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The Labor Market as a Smoothing Device: Labor S pply Responses to Crop Loss

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Abstract

The paper studies the way in which labor supply responses enable households to smooth consumption in the face of crop loss. The 1993 Indonesian Family Life Survey is unusual because it contains self-reported information on crop loss and on household responses to crop loss. Of those households that report a crop loss, 41.6% also report that they responded by taking an extra job. Using these self-reported measures, the authors find evidence which suggests that the income associated with this shock-induced labor supply is important in allowing the household to avoid reducing consumption expenditure. Household members, however, do not seem to increase their total hours of work. They appear to just reallocate their time from household farming to other labor market activities.

1. Introd ction

Many farming households in developing countries live close to or below the poverty line and their income is also extremely variable. It is buffeted by weather shocks and unpredictable price movements. Governments have thus implemented a variety of income support schemes which attempt to decrease the volatility of small farmers' incomes. However, if farmers are able to smooth their consumption by saving in a good year and dissaving in bad years then such macro-smoothing schemes are redundant. The important question therefore becomes whether farmers are capable of such smoothing.

Literature in this area has examined the impact of transitory income shocks on household consumption and saving behavior and the evidence on net supports the view that households are largely able to smooth consumption. An example is Paxson (1992). However, most of the existing research has centered on the use of credit and asset markets and the running down of savings. Relatively little has been written on the use of labor markets for smoothing. In fact, the studies that examine the credit and savings mechanisms assume labor supply is fixed in the face of an income shock. It is likely, however, that labor markets play an important role in consumption smoothing. By increasing the hours households dedicate to working, or by reallocating their use of time across work alternatives, income losses can be at least partially recouped. Furthermore, the use of labor markets for smoothing may have serious welfare implications that are not apparent if savings are run down or credit markets used for smoothing. For example, household welfare may be severely affected if individuals

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work long and strenuous hours that impact negatively on their health, or if households remove children from school and send them to work. By ignoring labor supply responses, the role of leisure as a consumption good and contributor to welfare has been ignored.

Kochar (1999) is one of only a few papers that directly examines household labor supply behavior in relation to income shocks. She uses data on households in rural India and finds that they increase their market hours of work in response to crop losses. Specifically, she finds that if one doesn't control for market hours of work then crop loss has no effect on consumption. However, once one controls for hours in the labor market, then crop loss is found to reduce consumption. Kochar used ICRISAT panel data covering the period 1979 to 1984. The ICRISAT data covers 40 households in three villages in central India. The use of a panel is an advantage when estimating the permanent and transitory components of income; but one drawback of this dataset, as noted in the paper, is its limited cross-sectional component. Kochar also notes the fragility of her results and the need for confirmation using "alternative larger data sets".[1]

In this study we examine these issues using a large cross-sectional dataset: the 1993 Indonesian Family Life Survey (IFLS). Although we are unable to control for unobserved household heterogeneity as one can with panel data, we believe that it is nevertheless important to attempt to verify Kochar's results on a larger, more representative sample. Our results confirm Kochar (1999)'s findings. We find that the earnings that flow from changes in labor market behavior following crop loss are very important in enabling households to smooth their consumption, and households that are credit constrained would be unable to smooth consumption without this extra source of earnings.

In addition, we seek to explicitly examine the welfare consequences of this behavior. That is, we examine whether individuals increase their total hours of work or if they merely switch out of farm work and into other work. It is possible that households which face a crop loss experience a drop in the value of household members' time spent in own farming. In response to this, household members may substitute labor into waged employment and out of family farming activities. In this case, taking on an extra job during a crop loss may not imply a reduction in leisure (and hence welfare). Kochar assumes that leisure time is unaffected in the discussion of her results but does not test it explicitly. We find that total hours worked by individuals in crop loss households do not increase significantly. We also show that ignoring labor supply responses when testing whether households are able to smooth consumption biases studies towards concluding in favor of smoothing.

Below we discuss the IFLS data and then introduce the estimating equations that are used to investigate the responses that households may have to the crop loss. (The equations are based on a formal theoretical model which is presented in the Appendix.) Of particular interest are the following possibilities: (1) whether the household can reduce savings (through running down assets or borrowing); (2) whether the household must reduce consumption expenditure; (3) whether the household must increase total hours of work of household members by having them take on waged employment in addition to their farming activities; and (4) whether the household chooses to have its members shift their time out of own farming when faced with a crop loss and into waged employment without an increase in their total hours of work. Most previous studies have focused on whether households are able to reduce savings to offset the income shock (point 1) or must instead (as in point 2) reduce consumption leading to a larger decrease in welfare. In our analysis, the model is broadened to allow for possibilities 3 and 4 and we discuss the household welfare implications and policy implications of these household responses.

