0.006)	(0.010)	(0.006)	(0.006)	(0.007)	(0.004)	(0.009)	(0.014)	(0.010)
Rain current and lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & Region & Year clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	9.8415***	8.4916***	7.0677***	2.7657***	4.8998	6.8208**	0.0301	-0.1523	0.5803	8.7451***	11.7532***	5.6232**
	(0.559)	(1.483)	(0.926)	(0.513)	(2.577)	(2.179)	(1.170)	(2.842)	(0.618)	(1.657)	(1.396)	(2.319)
Observations	99,670	15,831	14,304	99,675	15,832	14,309	99,675	15,832	14,309	99,675	15,832	14,309
R-squared	0.603	0.541	0.714	0.500	0.614	0.790	0.210	0.403	0.369	0.305	0.466	0.371

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A10: Estimated effect of *seasonal* climate variability on household income per capita of selected most marginalised groups in the population in Vietnam. Selected results. (VHLSS 2002-2018).

Vietnam	Total income					Farm income		Non-farm income			Wage non-farm income			
	Rural	Ethnic minority	Head low education	Young head	Old HH head	Ethnic minority	Old HH head	Ethnic minority	Head with low education	Young HH head	Rural	Ethnic minority	Head with low education	Old H head
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc	Ln wag income pc
tembin00_12_dry	-0.0071	0.0023	-0.0036	-0.0006	0.0082	0.0152	-0.0217	-0.0072	-0.0063	0.0116	-0.0227	-0.0265	-0.0088	-0.0211
	(0.006)	(0.005)	(0.006)	(0.008)	(0.008)	(0.009)	(0.030)	(0.013)	(0.010)	(0.008)	(0.013)	(0.024)	(0.018)	(0.036)
tembin12_15_dry	-0.0015	-0.0028	-0.0013	-0.0037	-0.0022	-0.0023	-0.0030	**0.0091***	0.0062	**0.0108*****	-0.0031	0.0046	-0.0062	0.0060
	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.008)	(0.005)	(0.004)	(0.002)	(0.003)	(0.005)	(0.004)	(0.005)
tembin15_18_dry	-0.0013	0.0012	-0.0013	-0.0013	-0.0018	0.0034	0.0090	**0.0045***	0.0015	0.0007	-0.0027	0.0038	0.0003	-0.0052
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.004)	(0.005)	(0.002)	(0.004)	(0.005)	(0.003)	(0.006)	(0.004)	(0.005)
tembin21_24_dry	-0.0000	-0.0010	-0.0007	-0.0005	**-0.0027***	0.0004	-0.0043	-0.0015	-0.0027	0.0027	-0.0021	0.0006	0.0008	-0.0065
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.005)	(0.001)	(0.002)	(0.003)	(0.001)	(0.004)	(0.002)	(0.007)
tembin24_27_dry	0.0012	-0.0013	-0.0002	-0.0001	-0.0033	-0.0011	**-0.0158****	-0.0042	**-0.0054***	0.0060	-0.0001	0.0024	0.0030	-0.0065
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.004)	(0.005)	(0.002)	(0.002)	(0.003)	(0.002)	(0.004)	(0.004)	(0.007)
tembin27_30_dry	0.0018	-0.0016	-0.0004	0.0003	-0.0026	0.0030	**-0.0231****	-0.0049*	**0.0084****	0.0059	0.0005	0.0001	0.0043	-0.0004
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.006)	(0.008)	(0.002)	(0.003)	(0.006)	(0.004)	(0.007)	(0.005)	(0.008)
tembin30_40_dry	0.0053*	0.0049	0.0006	0.0063	-0.0043	0.0034	**0.0260****	-0.0014	-0.0076	0.0115	0.0031	-0.0051	0.0066	0.0014
	(0.002)	(0.004)	(0.003)	(0.005)	(0.005)	(0.011)	(0.011)	(0.009)	(0.005)	(0.012)	(0.008)	(0.011)	(0.009)	(0.013)
tembin00_12_wet	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin12_15_wet	-0.0791	-0.0082	0.0689	-0.0444	0.0000	0.4505	0.0000	-0.0984	0.0680	-0.2644	-0.4698	-0.4085	-0.4722	0.0000
	(0.278)	(0.185)	(0.197)	(0.202)	(0.000)	(0.788)	(0.000)	(0.203)	(0.442)	(0.658)	(0.364)	(0.485)	(0.550)	(0.000)
tembin15_18_wet	-0.0152	-0.0109	-0.0182	0.0119	0.1024	-0.0386	0.2561	0.0414	-0.0115	-0.0504	0.0368	0.0426	0.0313	0.4351
	(0.025)	(0.020)	(0.020)	(0.026)	(0.133)	(0.050)	(0.286)	(0.037)	(0.043)	(0.052)	(0.032)	(0.045)	(0.074)	(0.281)
tembin21_24_wet	**0.0139***	**0.0123****	**0.0118*****	**0.0116*****	0.0071	0.0007	**0.0273****	0.0080*	0.0068	**-0.0117***	0.0008	0.0047	0.0010	0.0081
	(0.006)	(0.004)	(0.002)	(0.003)	(0.004)	(0.003)	(0.008)	(0.004)	(0.005)	(0.006)	(0.007)	(0.009)	(0.010)	(0.008)
tembin24_27_wet	**0.0115***	**0.0118****	**0.0113*****	**0.0137*****	**0.0063****	-0.0022	**0.0224***	0.0023	0.0031	**-0.0150****	-0.0026	0.0010	-0.0011	-0.0101
	(0.005)	(0.004)	(0.002)	(0.003)	(0.002)	(0.004)	(0.010)	(0.003)	(0.004)	(0.005)	(0.008)	(0.011)	(0.009)	(0.009)
tembin27_30_wet	**0.0100***	**0.0112****	**0.0112*****	**0.0123****	**0.0068****	-0.0050	**0.0312****	0.0009	0.0038	**-0.0216****	-0.0034	-0.0011	-0.0017	-0.0109

Vietnam	Total income					Farm income		Non-farm income			Wage non-farm income			
	Rural	Ethnic minority	Head low education	Young head	Old HH head	Ethnic minority	Old HH head	Ethnic minority	Head with low education	Young HH head	Rural	Ethnic minority	Head with low education	Old HI head
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc	Ln wag income pc
	(0.005)	(0.004)	(0.002)	(0.004)	(0.003)	(0.004)	(0.012)	(0.004)	(0.007)	(0.006)	(0.008)	(0.011)	(0.011)	(0.008)
tembin30_40_wet	0.0103	**0.0127***	**0.0134*****	**0.0123****	**0.0085***	-0.0075	**0.0415****	0.0041	0.0063	**-0.0235****	-0.0032	-0.0016	-0.0015	-0.0115
	(0.006)	(0.006)	(0.003)	(0.004)	(0.004)	(0.005)	(0.016)	(0.007)	(0.008)	(0.009)	(0.009)	(0.013)	(0.012)	(0.007)
tembin00_12_lag_dry	-0.0040	**-0.0097****	-0.0058	-0.0002	-0.0002	0.0128	0.0275	-0.0020	0.0018	0.0116	0.0056	-0.0096	-0.0117	0.0057
	(0.005)	(0.004)	(0.004)	(0.007)	(0.005)	(0.007)	(0.021)	(0.007)	(0.011)	(0.012)	(0.008)	(0.010)	(0.013)	(0.034)
tembin12_15_lag_dry	0.0021	-0.0001	0.0008	0.0030	0.0030	0.0017	0.0043	0.0019	-0.0015	0.0043	**0.0073***	**0.0073***	0.0016	**0.0169***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.005)	(0.003)	(0.005)	(0.004)	(0.003)	(0.004)	(0.004)	(0.009)
tembin15_18_lag_dry	0.0016	-0.0017	0.0000	0.0004	**0.0026****	0.0007	**0.0071***	-0.0014	-0.0042	-0.0020	**0.0069****	0.0030	0.0038*	**0.0111***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)	(0.002)	(0.005)
tembin21_24_lag_dry	-0.0014	-0.0016	-0.0008	-0.0021	-0.0018	**-0.0054***	0.0067	-0.0012	0.0010	0.0016	**-0.0034***	0.0011	-0.0034	**-0.0111****
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)
tembin24_27_lag_dry	-0.0019	-0.0016	**-0.0020***	-0.0026*	**0.0035****	-0.0042	0.0030	**0.0058****	0.0000	0.0012	-0.0023	0.0011	-0.0037	-0.0043
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.003)
tembin27_30_lag_dry	-0.0004	-0.0010	-0.0014	-0.0024	-0.0031	**0.0067****	**0.0094***	-0.0018	0.0005	0.0019	-0.0038	0.0008	-0.0045	-0.0016
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)
tembin30_40_lag_dry	**-0.0053****	**-0.0061*****	**-0.0063****	**-0.0096****	**-0.0060***	**-0.0144****	0.0131	0.0071	0.0065	-0.0033	**0.0072****	-0.0030	-0.0047	0.0016
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.008)	(0.006)	(0.005)	(0.005)	(0.002)	(0.009)	(0.003)	(0.007)
tembin00_12_lag_wet	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin12_15_lag_wet	-0.0788	-0.1216	-0.1110	-0.1293	0.0000	-0.5386	0.0000	-0.1384	-0.2476	-0.6395	**0.6800****	**0.7262****	0.5143	0.0000
	(0.122)	(0.085)	(0.133)	(0.134)	(0.000)	(0.291)	(0.000)	(0.182)	(0.246)	(0.397)	(0.283)	(0.247)	(0.329)	(0.000)
tembin15_18_lag_wet	-0.0106	-0.0065	0.0124	-0.0083	0.0606	-0.0008	0.0772	0.0240	0.0651	0.0098	-0.0552	-0.0594	-0.0536	0.0316
	(0.031)	(0.022)	(0.019)	(0.019)	(0.043)	(0.040)	(0.085)	(0.032)	(0.037)	(0.050)	(0.040)	(0.081)	(0.052)	(0.147)
tembin21_24_lag_wet	-	-0.0057	-0.0019	-	-0.0073	0.0027	-0.0103	-0.0058	-0.0011	-0.0013	-	-	-	-

Vietnam	Total income					Farm income		Non-farm income			Wage non-farm income			
	Rural	Ethnic minority	Head low education	Young head	Old HH head	Ethnic minority	Old HH head	Ethnic minority	Head with low education	Young HH head	Rural	Ethnic minority	Head with low education	Old HH head
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln nonfarm income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc
	0.0191* **			**0.0067** **							**0.0369** **	**0.0327*** **	**0.0278** **	**0.0307** **
	(0.002)	(0.005)	(0.004)	(0.002)	(0.004)	(0.004)	(0.012)	(0.013)	(0.009)	(0.009)	(0.006)	(0.004)	(0.010)	(0.012)
	-										**0.0396** **	**0.0347** **	**0.0348** **	
tembin24_27_lag_wet	**0.0198*** **	-0.0080	-0.0040	**-0.0070** *	-0.0065	0.0044	-0.0071	-0.0062	-0.0010	0.0027	(0.006)	(0.005)	(0.009)	-0.0182
	(0.001)	(0.006)	(0.005)	(0.003)	(0.004)	(0.003)	(0.016)	(0.013)	(0.008)	(0.007)	-		-	(0.013)
	-										**0.0404** **	-	**0.0374** **	
tembin27_30_lag_wet	**0.0199*** **	-0.0085	-0.0040	-0.0078	-0.0071	0.0063	-0.0003	-0.0038	-0.0014	0.0022	*	**0.0361*** **	*	-0.0118
	(0.001)	(0.006)	(0.005)	(0.004)	(0.004)	(0.005)	(0.013)	(0.013)	(0.008)	(0.006)	(0.006)	(0.005)	(0.009)	(0.013)
	-										-	-	-	
tembin30_40_lag_wet	**0.0191*** **	-0.0053	-0.0028	-0.0064	-0.0056	0.0134*	0.0007	-0.0062	-0.0042	-0.0001	**0.0388** **	**0.0356** **	**0.0424** **	-0.0043
	(0.001)	(0.006)	(0.005)	(0.004)	(0.005)	(0.006)	(0.011)	(0.014)	(0.008)	(0.004)	*	*	*	(0.017)
											(0.005)	(0.009)	(0.008)	
Rain current and lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & Region & Year clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	12.2401***	9.2705***	9.1855***	9.0563***	11.3030***	3.5913***	2.1887	2.4670	2.1120***	1.8726	13.3216***	12.4576***	12.9215***	12.3227***
	(0.751)	(1.715)	(1.067)	(1.152)	(1.253)	(0.727)	(2.310)	(2.436)	(0.539)	(1.881)	(1.755)	(2.245)	(1.465)	(1.787)
Observations	73,509	14,982	51,254	29,084	22,578	14,982	22,579	14,982	51,257	29,084	73,509	14,982	51,257	22,579
R-squared	0.541	0.618	0.569	0.733	0.653	0.546	0.561	0.283	0.290	0.400	0.272	0.425	0.325	0.442

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A11: Summary table of the changes in the coefficient of interest when controlling for transfers (dummy in Panel A and log of real value in Panel B) received by the households in Vietnam.
Source: Authors' calculation using VHLSS data (2002-2018)

Panel A: Transfer dummy

Seasonal	Total income			Crop income			Wage income		
	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable
All	no difference	**negative**	negative	no difference	**negative**	positive	no difference	not significant	not significant
Mostly Agricultural	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Rural	not significant	not significant	negative	no difference	**negative**	positive	no difference	not significant	not significant
Young head	no difference	**negative**	negative	no difference	**negative**	positive	no difference	not significant	not significant
Old head	not significant	negative	not significant	no difference	not significant	not significant	no difference	no difference	not significant
Low education	no difference	no difference	not significant	no difference	no difference	not significant	no difference	not significant	not significant
Female head	no difference	**negative**	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Ethnic minority	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Poor	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant

Panel B: Log of real value of transfers received

Seasonal	Total income			Crop income			Wage income		
	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable
All	no difference	negative	negative	no difference	no difference	positive	no difference	not significant	negative
Mostly Agricultural	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Rural	no difference	no difference	not significant	no difference	negative	positive	no difference	not significant	not significant
Young head	no difference	no difference	not significant	no difference	no difference	not significant	no difference	negative	not significant
Old head	not significant	negative	not significant	no difference	not significant	not significant	no difference	no difference	not significant
Low education	no difference	no difference	not significant	no difference	no difference	not significant	no difference	not significant	not significant
Female head	no difference	negative	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Ethnic minority	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Poor	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant

Table A12: Estimated effect of seasonal climate variability on household income per capita (total, farm, non-farm and wage income) in Indonesia. Selected results. (IFLS 1993-2014).

