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Notices

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Abstract

While formal insurance is widespread in much of the developed world, households in lower-income countries continue to rely heavily on informal risk-sharing networks when faced with unexpected shocks. Kin networks of non-coresident family members may play an important role by providing each other with informal social protection, sharing resources in response to correlated production shocks (rainfall) or idiosyncratic household shocks (sickness and death). Using detailed panel data from Indonesia, we examine how inter-household transfers within a household's kin network respond to different types of shocks and whether they are able to reduce household vulnerability. We find that households are exposed to meaningful risk from variations in local rainfall in the form of both income and household consumption. Rainfall substantially increases both transfers sent and received by households, suggesting that household and local supply effects dominate demand effects resulting from rainfall fluctuation. Finally, we find modest evidence that transfers reduce vulnerability of consumption to rainfall fluctuations by up to 11%, but do not find strong evidence on the efficacy of formal social protection programs.

Keywords: Transfers, Kin Networks, Informal Risk Sharing, Shock Coping
JEL Codes: O1, D64, D81, I3, J1

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1 Introduction

While formal insurance is widespread in much of the developed world, households in developing countries continue to rely heavily on informal risk-sharing networks when faced with unexpected shocks. Kin networks of non-coresident family members may play an especially important role by providing informal social protection and helping households spread risk across broader family units.

We use detailed longitudinal data from the Indonesian Family Life Survey (IFLS) and exploit unique inter-household transfer data to examine how these kin networks respond to both correlated and idiosyncratic shocks. We link households to administrative data on correlated local shocks in the form of historical rainfall measures and identify idiosyncratic health shocks from the reported data in the IFLS interviews. With this data, we are able to test several predictions on the impacts of and responses to these two distinct forms of household shocks.

In our sample of agriculture-dependent households, we find that higher levels of rainfall increase household agricultural income as well as both food and non-food consumption, suggesting imperfect income smoothing over time. By contrast, household health shocks do not appear to affect agricultural earnings and slightly increase household consumption of non-food goods, which includes health care and funeral expenses. Next, we find evidence that higher rainfall increases both transfers received from and sent to non-cohabiting family members, suggesting that the overall supply of transfers increases when rainfall is greater in a given area. Recent death or illness are associated with a modest and imprecise increase in net inward transfers. We find some evidence that transfers reduce consumption sensitivity to rainfall fluctuations by between 5-11%. We additionally examine but do not find meaningful evidence of whether close kin transfers are more responsive to health shocks in stronger economic times or whether vulnerability of household consumption to fluctuating rainfall is lower in the presence of formal safety net programs.

These findings contribute, first, to a broad literature on household response to aggregate climate and weather shocks. Various papers demonstrate that higher rainfall increases agricultural productivity, income, and wealth in the case of Indonesia, where many farmers continue to rely on rain-fed agriculture (Kishore et al., 2000; Levine and Yang, 2014). Building on these patterns, other papers have used weather shocks along with the IFLS data to examine impacts on long-term human capital outcomes (Maccini and Yang, 2009), labor markets (Kleemans and Magruder, 2018), migration (Kleemans, 2017), and crime and violence (Feld and Kleemans, 2022). We additionally connect to the literature on household coping with health shocks where a seminal paper by Gertler and Gruber (2002) shows that Indonesian households struggle to completely insure against major illnesses, are forced to reduce labor supply and, to a lesser extent, devote resources to medical expenditures.

This paper also adds to a long-standing literature on informal risk-sharing and kin networks summarized by Cox and Fafchamps (2007). Many papers in this literature use variation in consumption, income and investments as indirect evidence of extended family members sharing resources or spreading risk across households. Our ability to observe and analyze transfer behavior directly allows us to better understand motivations and mechanisms of risk and income sharing. Then, using plausibly exogenous effects of different types of shocks on transfers, we can further enrich our understanding of how, when, and why these transfers take place. Our findings are consistent with the broad consensus that informal insurance takes places but is far from complete, and we add evidence on when kin networks are more likely to be activated and offer social protection (Bau, 2021; Kinnan, 2022).[1] Our paper further assesses the interaction between idiosyncratic and correlated shocks, as well as between formal and informal social safety nets as emphasized by Cox and Fafchamps (2007) and examined in India by Mobarak and

[1] In related work, Kinnan (2022) explores the role of market imperfections, such as limited commitment, moral hazard, and hidden income, in hindering informal risk-sharing. Also, in Indonesia (and Ghana), Bau (2021) shows that kinship traditions that provide child-parent insurance can be deterred by public pension programs.

Rosenzweig (2013).

Within the Indonesian context, a number of papers have used IFLS data to examine inter-household and informal risk-sharing. Most of these contributions are primarily descriptive, offering a rich characterization of the types of relationships observed in the transfers and estimating predictors of different types of familial support (Hatmadji and Wiyono, 2008; Huda, 2020). Cameron and Cobb-Clark (2008) show that intergenerational transfers have minimal influence on parental labor supply. Park (2003) finds that a single motive for kin transfers is inadequate for rationalizing patterns in the first round of IFLS data. Raut and Tran (2005) also use the first round of the IFLS to provide evidence in favor of a model of reciprocity over one of pure transactional loan behavior. Witoelar (2013) uses two rounds of the IFLS, focusing on consumption data, to show that extended family networks play an important, thought partial, role in reducing consumption volatility. LaFave and Thomas (2017) show evidence that extended family resources affect human capital investments of children in non-coresident households. Genoni (2012) use the second and third round of the IFLS to focus on informal consumption insurance in response to household health deterioration, finding near-complete informal consumption insurance along with increases in incoming extended family transfers among the set of households that also show the highest levels of income vulnerability to health shocks. Rather than using one or two rounds of IFLS data, we build on these contributions by leveraging all five rounds of the IFLS, spanning 23 years, to create a unique panel of transfers, consumption, earnings, and family structure of over 7 thousand households for a comprehensive analysis on how and when transfers in close-kin networks respond to shocks.