2. Data

The data are from the 1993 Indonesian Family Life Survey (IFLS). The IFLS covers a sample of 7,224 households across 13 provinces of Indonesia.[2] Together these provinces account for approximately 83% of the Indonesian population. Only households that supplied a complete set of income data (6,251 households) and lived in rural areas (3,352 households) were included in the final dataset. After cleaning the income data for outliers and dropping those households that reported missing values for some of the explanatory variables, the sample used for estimation was 3,073 households. An unusual and attractive feature of the IFLS data is that respondents were asked whether the household had experienced an economic shock in the survey year.[3] They were then asked what measures the household took to overcome the shock (Table 1). Of households that experienced a crop loss, 42% reported having taken an extra job as a result. This suggests the importance of allowing labor supply to vary when examining whether households are able to smooth consumption and also the need to examine the impact of smoothing via labor markets on household welfare.[4] These self-reported measures of crop loss and labor supply responses are used in the econometric analysis below.

3. Empirical Strategy and Res lts

The estimation strategy consists of three main steps. First, we assume, like most of the literature, that labor supply is fixed. We will refer to this as the constant labor supply (CLS) case. Following the existing literature (Paxson, 1992), we obtain estimates of permanent and transitory income and estimate households' marginal propensity to save out of each component. If households are able to smooth consumption then the marginal propensity to save out of permanent income should be close to one and that out of transitory income should be close to zero. In the second stage of the analysis, we explicitly allow households to change their labor supply when they experience a crop loss and test whether this is what allows them to smooth. We call this the variable labor supply (VLS) case. In the final stage of the analysis, we examine hours of work data to determine whether the total number of hours worked increased for individuals in households that responded to the crop loss via the labor market or if they instead reallocated their labor away from the agricultural sector to other activities.

Table 1. Responses to a Crop Loss

Measure taken	*No. of households*	*Percentage of households*
Extra job	62	41.61
Acquired debt	44	29.53
Sold assets	36	24.16
Used savings	9	6.04
Received gifts	18	12.08
Cut down on household expenses	50	33.56

Exogenous Labor Supply

Before we can proceed to test households' ability to smooth consumption we must first separately identify the permanent and transitory components of income. We follow Paxson (1992)'s method for obtaining these estimates. We estimate the following equation:

$$Y_i = \alpha_0 + \alpha_1 X_i^P + \alpha_2 X_i^T + \varepsilon_i, \tag{1}$$

where Y_i is household income, X_i^P is a vector of variables that one would expect to permanently and predictably affect income, and X_i^T is a vector of variables that are correlated with transitory income. The estimates of permanent income, Y_i^P, and transitory income, Y_i^T, are then obtained as follows:

$$\hat{Y}_i^P = \hat{\alpha}_0 + \hat{\alpha}_1 X_i^P, \tag{2}$$

$$\hat{Y}^T = \hat{\alpha}_2 X_i^T. \tag{3}$$

To identify transitory income, Paxson used regional deviations of rainfall from the mean and the variance of rainfall as the variables X_i^T. In this paper we use a dummy variable *crop loss* that equals 1 if the household reported that they experienced a crop loss in 1993 and zero otherwise. To recognize that larger farms may encounter larger transitory income, we also interact the crop loss variable with the value of the farm land. The variables, X_i^P, which we used to identify permanent income are the number of adults in each of several education/gender categories, the occupation of the household head, whether self-employed or not, provincial dummy variables, and the value of land (if any) farmed by the family.

Paxson shows that the assumption of quadratic utility generates a savings equation of the form

$$S_i = \beta_0 + \beta_1 Y_i^P + \beta_2 Y_i^T + \beta_3 \varepsilon_i + \beta_4 W_i + e_i, \tag{4}$$

where W_i is a vector of variables that control for the lifecycle characteristics of the household.[5] The variable ε_i is the residual from equation (1). These residuals capture the variations in income across households due to either: (1) transitory income shocks not captured by the X_i^T variables, or (2) differences in permanent income across otherwise identical households. They are thus a mix of permanent and transitory components of income. Equation (4) is estimated using the predicted estimates: $\hat{Y}_i^P$, $\hat{Y}_i^T$, and $\hat{\varepsilon}_i$. If households can smooth consumption then β_1 should be close to 0 and β_2 should be close to 1. Also, since $\hat{\varepsilon}_i$ is an estimate of both unobserved variation in $\hat{Y}_i^T$ and unobserved variation in $\hat{Y}_i^P$, we expect $0 < \beta_3 < 1$.