Indonesia	Total income			Farm income			Non-farm income			Wage non-farm income		
	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultur HHs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln farm income pc	Ln non-farm income	Ln non-farm income	Ln non-farm income	Ln wage income	Ln wage income	Ln w income
tembin15_18_dry	0.6630***	-0.6612**	-0.5618**	-0.2236	-0.5977	-1.2329	3.1939***	-1.1662	-0.0575	-0.0995	-3.9833**	-1.1217*
	(0.252)	(0.299)	(0.224)	(0.821)	(1.550)	(1.135)	(0.940)	(1.300)	(1.206)	(0.941)	(1.708)	(0.659)
tembin21_24_dry	-0.0218	-0.1343***	-0.0170	-0.0945	-0.2738	0.1022	-0.0746	-0.4039**	0.1269	0.1849**	-0.0045	0.2619
	(0.024)	(0.046)	(0.061)	(0.103)	(0.187)	(0.263)	(0.057)	(0.186)	(0.283)	(0.079)	(0.165)	(0.192)
tembin24_27_dry	-0.0284	-0.1351***	-0.0255	-0.0973	-0.2617	0.0895	-0.0743	-0.3945**	0.1288	0.1701**	-0.0293	0.2360
	(0.023)	(0.047)	(0.060)	(0.102)	(0.188)	(0.260)	(0.053)	(0.180)	(0.280)	(0.076)	(0.159)	(0.190)
tembin27_30_dry	-0.0253	-0.1338***	-0.0196	-0.0946	-0.2703	0.0878	-0.0636	-0.3986**	0.1355	0.1699**	-0.0366	0.2308
	(0.023)	(0.048)	(0.060)	(0.102)	(0.189)	(0.262)	(0.053)	(0.180)	(0.281)	(0.076)	(0.159)	(0.190)
o.tembin30_40_dry	-	-	-	2.3571***	0.9311	-	2.8217***	0.1813	-	4.2637***	3.2966***	-
				(0.744)	(1.119)		(0.816)	(1.115)		(0.719)	(1.138)	
tembin15_18_wet	-0.8374***	-1.1881***	-0.6857***	-1.0271	-1.2329	0.2793	-2.2475***	-0.9831	-0.1317	0.4268	1.1780	0.0910
	(0.145)	(0.292)	(0.205)	(0.691)	(0.918)	(0.781)	(0.642)	(0.818)	(0.610)	(0.722)	(1.821)	(0.485)
tembin21_24_wet	-0.0347**	-0.0694**	-0.0005	-0.0613	-0.0534	0.1316	-0.1560**	-0.1252	0.2097**	0.1011	0.0799	0.1614**
	(0.017)	(0.027)	(0.024)	(0.076)	(0.104)	(0.095)	(0.078)	(0.105)	(0.092)	(0.078)	(0.098)	(0.080)
tembin24_27_wet	-0.0219	-0.0632***	0.0113	-0.0300	-0.0274	0.1338	-0.1279*	-0.1224	0.2049**	0.1083	0.0810	0.1555**
	(0.015)	(0.024)	(0.023)	(0.070)	(0.097)	(0.094)	(0.075)	(0.105)	(0.091)	(0.073)	(0.094)	(0.073)
tembin27_30_wet	-0.0229	-0.0641***	0.0113	-0.0299	-0.0137	0.1283	-0.1248*	-0.1244	0.2045**	0.1028	0.0824	0.1487**
	(0.016)	(0.024)	(0.023)	(0.070)	(0.098)	(0.094)	(0.075)	(0.106)	(0.092)	(0.073)	(0.095)	(0.073)
tembin30_40_wet	0.2225***	0.1469	0.2601**	0.0569	-0.0560	0.2417	0.1702	-0.1250	0.8628**	0.4744*	0.4326	0.4054
	(0.084)	(0.129)	(0.106)	(0.244)	(0.356)	(0.330)	(0.287)	(0.345)	(0.356)	(0.263)	(0.365)	(0.265)
o.tembin15_18_lag_dry	-	-	-	-	-	-	-	-	-	-	-	-
tembin21_24_lag_dry	0.0353*	0.1593***	-0.0131	0.1133	0.2309	0.0174	0.1434*	0.6117***	-0.2294	-0.2342***	0.0987	-0.1181
	(0.021)	(0.047)	(0.053)	(0.123)	(0.195)	(0.244)	(0.077)	(0.162)	(0.244)	(0.068)	(0.163)	(0.154)
tembin24_27_lag_dry	0.0309	0.1537***	-0.0155	0.1161	0.2395	0.0433	0.1303*	0.6135***	-0.2244	-0.1746***	0.1469	-0.0895
	(0.020)	(0.047)	(0.052)	(0.120)	(0.195)	(0.238)	(0.074)	(0.163)	(0.241)	(0.063)	(0.160)	(0.151)
tembin27_30_lag_dry	0.0253	0.1526***	-0.0207	0.1131	0.2536	0.0467	0.1354*	0.6263***	-0.2247	-0.1804***	0.1416	-0.0894
	(0.020)	(0.047)	(0.052)	(0.120)	(0.196)	(0.239)	(0.075)	(0.165)	(0.244)	(0.063)	(0.162)	(0.153)
tembin30_40_lag_dry	-0.0765	-0.4794**	0.4392***	-0.2127	0.0640	0.7038	-0.1921	-0.9975*	0.0589	0.3096	0.8450	-0.2516
	(0.095)	(0.220)	(0.141)	(0.328)	(0.691)	(0.473)	(0.381)	(0.538)	(0.475)	(0.297)	(0.672)	(0.336)

Indonesia	Total income			Farm income			Non-farm income			Wage non-farm income		
	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs	All	Poor HH	Agricultural HHs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln farm income pc	Ln non-farm income	Ln non-farm income	Ln non-farm income	Ln wage income	Ln wage income	Ln wage income
o.tembin15_18_lag_wet	-	-	-	-	-	-	-	-	-	-	-	-
tembin21_24_lag_wet	0.0048	0.0301	-0.0422**	-0.0472	0.0088	0.0636	0.0279	0.0887	-0.0974	-0.1398***	-0.0126	0.1083
	(0.010)	(0.021)	(0.021)	(0.073)	(0.157)	(0.124)	(0.050)	(0.065)	(0.113)	(0.048)	(0.110)	(0.072)
tembin24_27_lag_wet	0.0112	0.0474**	-0.0399**	-0.0273	0.0443	0.0596	0.0280	0.1010	-0.1059	-0.1527***	-0.0053	0.1086
	(0.009)	(0.020)	(0.020)	(0.073)	(0.145)	(0.123)	(0.051)	(0.063)	(0.116)	(0.043)	(0.107)	(0.072)
tembin27_30_lag_wet	0.0121	0.0522**	-0.0437**	-0.0371	0.0502	0.0732	0.0272	0.1065*	-0.1042	-0.1484***	0.0084	0.1074
	(0.009)	(0.021)	(0.020)	(0.073)	(0.145)	(0.124)	(0.050)	(0.062)	(0.116)	(0.043)	(0.106)	(0.072)
tembin30_40_lag_wet	0.0182	0.0923	-0.0070	0.1961	0.4547	0.7523*	0.0603	0.5514**	0.1123	-0.5980**	-0.6514**	-0.1259
	(0.062)	(0.072)	(0.086)	(0.229)	(0.300)	(0.397)	(0.191)	(0.267)	(0.228)	(0.252)	(0.306)	(0.205)
Rain current and lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district clustered FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	14.9005***	9.5608	15.9443*	-0.6786	-6.7088	-77.8985*	1.0477	-47.9513	-18.5596	9.1378	-46.2503	-80.2579***
	(3.803)	(10.095)	(8.220)	(18.649)	(56.314)	(45.109)	(17.299)	(33.962)	(31.534)	(18.502)	(41.550)	(30.516)
Observations	22,639	10,908	6,119	24,545	12,245	8,025	24,545	12,245	8,025	24,545	12,245	8,025
R-squared	0.450	0.394	0.668	0.088	0.093	0.305	0.080	0.064	0.071	0.186	0.168	0.077
Number of hhid_n	4,909	4,647	2,432	4,909	4,766	3,455	4,909	4,766	3,455	4,909	4,766	3,455
Robust standard errors in parentheses												
*** p<0.01, ** p<0.05, * p<0.1												

Table A13: Estimated effect of *seasonal* climate variability on household income per capita of selected most marginalised groups in the population in Indonesia. Selected results. (IFLS 1993-2014).

Indonesia	Total income		Farm income				Non-farm income			Wage non-farm income			
	Rural HHs	Old HH head	Rural HHs	Head with low education	Young HH head	Old HH head	Rural HHs	Female HH head	Old HH head	Rural HHs	Female HH head	Young HH head	Old HH head
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln farm income pc	Ln non-farm income pc	Ln non-farm income pc	Ln non-farm income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc
tembin15_18_dry	**0.5966***	**0.7757***	-0.4904	**-3.0773***	-0.4129	-3.3229	**3.1025*****	1.4021	**6.4272*****	0.2794	**7.0868*****	**-5.3415****	**7.7271*****
	(0.334)	(0.454)	(1.099)	(1.675)	(1.756)	(2.727)	(1.094)	(1.698)	(1.809)	(1.274)	(2.127)	(2.407)	(1.638)
tembin21_24_dry	-0.0510	**-0.1716****	-0.0124	-0.2564	**0.4149****	-0.4296	-0.0638	-0.0941	-0.2692	**0.2731***	0.2963	**-0.3211****	**0.6640****
	(0.038)	(0.086)	(0.110)	(0.238)	(0.186)	(0.379)	(0.108)	(0.246)	(0.224)	(0.143)	(0.363)	(0.157)	(0.305)
tembin24_27_dry	-0.0605	**-0.2157****	-0.0253	-0.2796	**0.4172****	-0.4515	-0.0578	-0.0947	-0.3072	**0.2517***	0.3140	**-0.2826***	**0.6253****
	(0.039)	(0.089)	(0.110)	(0.214)	(0.179)	(0.386)	(0.104)	(0.239)	(0.238)	(0.136)	(0.340)	(0.164)	(0.302)
tembin27_30_dry	-0.0556	**-0.2114****	-0.0198	-0.2630	**0.4206****	-0.4455	-0.0489	-0.0880	-0.3208	**0.2446***	0.3125	**-0.2832***	**0.6141****
	(0.039)	(0.090)	(0.111)	(0.215)	(0.180)	(0.387)	(0.103)	(0.240)	(0.238)	(0.136)	(0.341)	(0.166)	(0.302)
tembin30_40_dry		**1.5353*****		-	-	-		**4.1019****	-		0.9714	-	-
		(0.549)						(1.610)			(1.555)		
tembin15_18_wet	**-0.7968*****	**-1.3867*****	-1.2492	-1.7246	**-4.7520****	0.5048	**-1.5266****	**3.9440*****	**-1.8786****	**1.4009****	-0.9280	**8.2867***	-0.5011
	(0.213)	(0.286)	(0.788)	(1.409)	(2.045)	(1.092)	(0.675)	(1.348)	(0.944)	(0.675)	(1.396)	(4.427)	(1.331)
tembin21_24_wet	-0.0363	0.0213	-0.0879	-0.2474	-0.0629	**0.3323****	-0.0245	-0.0576	0.0468	**0.3136*****	-0.0382	0.0518	0.3493
	(0.030)	(0.043)	(0.095)	(0.218)	(0.139)	(0.157)	(0.089)	(0.222)	(0.161)	(0.096)	(0.327)	(0.156)	(0.219)
tembin24_27_wet	-0.0221	0.0557	-0.0477	-0.1735	-0.0149	**0.3576****	-0.0037	-0.0124	0.1018	**0.3052*****	-0.0759	0.0531	**0.3559***
	(0.026)	(0.040)	(0.091)	(0.217)	(0.134)	(0.147)	(0.086)	(0.209)	(0.158)	(0.093)	(0.314)	(0.146)	(0.208)
tembin27_30_wet	-0.0253	0.0453	-0.0503	-0.1684	-0.0212	**0.3680****	-0.0001	-0.0050	0.1069	**0.2961*****	-0.0742	0.0487	0.3425
	(0.027)	(0.041)	(0.092)	(0.216)	(0.136)	(0.149)	(0.087)	(0.208)	(0.159)	(0.095)	(0.313)	(0.146)	(0.208)
tembin30_40_wet	**0.2810****	0.2348	0.0805	0.6845	-0.1047	**1.2759*****	0.3701	0.5387	-0.2440	**0.7205****	0.6751	**1.3103*****	-0.2477
	(0.109)	(0.151)	(0.318)	(0.641)	(0.496)	(0.486)	(0.350)	(0.620)	(0.418)	(0.332)	(0.593)	(0.438)	(0.403)
o.tembin15_18_lag_dry	-	-	-	-	-	-	-	-	-	-	-	-	-
tembin21_24_lag_dry	**0.0764****	**0.1459***	-0.0186	0.1816	**-0.5125*****	0.3718	**0.2229****	0.1961	**0.3950****	**-0.2330****	**-0.6809****	-0.0107	-0.4237
	(0.031)	(0.077)	(0.090)	(0.173)	(0.157)	(0.312)	(0.105)	(0.201)	(0.179)	(0.094)	(0.295)	(0.150)	(0.258)
tembin24_27_lag_dry	**0.0709****	**0.1443***	-0.0205	0.1427	**0.4539*****	0.4168	**0.2203****	0.1409	**0.3704****	**-0.1578***	**-0.6622****	0.0670	-0.3983
	(0.031)	(0.076)	(0.088)	(0.149)	(0.152)	(0.312)	(0.102)	(0.189)	(0.177)	(0.085)	(0.281)	(0.145)	(0.248)
tembin27_30_lag_dry	**0.0643****	**0.1374***	-0.0292	0.1261	**-0.4491*****	0.4196	**0.2272****	0.1398	**0.3790****	**-0.1570***	**-0.6817****	0.0660	-0.4007
	(0.030)	(0.076)	(0.089)	(0.154)	(0.153)	(0.313)	(0.104)	(0.190)	(0.177)	(0.086)	(0.282)	(0.148)	(0.249)

Indonesia	Total income		Farm income				Non-farm income			Wage non-farm income			
	Rural HHs	Old HH head	Rural HHs	Head with low education	Young HH head	Old HH head	Rural HHs	Female HH head	Old HH head	Rural HHs	Female HH head	Young HH head	Old HH head
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
VARIABLES	Ln income pc	Ln income pc	Ln income pc	Ln farm income pc	Ln farm income pc	Ln farm income pc	Ln non-farm income pc	Ln non-farm income pc	Ln non-farm income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc	Ln wage income pc
tembin30_40_lag_dry	-0.0841	0.1214	-0.0609	-0.1656	-1.2326*	0.5533	-0.5107	0.5046	0.6536	0.4729	-0.5818	0.5978	-0.0925
	(0.146)	(0.268)	(0.545)	(1.059)	(0.707)	(0.681)	(0.615)	(0.748)	(0.740)	(0.496)	(0.880)	(0.773)	(0.682)
o.tembin15_18_lag_wet	-	-	-	-	-	-	-	-	-	-	-	-	-
tembin21_24_lag_wet	0.0071	**-0.0952*****	-0.1155	**-0.3165*****	-0.0689	-0.2152	0.0593	0.0546	-0.0555	-0.0189	-0.0729	**-0.4026****	**0.3505***
	(0.023)	(0.032)	(0.097)	(0.118)	(0.196)	(0.141)	(0.077)	(0.113)	(0.130)	(0.086)	(0.239)	(0.162)	(0.201)
tembin24_27_lag_wet	0.0169	**-0.0617****	-0.0805	**-0.2636*****	-0.0774	-0.1976	0.0424	0.0674	0.0093	-0.0519	-0.0373	**0.4555*****	**0.3515***
	(0.021)	(0.031)	(0.094)	(0.098)	(0.183)	(0.122)	(0.076)	(0.099)	(0.110)	(0.078)	(0.223)	(0.150)	(0.200)
tembin27_30_lag_wet	0.0179	**-0.0646****	-0.0882	**0.2668*****	-0.1048	-0.1868	0.0341	0.0600	0.0200	-0.0457	-0.0162	**0.4354*****	**0.3442***
	(0.021)	(0.031)	(0.094)	(0.098)	(0.182)	(0.123)	(0.076)	(0.098)	(0.109)	(0.077)	(0.223)	(0.148)	(0.200)
tembin30_40_lag_wet	**0.1318***	-0.1530	0.1432	0.0865	0.3533	-0.0722	0.0996	0.4259	0.1915	-0.3631	-0.5188	**-1.0109*****	0.2758
	(0.070)	(0.121)	(0.294)	(0.404)	(0.309)	(0.367)	(0.249)	(0.385)	(0.336)	(0.288)	(0.471)	(0.340)	(0.518)
Rain current and lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district & Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district clustered FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	10.4846	25.6393*	26.1069	92.7525	21.0028	-23.9693	-45.5484	-13.7821	-27.6799	-62.6196	88.0526	114.0752*	-163.2373**
	(9.785)	(13.820)	(35.571)	(69.533)	(67.846)	(50.028)	(30.659)	(61.437)	(51.960)	(38.193)	(108.184)	(58.536)	(79.071)
Observations	12,433	5,727	13,468	4,494	6,572	6,157	13,468	4,292	6,157	13,468	4,292	6,572	6,157
R-squared	0.453	0.251	0.115	0.100	0.108	0.081	0.066	0.070	0.060	0.157	0.133	0.290	0.094
Number of hhid_n	3,010	2,693	3,027	1,760	3,016	2,740	3,027	1,841	2,740	3,027	1,841	3,016	2,740