The remainder of the paper proceeds as follows. Section 2 describes the context and data, Section 3 presents our hypotheses and describes our empirical approach. Section 4 presents the results and Section 5 concludes with a brief discussion.

2 Background and Data

2.1 Background

Indonesia has the world's fourth-largest population and, consisting of more than seventeen thousand islands, contains rich cultural diversity. Anthropological work suggests that cultural norms play an important role in driving support between non-coresident family members (Jay, 1969; Geertz, 1961). Hatmadji and Wiyono (2008) argue that increased industrialization and falling fertility rates have led to a decline in end-of-life cohabitation, parents moving back in with adult children, which has increased the importance of intergenerational transfers. Such transfers are further encouraged by challenges in the health care system (Banerjee et al., 2021) and by Indonesia's aging population and a weak and incomplete pension system (Cameron and Cobb-Clark, 2008).[2] Demographic, cultural, and structural factors therefore all contribute to the importance of informal safety nets.

2.2 Data Sources and Treatment

We use data from all five rounds of the IFLS, collected between 1993 and 2015 and designed to be representative of 83% of the country's population. Despite high rates of internal migration, intensive tracking efforts have kept attrition rates low, additionally following family members after they leave their original households to form their own. Between any set of two rounds, more than 90% of households were successfully recontacted and 87% of households in the original sample were reached in all five rounds (Strauss et al., 2016). While the full IFLS includes information on nearly 19,000 households, we focus on the 7,245 households that ever report earning agricultural income over the course of the study, anticipating the use of rainfall as a shock to income. The majority of households in

[2] Bau (2021) finds that Indonesia's new pension program in 1977 influenced education and cultural practices, but only in matrilocal ethnic groups that constitute a small minority.

our sample appear in all five waves with an average of 3.8 appearances.

In addition to basic demographics, the IFLS includes detailed information on income, consumption, health, migration, and enrolment in social protection programs. To understand how shocks affect household production, we use a reported measure of agricultural income as it is most likely to respond to rainfall shocks. The IFLS collects detailed income data from primary and secondary jobs held by all household members ages 15 and above. Information from all sectors and all types of employment are collected (wage, self-employment, family-owned businesses, temporary). The single largest sector is "agriculture, forestry, fishing, and hunting" with 31% of individuals reporting it as their primary employment sector, and 50% as their secondary employment sector.[3] For each year, we combine all income sources to obtain individual agricultural income, and we sum across all members of the household to obtain household income.

Second, we use sensitivity of household consumption to shocks as a way of identifying uncovered household risk. Using detailed consumption data in the IFLS, we generate aggregates of reported annual household food and non-food consumption.[4] While the main results use total household consumption levels, we also calculate and present results using per-capitized measures in the appendices as well.

Central to our study, the IFLS also collects unique data on transfers between non-coresident parents, children, and siblings. These are individually reported data on transfers to and from household members and family members living outside the household.[5] These responses are aggregated across household members to the household level. In addition, we compute measures of *net* transfers (out-in) and *total* transfers (out+in).

Finally, we use two types of household shocks in our analysis. First, the IFLS asks

[3]Please refer to Hamory et al. (2021) for further details on the sectoral composition of the sample.

[4]The KS module includes questions on food expenditure (e.g., staple foods) and non-food expenditure (e.g., utilities, clothing, transportation, among others). While most of these questions are asked for the last week, or the last month, we convert them into measures of annual household consumption (food and non-food) to make them comparable to one another.

[5]These data are recorded in the IFLS's module on non-coresident family members ("BA module"). The module also asks respondents about non-monetary transfers, but we focus on monetary transfers in our analysis.

households if a household member became seriously ill or passed away. We use this as an indicator for idiosyncratic health shocks that occurred over the prior two years. Second, based on the reported locations of their members, we link households to historical local rainfall data from the University of Delaware's Center for Climatic Research as a measure of plausibly exogenous economic conditions (Jones and Olken, 2010; Dell et al., 2012; Burke et al., 2015; Kaur, 2019; Corno et al., 2020).[6] We then construct a measure of geographically correlated weather shocks following a procedure used frequently in the literature by Burke et al. (2015), situating each year's rainfall in a historical gamma distribution for that location. The resulting variable is coded between 0 and 1 with higher values corresponding to higher levels of precipitation.

2.3 Summary Statistics

Table 1 shows summary statistics for our sample. Households typically have between four and five members, including 1.2 children on average. Mean total household income in the sample is 5.9 million Indonesian Rupiah with agricultural income accounting for just under 40% of the total. Mean reported consumption is 7.8 million Rupiah with a nearly even split between food and non-food consumption, and the share of food consumption is larger at lower consumption levels.[7] Health shocks are rare with 3.4% of households reporting death and 6.1% reporting a serious illness of a household member in the previous two years. Thirty-nine percent of households are enrolled in a social protection program.[8]

[6]The IFLS provides information on the sub-district (*kecamatan*) where each household member was located during each interview. We then link individuals to the GPS coordinates of their sub-district. This then allows us to link our household-level data to the University of Delaware data. These data are extrapolated from weather stations and provided for 0.5 by 0.5 degree grids, which corresponds to about 50 by 50 km (Matsuura and Willmott, 2009).

[7]Reported consumption is substantially higher than income, which Meyer and Sullivan (2003) argue is a common feature of household surveys resulting from difficulty in calculating income that comes irregularly from multiple sources and reporting biases (and inflation) induced by standard methods of providing reported consumption of long lists of irregularly purchased items.