The results of the income regressions are reported in column 1 of Table 3. Table 2 presents the sample means and variance of the variables that are used in the estimations. The dummy variable, *crop loss*, is insignificant but is negative and statistically significant when interacted with land value. The coefficients are then used to construct estimates of $\hat{Y}_i^T$ and $\hat{Y}_i^P$ following equations (2) and (3). The first column of Table 4 reports the mean and standard deviation of the transitory income estimates. The mean of the $\hat{Y}_i^T$ estimates for households that experience a crop loss is Rp –83,920.[6]

The estimates of transitory income and permanent income are then used in the estimation of the savings equation. The saving measure is annual income less total annual expenditure.[7] Column 1 of Table 5 reports the results. The point estimate of the

Table 3. Income Equation Estimates

	CLS		*VLS(OLS)*		*VLS(Selection)*	
Variable	*Estimate*	*t*	*Estimate*	*t*	*Estimate*	*t*
Intercept	556,698	1.819	566,219	1.849	543,299	1.813
Transitory income variables:						
Crop loss	989.67	0.009	–265,457	–2.597	–1,235,107	1.813
Crop loss* land value/10,000	–163.59	–2.299	–119.51	–1.675		–3.358
LS response* (h'hold members 12–64)			184,366	2.123	265,109	1.428
LS response* 1st selection term					799,187	1.007
(No LS response)* 2nd selec. term					1,275,288	2.796
Permanent income variables:						
Land value/10,000	234.68	3.819	234.72	3.821	296.21	4.680
Members age 0–5	16,634	0.572	19,391	0.671	24,054	0.832
Members age 6–11	91,071	2.592	90,851	2.588	92,730	2.647
Members age 12–17	106,282	3.023	102,106	2.891	101,430	2.877
Members age 18–64	489,072	10.44	485,639	10.54	488,869	10.72
R^2	0.353		0.355		0.355	
N	3,073		3,073		3,073	

Note: Each equation also contains controls for the number of household members between the ages of 18 and 64 by gender and education level, the employment type (for example, self-employed) and the occupation of the household head as well as provincial dummy variables. The standard errors used in columns (1) and (2) are White-corrected. The standard errors in column (3) are derived using a bootstrap method.

Table 4. Means of Predicted Income Variables

CLS method	*VLS method (OLS)*		*VLS method (Selection)*	
Y^T if $\neq 0$	Y^T if $\neq 0$	Y^{LS} if $\neq 0$	Y^T if $\neq 0$	Y^{LS} if $\neq 0$
–83,920	–331,552	582,833	–1,235,107	838,088
$N = 149$	$N = 149$	$N = 61$	$N = 149$	$N = 61$

where u_{1i} is mean zero and X_i^{LS} is a vector of variables that determine the size of the increase in income from the labor supply response. In our analysis, this is a dummy variable for whether the household had a labor supply response to the crop loss multiplied by the number of household members aged 12 to 64 (because households with more people of working age are capable of increasing their labor hours by more). Since the labor supply response is endogenous, least-squares estimation of (5) may lead to

Table 5. Savings Equation Estimates

Save = Y − C	*CLS*		*VLS(OLS)*		*VLS(Selection)*	
Variable	*Estimate*	*t*	*Estimate*	*t*	*Estimate*	*t*
Y^P	0.1633	2.805	0.1636	2.816	0.1698	3.098
Y^T	1.9004	2.441	0.8182	1.701	0.2093	2.006
ε	0.6827	15.00	0.6831	14.97	0.6807	15.06
R^2	0.1894		0.1880		0.1864	
N	3,073		3,073		3,073	
F-tests:	(P-value)		(P-value)		(P-value)	
$Y^P = 1$	0.000		0.000		0.000	
$Y^T = 1$	0.248		0.706		0.000	
$Y^T = Y^P$	0.025		0.174		0.681	

Note: Equations also include controls for the number of household members by age categories as defined in Table 3. The standard errors are White-corrected.

Table 6. Probit Estimates from the Labor Response Equation

Variable	*Estimate*	*t*
Intercept	0.2246	2.980
No. of people 65 years and over	–0.4171	–2.981
No. of people aged 18 to 65 with secondary education	–0.2050	–2.748
Land value/10,000	–0.000467	–3.681
R^2 (Cragg–Uhler)	0.1145	
Percentage of correct predictions	59.14	
N	514	

biased estimates of the parameters. We control for the endogeneity of the labor supply response by employing a switching regression model with endogenous switching. Both the OLS and the switching results are reported below. Estimation of equation (5) provides estimates of permanent income, the income drop due to the crop loss holding labor supply constant, and the amount of income generated from the labor supply response.