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A14: Summary table of the changes in the coefficient of interest when controlling for transfers (dummy in Panel A and log of real value in Panel B) received by the households in Indonesia.
Source: Authors' calculation using IFLS data (1993-2014)

Panel A: Transfer dummy

Seasonal	Total income			Crop income			Non-farm income			Wage income		
	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable
All	no difference	no difference	not significant	no difference	no difference	not significant	not significant	no difference	not significant	no difference	no difference	not significant
Mostly Agricultural	no difference	no difference	not significant	positive	no difference	not significant	no difference	no difference	positive	no difference	no difference	positive
Rural	no difference	no difference	positive	negative	no difference	positive	no difference	no difference	positive	no difference	no difference	not significant
Young head	no difference	no difference	negative	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Old head	no difference	no difference	positive	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Low education	no difference	no difference	not significant	no difference	no difference	not significant	positive	positive	positive	no difference	no difference	not significant
Female head	no difference	no difference	not significant	no difference	no difference	not significant	not significant	no difference	not significant	no difference	no difference	not significant
Poor	no difference	no difference	positive	no difference	no difference	pos	no difference	no difference	not significant	no difference	no difference	not significant

Panel B: Log real value of received transfers

Seasonal	Total income			Crop income			Non-farm income			Wage income		
	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable	Wet	Dry	Transfer variable
All	no difference	no difference	positive	no difference	no difference	positive	not significant	no difference	positive	no difference	no difference	not significant
Mostly Agricultural	no difference	no difference	positive	positive	no difference	positive	no difference	no difference	positive	no difference	no difference	positive
Rural	no difference	no difference	positive	no difference	no difference	positive	no difference	no difference	positive	no difference	no difference	not significant
Young head	no difference	no difference	positive	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Old head	no difference	no difference	positive	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Low education	no difference	no difference	positive	no difference	no difference	not significant	positive	positive	positive	no difference	no difference	not significant
Female head	no difference	no difference	positive	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant
Poor	no difference	no difference	positive	no difference	no difference	not significant	no difference	no difference	not significant	no difference	no difference	not significant

Table A15: Estimated effect of climate variability on the income Gini coefficient estimated at provincial level in Vietnam

Vietnam	All	Poor	Rural	Agricultural HH	Female HH head	Ethnic minority	Head with low education	Young HH head	Old HH head
	(1) Gini coefficient	(2) Gini coefficient	(3) Gini coefficient	(4) Gini coefficient	(5) Gini coefficient	(6) Gini coefficient	(7) Gini coefficient	(8) Gini coefficient	(9) Gini coefficient
tembin00_12_lag	0.0015	**0.0016****	**0.0019***	**0.0021***	0.0010	0.0015	**0.0019****	**0.0019***	0.0006
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
tembin12_15_lag	0.0004	0.0001	0.0003	0.0001	0.0005	0.0003	0.0002	0.0004	0.0003
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
tembin15_18_lag	0.0002	0.0001	0.0002	-0.0002	0.0002	0.0001	-0.0000	0.0002	0.0002
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin21_24_lag	0.0001	0.0005	0.0002	0.0004	0.0001	0.0006	0.0000	-0.0000	0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin24_27_lag	**0.0008*****	**0.0008****	**0.0006****	**0.0010*****	**0.0007*****	**0.0008****	**0.0006***	**0.0007****	**0.0008*****
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin27_30_lag	**0.0006*****	**0.0007***	**0.0005****	**0.0008*****	**0.0005****	**0.0007****	0.0004	**0.0004***	**0.0005****
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin30_40_lag	**0.0006****	**0.0008***	**0.0005***	**0.0011*****	**0.0004***	**0.0010***	0.0005	**0.0006****	0.0005
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
tembin00_12_lag2	-0.0016	-0.0006	-0.0018	-0.0003	-0.0020	-0.0009	-0.0008	-0.0013	-0.0031
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)
tembin12_15_lag2	0.0002	0.0008**	0.0003	0.0010*	-0.0002	0.0008**	0.0005	0.0000	0.0003
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
tembin15_18_lag2	-0.0003	0.0001	-0.0000	0.0000	-0.0005	0.0001	-0.0000	-0.0004	-0.0002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin21_24_lag2	0.0001	0.0007**	0.0000	0.0003*	0.0001	0.0004*	0.0003	0.0003	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin24_27_lag2	0.0001	0.0006*	-0.0000	0.0003**	0.0000	0.0005*	0.0002	0.0002	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin27_30_lag2	-0.0000	0.0008**	-0.0001	0.0003	-0.0000	0.0006*	0.0003	0.0002	-0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin30_40_lag2	-0.0001	0.0008**	-0.0002	0.0003	-0.0002	0.0005	0.0002	0.0001	-0.0002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Rain and rain lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Vietnam	All	Poor	Rural	Agricultural HH	Female HH head	Ethnic minority	Head with low education	Young HH head	Old HH head
	(1) Gini coefficient	(2) Gini coefficient	(3) Gini coefficient	(4) Gini coefficient	(5) Gini coefficient	(6) Gini coefficient	(7) Gini coefficient	(8) Gini coefficient	(9) Gini coefficient
Commune & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region, commune and year clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.2166**	-0.0101	0.2762**	0.0378	0.2260***	0.1227	0.1690	0.2015**	0.2082
	(0.068)	(0.163)	(0.111)	(0.084)	(0.059)	(0.147)	(0.161)	(0.082)	(0.148)
Observations	97,783	16,195	71,955	13,675	23,603	14,304	25,747	28,374	22,318
R-squared	0.569	0.755	0.596	0.710	0.620	0.746	0.612	0.638	0.641

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A16: Estimated effect of climate variability on the income Gini coefficient estimated at provincial level in Vietnam, seasonal variables

Vietnam	All	Poor	Rural	Agricultural HH	Female HH head	Ethnic minority	Head with low education	Young HH head	Old HH head
	(1) Gini coefficient	(2) Gini coefficient	(3) Gini coefficient	(4) Gini coefficient	(5) Gini coefficient	(6) Gini coefficient	(7) Gini coefficient	(8) Gini coefficient	(9) Gini coefficient
tembin00_12_y_lag_dry	0.0014	0.0016	0.0014	0.0015	0.0018	-0.0002	0.0015	0.0017	-0.0002
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)
tembin12_15_y_lag_dry	0.0007	**0.0013****	0.0009	**0.0010****	0.0004	0.0002	0.0010	0.0007	0.0004
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
tembin15_18_y_lag_dry	0.0004	0.0004	0.0006	0.0002	0.0004	-0.0003	0.0004	0.0004	0.0004
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin21_24_y_lag_dry	0.0000	0.0006	-0.0000	0.0000	0.0001	0.0005	0.0003	0.0001	-0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin24_27_y_lag_dry	-0.0003	0.0003	-0.0003	-0.0003	-0.0004	0.0005	-0.0001	-0.0002	-0.0004
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin27_30_y_lag_dry	-0.0008	0.0001	-0.0006	-0.0005	**-0.0008***	0.0005	-0.0002	-0.0008	-0.0007
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
tembin30_40_y_lag_dry	-0.0010*	0.0004	**-0.0011***	-0.0011	**-0.0013****	0.0015	-0.0006	-0.0007	**-0.0011***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
tembin00_12_y_lag_wet	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin12_15_y_lag_wet	-0.0695	**-0.0615***	-0.0557	-0.0632	0.0000	-0.0494	-0.0646	-0.0490	0.0000
	(0.045)	(0.032)	(0.062)	(0.053)	(0.000)	(0.032)	(0.061)	(0.036)	(0.000)
tembin15_18_y_lag_wet	-0.0056	-0.0009	-0.0040	-0.0029	-0.0102	0.0005	0.0004	-0.0045	-0.0010
	(0.007)	(0.004)	(0.008)	(0.008)	(0.012)	(0.004)	(0.004)	(0.008)	(0.008)
tembin21_24_y_lag_wet	**-0.0031****	**-0.0024*****	**-0.0039*****	**-0.0032***	-0.0028	**-0.0018****	**-0.0027****	**-0.0032****	-0.0024
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
tembin24_27_y_lag_wet	-0.0020	**-0.0018***	**-0.0029*****	-0.0017	-0.0015	-0.0012	-0.0019	**-0.0023***	-0.0011
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
tembin27_30_y_lag_wet	-0.0023	-0.0019	**-0.0031****	-0.0018	-0.0018	-0.0014	-0.0020	**-0.0027***	-0.0013
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
tembin30_40_y_lag_wet	-0.0023	-0.0017	**-0.0031****	-0.0017	-0.0019	-0.0016	-0.0021	**-0.0028***	-0.0014
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
tembin00_12_y_lag2_dry	0.0019	**0.0021****	0.0023	0.0017	0.0021	0.0014	0.0026*	0.0021	0.0015
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
tembin12_15_y_lag2_dry	0.0008	0.0006	0.0007	0.0009	0.0007	**0.0009***	0.0008	0.0009	0.0005
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)

Vietnam	All	Poor	Rural	Agricultural HH	Female HH head	Ethnic minority	Head with low education	Young HH head	Old HH head
	(1) Gini coefficient	(2) Gini coefficient	(3) Gini coefficient	(4) Gini coefficient	(5) Gini coefficient	(6) Gini coefficient	(7) Gini coefficient	(8) Gini coefficient	(9) Gini coefficient
tembin15_18_y_lag2_dry	0.0005	0.0003	0.0005	0.0006	0.0007	**0.0006***	0.0005	0.0004	0.0006
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin21_24_y_lag2_dry	0.0000	0.0002	0.0001	-0.0002	0.0001	-0.0001	-0.0001	-0.0001	0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin24_27_y_lag2_dry	0.0001	0.0001	0.0003	0.0001	0.0001	-0.0003	0.0001	0.0002	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
tembin27_30_y_lag2_dry	0.0003	0.0006	0.0004	0.0002	0.0004	0.0002	0.0003	0.0002	0.0003
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin30_40_y_lag2_dry	0.0003	0.0001	0.0001	-0.0004	0.0006	**-0.0019****	0.0001	0.0005	0.0003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
tembin00_12_y_lag2_wet	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin12_15_y_lag2_wet	-0.0176	0.0186	-0.0200	-0.0258	0.0000	0.0299	-0.0016	0.0019	0.0000
	(0.041)	(0.035)	(0.058)	(0.026)	(0.000)	(0.037)	(0.039)	(0.052)	(0.000)
tembin15_18_y_lag2_wet	**-0.0135***	**-0.0127***	-0.0130	**-0.0099****	**-0.0136***	-0.0086	-0.0116	**-0.0119***	-0.0207
	(0.006)	(0.007)	(0.007)	(0.004)	(0.006)	(0.006)	(0.007)	(0.005)	(0.013)
tembin21_24_y_lag2_wet	0.0007	0.0009	0.0018	0.0012	-0.0000	0.0008	0.0014	0.0012	-0.0003
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
tembin24_27_y_lag2_wet	0.0015	0.0012	0.0026	0.0016	0.0011	0.0008	0.0020	0.0020	0.0006
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
tembin27_30_y_lag2_wet	0.0020	**0.0017***	0.0031	0.0021	0.0017	0.0009	0.0024	**0.0026***	0.0010
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
tembin30_40_y_lag2_wet	0.0019	**0.0018***	0.0030	0.0022	0.0014	0.0013	0.0024	**0.0026***	0.0008
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Rain and rain lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region, commune and year clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.2024	0.1881	0.1428	0.1505	0.1751	0.3306	0.0830	0.1623	0.2840
	(0.181)	(0.216)	(0.277)	(0.151)	(0.272)	(0.217)	(0.215)	(0.214)	(0.221)
Observations	97,783	16,195	71,955	13,675	23,603	14,304	25,747	28,374	22,318
R-squared	0.589	0.769	0.615	0.722	0.636	0.765	0.629	0.655	0.659

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A17: Summary table of the changes in the coefficient of interest when controlling for transfers (dummy in Panel A and log of real value in Panel B) received by the households in Vietnam.
Source: Authors' calculation using VHLSS data (2002-2018)

Panel A: Transfer dummy		
Annual	**Gini coefficient**	**Transfer variable**
All	no difference	not significant
Mostly agricultural	no difference	not significant
Rural	no difference	not significant
Young head	no difference	not significant
Old head	no difference	not significant
Low education	no difference	not significant
Female head	no difference	not significant
Ethnic minority	no difference	not significant
Poor	no difference	not significant

Panel B: Log real value of transfers received		
Annual	**Gini coefficient**	**Transfer variable**
All	no difference	not significant
Mostly agricultural	no difference	not significant
Rural	no difference	not significant
Young head	no difference	not significant
Old head	no difference	not significant
Low education	no difference	not significant
Female head	no difference	not significant
Ethnic minority	no difference	not significant
Poor	no difference	not significant

Table A18: Summary table of the changes in the coefficient of interest when controlling for transfers (dummy in Panel A and log of real value in Panel B) received by the households in Vietnam.
Source: Authors' calculation using VHLSS data (2002-2018)

Panel A: Transfer dummy			
Seasonal	**Gini coefficient**		
	Wet	**Dry**	**Transfer variable**
All	no difference	no difference	not significant
Mostly agricultural	no difference	no difference	not significant
Rural	no difference	no difference	not significant
Young head	no difference	no difference	not significant
Old head	no difference	no difference	not significant
Low education	no difference	no difference	not significant
Female head	no difference	no difference	not significant
Ethnic minority	no difference	no difference	not significant
Poor	no difference	no difference	not significant

Panel B: Log real value of transfers received			
Seasonal	**Gini coefficient**		
	Wet	**Dry**	**Transfer variable**
All	no difference	no difference	not significant
Mostly agricultural	no difference	no difference	not significant
Rural	no difference	no difference	not significant
Young head	no difference	no difference	not significant
Old head	no difference	no difference	not significant
Low education	no difference	no difference	not significant
Female head	no difference	no difference	not significant
Ethnic minority	no difference	no difference	not significant
Poor	no difference	no difference	not significant

Table A19: Estimated effect of climate variability on the income Gini coefficient estimated at provincial level in Indonesia