[8]As listed in Table A.1, the IFLS collects data on enrollment in a number of social protection programs, including health care and insurance programs, conditional and unconditional cash transfers programs, and

Panel B shows summary statistics on the transfer data. In 79.4% of all 27,603 household-year observations at least one outward transfer is reported and in 79.6% at least one inward transfer. Amongst positive transfer values in either direction, the mean is around 600,000 Rupiah, more than 10% of average income. Many transfers are considerably larger, with the 90th percentile of annual transfers in and out over 1.5 million, Rupiah. These transfers are substantial relative to household income: 10% of observations have outgoing transfers of more than 30% of household income and 10% of observations report incoming transfers greater than 50% of household income.

Table 1 reveals a high degree of skewness in all monetary values, which are converted into 2000 Indonesian rupiah using the country's consumer price index. We employ two strategies to address this skewness. First, we winsorize the top 5% of all non-zero values of agricultural income, consumption, and transfers in and out.[9] Second, we apply an inverse hyperbolic sine transformation (IHST) to the winsorized values to further minimize the influence of outliers.[10] We present these two versions in all analyses.

3 Hypotheses and Empirical Approach

3.1 Hypotheses

Table 2 summarizes our main predictions and analyses. First, we want to understand if and how idiosyncratic and correlated shocks relate to household income and productivity. Indonesia's agricultural sector remains largely (though not entirely) rainfall dependent and although flooding is possible in extreme instances, we predict that rainfall increases agricultural income. We also anticipate that death or illness of a household member will

social security for people with disabilities and the elderly. Not all programs existed throughout the study duration, so we group them together in an indicator for being enrolled in at least one program.

[9] We also winsorize the bottom 5% of agricultural income. For net transfers, we calculate the difference between the two winsorized measures of transfers.

[10] The inverse hyperbolic sine transformation has become increasingly common in the literature with a recent paper by Bellemare and Wichman (2020) presenting best practices.

lead to lower labor contributions and agricultural income, either from the directly affected family member or indirectly from other household members diverting their productive energy towards caretaking or uncovered household responsibilities.

Second, if consumption smoothing is imperfect, then we expect that rainfall will have a positive impact on consumption, with households consuming more after receiving positive production shocks (higher rainfall). The effect of health shocks on consumption is ambiguous. Health shocks could reduce household consumption because of income loss or it could increase consumption if they drive meaningful healthcare and funeral expenses.

Third, we anticipate both supply and demand responses from rainfall shocks on transfers. If higher rainfall increases disposable income, this could lead to an increase in household supply of outgoing transfers. Conversely, it could also reduce the household's need for transfers from others, lowering demand for incoming transfers. In addition to that, rainfall shocks affect other nearby households as well. Higher rainfall could increase the supply of incoming transfers from a household's kin network (if they are located nearby) and also reduce demand for their own outgoing transfers. The predictions for the overall effects of production shocks on outgoing, incoming, and net transfers are, therefore, ambiguous. By contrast, predictions for health shocks are unambiguous. Driven by greater household need for resources and possible reduction in income following a negative health shock, we expect a decrease in outward transfers and an increase in incoming transfers. Because these household shocks are idiosyncratic and likely not shared by others in the network, there are no offsetting responses or ambiguity as with rainfall.

We also hypothesize three further patterns in the data. First, if transfers are being used as informal insurance and to reduce vulnerability of consumption to variations in rainfall (and income), then controlling for transfers should reduce any observed relationship between shocks and consumption. Second, informal insurance may only function in times when contributing network members have sufficient available liquidity to be willing and

able to insure one another. As such, we expect that our predictions on transfers following health shocks should be stronger when recent rainfall (and local economic conditions) has also been higher. And finally, we anticipate that if social protection programs are effective in protecting households from uncovered consumption risk, then the relationship between rainfall and consumption should be reduced among those participating in formal social safety net programs. We describe our empirical approach to these hypotheses in the next section.

3.2 Empirical Approach

We use a two-way fixed effects model to estimate the effect of shocks on various outcomes:

$$outcome_{i,t} = \beta_0 + \beta_1 shock_{i/l,t} + \delta_t + \gamma_i + \epsilon_{l,t} \tag{1}$$

$outcome_{i,t}$ is the value of one of our three main outcomes —agricultural income, consumption or transfers — for household, i, at time, t. $shock_{i/l,t}$ measures the shock experienced by household, i, belonging to location (grid-cell), l, at time, t. Idiosyncratic health shocks, in the form of recent death or illness of a family member, are at the household level whereas correlated production shocks from rainfall are attributed to all households within the same location and thus who experienced similar rainfall. We additionally control for time and household fixed effects, δ_t and γ_i. When testing for heterogeneity or interactions of treatment effects, we add interaction terms and relevant controls. Standard errors are clustered at the location level.

Controlling for household fixed effects removes variation in our outcomes explained by time-invariant household-level characteristics or preferences. Time fixed effects absorb time-varying factors shared by all households, such as variation in national prices of consumption goods our agricultural outputs, aggregate labor conditions, or other national shocks. A threat to identification would occur if there are confounding variables

that vary over time as well as at the household level and that affect the relationship between the shock and outcome variable. While rainfall shocks are plausibly exogenous, sickness and death may be endogenous to household-level outcomes such as income and consumption or a third omitted variable. Therefore, our results using idiosyncratic shocks should be interpreted with caution.

4 Results

4.1 Income and Consumption

We begin by examining the impact of our two types of shocks on two frequently used dimensions of household welfare. First, we assess whether rainfall or household death and illness impact household agricultural income. Second, we assess the impact of these shocks on household consumption as a measure of uncovered exposure to risk.

Table 3 presents these results, showing the effects of rainfall in panel A and household health shocks in panel B. The first two columns of each panel use agricultural income as the dependent variable, first winsorized at the 95% level and second taking the IHST of that value. Columns 3-6 switch to consumption, looking at winsorized and IHST versions of household food consumption in columns 3 and 4, and non-food consumption in columns 5 and 6.