The results of the first-stage probit estimation used in the estimation of the selection model which endogenizes the labor supply response are shown in Table 6. To identify the selection term we include household structure variables that we expect to be correlated with the probability of a household being able to find an extra job in the labor market in the probit. The number of members age 18 to 65 with secondary education was a statistically significant determinant of the likelihood of a household reporting a labor supply response. These household members are more likely to be in the formal job market and so are less able to take on extra work. Also, they may have better access to credit because of the stability of income generated by their members' human capital. The number of household members 65 years or over also had a significant and negative effect on labor supply responses. Older household members may have built up savings and assets which can be used by the household to smooth the transitory income shock and so make a labor supply unnecessary. These householders are also less likely to be able to undertake further work in response to a crop loss. Land value was also included in the probit and found to have a negative and significant effect on the probability of the household having a labor supply response to the crop loss. This may reflect the fact that households with more valuable land have better access to credit since the land can be used as security against the loan.[9]

Column 3 of Table 3 presents the results from the income equation when the selection terms are included. As in the CLS case, households that report a crop loss are found to have lower income than the other households. The crop loss dummy variable has a negative coefficient and is statistically significant at the 5% level.[10] The selection terms show that the endogeneity of the labor supply response is potentially very important. Households with lower permanent income were much more likely to use the labor market to smooth than higher income households who presumably have better access to credit markets. The point estimate on X^{LS} indicates that once we've controlled for selection, the income of those who had a labor supply response is Rp265,109 higher per householder aged 12–64 than if they had not been able to take on extra jobs. However, it is statistically insignificant in this specification ($t = 1.43$). This is in sharp contrast to the OLS results reported in column 2. Given the results in column 2 and the significance of the selection term, it is surprising that the estimate of the income generated from the labor supply responses is insignificant in the selection model. This may be due to the relatively small number of households that have a crop loss and report a labor supply response.

Table 4 shows the estimates of transitory income that arise out of the three specifications. The estimate of transitory income increases from a value of Rp –83,920 under the CLS assumption to Rp –331,552 if one takes labor supply reactions into account but treats them as exogenous and Rp –1,235,107 once the endogeneity of the labor supply response is taken into account. The estimated size of the direct loss in income from the crop loss (in the absence of a labor supply response) is hence many times larger in the VLS specification than in the CLS estimate. This indicates that ignoring labor supply responses leads to an underestimate of the size of the loss in income due to the crop loss in the absence of a labor supply response. Also, it appears that the income generated from the labor supply response is an important aspect of the household's response to the crop loss. In the VLS specification, the income generated from labor supply responses is estimated to be larger than the estimated loss in income due to crop failure. This may be due to the imprecision of the estimates or the endogeneity of the labor supply response. It could be that households with more severe crop losses are more likely to respond using the labor market and that this is not being picked up in our selection equation.

To examine the importance of flexible labor supply as a smoothing device (and also the impact of not controlling for labor supply responses when examining smoothing), we examine the counterfactual case of what may have happened if the household was unable to smooth via the labor market. We re-estimate the savings equation using the new estimates of Y^P and defining Y^T as equal to $\gamma_2 X_i^T$. That is, transitory income in this equation is the negative crop loss, net of any labor supply income. This is a better estimate of transitory income for households who had a crop loss but did not have a labor supply response. For those who did have a labor supply response it assumes that if they had not been able to adjust their labor supply they would have had to reduce their expenditure by the extra amount they earned.[11] We do not actually know if these households are credit constrained although it seems likely that they are. Maitra (2001) finds that only poor households that do not have access to credit markets use the labor market for smoothing, and in this study it is similarly the poorer households in our sample who report a labor supply response. Nevertheless, the findings below should be treated as an upper bound on the importance of labor supply responses.