Indonesia	All	Poor	Rural	Agricultural HH	Female HH head	Head with low education	Young HH head	Old HH head
	(1) Gini coefficient	(2) Gini coefficient	(3) Gini coefficient	(4) Gini coefficient	(5) Gini coefficient	(7) Gini coefficient	(8) Gini coefficient	(9) Gini coefficient
tembin15_18_lag	**0.0989*** **	**0.1159*** **	**0.1044*** **	**0.0851*** **	**0.0765*** **	**0.0775*** **	**0.0543*** **	**0.0807*** **
	(0.009)	(0.016)	(0.012)	(0.012)	(0.008)	(0.011)	(0.015)	(0.009)
tembin21_24_lag	-0.0000	0.0002	-0.0001	-0.0002	0.0001	-0.0008**	0.0002	-0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin24_27_lag	**-0.0005*** **	**-0.0005* **	**-0.0006** **	**-0.0008** **	**-0.0005** **	**-0.0009*** **	**-0.0006** **	**-0.0005* **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin27_30_lag	**-0.0007*** **	**-0.0008*** **	**-0.0008*** **	**-0.0009*** **	**-0.0008*** **	**-0.0010*** **	**-0.0008*** **	**-0.0007** **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
tembin30_40_lag	**0.0258*** **	**0.0227*** **	**0.0195** **	**0.0186* **	**0.0149**	0.0167	**0.0195*** **	**0.0201* **
	(0.007)	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)	(0.008)	(0.011)
o.tembin15_18_lag2	-	-	-	-	-	-	-	-
tembin21_24_lag2	-0.0056	-0.0042	-0.0108	-0.0103	-0.0065	-0.0157**	-0.0053	-0.0062
	(0.004)	(0.006)	(0.011)	(0.008)	(0.005)	(0.008)	(0.005)	(0.009)
tembin24_27_lag2	-0.0053	-0.0040	-0.0105	-0.0099	-0.0060	-0.0154**	-0.0050	-0.0060
	(0.004)	(0.006)	(0.010)	(0.008)	(0.005)	(0.008)	(0.005)	(0.009)
tembin27_30_lag2	-0.0052	-0.0038	-0.0104	-0.0099	-0.0059	-0.0154**	-0.0048	-0.0059
	(0.004)	(0.006)	(0.010)	(0.008)	(0.005)	(0.008)	(0.005)	(0.009)
tembin30_40_lag2	-0.0146***	-0.0077	-0.0281**	-0.0249***	-0.0151**	-0.0270***	-0.0166**	-0.0148
	(0.005)	(0.008)	(0.011)	(0.009)	(0.007)	(0.009)	(0.007)	(0.010)
Rain current and lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.9312**	2.6903	5.0231	4.6843*	3.2026	6.7410**	2.8081	3.3319
	(1.387)	(2.048)	(3.816)	(2.794)	(2.021)	(2.822)	(1.892)	(3.291)
Observations	24,544	12,244	13,468	8,024	4,292	4,494	6,572	6,157
R-squared	0.589	0.525	0.602	0.615	0.565	0.618	0.450	0.544
Number of hhid_n	4,909	4,766	3,027	3,454	1,841	1,760	3,016	2,740

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A20: Estimated effect of climate variability on the income Gini coefficient estimated at provincial level in Indonesia, seasonal variables

Indonesia	All	Poor	Rural	Agricultural HH	Female HH head	Head with low education	Young HH head	Old HH head
	(1) Gini coefficient	(2) Gini coefficient	(3) Gini coefficient	(4) Gini coefficient	(5) Gini coefficient	(7) Gini coefficient	(8) Gini coefficient	(9) Gini coefficient
tembin15_18_y_lag_dry	-0.0178	-0.0315	0.0155	**-0.0731***	-0.0423	0.0287	-0.0317	0.0320
	(0.030)	(0.064)	(0.031)	(0.041)	(0.042)	(0.043)	(0.048)	(0.048)
tembin21_24_y_lag_dry	0.0012	0.0044	0.0043	**-0.0179****	0.0009	**0.0086****	-0.0004	-0.0011
	(0.004)	(0.007)	(0.004)	(0.009)	(0.006)	(0.004)	(0.005)	(0.007)
tembin24_27_y_lag_dry	0.0011	0.0047	0.0041	**-0.0182****	0.0014	**0.0093*****	0.0010	-0.0008
	(0.004)	(0.007)	(0.004)	(0.009)	(0.006)	(0.003)	(0.006)	(0.007)
tembin27_30_y_lag_dry	-0.0001	0.0035	0.0030	**-0.0193****	0.0003	**0.0081*****	0.0000	-0.0018
	(0.004)	(0.007)	(0.004)	(0.009)	(0.006)	(0.003)	(0.006)	(0.007)
tembin30_40_y_lag_dry		**-0.1428*****		-	**-0.1082*****	-	-	-
		(0.021)			(0.027)			
tembin15_18_y_lag_wet	**0.1152*****	**0.1182****	**0.1329*****	**0.1306*****	**0.0801****	**0.1118*****	0.0411	**0.1248*****
	(0.025)	(0.051)	(0.020)	(0.021)	(0.034)	(0.027)	(0.074)	(0.020)
tembin21_24_y_lag_wet	0.0012	0.0056**	0.0023	0.0040	0.0008	0.0052	-0.0024	0.0012
	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
tembin24_27_y_lag_wet	0.0002	0.0042	0.0014	0.0033	-0.0007	0.0033	-0.0040	0.0007
	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
tembin27_30_y_lag_wet	0.0003	0.0041	0.0013	0.0032	-0.0006	0.0030	-0.0040	0.0007
	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
tembin30_40_y_lag_wet	**-0.0289*****	**-0.0190***	**-0.0288*****	**-0.0228****	**-0.0298*****	**-0.0378*****	**-0.0268*****	**-0.0251****
	(0.008)	(0.010)	(0.010)	(0.009)	(0.009)	(0.008)	(0.010)	(0.010)
o.tembin15_18_y_lag2_dry	-	-	-	-	-	-	-	-
tembin21_24_y_lag2_dry	-0.0032	-0.0062	**-0.0066***	0.0123	-0.0042	**-0.0124*****	-0.0034	-0.0011
	(0.004)	(0.006)	(0.003)	(0.008)	(0.005)	(0.002)	(0.005)	(0.006)
tembin24_27_y_lag2_dry	-0.0019	-0.0036	-0.0054	0.0138	-0.0031	**-0.0107*****	-0.0010	0.0000
	(0.004)	(0.006)	(0.003)	(0.009)	(0.004)	(0.002)	(0.005)	(0.006)
tembin27_30_y_lag2_dry	-0.0011	-0.0023	-0.0045	**0.0145***	-0.0026	**-0.0097*****	0.0002	0.0007
	(0.004)	(0.006)	(0.003)	(0.009)	(0.004)	(0.002)	(0.005)	(0.006)
tembin30_40_y_lag2_dry	0.0003	0.0123	0.0038	**0.0263***	0.0019	**-0.0166****	0.0140	0.0091
	(0.007)	(0.012)	(0.011)	(0.014)	(0.009)	(0.008)	(0.010)	(0.010)
o.tembin15_18_y_lag2_wet	-	-	-	-	-	-	-	-
tembin21_24_y_lag2_wet	0.0003	**0.0050****	0.0019	0.0040	-0.0007	0.0008	**0.0055****	0.0034
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
tembin24_27_y_lag2_wet	0.0002	0.0036	0.0016	0.0034	-0.0005	0.0001	**0.0045***	0.0025
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
tembin27_30_y_lag2_wet	0.0004	0.0034	0.0018	0.0036	-0.0003	0.0001	**0.0047****	0.0025
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
tembin30_40_y_lag2_wet	0.0014	0.0050	**-0.0119****	-0.0030	-0.0101	-0.0027	0.0050	0.0000
	(0.005)	(0.007)	(0.005)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
Rain and rain lagged	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune & year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region, commune and year clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.7143*	-1.3896	-0.0177	0.2860	1.0661	0.5863	0.1359	0.2135
	(0.413)	(1.030)	(0.825)	(1.058)	(1.319)	(1.130)	(0.784)	(1.152)
Observations	24,544	12,244	13,468	8,024	4,292	4,494	6,572	6,157
R-squared	0.622	0.570	0.641	0.664	0.599	0.658	0.506	0.560
Number of hhid_n	4,909	4,766	3,027	3,454	1,841	1,760	3,016	2,740

Robust standard errors in parentheses
*** p<0.01, * p<0.05, * p<0.1

Table A21: Summary table of the changes in the coefficient of interest when controlling for transfers (dummy in Panel A and log of real value in Panel B) received by the households in Indonesia.
Source: Authors' calculation using IFLS data (1993-2014)

Panel A: Transfer dummy		
Annual	**Gini coefficient**	**Transfer variable**
All	no difference	positive
Mostly agricultural	no difference	positive
Rural	no difference	positive
Young head	no difference	positive
Old head	no difference	not significant
Low education	no difference	positive
Female head	no difference	positive
Poor	no difference	positive

Panel B: Log real value of transfer received		
Annual	**Gini coefficient**	**Transfer variable**
All	no difference	not significant
Mostly agricultural	no difference	not significant
Rural	no difference	not significant
Young head	no difference	not significant
Old head	no difference	not significant
Low education	no difference	not significant
Female head	no difference	not significant
Poor	no difference	not significant

Table A22; Summary table of the changes in the coefficient of interest when controlling for transfers (dummy in Panel A and log of real value in Panel B) received by the households in Indonesia.
Source: Authors' calculation using VHLSS data (1993-2014)

Panel A: Transfer dummy			
Seasonal	**Gini coefficient**		
	Wet	**Dry**	**Transfer variable**
All	no difference	no difference	positive
Mostly agricultural	no difference	no difference	positive
Rural	no difference	no difference	positive
Young head	no difference	no difference	positive
Old head	no difference	no difference	positive
Low education	no difference	no difference	positive
Female head	no difference	no difference	positive

Panel B: Log real value of transfer received			
Seasonal	**Gini coefficient**		
	Wet	**Dry**	**Transfer variable**
All	no difference	no difference	positive
Mostly agricultural	no difference	no difference	positive
Rural	no difference	no difference	positive
Young head	no difference	no difference	positive
Old head	no difference	no difference	not significant
Low education	no difference	no difference	not significant
Female head	no difference	no difference	positive
Poor	no difference	no difference	positive

Appendix - 2

Synthetic panels for Vietnam, Household level data

Summary for Tables B 4.1-B4.4

1. Tables B4.1-B4.4 report estimates of mobility measured by changes in the proportion of households that move across poverty status. The tables show point estimates and standard errors of true panel mobility, together with lower and upper bound predictions of poverty mobility for the specification showed in Table B2. The model overall works well: true panel estimates lie within the estimated bounds and most of the point estimates lie within the 95 percent confidence interval of the true poverty rate.
2. For example, Table B4.2 suggests that 6.5 and 6.2 percent of households escape poverty in Vietnam between 2010-2012 and 2014-2016 respectively, while the actual panel dataset suggests that actual upward mobility is 9.7 and 7.0 percent.
3. Similarly, true downward mobility (Table B4.3) is 4.2 and 1.5 percent in Vietnam between 2010-2012 and 2014-2016 respectively, while the model predicts that 2.8 and 1.4 entered poverty between first and second rounds of the survey.

Summary for Figures B1-B2

4. We plot the proposed point estimates of poverty transition rates for sub-groups of the population in Vietnam categorized by ethnicity (i.e., ethnic minority groups), by gender and employment sector of household heads (i.e., employed in agriculture or in other sectors), and residence areas (i.e., urban or rural households) in Figures B1 and B2.
5. These graphs indicate that female-headed are most likely to experience substantial transitions in and out of poverty in all periods compared to male-headed households. For example, Figure B1 suggests 48 percent of the population with female household heads move out of poverty in the past 2 years in 2014-2016, while 41 percent of population with male heads have similar transition.
6. Ethnic minority groups have a higher probability of moving into poverty than ethnic majority groups in all periods. For example, Figure B2 suggests 37 percent of the minor ethnicity population move in poverty in the past 2 years in 2008-2010, while only 9 percent of population with major ethnicity have similar transition.
7. On the other hand, households living in an urban area appear to be better off than those living in rural area: only 4 percent of urban population moved into poverty between 2008-2010 compared to 15 percent of rural households (Figure B2).

Summary for Figures B3-B4

8. Figure B3 and B4 show the results of locally weighted regressions of (conditional) probability of upward mobility on the mean temperature (Panel A) and rainfall (Panel B) of the past 12 month (Figure B3) and of the past 12-24 month (Figure B4) from the second survey round.
9. Although, Figure B3 and Figure B4 suggest that higher temperatures are positively correlated with upward mobility (Panel A), the effect of temperature on mobility seems to be quite non-linear at the tails of the distributions.
10. On the other hand, the effect of rainfall on upward mobility (Panel B) is negative and quite linear in Figure B4 but has a non-linear shape in Figure B3 with negative effect starting from 2000mm.

Summary for Figures B5-B8

11. The same strategy as in Figure B4 was applied to various demographic groups. There is unequal effect of rising temperature and rainfall on downward mobility of households by ethnicity, gender and occupation of household head and by locality.

12. Figure B5 indicates that male-headed households have the higher the sensitivity to warm and moderately hot days: rising the temperature from 20C to 26C is associated with lower downward mobility in this group than in female-headed households (Panel A).

13. Figure B6 shows weak positive effect of rising temperature on downward mobility for major ethnicities and weak negative effect of warming on minor ethnicities (Panel A).

14. Figures B7 and B8 show that poverty status of households with heads employed in agriculture and living in rural areas are more sensitive to rising the temperature (Panel A) as well as to rising rainfall (Panel B).

Summary for Figures B9-B13

15. We also estimated the same correlations than before but instead of using mean temperature, we use deviations from (monthly) mean temperature over the past 3, 5, 10, 15 and 20 years.

16. Figures B9 and B10 are based on data in 2002, 2004, 2006 and 2008. We find that positive temperature shock has negative effect on probability of becoming poor (Figure B9) and positive effect on upward mobility (Figure B10). Relationship is linear and holds regardless of the period we used as a base.

17. Figures B11 and B12 are based on data 2008, 2010, 2012, 2014 and 2016. We again find the same pattern as in Figures B9 and B10, but the effect of positive temperature shock on mobility is more non-linear.

18. The main findings in Figures B13 and B14 are not changed by using all available data (2002-2016).

Table B1. Poverty Rates, Vietnam

		Poverty headcount ratio	
	VHLSS	**At $1.90 a day (2011 PPP)**	**At national poverty lines**
2002	28.8	38	
2004	19.5	26.5	
2006	13.5	19.5	
2008	11.7	14.8	
2010	20.7	4.2	20.7
2012	17.2	2.8	17.2
2014	13.5	2.7	13.5
2016	9.8	2	9.8

Source: VHLSS, Poverty & Equity Databank and PovcalNet

Table B2. Estimated parameters of household consumption per capita (first stage regression: OLS model for second year based on characteristics of household heads),VHLSS

	2004	**2006**	**2008**	**2010**	**2012**	**2014**	**2016**
Age of head	0.010***	0.010***	0.009***	0.009***	0.010***	0.010***	0.012***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Female	0.093***	0.084***	0.087***	0.121***	0.082***	0.076***	0.100***
	(0.02)	*(0.01)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
Education level (reference level - < primary)							
Primary	0.157***	0.132***	0.168***	0.202***	0.220***	0.200***	0.173***
	(0.02)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
Lower secondary	0.228***	0.182***	0.241***	0.294***	0.301***	0.269***	0.267***
	(0.02)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
Upper-secondary	0.373***	0.361***	0.411***	0.440***	0.448***	0.455***	0.420***
	(0.03)	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*
Technical degree	0.502***	0.504***	0.514***	0.567***	0.550***	0.559***	0.538***
	(0.02)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.03)*	*(0.03)*
Post-secondary	0.808***	0.805***	0.848***	0.922***	0.892***	0.851***	0.820***
	(0.03)	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*	*(0.03)*
Ethnic minorities	-0.452***	-0.414***	-0.418***	-0.516***	-0.482***	-0.571***	-0.571***
	(0.02)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
Type of location							
Urban	0.457***	0.417***	0.338***	0.292***	0.250***	0.211***	0.218***
	(0.02)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
_cons	8.504***	8.723***	8.763***	9.255***	9.294***	9.400***	9.491***
	(0.04)	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*
Adjusted R2	0.438	0.435	0.403	0.426	0.410	0.428	0.431
Number of observations	6 784	6 788	6 669	6 829	6 665	6 500	6 347

Note: *** p<0.01, ** p<0.05, * p<0.1; Standard errors clustered at psu are in parentheses. Household heads' ages are restricted to between 25 and 55 for the first survey round and between 27 and 57 for the second survey round.
All estimates are obtained using cross sectional (representative) data for each year

Table B3. Comparison of estimates

	Dang et al.(2019)	Dang et al.(2014)	Our estimates	
Period	2012-2014	2006-2008	2006-2008	2012-2014
Model		Specification 2		
First Stage				
Year		2008	2008	2014
R_squared		0.465	0.403	0.428
N		1,335	6,669	6,500
Poverty Status				
Poor, Poor	10.80	10.1	8.7	11.6
	(0.3)			
Poor, Non-poor	5.90	4.5	3.8	4.2
	(0.1)			
Non-poor, Poor	4.00	4.6	3	2.4
	(0.1)			
Non-poor, Non-poor	79.30	80.9	84.5	81.8
	(0.4)			
N	3,519	3,701	6,669	6,500