As anticipated, we find a strong positive relationship between the preceding year's rainfall and reported agricultural income (from the prior 12 months). Rainfall that is 25 percent, or one quartile, higher in the distribution of local historical rainfall, causes an 8.8% increase in household agricultural income relative to the sample mean when using the winsorized measure ($\frac{781}{4}/2226 \approx 8.8\%$). While the IHST version in column two is noisily estimated, the coefficient suggests a similar-sized effect of 10.3% ($\frac{0.41}{4} \approx 10.3\%$).

In panel B, we do not see a clear response to household health shocks. Point estimates are positive for both versions and the winsorized estimates are precise enough to rule

out large negative effects, but the IHST version has wider confidence intervals that make drawing clear conclusions more difficult. There may truly be no relationship between household health shocks and agricultural income if affected household family members were not meaningful earners and overall household labor adjustments were minimal, although other work in the same setting has shown a strong relationship between health shocks and income (Genoni, 2012).

Shifting to consumption, we see a strong effect of lagged rainfall on food consumption. An increase in rainfall by one quartile causes an increase in total food consumption by between 2.6-4% (depending on winsorization or IHST). We also see a significant increase in non-food consumption of around 2% in the winsorized specification ($\frac{310}{4}/3,796 \approx 2.04\%$) although it falls to less than one percent and is not distinguishable from zero when applying the IHST. While changes in non-food consumption could be opportunistic spending in luxury items, the sensitivity of household food consumption to variation in year-to-year rainfall is a concerning sign of household vulnerability and exposure to uncovered risk.

Switching again to panel B, we do not find any evidence that recent death or illness is associated with changes in household food consumption. This is consistent with the lack of effects on household agricultural income. By contrast, recent death and illness appear highly significantly associated with an increase in non-food consumption, by 14-18% depending on specification choice. This surprising result could be driven by health or funeral expenditures incurred by the household in response to idiosyncratic health shocks. Table A.2 shows these effects separately for household illnesses and death of a family member. Illnesses have a more consistent positive relationship across all categories of income and consumption, especially in non-food consumption, suggesting that health-related costs may play an important role. Further analysis will be required to identify the specific expenditures driving this response.

Results using per capitized versions of food and non-food consumption show similar

patterns and are included in Table A.3.[11]

4.2 Transfers

While rainfall appears to have an important impact on agricultural income and we find evidence of uncovered risk in the form of consumption sensitivity to recent rainfall, we also expect inter-household transfers to respond to shocks if they are, in fact, being used to spread risk and smooth income across kin networks. We, therefore, examine whether the two types of shocks lead to responses in transfers observed in the data in Table 4. As before, panel A looks at the effects of lagged rainfall while panel B examines the effect of recent household health shocks. In Panel C we combine both shocks along with an interaction to test if stronger correlated economic conditions in one's community (following better rainfall) lead to higher responsiveness and informal support when experiencing idiosyncratic health shocks.

The columns are organized to show the winsorized and IHST versions of transfers out in the first two columns, incoming transfers (columns 3-4), net transfers (out minus in, columns 5-6), and aggregate transfers (out plus in, columns 7-8). Panel A shows, across all outcome variables, that higher recent rainfall increases transfers. Both transfers out and transfers in increase substantially, although the precision and size of the point estimates vary depending on treatment of the outcome. With a rise in both outward and inward transfers, we see a small rise in net transfers with the winsorized version (p-value = 0.06), but a noisy estimate for the IHST version. In the final two columns, we look at total transfers. As anticipated, we see a very large and significant response of aggregate transfers to rainfall. We take this as evidence that supply effects for transfers dominate the offsetting demand effects hypothesized in Section 3 for both outgoing and incoming transfers.

[11] For completeness, we also show similar analyses and evaluate whether the effects of rainfall and household health shocks have meaningful interactions, shown in Table A.4 but do not have clear predictions on these effects and lack precision to draw conclusions.

In panel B, we examine household health shocks. For these idiosyncratic shocks, we did not have the ambiguity of predictions that affected our understanding of rainfall. Most point estimates are consistent with less outward and greater inward transfers. Net transfers show the expected sign and the magnitude of the IHST measure in column 6 is large, but all confidence intervals include zero and we thus cannot rule out null effects.

Finally, in panel C we examine whether kin transfers are more responsive to health shocks in times where aggregate economic conditions are also better. If so, we would expect higher rainfall levels (better household and nearby economic conditions) to result in lower net flows (less going out and more coming in) for households experiencing recent health shocks and therefore in greater relative need. Focusing on the interaction terms for net transfers in columns 5 and 6, we do see large negative point estimates regardless of winsorization or IHST. However, again, lack of precision of the estimates prevents us from determining if transfers are better able to insure households against idiosyncratic health shocks when local economic conditions are better.

4.3 Vulnerability Reduction from Informal Networks and Formal Social Protection Programs

Next, we look at our final two hypotheses: whether informal (kin transfers) and formal (social protection programs) systems of insurance reduce the sensitivity of household food consumption to variations in recent rainfall. We focus on the strong earlier observed relationship between household food consumption and prior year rainfall. While non-food expenditures were also responsive, we focus on food consumption as an essential expenditure where responses are likely to reflect more meaningful economic vulnerability than if luxury purchases respond to short-term economic conditions. For ease of reference, we reproduce this result, from Table 3, in columns 1 and 2 of Table 5.