The third column of Table 5 presents the results when the estimates of transitory and permanent income generated in the selection model are used. The estimation results show that the coefficient on transitory income in the saving equation falls from 1.90 under the CLS estimation to 0.21. We now reject the hypothesis that the marginal propensity to save out of transitory income equals one. Furthermore, the coefficients on permanent income and residual income are very similar across the two models. As a result we now also cannot reject the hypothesis that the MPS out of transitory income equals the MPS out of permanent income (p-value of 0.681).[12]

Hence we find that income generated from labor supply responses has potentially a large impact on the welfare of households when crop losses occur. If households that have a labor supply response are credit constrained then it appears that households would be unable to fully smooth the impact of the crop loss shock. The coefficient on the transitory income variable implies that savings drop by only 21% of the value of the crop loss shock in this case. Expenditure would then need to fall by the equivalent of 79% of the loss in income due to the crop loss. This is consistent with the estimates found by Kochar (1999) of a 44–83% fall in expenditure in the absence of hours-of-work adjustments.

The results of the savings equation estimation indicate that our conclusions on whether the households that experience a crop loss are able to smooth consumption (and hence welfare) when facing a crop loss appear to hinge on our interpretation of the welfare costs of the labor supply responses. If the labor supply responses represent extra hours devoted to the labor market without a decline in time spent on the farm, and if the households carry out this labor supply response because of credit constraints, then the labor supply response income masks the fact that the household is credit constrained. Further, the increase in total hours of work may represent a large drop in household welfare even in the absence of a noticeable decline in household consumption expenditure. It is, however, possible that the households are not credit constrained and are merely reallocating labor time from relatively unproductive farming activities to relatively productive time spent in waged employment.[13] In the next subsection, we investigate the behavior of total hours of work devoted to income-generating activities in order to differentiate between these two cases.

Examining Hours of Work

Our final exercise is to examine whether a household member taking on an extra job in response to the crop loss results in an increase in total labor supply or whether it, at least in part, is a replacement of hours spent on the family farm with hours spent in the labor market. Unfortunately, we are not able to separately identify hours spent

$$h_j(\tau) - \sum_{k=1}^{5} h_j(\tau - k)/5 = \theta_0 + \theta_1 croploss_j + u_{hj}, \quad (14)$$

where $h_j(\tau) \equiv h_{jw}(\tau) + h_{jf}(\tau)$ and u_{hj} is a mean-zero error term. Hence our dependent variable is the difference between current total hours of work and "normal" hours of work as proxied by average hours in the previous five years.[15] At this point we are constrained in one respect by the data. Although the IFLS provides information on current annual hours in all income-generating activities and annual hours over the last five years, it does so only for a randomly selected sample of individuals aged over 10 in the household. It is hence possible that if, for instance, we find that total hours worked do not increase appreciably for these "respondents," that non-respondents' hours do. However, the respondents always include the household head and his wife, an individual aged 50 or above, and his/her spouse, and 25% of households had an additional individual aged 15 to 49 and their spouse interviewed. Hence, we have information on most (and for some households all) of the individuals of working age in the household. The behavior of the respondents is hence likely to be a good indication of the experience of the household as a whole.[16]

Another difficulty in this section is the existence of corner solutions. Quite a large percentage of the sample of respondents report that they don't work at all. Kochar (1999) also had to deal with this problem. She did so by estimating fixed-effect tobit regressions but noted that these produce biased estimates in short panels. One possibility for dealing with observations with zero hours of work in this study would be to restructure our retrospective data on hours as a panel and estimate fixed-effect tobits. We have elected not to do this for two reasons. First, our pseudo-panel would, like Kochar's, consist of five years' of data and so be "short" and hence the estimates from this procedure would still be biased. In addition, it is not clear how we would endogenize labor supply behavior if we were to estimate tobits. Below we find that endogenizing labor supply provides an interesting insight into labor supply response households. Given this and the lack of an easily identifiable econometric solution to the problem of zero hours observations, instead of endeavoring to correct for the existence of zeros econometrically, we conduct a series of sensitivity tests with respect to zero values. The results reported below were found to be robust to restricting the sample just to men—who are more likely to work (89% of men report positive hours compared to 50% of women).

Table 7 reports the results over the whole sample. In the first column, the estimates are based on a model where the only control is for whether the household experienced a crop loss. The coefficient is negative but insignificant. This indicates that household members on average do not increase their total hours of work in crop loss years relative to their usual hours of work but instead labor is just being redistributed from own farming to the labor market. In column (3), the model is re-estimated controlling for whether the household reported taking an extra job and for the endogeneity of that decision. The selection terms are defined in the same way as in column 3 of Table 3.[17] The coefficient on the crop loss dummy is again negative and insignificant. The coefficient on the labor supply response dummy variable is, however, positive, large and significant at the 5% level. This should be interpreted in conjunction with the coefficient on the selection term which is also large, negative and significant. The results indicate that households that experience a crop loss and have a labor supply response are the ones that would have seen a large drop in their members' hours spent on the family farm.[18] The estimate of column (3) indicates that the average change in annual hours is substantial at 475 hours. However, this does not represent an increase in the total labor supplied. We