References:

Dang, Hai-Anh, Dean Jolliffe, and Calogero Carletto. "Data Gaps, Data Incomparability, and Data Imputation: A Review of Poverty Measurement Methods for Data-Scarce Environments." Journal of Economic Surveys, (2019) Dang, Hai-Anh, Peter Lanjouw, Jill Luoto, and David McKenzie. "Using repeated cross-sections to explore movements into and out of poverty." Journal of Development Economics 107 (2014): 112-128

Table B4. Estimated rho from cross-sectional data, VHLSS

Period	simple rho	partial rho	
		round 1	round 2
2002-2004	0.96	0.92	0.83
2004-2006	0.95	0.87	0.87
2006-2008	0.94	0.85	0.86
2008-2010	0.92	0.87	0.79
2010-2012	0.93	0.86	0.85
2012-2014	0.95	0.88	0.89
2014-2016	0.93	0.85	0.84

Poverty dynamics from synthetic panel data for Vietnam

Table B4.1 Poverty dynamics (Poor in Year 1 and Poor in Year 2)

Period	Non-parametric estimates		Point Estimates	Number of hhs	Truth *(se)*
	Lower bound	Upper bound			
2002-2004	19.8	8.9	16.1	6,784	. .
2004-2006	13.4	5.4	11.3	6,788	10.8 *(0.8)*
2006-2008	11.9	3.7	8.7	6,669	7.7 *(0.7)*
2008-2010	12.1	5.8	10.2	6,829	. .
2010-2012	16.9	7.6	13.8	6,665	12.7 *(0.8)*
2012-2014	13.7	5.9	11.6	6,500	10.6 *(0.8)*
2014-2016	10.6	5.1	8.6	6,347	8.0 *(0.7)*

Note: Poverty rates in percent are based on the household consumption per capita and predictions obtained using data in the second survey rounds. All numbers are weighted using population weights and adjusted for complex survey design. Number of replications for non-parametric estimates is 500. Household heads' ages are restricted to between 25 and 55 for the first survey round and between 27 and 57 for the second survey round. Consumption levels are deflated using CPI to obtain real levels in 2018 prices.

Table B4.2 Poverty dynamics (Poor in Year 1 and Non-Poor in Year 2)

Period	Non-parametric estimates		Point Estimates	Number of hhs	Truth *(se)*
	Lower bound	Upper bound			
2002-2004	7.5	16.7	9.3	6,784	. .
2004-2006	7.1	13.2	7.6	6,788	10.3 *(0.7)*
2006-2008	1.3	8.3	3.8	6,669	5.6 *(0.5)*
2008-2010	0.0	5.7	1.7	6,829	. .
2010-2012	4.2	12.3	6.5	6,665	9.7 *(0.6)*
2012-2014	1.8	9.4	4.2	6,500	6.8 *(0.5)*
2014-2016	4.7	9.4	6.2	6,347	7.0 *(0.6)*

Note: Poverty rates in percent are based on the household consumption per capita and predictions obtained using data in the second survey rounds. All numbers are weighted using population weights and adjusted for complex survey design. Number of replications for non-parametric estimates is 500. Household heads' ages are restricted to between 25 and 55 for the first survey round and between 27 and 57 for the second survey round. Consumption levels are deflated using CPI to obtain real levels in 2018 prices.

Table B4.3 Poverty dynamics (Non-Poor in Year 1 and Poor in Year 2)

	Non-parametric estimates		Point Estimates	Number of hhs	Truth *(se)*
	Lower bound	Upper bound			
2002-2004	0.0	10.9	3.0	6,784	.
2004-2006	0.0	8.0	1.6	6,788	2.7 *(0.4)*
2006-2008	0.1	8.3	3.0	6,669	4.1 *(0.4)*
2008-2010	8.6	14.9	10.1	6,829	.
2010-2012	0.0	9.3	2.8	6,665	4.2 *(0.4)*
2012-2014	0.1	7.9	2.4	6,500	4.5 *(0.5)*
2014-2016	0.0	5.5	1.4	6,347	1.5 *(0.3)*

Note: Poverty rates in percent are based on the household consumption per capita and predictions obtained using data in the second survey rounds. All numbers are weighted using population weights and adjusted for complex survey design. Number of replications for non-parametric estimates is 500. Household heads' ages are restricted to between 25 and 55 for the first survey round and between 27 and 57 for the second survey round. Consumption levels are deflated using CPI to obtain real levels in 2018 prices.

Table B4.4 Poverty dynamics (Non-Poor in Year 1 and Non-Poor in Year 2)

Period	Non-parametric estimates		Point Estimates	Number of hhs	Truth *(se)*
	Lower bound	Upper bound			
2002-2004	72.7	63.5	71.6	6,784	.
2004-2006	79.6	73.4	79.5	6,788	76.3 *(1.1)*
2006-2008	86.6	79.6	84.5	6,669	82.6 *(1.0)*
2008-2010	79.3	73.6	78.0	6,829	.
2010-2012	78.9	70.7	76.8	6,665	73.4 *(1.1)*
2012-2014	84.4	76.8	81.8	6,500	78.2 *(1.1)*
2014-2016	84.6	80.0	83.8	6,347	83.5 *(1.0)*

Note: Poverty rates in percent are based on the household consumption per capita and predictions obtained using data in the second survey rounds. All numbers are weighted using population weights and adjusted for complex survey design. Number of replications for non-parametric estimates is 500. Household heads' ages are restricted to between 25 and 55 for the first survey round and between 27 and 57 for the second survey round. Consumption levels are deflated using CPI to obtain real levels in 2018 prices.

Figure B1. Profiling of the Poor Population that Escaped Poverty (conditional probabilities), Vietnam

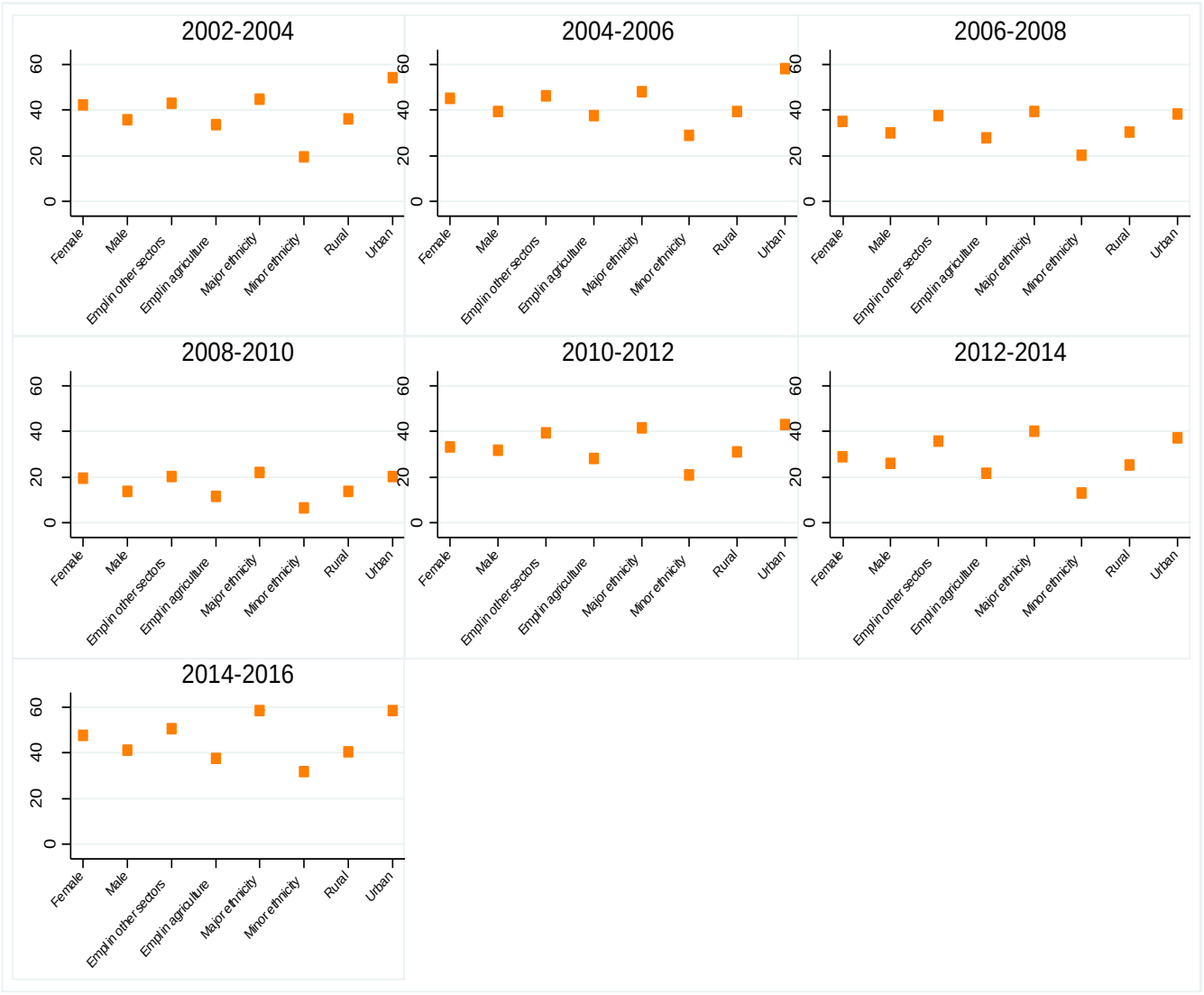


Figure B2. Profiling of the Non-Poor Population that Enter Poverty (conditional probabilities), Vietnam

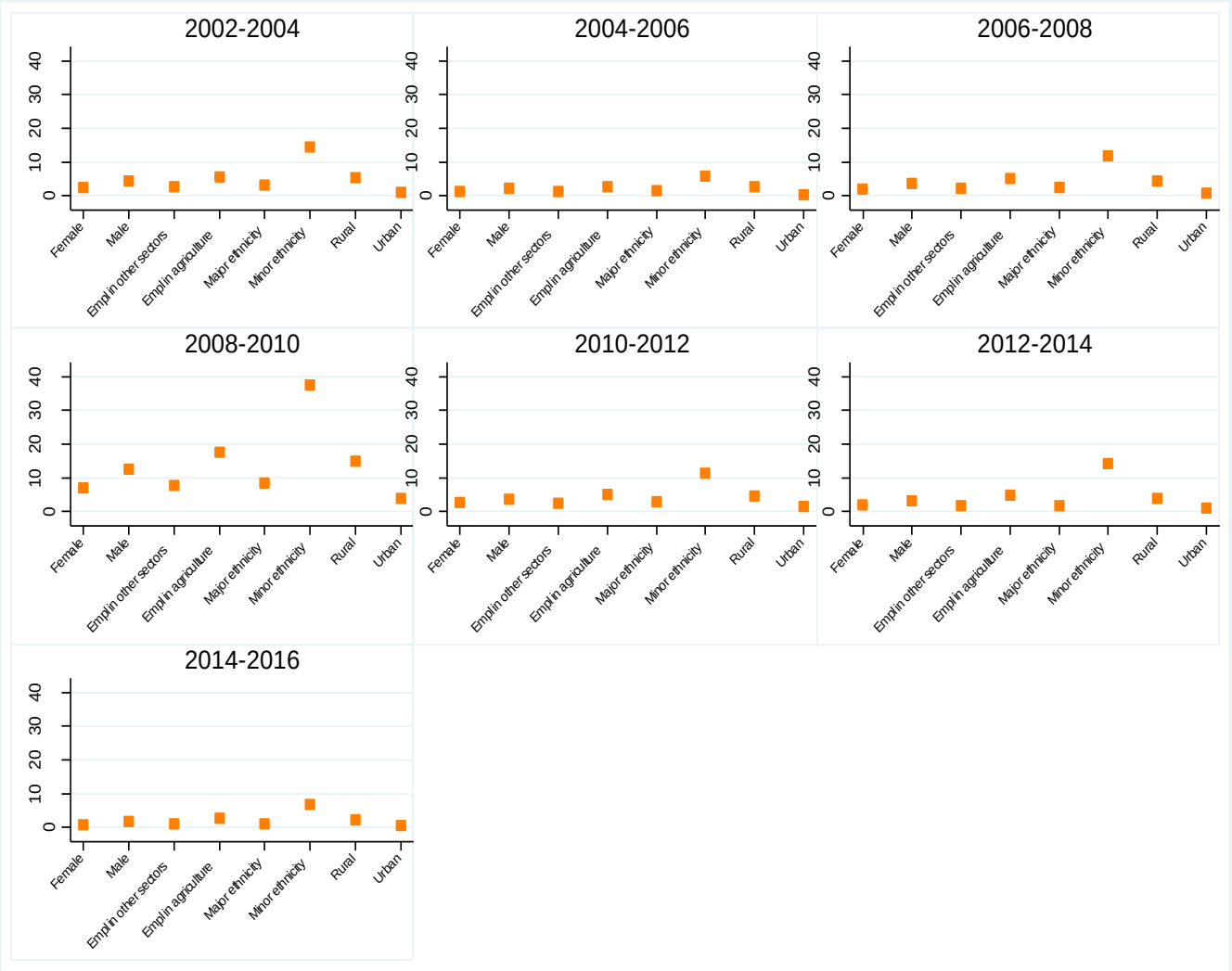


Figure B3. Correlation between average weather of the past 12 months and (conditional) probability (at household level) a poor household in the first period becomes non-poor in the second period

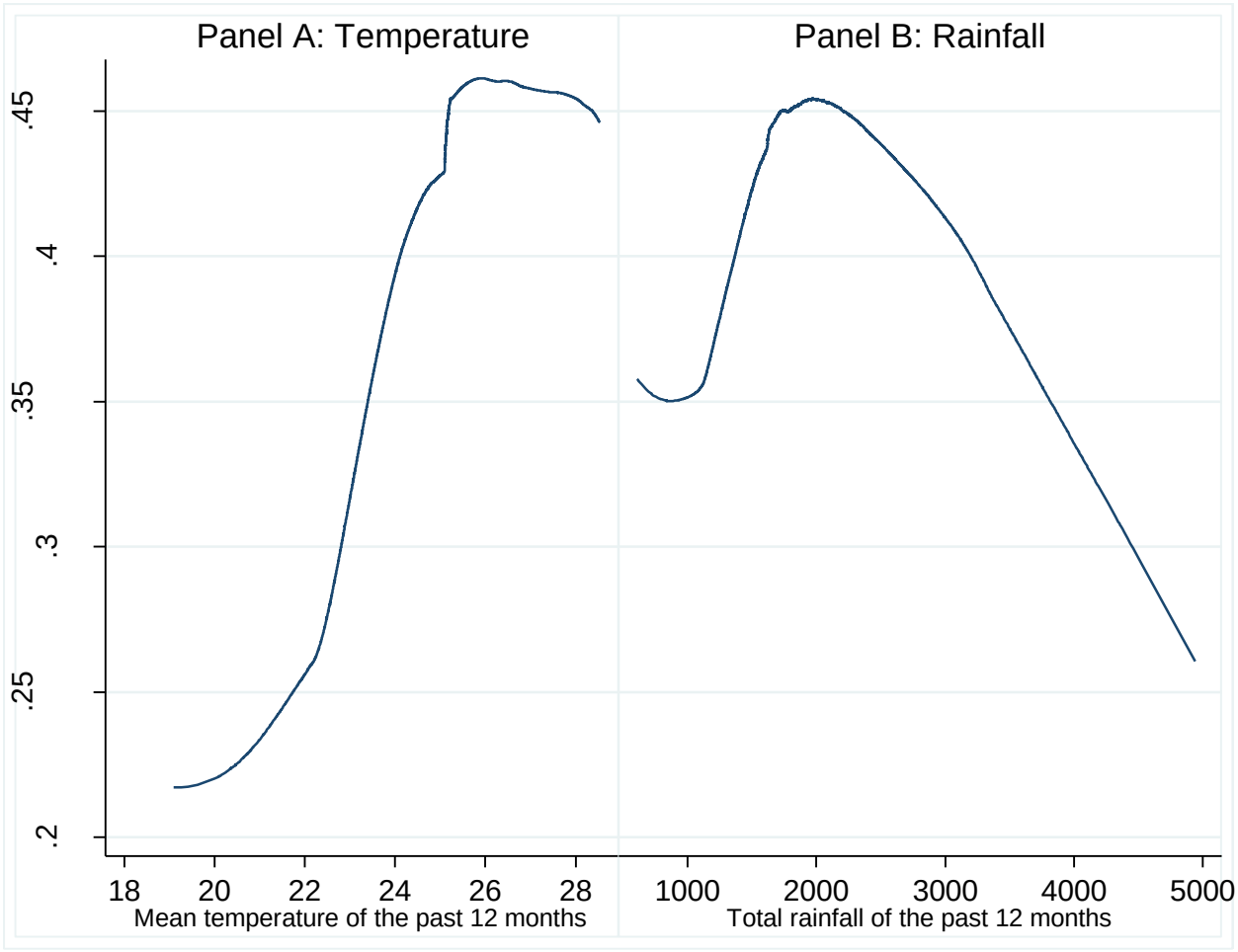


Figure B4. Correlation between average weather of the past 12-24 months and (conditional) probability (at household level) a poor household in the first period becomes non-poor in the second period