From the preceding analysis, we also saw that rainfall has a substantial impact on transfers (Table 4). If these inter-household transfers adapt and are used to reduce house-

hold vulnerability, controlling for them while estimating the effect of rainfall on food consumption should reduce the strength of this relationship. We control separately for transfers in and out as they may reflect different behaviors and link to different network members. These estimates are shown in columns 3 and 4 of Table 5. The point estimates on rainfall fall by just under 11% from 421.5 to 375.8 using the winsorized versions of the outcome and transfers. Conducting a test of differences in the coefficient on rainfall using a seemingly unrelated estimation test, we find that this difference is significant at the 1% level (p-value = 0.006). Using the IHST measures in columns 2 and 4 we see a less pronounced drop of around 5% that is not significant at conventional significance levels (p-value = 0.19). We consider this to be evidence of a modest role for using transfers as informal insurance across non-coresident family members.

Finally, we examine whether enrollment in formal national social protection programs reduces food consumption sensitivity to recent rainfall and if transfers respond differently among those enrolled in these programs. The interaction terms for both versions of both outcomes are negative, suggesting lower sensitivity to rainfall for SPP participants. In particular, the magnitudes of these coefficients for transfers are large, 60% of the main effect. However, lack of precision prevents us from knowing if these differences reflect meaningful changes in vulnerability.[12]

5 Discussion

In this paper, we have examined the rich data from the Indonesia Family Life Survey to assess how different types of shocks impact households in terms of income, consumption, and kin transfers. In particular, we explored whether there was evidence that kin transfers serve as a system of informal insurance and income smoothing for households with close kin living outside the household.

[12] Appendix Table A.5 shows these results with per-capitized versions of food consumption.

Shocks do impact households. Recent rainfall appears to both influence agricultural income as well as consumption, signifying exposure to meaningful uncovered risk. By contrast, health shocks are not strongly associated with these key measures of household welfare. We also find that higher rainfall increases both inwards and outwards transfers, suggesting that the supply effects for both types of transfers dominate offsetting demand effects.

We additionally examine whether transfers are better able to serve as informal health insurance when aggregate economic conditions are stronger, whether formal social safety net programs reduce responsiveness of transfers, and whether transfers reduce household consumption vulnerability to rainfall fluctuations. While point estimates are largely consistent with our theorized relationships, our findings are limited by the noisiness of these estimates. We do, however, observe some modest evidence that transfers reduce the sensitivity of household's food consumption to rainfall by between 5-11%.

A primary challenge in this analysis is that the shocks to household production are likely to affect both the household itself as well as their nearby non-cohabiting family members. As observed, the correlated nature of this shock induces offsetting influences on transfers and that may inhibit the ability of extended family members to informally insure one another against household production shocks. Further research is needed to disentangle these shocks and determine to what extent correlated risks across family networks inhibit the efficacy of informal insurance.

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Figures and Tables

Table 1: Summary Statistics

	$N = 27,605$ household-year obs.				
	Mean	SD	p10	Median	p90
A. Household characteristics					
Number of household members	4.5	2.1	2.0	4.0	7.0
Number of adults	3.2	1.5	2.0	3.0	5.0
Number of children (< 15 years old)	1.2	1.2	0.0	1.0	3.0
Total income (Rp.)	5,898	6,449	582	3,615	14,281
Agricultural income (Rp.)	2,226	3,458	0	831	6,500
Total consumption (Rp.)	7,845	6,746	1,814	5,743	17,060
Food consumption (Rp.)	4,053	3,018	1,048	3,254	8,297
Non-food consumption (Rp.)	3,796	4,679	440	2,093	9,392
Death of a HH member in the past two years (0/1)	3.4	18.2	-	-	-
Illness of a HH member in the past two years (0/1)	6.1	23.9	-	-	-
HH enrolled in any social protection program (0/1)	39.3	48.8	-	-	-
B. Transfers with kin network					
Any outward transfers (0/1)	79.4	40.5	-	-	-
Any inward transfers (0/1)	79.6	40.3	-	-	-
Transfers out value if >0 (Rp.)	611	1,111	27	227	1,589
Transfers in value if >0 (Rp.)	587	918	29	243	1,561
Transfers out/HH income (%)	19.9	244.2	0.0	3.8	32.4
Transfers in/HH income (%)	33.2	238.4	0.0	3.7	50.0

Notes: This table shows summary statistics at the household-year level. Columns 1-5 report the mean, standard deviation, 10th percentile, median, and 90th percentile of each variable, respectively. The sample consists of 27,603 household-year observations and 7,245 unique households reporting agricultural income in one or more IFLS waves. All monetary values are expressed in thousands of Indonesian Rupiah (year 2000) and winsorized at the 95th percentile (agricultural income is also winsorized at the bottom 5th percentile because profits may be negative). Data on idiosyncratic shocks are not available for the fourth IFLS wave (2007/2008).

Table 2: Predictions

	Type of Shock	
Outcome	*Rainfall* Correlated, Production Shock	*Death/Illness* Idiosyncratic, Health Shock
Agricultural income	↑ on average	↓ labor loss
Consumption	↑ income gain	↓ income loss ↑ health costs / ceremonies
Transfers out	↑ greater income/supply ↓ lower network demand	↓ own need / income loss
Transfers in	↓ reduced own need ↑ greater network supply	↑ own need / network support

Notes: This table summarizes the main predictions for the main outcome variables: agricultural income, household-level consumption, and transfers to and from non-household family members. These predictions are further elaborated on in Section 3.1.