Table 7. Hours Difference Estimates

Variable	*Estimate*	*Estimate*	*Estimate*
Crop loss	–61.520 (–1.618)	–56.623 (–1.198)	–46.525 (–0.551)
LS response		–12.035 (–0.156)	475.366 (2.014)
LS response × selec. term			–607.567 (–2.513)
No LS response × selec. term			–14.593 (–0.103)
R^2	0.0002	0.0002	0.0004
N = 11,867			

Note: The standard errors are White-corrected. *t*-statistics are shown in parentheses.

can see this by looking at the results in column (2). The explanatory variables in column (2) are just the crop loss dummy and the labor supply dummy. They show that total hours of work do not rise for members of households that have a crop loss and a labor supply response. Hence we conclude that labor supply responses are a response to decreased productivity on the farm caused by crop loss. They are hence less likely to involve large welfare costs because work hours are merely being reallocated to more productive pursuits, given the crop loss, and little is lost in the way of leisure.

4. Concl sions and Implications for P blic Policy

The self-reported measures taken to overcome crop loss suggest that 42% of rural households in Indonesia increase labor supply when faced with a crop loss. Estimation based on a model of saving that ignores labor supply responses was found to strongly support the hypothesis that households are able to smooth consumption through a reduction in savings and/or the use of credit markets (even though 34% of households report that they cut household expenditure). We show that by incorporating extra labor supply income into the analysis it is possible to come to the opposite conclusion. In the absence of this income, and if households that report taking extra jobs in response to the crop loss are credit-constrained (as there is reason to suspect they are), households would need to cut expenditure significantly. This indicates that income generated from labor supply responses plays an important role in allowing households to smooth consumption in the face of crop losses.

The welfare consequences of the use of the labor market to smooth consumption of goods and services to a large extent depend on whether total hours of work increase or whether the shock has decreased the marginal product of family farm work and so less hours are being worked on the farm, more off the farm, and total hours remain unchanged. The results indicated that in households that had experienced a crop loss, individuals did not have significantly higher total hours of work in the year of the crop loss than they had on average in the previous five years.

The evidence indicates that although some households may be able to smooth household consumption when faced with crop losses by reducing savings and using credit markets, other households must reallocate labor out of temporarily unproductive activities on the family farm and into relatively more productive forms of employment. This highlights the potential importance of the development of rural labor markets in order to help rural households deal with their volatile environment.

Appendix

Households are modeled as choosing consumption, $c(\tau)$, hours of work in own farming, $h_f(\tau)$, and hours of work for wages, $h_w(\tau)$, so as to maximize the expected value of discounted lifetime family utility:

$$U(t)+(1/(1+\rho))\mathrm{E}_t\left\{\sum_{\tau=t+1}^{T}\left(U(\tau)/(1+\rho)^{\tau-t-1}\right)\right\} \tag{A1}$$

subject to the savings constraint:

$$S(\tau)\equiv A(\tau)-A(\tau-1)(1+r(\tau))=w(\tau)h_w(\tau)+F(h_f(\tau))-p(\tau)c(\tau), \tag{A2}$$

where τ indexes future time periods, $U(\tau) = U(c(\tau), l(\tau))$, ρ is the rate of time preference, $p(\tau)$ is the price of the composite commodity, $l(\tau) \equiv T - h_w(\tau) - h_f(\tau)$ is leisure, $w(\tau)$ is the wage paid to labor, $F(h_f(\tau))$ is the value of agricultural production, and F is a strictly concave function. $A(\tau)$ is nonhuman wealth held at the end of period τ; and $r(\tau)$ is the interest rate.[19]

We allow for the possibility of credit constraints by a non-negativity constraint on $A(\tau)$:

$$A(\tau)\geq 0 \tag{A3}$$

so that the household can sell off assets which it holds at the beginning of the period but it cannot allow its end-of-period assets, $A(\tau)$, to drop below zero.