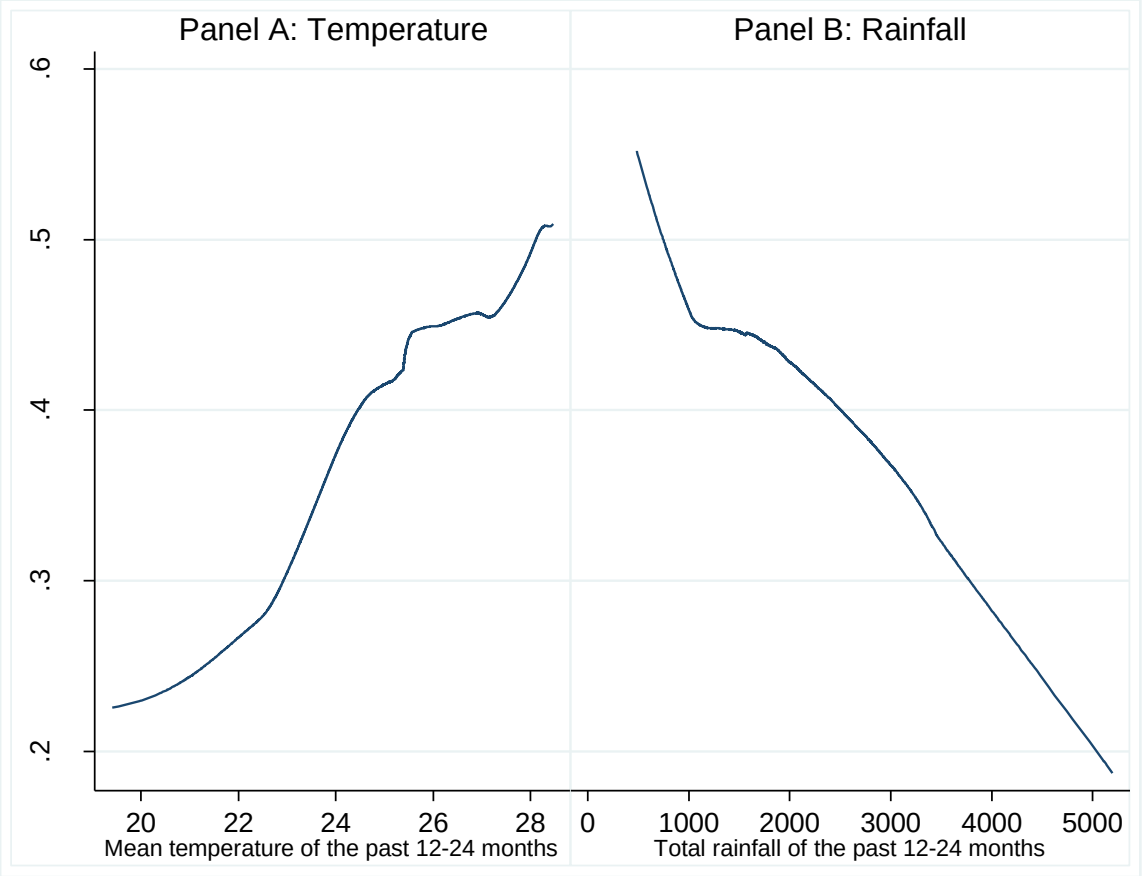


Figure B3b. Correlation between average weather of the past 12 months and (conditional) probability (at household level) a poor household in the first period becomes non-poor in the second period

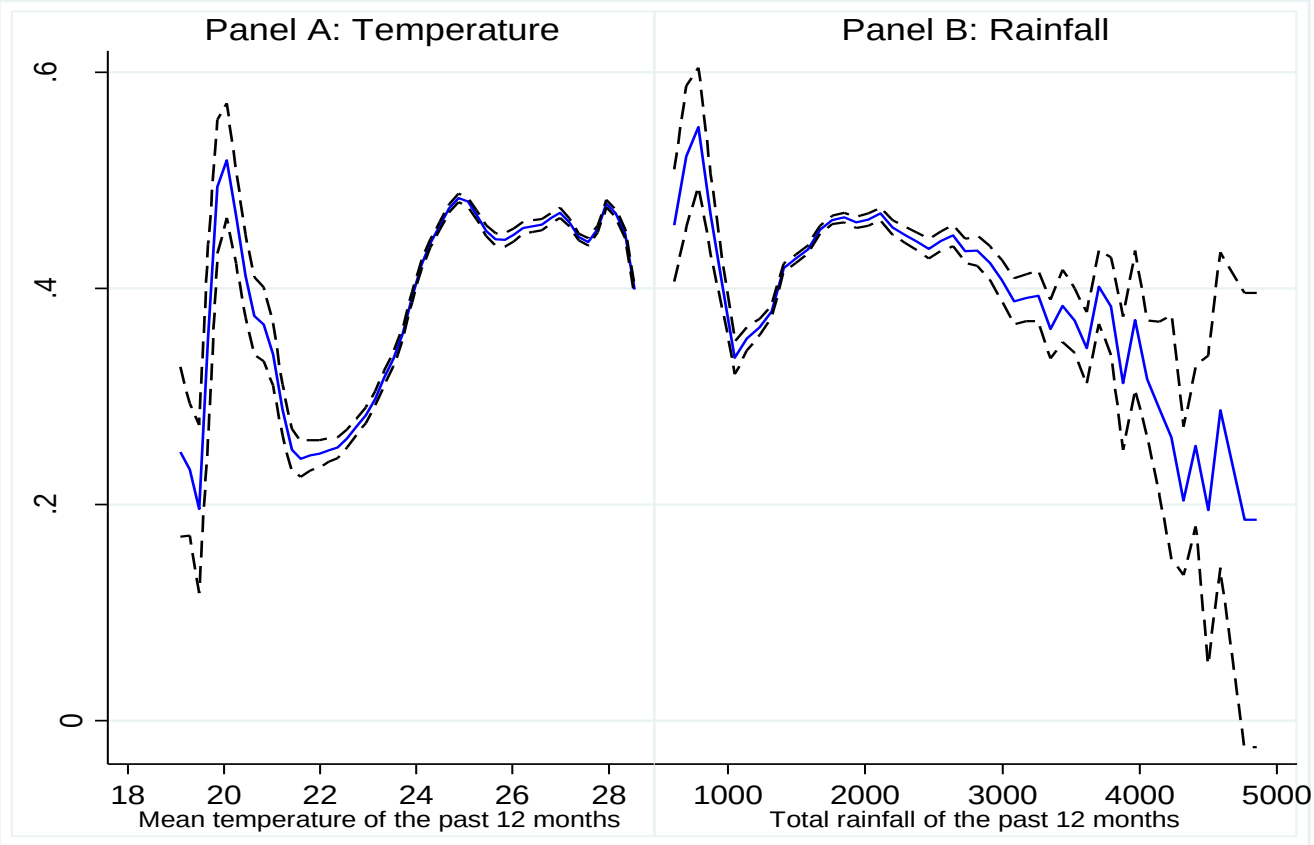
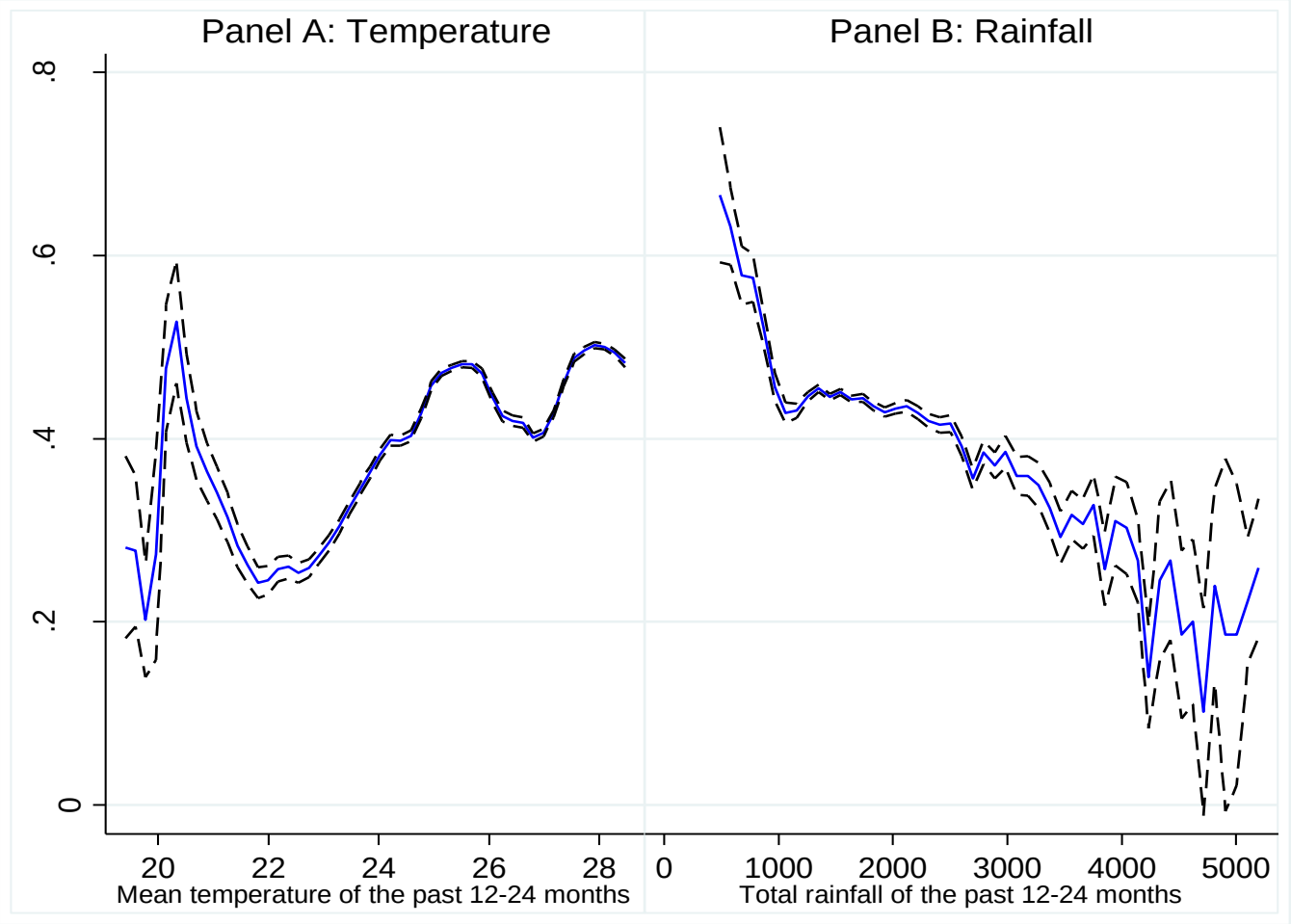


Figure B4b. Correlation between average weather of the past 24 months and (conditional) probability (at household level) a poor household in the first period becomes nonpoor in the second period



Poverty and Weather by Demographic Groups

Figure B5. Correlation between weather of the past 12-24 months and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period, by gender of household head

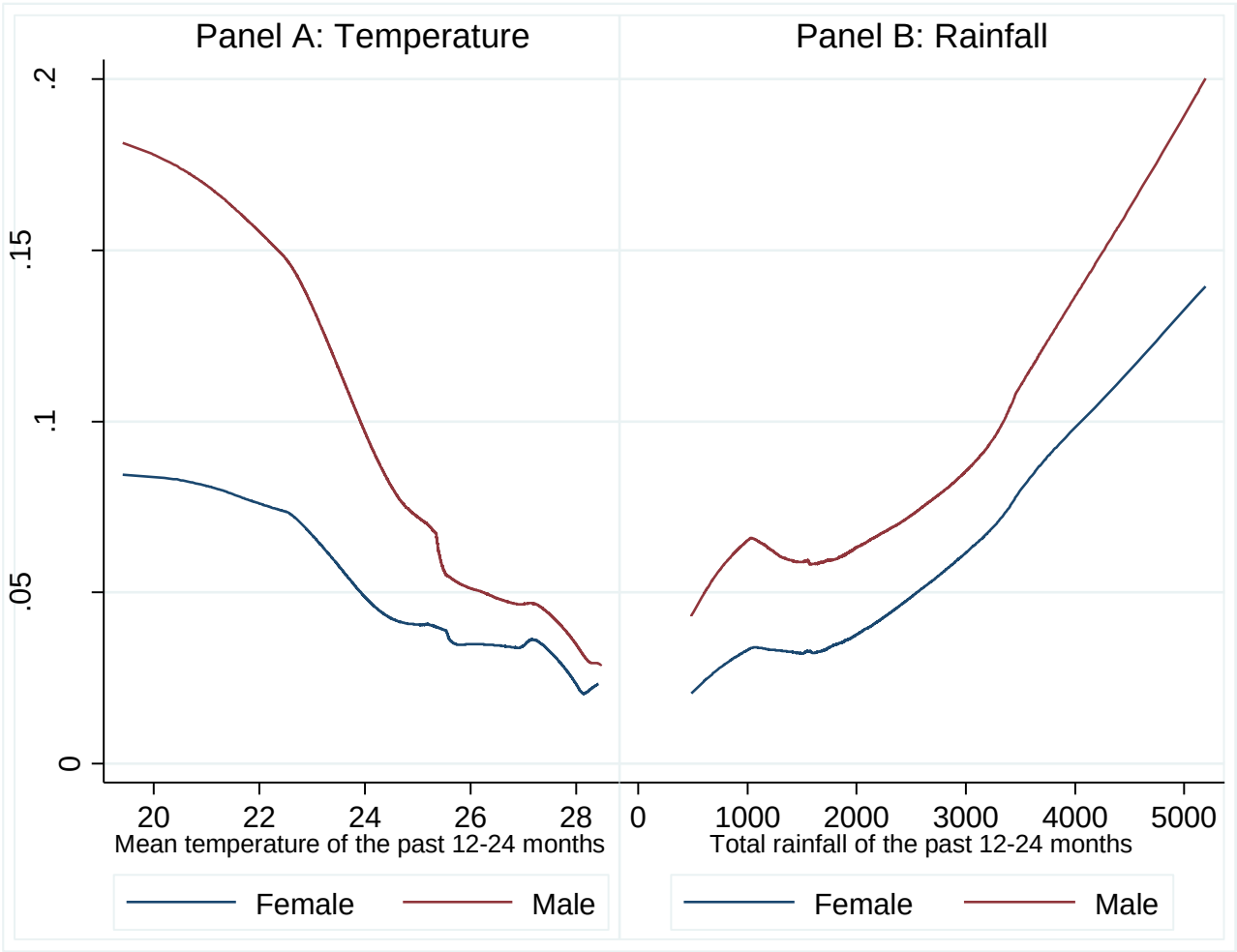


Figure B6. Correlation between weather of the past 12-24 months and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period, by ethnicity of household head