Table 3: Effects of Rainfall and Death/Illness on Earnings and Consumption

	Agricultural income		Food consumption		Non-food consumption	
	Winsor. (1)	IHST (2)	Winsor. (3)	IHST (4)	Winsor. (5)	IHST (6)
A. Correlated shock						
Rainfall (1st lag)	780.9***	0.41	421.5***	0.15***	309.9*	0.02
	(171.4)	(0.29)	(122.4)	(0.05)	(174.0)	(0.06)
HH-year observations	25,837	25,837	25,169	25,169	25,194	25,194
R^2	0.44	0.43	0.57	0.45	0.56	0.61
B. Idiosyncratic shock						
Death or illness of a HH member	40.6	0.11	109.9	0.01	530.8***	0.18***
	(111.5)	(0.20)	(80.3)	(0.04)	(129.1)	(0.03)
HH-year observations	18,552	18,552	18,346	18,346	18,370	18,370
R^2	0.44	0.46	0.59	0.48	0.57	0.63
Outcome's sample mean	2,225.8	10.33	4,052.5	15.56	3,795.6	15.21
Household FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Notes: Data are at the household-year level. This table shows the effects of correlated and idiosyncratic shocks on household-level agricultural income and consumption. The rainfall variable is based on the historical (gamma) distribution of precipitation of each grid-cell. The idiosyncratic shock is an indicator equal to 1 if the household suffered the death or illness of a member in the past two years. Data on idiosyncratic shocks are not available for the fourth IFLS wave (2007/2008). All the outcome variables are expressed in thousands of Indonesian Rupiah (year 2000) and in two versions: (i) winsorized at the 95th percentile (agricultural income is also winsorized at the bottom 5th percentile because profits may be negative); and (ii) the inverse hyperbolic sine transformation (IHST) of the winsorized value. The sample consists of households reporting agricultural income in one or more IFLS waves. All the specifications include household and year fixed effects. Standard errors are clustered at the location (grid-cell) level.

Table 4: Effects of Rainfall and Death/Illness on Transfers

	Transfers out		Transfers in		Net transfers (out−in)		Total transfers (out+in)	
	Winsor. (1)	IHST (2)	Winsor. (3)	IHST (4)	Winsor. (5)	IHST (6)	Winsor. (7)	IHST (8)
A. Correlated shock								
Rainfall (1st lag)	118.6***	0.72**	28.8	0.81***	88.3*	0.00	147.5***	0.71***
	(34.3)	(0.29)	(33.5)	(0.30)	(47.2)	(0.51)	(48.6)	(0.25)
HH-year observations	24,936	24,936	24,936	24,936	24,934	24,934	24,938	24,938
R^2	0.42	0.44	0.42	0.43	0.34	0.39	0.47	0.43
B. Idiosyncratic shock								
Death or illness of a HH member	-29.8	-0.06	-6.9	0.29	-21.4	-0.58	-37.0	0.08
	(34.2)	(0.17)	(27.3)	(0.18)	(40.9)	(0.42)	(46.4)	(0.12)
HH-year observations	18,263	18,263	18,263	18,263	18,261	18,261	18,265	18,265
R^2	0.44	0.47	0.45	0.46	0.36	0.41	0.50	0.46
C. Correlated and idiosyncratic shocks								
Rainfall (1st lag)	112.5**	0.28	-2.1	0.55	113.3*	-0.32	110.6	0.53
	(53.9)	(0.42)	(43.4)	(0.45)	(67.1)	(0.64)	(71.2)	(0.38)
Rainfall × Death or illness	-68.5	0.05	-28.7	0.13	-47.2	-0.94	-95.7	0.08
	(108.2)	(0.58)	(89.5)	(0.52)	(123.2)	(1.36)	(155.2)	(0.38)
Death or illness of a HH member	1.7	-0.08	10.7	0.24	-4.2	-0.20	11.3	0.03
	(65.3)	(0.29)	(42.6)	(0.29)	(69.6)	(0.68)	(85.2)	(0.22)
HH-year observations	18,081	18,081	18,081	18,081	18,079	18,079	18,083	18,083
R^2	0.44	0.47	0.45	0.46	0.36	0.41	0.50	0.46
Outcome's sample mean	479.9	10.21	462.1	10.26	18.4	-0.17	941.9	12.52
Household FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Data are at the household-year level. This table shows the effects of correlated and idiosyncratic shocks on household-level transfers. The rainfall variable is based on the historical (gamma) distribution of precipitation of each grid-cell. The idiosyncratic shock is an indicator equal to 1 if the household suffered the death or illness of a member in the past two years. Data on idiosyncratic shocks are not available for the fourth IFLS wave (2007/2008). All the outcome variables are expressed in thousands of Indonesian Rupiah (year 2000) and in two versions: (i) winsorized at the 95th percentile (net transfers in columns 5-6 are also winsorized at the bottom 5th percentile); and (ii) the inverse hyperbolic sine transformation (IHST) of the winsorized value. The sample consists of households reporting agricultural income in one or more IFLS waves. All the specifications include household and year fixed effects. Standard errors are clustered at the location (grid-cell) level.