The family farm's production function can be written as

$$y(\tau)=F(h_f(\tau))=f(h_f(\tau))+u(\tau), \tag{A4}$$

where $h_f(\tau)$ is farm labor and $f(h_f(\tau))$ is a strictly concave function and $u(\tau)$ is a mean zero random shock. Assuming interior solutions for $c(\tau)$, $h_w(\tau)$, and $h_f(\tau)$, the necessary conditions are

$$U_c(\tau)=\lambda(\tau), \tag{A5}$$

$$U_l(\tau)=\lambda(\tau)w(\tau), \tag{A6}$$

$$U_l(\tau)=\lambda(\tau)f'(h_f(\tau)), \tag{A7}$$

where $\lambda(\tau)$ is the multiplier for the period τ asset accumulation constraint. The motion equation for the marginal utility of wealth, $\lambda(\tau)$, is

$$\lambda(\tau)=(1/(1+\rho))\mathrm{E}_t\{\lambda(t+1)(1+r(t+1))\}+\gamma(t). \tag{A8}$$

If the household is credit-constrained in period t, $\gamma(t) > 0$, otherwise $\gamma(t) = 0$. The random shock, $u(\tau)$, does not enter directly into the first-order conditions but operates via the marginal utility of household wealth term, $\lambda(\tau)$. Positive shocks of this kind add to household wealth and the majority of it will be saved so as to increase consumption in future periods as well as the current period. Negative shocks may be smoothed through borrowing or running down assets so as to decrease consumption only slightly in each period over the remainder of the lifetime of the household. However, this will not be possible if the shock is negative, large enough to force the household's assets to be zero, and if the household is not able to borrow. In this case, the marginal utility of wealth in the period of the shock, $\lambda(\tau)$, is larger than it would have been if the household were not credit-constrained (because $\gamma(\tau) > 0$) leading the household to consume less and work longer hours.

We can use equation (A6) to derive an expression for total hours of work in the period. Assuming separability between consumption and leisure, and taking the natural logarithm of both sides of (A6), a first-order approximation of the left-hand side with respect to total hours of work, $h_j(\tau) \equiv h_{jw}(\tau) + h_{jf}(\tau)$ and a first difference gives

$$h_j(\tau) - h_j(\tau-1) = \ln\lambda(\tau) - \ln\lambda(\tau-1) + \ln w(\tau) - \ln w(\tau-1). \quad \text{(A9)}$$

If we assume that the change in the market wage rate is zero and model the change in the marginal utility of wealth term as a reduced form function, we get

$$h_j(\tau) - h_j(\tau-1) = \theta_0 + \theta_1 CL_j + u_{hj}. \quad \text{(A10)}$$

In this simple specification, taking the first difference eliminates household heterogeneity and the credit constraint effect is represented by the change in the marginal utility of income term from (A9). In the actual estimation we use the difference between the current year and a five-year average instead of the first difference, but the same intuition holds.

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Notes

1. See also Maitra (2001) which similarly uses the ICRISAT data and finds that small farmers and landless workers are excluded from credit markets. Small farmers are able to smooth consumption through compensating changes in labor market participation and reducing own farm work, but landless farmers cannot vary their labor market participation and so are left vulnerable to such shocks.

2. The survey was a collaborative effort of Lembaga Demografi at the University of Indonesia and RAND and received financial support from the National Institute of Child Health and Human Development, USAID, the Ford Foundation and the World Health Organization. The provinces covered in the survey are in Java, Sumatra, Bali, West Nusa Tenggara, Kalimantan, and Sulawesi.