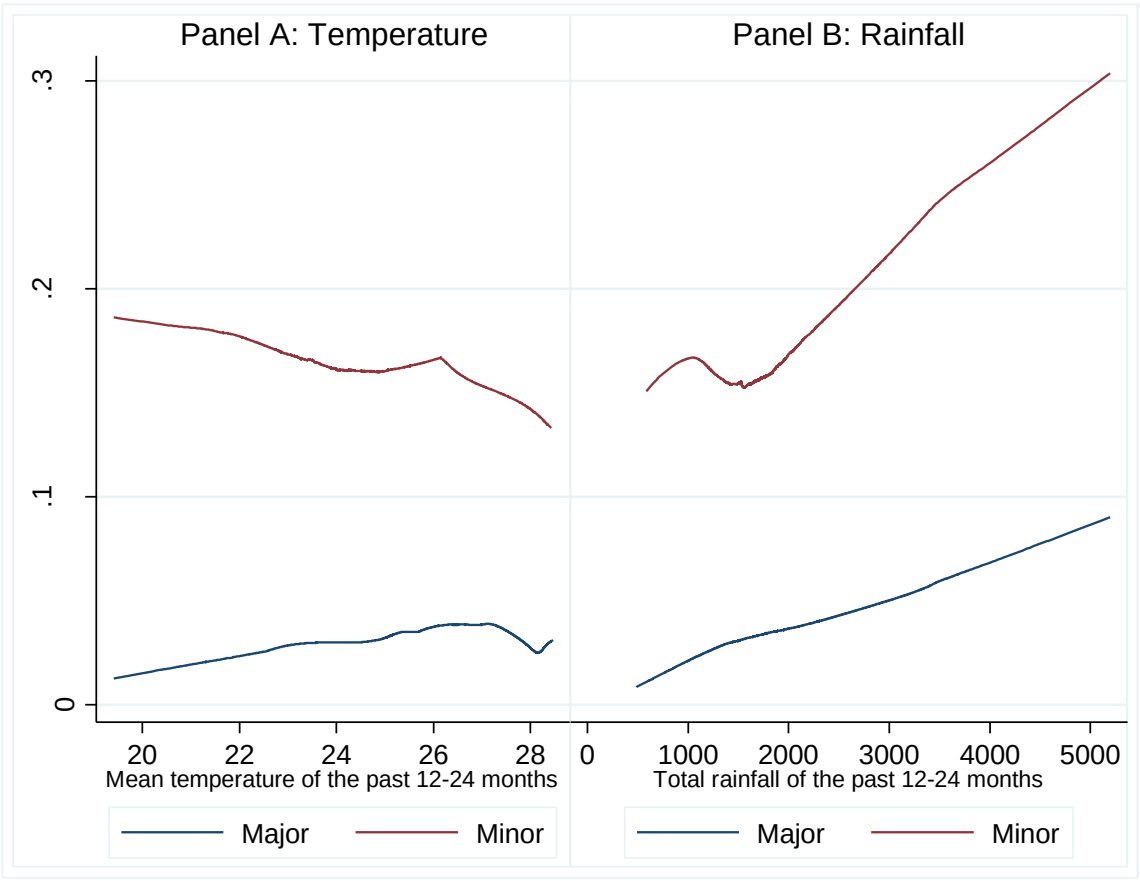


Figure B7. Correlation between weather of the past 12-24 months and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period, by employment sector of household head

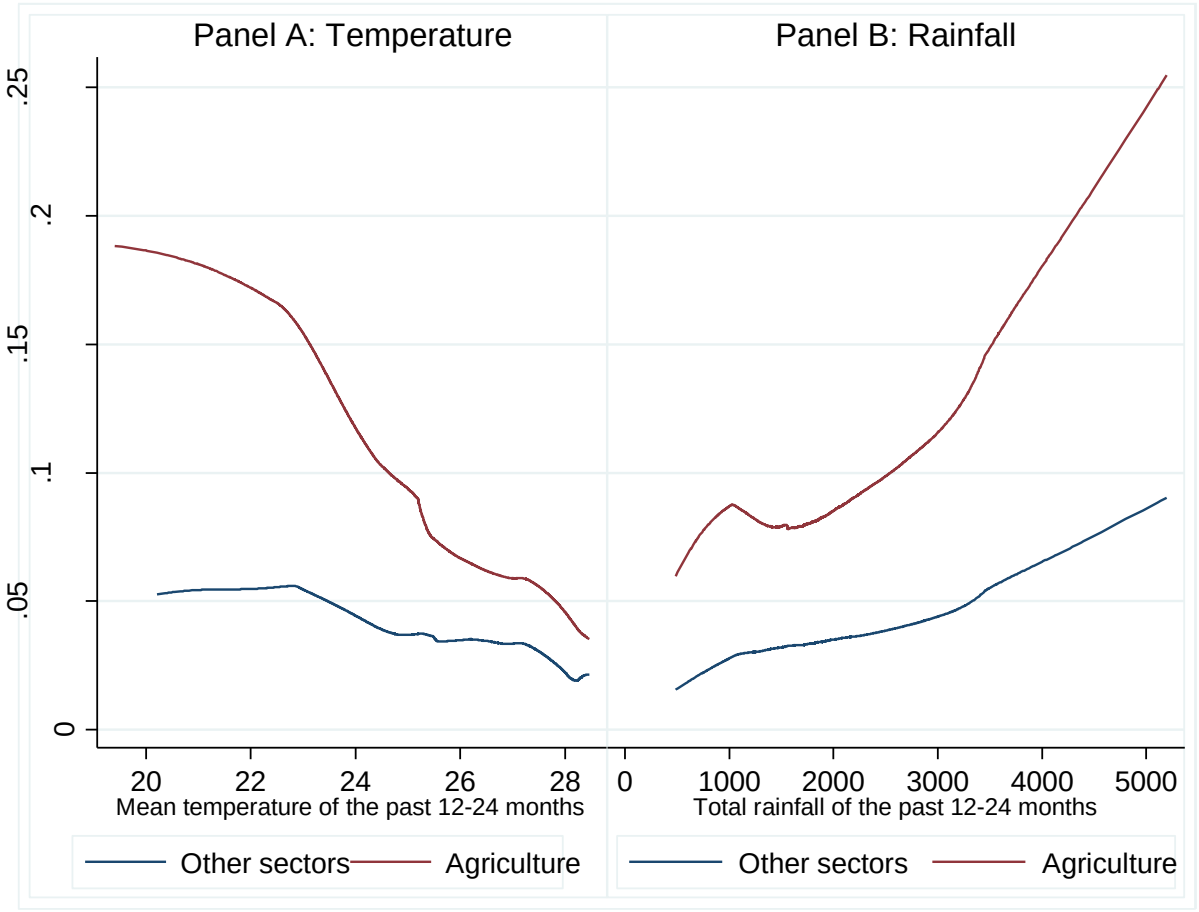
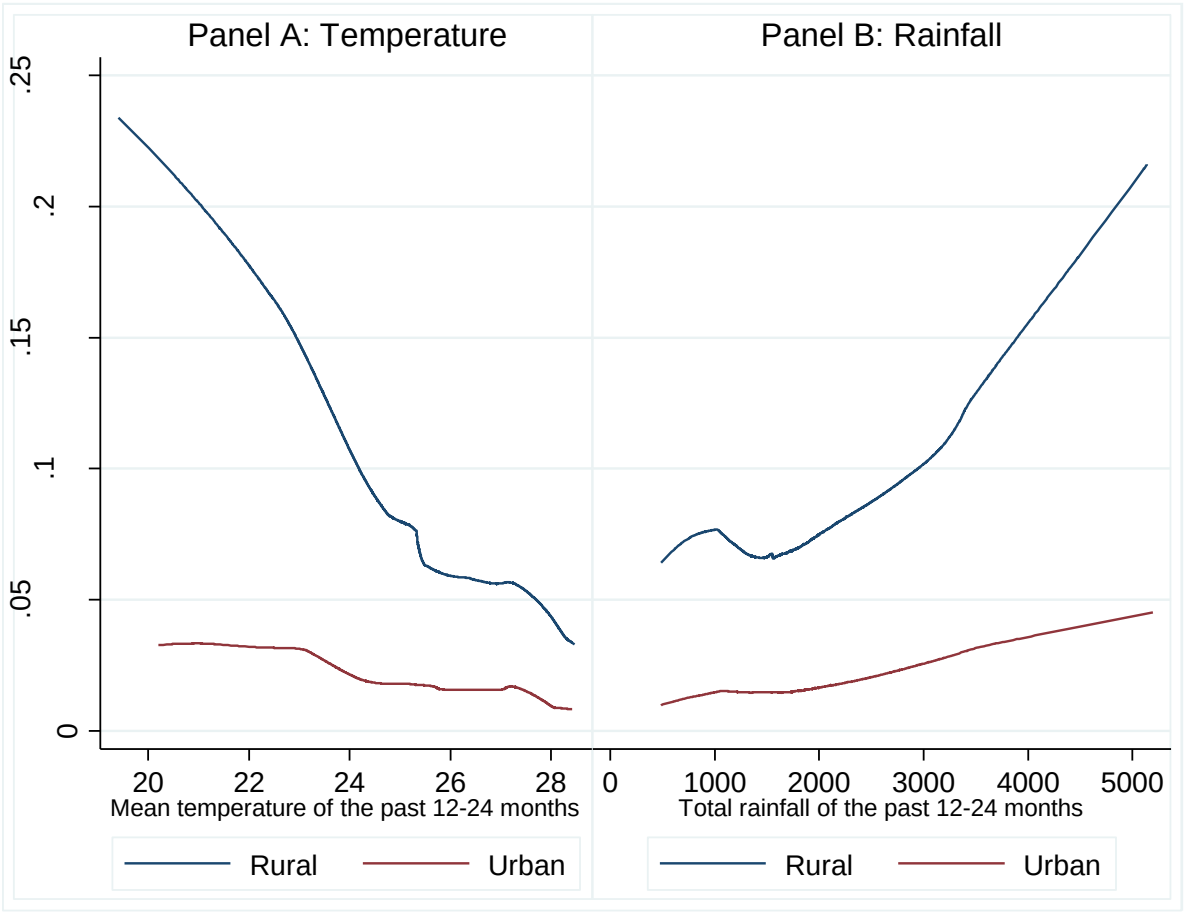
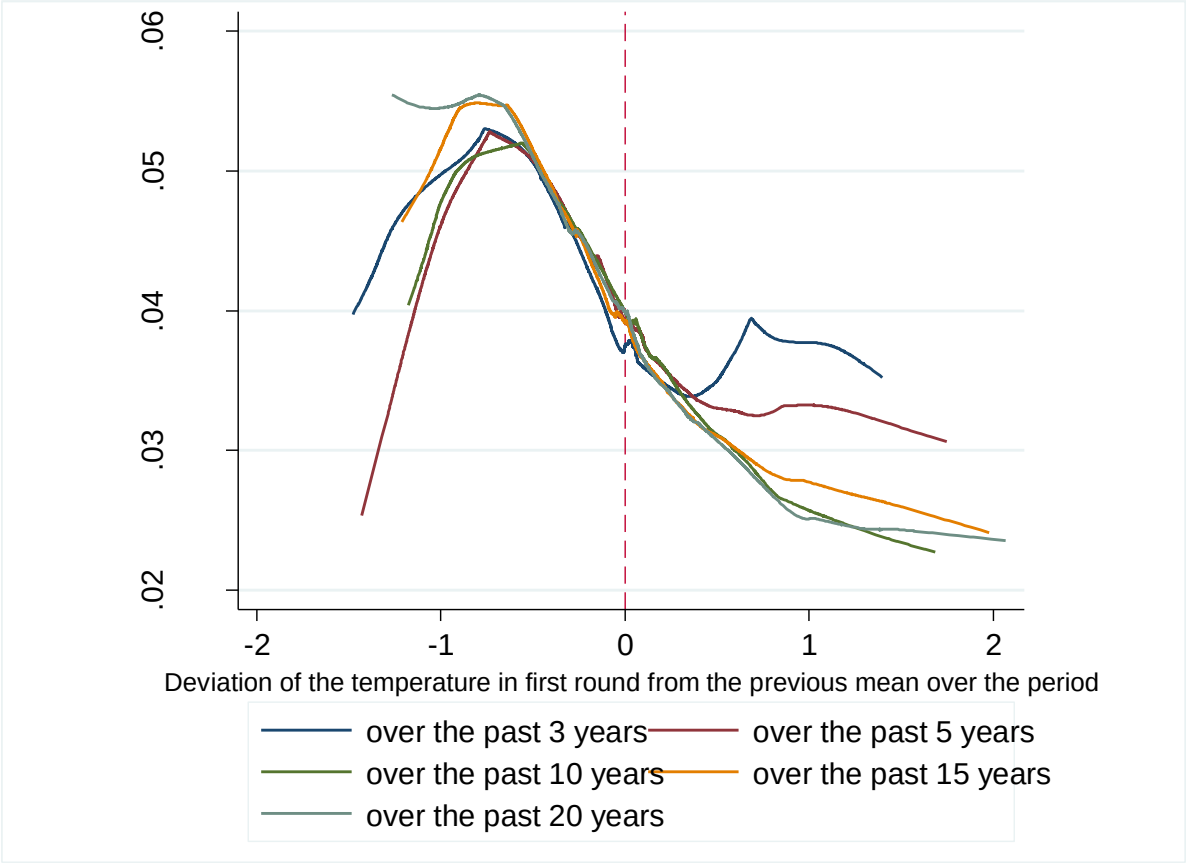


Figure B8. Correlation between weather of the past 12-24 months and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period, by locality



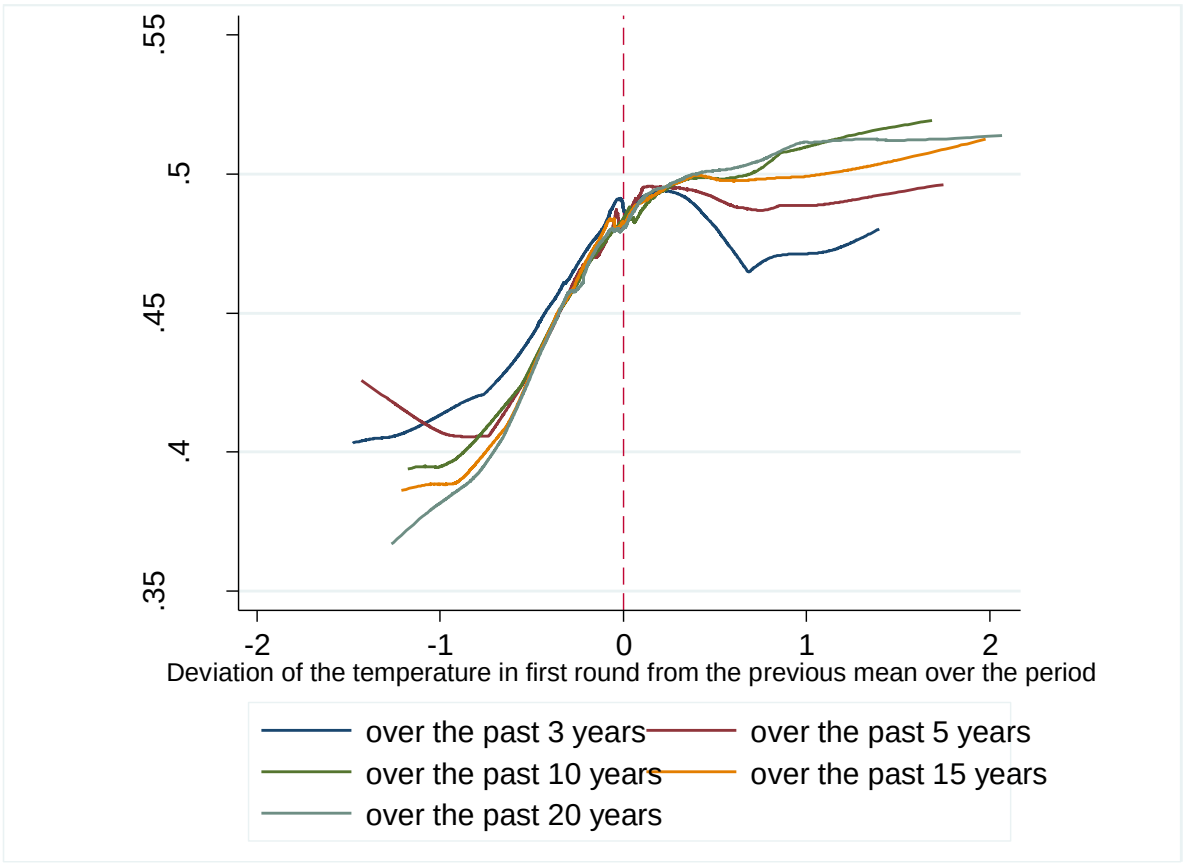
Temperature shock
(Using data 2002-2004, 2004-2006, 2006-2008)