Table 5: Effects of Rainfall, Death/Illness, and Social Protection

	Food consumption						Net transfers (out−in)	
	Winsor. (1)	IHST (2)	Winsor. (3)	IHST (4)	Winsor. (5)	IHST (6)	Winsor. (7)	IHST (8)
Rainfall (1st lag)	421.5***	0.15***	375.79***	0.142***	269.7	0.11	149.4*	1.14
	(122.4)	(0.05)	(123.79)	(0.048)	(213.9)	(0.07)	(87.2)	(0.84)
Transfers out	-	-	0.00***	0.027***	-	-	-	-
	-	-	(0.00)	(0.003)	-	-	-	-
Transfers in	-	-	0.00	-0.003	-	-	-	-
	-	-	(0.00)	(0.002)	-	-	-	-
Rainfall × Social protection program	-	-	-	-	-76.9	0.00	-111.8	-0.72
	-	-	-	-	(184.3)	(0.07)	(107.1)	(0.94)
HH enrolled in a social protection program	-	-	-	-	7.1	0.05	12.1	0.10
	-	-	-	-	(105.8)	(0.04)	(64.5)	(0.51)
Outcome's sample mean	4,052.5	15.56	4,052.5	15.56	4,052.5	15.56	18.4	-0.17
HH-year observations	25,169	25,169	24,757	24,757	20,864	20,864	20,737	20,737
# of households	6,201	6,201	6,132	6,132	6,129	6,129	6,091	6,091
R^2	0.57	0.45	0.58	0.47	0.59	0.49	0.39	0.43
Household FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Data are at the household-year level. This table shows the effects of correlated shocks, idiosyncratic shocks, and social protection programs on household-level consumption. The rainfall variable is based on the historical (gamma) distribution of precipitation of each grid-cell. Social protection is defined as an indicator equal to 1 if the household is enrolled in one (or more) of the social protection programs asked in a given IFLS wave. Data on social protection programs are not available for the first IFLS wave in 1993. All the outcome variables are expressed in thousands of Indonesian Rupiah (year 2000) and in two versions: (i) winsorized at the 95th percentile (net transfers in columns 7-8 are also winsorized at the bottom 5th percentile); and (ii) the inverse hyperbolic sine transformation (IHST) of the winsorized value. Controls of transfers out/in are winsorized in column 3 and transformed via IHST in column 4 to match the transformation of their corresponding outcome variable. The sample consists of households reporting agricultural income in one or more IFLS waves. All the specifications include household and year fixed effects. Standard errors are clustered at the location (grid-cell) level. Using a seemingly unrelated estimation test, we find a statistically significant difference in the coefficients on rainfall in columns 1 and 3 (p-value = 0.006). Conversely, the difference is insignificant when comparing the coefficientes in columns 2 and 4, based on the IHST outcomes (p-value = 0.19).

Appendices

Table A.1: Social Protection Programs in the IFLS

Category	Program	IFLS waves with data
Health insurance and provision of healthcare services at the national and/or local levels	- Indonesian Health Card (*Kartu Sehat/KS/KIS*)	2345
	- Community Health Care Insurance (*JPKM*)	2345
	- Health Sector Social Safety Net Program (*JPSBK*)	2345
	- Social Health Insurance for the Poor (*Askeskin*)	2345
	- National Health Insurance scheme (*JAMKESMAS, BPJS, JKN*)	2345
	- Community Health Fund (*Dana Sehat*)	2345
Benefits for low-income individuals	- Letter for the Poor (*Surat Keterangan Tidak Mampu, SKTM*)	345
	- Fuel Subsidy Compensation Program (PKPS-BBM)	45
Cash transfer programs (CCTs/UCTs)	- Cash Transfers to Poor Students (*Bantuan Siswa Miskin, BSM*)	5
	- Cash Transfers for Disadvantaged Children (*Kesejahteraan Sosial Anak*)	5
	- Cash Transfers for the Elderly (*Jaminan Sosial Lanjut Usia*)	5
Other	- Social Security Disability Program	5
	- Social Protection Card (*Kartu Perlindungan Sosial, KPS*)	5

Notes: This table summarizes the social protection programs in the IFLS, a brief description of each program, and the waves in which each program is asked in the survey. Data on social protection programs are asked in the KR module on household characteristics (Book 2). No data are available for the first IFLS wave in 1993. 3.1.

Table A.2: Effects by Type of Idiosyncratic Shock

	Agricultural income		Food consumption		Non-food consumption	
	Winsor. (1)	IHST (2)	Winsor. (3)	IHST (4)	Winsor. (5)	IHST (6)
A. Shock = Death only						
Death of a HH member	-98.2	0.23	-74.7	-0.03	269.1	0.06
	(173.2)	(0.32)	(120.4)	(0.05)	(164.4)	(0.05)
HH-year observations	18,552	18,552	18,346	18,346	18,370	18,370
R^2	0.44	0.46	0.59	0.48	0.57	0.63
B. Shock = Illness only						
Illness of a HH member	176.8	0.17	190.9*	0.02	672.1***	0.26***
	(135.8)	(0.26)	(102.0)	(0.04)	(175.2)	(0.04)
HH-year observations	18,552	18,552	18,346	18,346	18,370	18,370
R^2	0.44	0.46	0.59	0.48	0.57	0.63
Outcome's sample mean	2,225.8	10.33	4,052.5	15.56	3,795.6	15.21
Household FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Notes: Data are at the household-year level. This table shows the effects of two different types of idiosyncratic shocks on household-level agricultural income and consumption. Each shock is defined as an indicator equal to 1 if the household suffered the death or the illness of a member in the past two years (panels A and B, respectively). Data on idiosyncratic shocks are not available for the fourth IFLS wave (2007/2008). All the outcome variables are expressed in thousands of Indonesian Rupiah (year 2000) and in two versions: (i) winsorized at the 95th percentile (agricultural income is also winsorized at the bottom 5th percentile because profits may be negative); and (ii) the inverse hyperbolic sine transformation (IHST) of the winsorized value. The sample consists of households reporting agricultural income in one or more IFLS waves. All the specifications include household and year fixed effects. Standard errors are clustered at the location (grid-cell) level.