3. Respondents were also asked about economic shocks due to death or sickness of a household member, unemployment, price falls, and natural disasters. Transitory income shocks must by definition be deviations from expectations and of a temporary nature. This paper concentrates on crop loss because it is unpredictable and the cause is short-lived (as opposed for example to the death of a family member). The examination of crop loss also enhances comparability with earlier studies that have focused on shocks to farming households.
4. The possible responses were acquiring debt, selling assets, using savings, receiving gifts, cutting down on household expenditure, or a householder taking an extra job.
5. The model also predicts that the variance of transitory shocks be included in equation (4) as a regressor. The dataset used in this study is not well suited to developing a variable of this kind.
6. The Indonesian currency is the rupiah. The IFLS provides information only on economic hardships (or negative shocks). Ideally we would also know which households experienced positive transitory income shocks in the period. Without this information, the mean of the positive shocks will be absorbed into the constant term and hence be incorporated in our estimates of $^{P}_{i}$. However, if the incidence of positive shocks is symmetrical to that of negative shocks, less than 5% of households will have experienced a positive shock and so this effect will be relatively small. We hence believe that the omission of information on positive shocks has not caused our estimates of permanent income to be seriously overstated. Any variability in the positive shocks across households will fall into the error term. Using this fact, the sensitivity of the savings equation results to the lack of information on positive shocks were explored further below but found not to be problematic.
7. A possible problem with this measure is that expenditure on durables includes a saving component. This measure therefore underestimates actual saving. To counter this problem another measure of saving was calculated that equals annual income minus expenditure on nondurables. Estimation using this variable produced very similar results. Another possible measure of saving is the change in household assets. The IFLS provides the data to construct such a variable. However, the data appeared to be very noisy and the results were judged to be unreliable. The savings measures were adjusted for inflation to account for the fact that annual expenditure is calculated from the response to questions about: (1) food expenditure over the last week, (2) nonfood expenditure on nondurables over the last month, and (3) nonfood expenditure on durables over the last year. The results for the alternative savings measures are available upon request from the authors.
8. As mentioned above, the residual income, ε_i, also contains a component of the positive income shocks experienced by the households. One would therefore expect the positive residuals to be comprised of a larger proportion of transitory income than the negative residuals. We can use the residual income to conduct a sensitivity analysis of the impact of not controlling for positive shocks. If positive income shocks are an important component of income in the survey year, one would expect the coefficients on the positive residuals to be closer to one. We re-estimated the equation replacing the variable ε_i with two variables: ε_i^+ residuals (and zeros if the residual was negative) and ε_i^- which contains the negative residuals (and zeros otherwise). The coefficient on ε_i^+ was only slightly, and insignificantly, closer to one than the coefficient on ε_i^-.
9. We estimated the probit over the 514 households that reported a crop loss in the survey year or any of the four years prior to the survey year (instead of just the 149 households that reported a crop loss in 1993 and who are in the income equation.) The IFLS provides a limited amount of retrospective data, information on previous crop losses being one example. We did this to increase the sample size and hence the precision of the estimates. This may introduce some measurement error because we are matching contemporaneous data on land value and number of household members by age and education categories with retrospective information on crop loss in the current year and in the four previous years. We are, however, of the view that any bias is unlikely to be large because the time differential will on average only be roughly two years and household composition and land value are not inherently highly variable. Specifications of the probit index that included number of household members by other age, education, and gender groups were also explored. In each case, the restrictions implicit in this specification could not be rejected.

10. The interaction of this crop loss dummy with land value was insignificant in this specification and so omitted from the equation. The standard errors were derived using a standard bootstrap method based on 1,000 replications. They are very similar to those generated from the OLS formula or using the method of White (1980). They were also very similar to the standard Heckman two-step standard errors. We didn't present these since it was unclear how to account for the fact that the probit estimation is carried out over a different sample than the regression analysis since retrospective data are used in the probit analysis but are not used in the regression analysis.
11. Note that we are increasing the magnitude of the transitory income shock (by ignoring the labor supply response income) but we are not adjusting any of the variables such as the dependent variable, savings. This is because if they are credit constrained, their income and consumption would have been lower by the same amount and so their savings would have been unaffected.
12. We would expect the coefficient on residual income, ε_i, under the VLS method to lie between the coefficients on Y^P and Y^T as hypothesized for crop loss households. However, because noncrop loss households are a much larger proportion of the sample, ε_i more closely reflects a mix of permanent, transitory, and labor supply response income components of those households. The coefficient on ε_i of 0.68 does not therefore reflect the marginal propensity to save out of residual income for crop loss households and so need not lie between the other two estimates.
13. This possibility can be incorporated in the theoretical model by the inclusion in the production function of a random shock to the marginal product of labor:

$$v(\tau): y(\tau) = F(h_f(\tau)) = e^{v(t)} f(h_f(\tau)) + u(\tau).$$

14. This equation is also based on the model presented in the Appendix.
15. An issue is whether previous years were also crop loss years. Given that only 5% of households have a crop loss in a given year, the five-year average will be dominated by years in which no crop loss has occurred. We also know that no household that reported a crop loss in the survey year reported a crop loss in the previous years.
16. The most common household structure in Indonesia consists of an elderly couple, their children, and their grandchildren.
17. We use land value to identify the selection term. Land value is likely to explain the household's access to credit and, therefore, enter as a determinant of the labor supply response income. We do not include it in the hours difference equation because it is likely to be a determinant of usual hours of work in income-generating activities but not in the change in the hours of work across time.
18. Note that the difference equation structure removes any household fixed effects and so this selection effect cannot be picking up time-invariant unobserved household heterogeneity. Rather, it is reflecting a difference in the impact of the crop loss on the households that have a labor supply response relative to the households that do not.
19. This model is based on the standard labor supply model (see Heckman and MaCurdy, 1980; Browning et al., 1985; Ball, 1990; Worswick, 1999).