Figure B9. Correlation between temperature shock and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period



Note: at disaggregated level by months

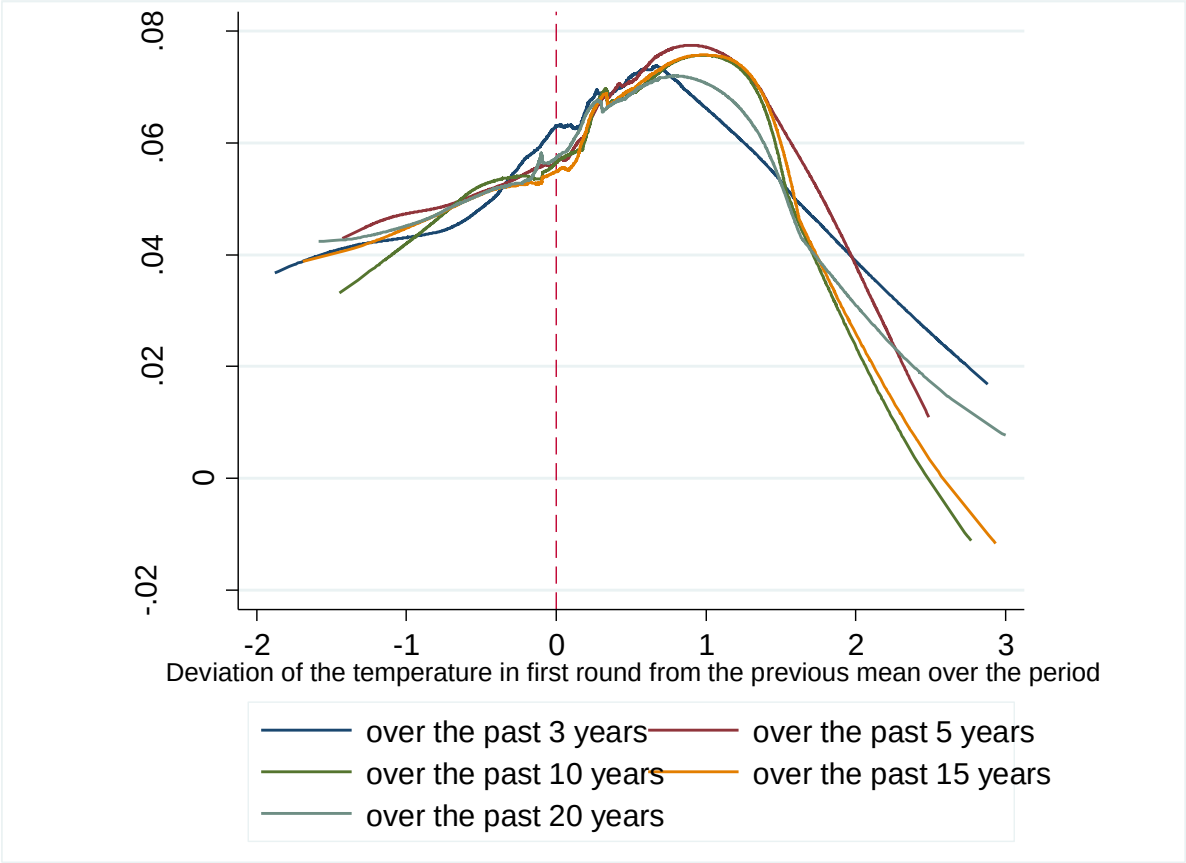
Figure B10. Correlation between temperature shock and (conditional) probability (at household level) a poor household in the first period becomes non-poor in the second period



Note: at disaggregated level by months

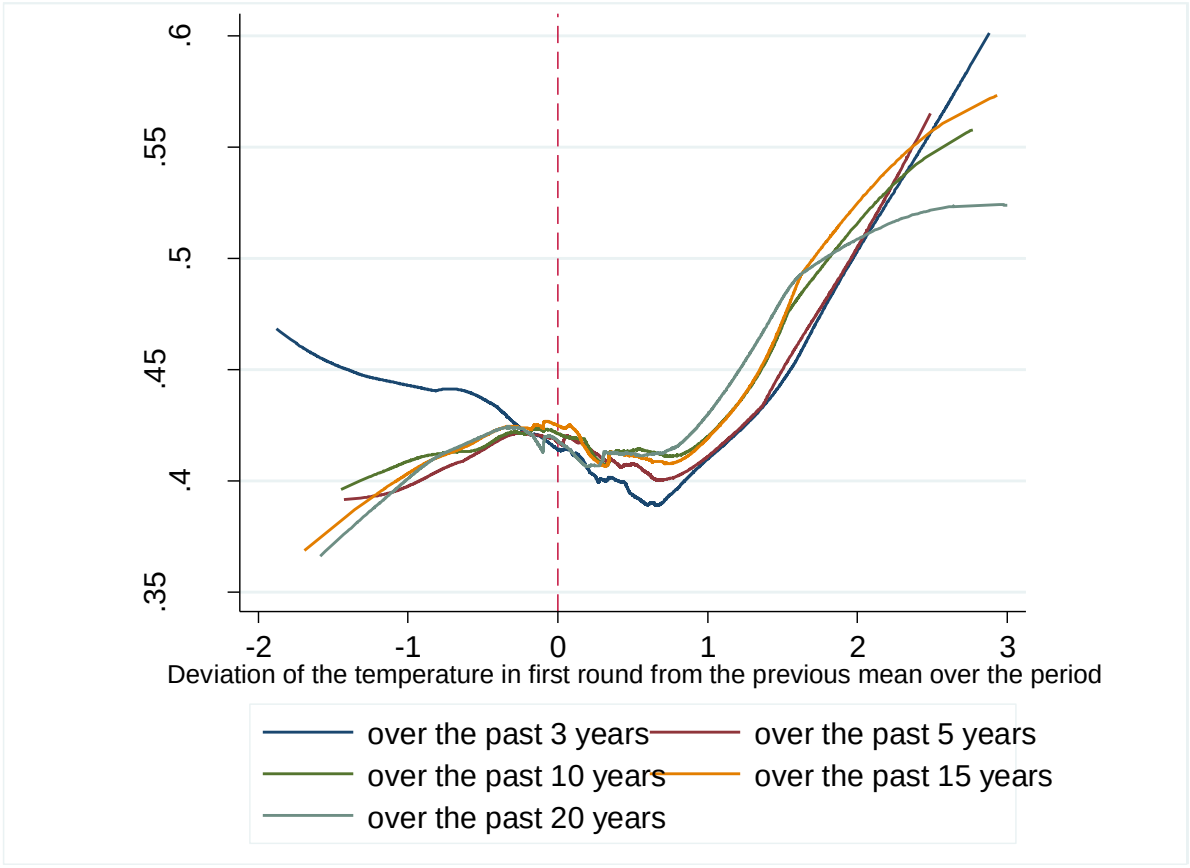
Temperature shock
(Using data 2008-2010, 2010-2012, 2012-2014, 2014-2016)

Figure B11. Correlation between temperature shock and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period



Note: at disaggregated level by months

Figure 12. Correlation between temperature shock and (conditional) probability (at household level) a poor household in the first period becomes non-poor in the second period



Temperature shock
(Using data 2002-2004, 2004-2006, 2006-2008, 2008-2010, 2010-2012, 2012-2014, 2014-2016)

Figure B13. Correlation between temperature shock and (conditional) probability (at household level) a non-poor household in the first period becomes poor in the second period

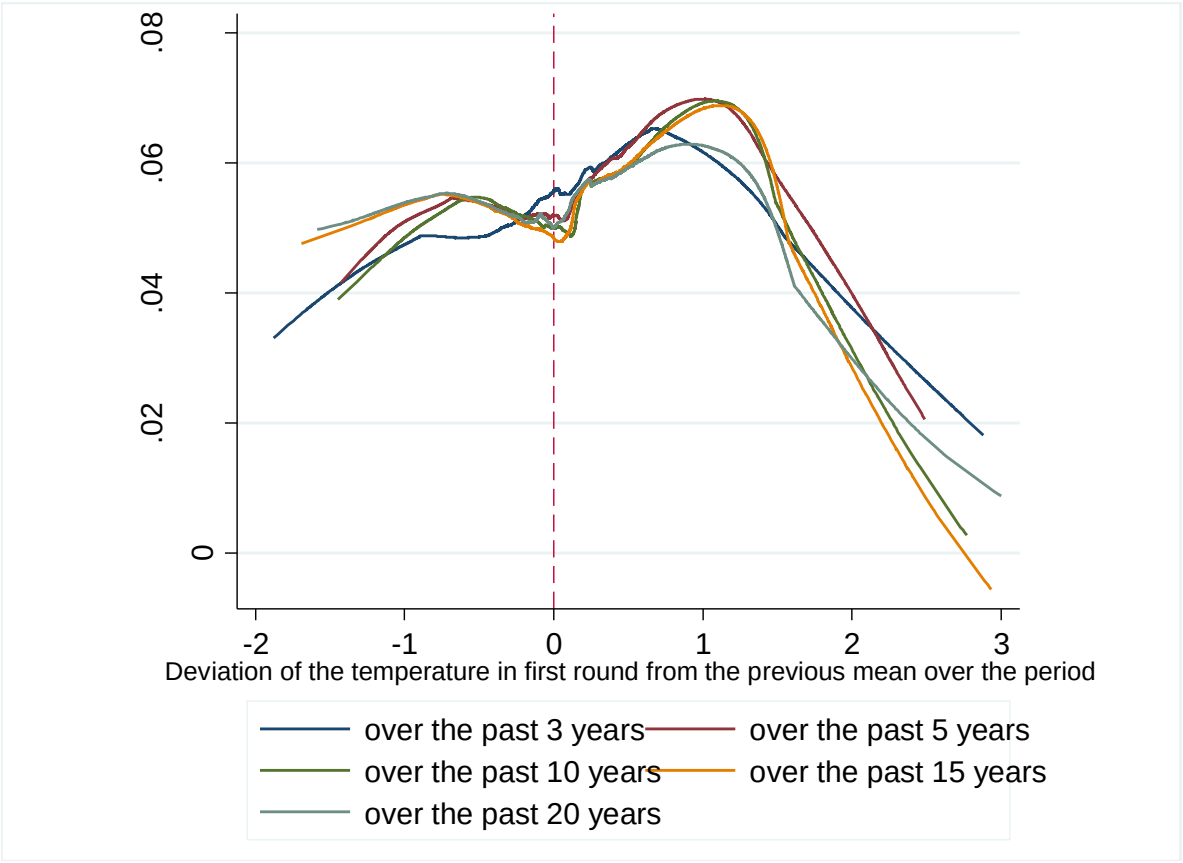
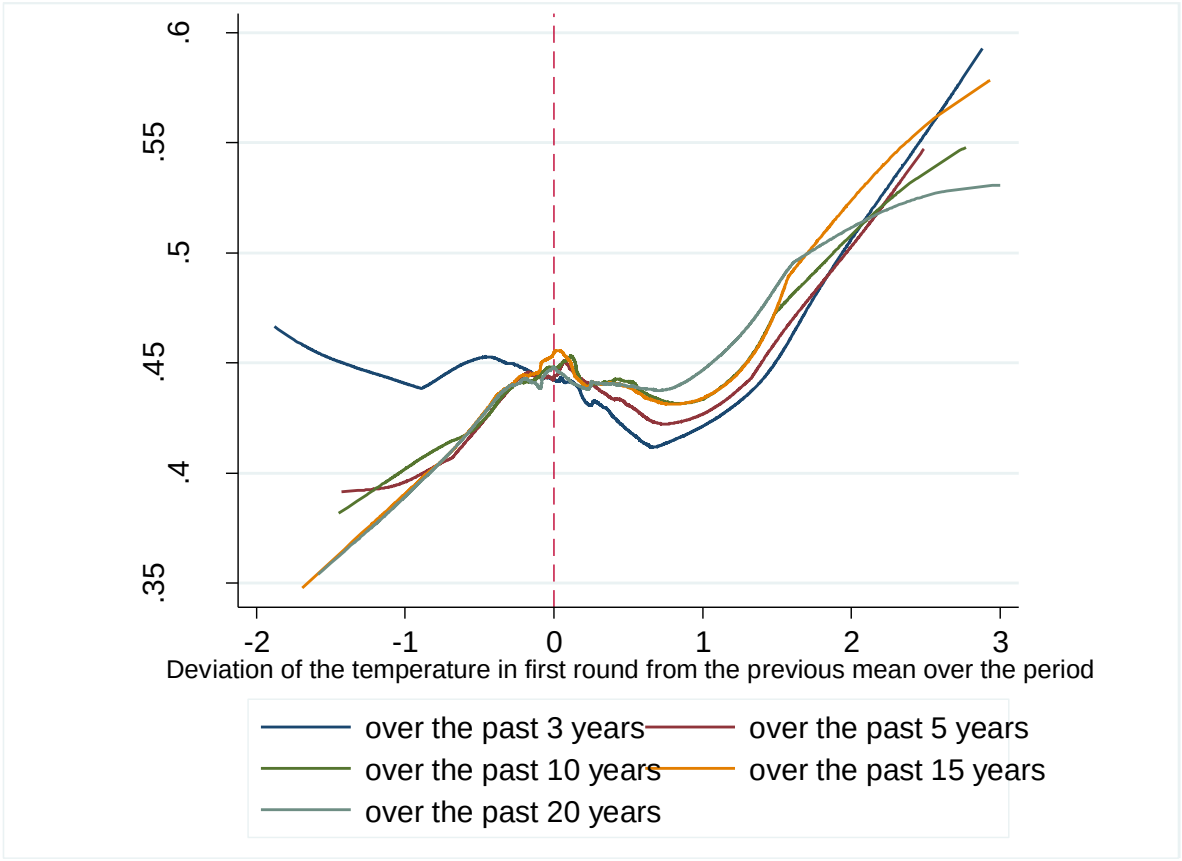


Figure B14. Correlation between temperature shock and (conditional) probability (at household level) a poor household in the first period becomes non-poor in the second period



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The Agence Française de Développement (AFD) Group is a public entity which finances, supports and expedites transitions toward a more just and sustainable world. As a French overseas aid platform for sustainable development and investment, we and our partners create shared solutions, with and for the people of the global South.
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Towards a world in common.

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