Table A.3: Effects on Consumption Per Capita

	Food consumption per capita		Non-food cons. per capita	
	Winsor. (1)	IHST (2)	Winsor. (3)	IHST (4)
A. Correlated shock				
Rainfall (1st lag)	104.3***	0.16***	102.6**	0.03
	(31.0)	(0.05)	(46.3)	(0.05)
HH-year observations	25,169	25,169	25,194	25,194
R^2	0.56	0.45	0.53	0.63
B. Idiosyncratic shock				
Death or illness of a HH member	5.2	-0.01	110.8***	0.16***
	(22.0)	(0.04)	(37.0)	(0.03)
HH-year observations	18,346	18,346	18,370	18,370
R^2	0.57	0.49	0.54	0.65
C. Correlated and idiosyncratic shocks				
Rainfall (1st lag)	52.1	0.13**	-67.1	-0.18***
	(41.0)	(0.06)	(63.9)	(0.07)
Rainfall × Death or illness	54.9	0.17	158.5	0.12
	(68.7)	(0.11)	(110.2)	(0.09)
Death or illness of a HH member	-21.0	-0.09	41.5	0.11**
	(40.3)	(0.07)	(60.4)	(0.05)
HH-year observations	18,160	18,160	18,184	18,184
R^2	0.57	0.49	0.54	0.65
Outcome's sample mean	1,033.7	14.18	973.0	13.82
Household FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Notes: Data are at the household-year level. This table shows the effects of correlated and idiosyncratic shocks on household-level consumption per capita. The rainfall variable is based on the historical (gamma) distribution of precipitation of each grid-cell. The idiosyncratic shock is an indicator equal to 1 if the household suffered the death or illness of a member in the past two years. Data on idiosyncratic shocks are not available for the fourth IFLS wave (2007/2008). All the outcome variables are expressed in thousands of Indonesian Rupiah (year 2000) and in two versions: (i) winsorized at the 95th percentile; and (ii) the inverse hyperbolic sine transformation (IHST) of the winsorized value. The sample consists of households reporting agricultural income in one or more IFLS waves. All the specifications include household and year fixed effects. Standard errors are clustered at the location (grid-cell) level.

Table A.4: Heterogeneous Effects of Shocks on Earnings and Consumption

	Agricultural income		Food consumption		Non-food consumption	
	Winsor. (1)	IHST (2)	Winsor. (3)	IHST (4)	Winsor. (5)	IHST (6)
Rainfall (1st lag)	880.1***	0.15	277.6*	0.12*	-379.7	-0.19***
	(221.7)	(0.39)	(161.9)	(0.06)	(236.2)	(0.07)
Rainfall × Death or illness	-155.3	-0.43	74.0	0.17	436.8	0.11
	(348.8)	(0.65)	(265.3)	(0.11)	(401.8)	(0.09)
Death or illness of a HH member	126.2	0.31	68.8	-0.08	335.2	0.14**
	(198.9)	(0.35)	(143.0)	(0.08)	(206.1)	(0.05)
Outcome's sample mean	2,225.8	10.33	4,052.5	15.56	3,795.6	15.21
HH-year observations	18,365	18,365	18,160	18,160	18,184	18,184
R^2	0.44	0.46	0.59	0.48	0.58	0.63
Household FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Notes: Data are at the household-year level. This table shows the effects of correlated and idiosyncratic shocks on household-level agricultural income and consumption, controlling for the interaction between the two types of shocks.. The rainfall variable is based on the historical (gamma) distribution of precipitation of each grid-cell. The idiosyncratic shock is an indicator equal to 1 if the household suffered the death or illness of a member in the past two years. Data on idiosyncratic shocks are not available for the fourth IFLS wave (2007/2008). All the outcome variables are expressed in thousands of Indonesian Rupiah (year 2000) and in two versions: (i) winsorized at the 95th percentile (agricultural income is also winsorized at the bottom 5th percentile because profits may be negative); and (ii) the inverse hyperbolic sine transformation (IHST) of the winsorized value. The sample consists of households reporting agricultural income in one or more IFLS waves. All the specifications include household and year fixed effects. Standard errors are clustered at the location (grid-cell) level.

Table A.5: Effects of Shocks and Social Protection on Consumption Per Capita

	Food consumption per capita					
	Winsor. (1)	IHST (2)	Winsor. (3)	IHST (4)	Winsor. (5)	IHST (6)
Rainfall (1st lag)	104.3***	0.16***	95.35***	0.153***	115.2**	0.13*
	(31.0)	(0.05)	(31.07)	(0.047)	(51.0)	(0.07)
Transfers out	-	-	0.00***	0.021***	-	-
	-	-	(0.00)	(0.002)	-	-
Transfers in	-	-	0.00	-0.001	-	-
	-	-	(0.00)	(0.002)	-	-
Rainfall × Social protection program	-	-	-	-	-47.5	-0.03
	-	-	-	-	(53.9)	(0.07)
HH enrolled in a social protection program	-	-	-	-	-33.7	0.02
	-	-	-	-	(30.4)	(0.04)
Outcome's sample mean	1,033.7	14.18	1,033.7	14.18	1,033.7	14.18
HH-year observations	25,169	25,169	24,757	24,757	20,864	20,864
# of households	6,201	6,201	6,132	6,132	6,129	6,129
R^2	0.56	0.45	0.57	0.47	0.57	0.48
Household FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Notes: Data are at the household-year level. This table shows the effects of correlated shocks, idiosyncratic shocks, and social protection programs on household-level food consumption per capita. The rainfall variable is based on the historical (gamma) distribution of precipitation of each grid-cell. Social protection is defined as an indicator equal to 1 if the household is enrolled in one (or more) of the social protection programs asked in a given IFLS wave. Data on social protection programs are not available for the first IFLS wave in 1993. All the outcome variables are expressed in thousands of Indonesian Rupiah (year 2000) and in two versions: (i) winsorized at the 95th percentile; and (ii) the inverse hyperbolic sine transformation (IHST) of the winsorized value. Controls of transfers out/in are winsorized in column 3 and transformed via IHST in column 4 to match the transformation of their corresponding outcome variable. The sample consists of households reporting agricultural income in one or more IFLS waves. All the specifications include household and year fixed effects. Standard errors are clustered at the location (grid-cell) level. Using a seemingly unrelated estimation test, we find a statistically significant difference (10% level) in the coefficients on rainfall in columns 1 and 3 (p-value = 0.08). Conversely, the difference is insignificant when comparing the coefficientes in columns 2 and 4, based on the IHST outcomes (p-value = 0.38).

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