The Labor Market as a Smoothing Device: Labor Supply Responses to Crop Loss in Indonesia

Lisa Cameron

and

Christopher Worswick

Department of Economics

The University of Melbourne

Parkville, Victoria, Australia 3052

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ABSTRACT

This paper studies the importance of labor supply responses in enabling 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. 41.6 percent of households who reported a crop loss also reported that they responded by increasing their labor supply. Using these self-reported measures, we 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 also do not need to increase their total hours of work as the crop losses appear to reduce the value of their time in household farming allowing them to take on extra jobs.

1. Introduction

Many farming households in developing countries live close to or below the poverty line. In addition to having very low income, 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.

The previous 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 (see for example, 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 work long and strenuous hours that impact negatively on their health or if households remove children from school and send them to work (as has been suggested has been the case during the Asian financial crisis). Unlike savings and credit markets, the time path of labor market use, rather than just the accumulated stocks, can have long term consequences. 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 examine household labor supply behaviour 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 advantage of this data set is its panel nature. The use of a panel is an advantage when estimating the permanent and transitory components of income but one drawback of this data set, as is 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 use the 1993 Indonesian Family Life Survey (IFLS) to examine the same issue. This is a large cross-sectional data set. While using cross-sectional data presents some challenges with regard to unobserved household heterogeneity when estimating transitory and permanent income, we believe that it is nevertheless still important to attempt to verify Kochar's results on a more representative sample. Our results confirm Kochar (1999)'s findings. We find that the earnings that flow from changes in labor market behaviour 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 these behavioral changes. 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

[1]See also Maitra (1997) 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 labour market participation and so are left vulnerable to such shocks.

in own farming. In response to this, household members may substitute labor into wage employment and out of family farming activities. In this case, that a household member takes on an extra job during a crop loss may not imply a reduction in leisure and hence welfare since total hours of leisure may not fall if time spent on own farming is merely being replaced by time spent in wage employment. Kochar assumes the latter in her 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.

In the next section, we present a simple life cycle model that allows us to characterize household responses to different types of crop loss shocks. Estimating equations are generated from the model and are used in the analysis to investigate different possible responses that households could undertake to the crop loss. 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 wage 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 wage employment without an increase in their total hours of work. Most previous studies have focussed 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. Theory and Estimation Strategy

2.1. The Model

We use the standard dynamic labor supply model (see Heckman and MaCurdy, 1980, Browning, Deaton and Irish, 1985, Ball, 1990, and Worswick, 1999). The model allows for two time uses: 1) own farming and 2) wage employment (see Bardhan and Udry, 1999, pp. 7-10, for an example of a static version). It is a simplified version of the model used by Kochar (1999).[2]

[2]The Indonesian data do not have information on farming methods used at the beginning of the year and part way through the year; therefore, we are not able to replicate Kochar's analysis.We also make the simplifying assumption that the household does not employ labour from outside the family. The theoretical implications are not sensitive to this assumption.

The household is modelled as choosing consumption, hours of work in own farming and hours of work for wages so as to maximize the expected value of discounted life-time family utility:[3]

$$U(t) + \frac{1}{1+\rho} E_t \left\{ \sum_{\tau=t+1}^{T} \frac{U(\tau)}{(1+\rho)^{\tau-t-1}} \right\} \tag{2.1}$$

subject to the savings constraint:

$$S(\tau) \equiv A(\tau) - A(\tau-1)(1+r(\tau)) = w(\tau)h_w(\tau) + F(h_f(\tau)) - p(\tau)c(\tau) \tag{2.2}$$

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, $c(\tau)$ is family consumption; $h_w(\tau)$ is the hours of work for wages in period τ, $h_f(\tau)$ is the hours of work on the family farm in period $\tau, l(\tau) \equiv T - h_w(\tau) - h_f(\tau)$ is leisure in period τ; $w(\tau)$ is the wage paid to labor, $F(h_f(\tau))$ is the value of agricultural production in period τ and F is a strictly concave function.[4] $A(\tau)$ is non-human wealth held at the end of period τ; and $r(\tau)$ is the interest rate.

The credit constraint in period τ is represented by a non-negativity constraint on $A(\tau)$:

$$A(\tau) \geq 0 \tag{2.3}$$

The household can sell off assets which it holds at the beginning of the period, $A(\tau - 1)(1+r(\tau))$, but it cannot allow its end of period assets, $A(\tau)$, to drop below zero. Given an initial condition, $A(0) = A_0$, and a terminal condition, $A(\overline{T}) = A_{\overline{T}}$, the household's problem is fully characterized.

We are interested in differentiating between two different types of shocks to the household's farming production process. We write the family farm's production function as:

$$y(\tau) = F(h_f(\tau)) = e^{v(\tau)} f(h_f(\tau)) + u(\tau) \tag{2.4}$$

where $v(\tau)$ and $u(\tau)$ are mean zero random shocks to household production and $f(h_f(\tau))$ is a strictly concave function. The first type of shock, $u(\tau)$, can be thought of as a shock to farm output that does not affect the marginal product of labor in farming that period. The second type of shock, $v(\tau)$, in contrast, affects the marginal product of labor in farming. We wish to differentiate between these two types of transitory shocks because, as discussed above, we wish to examine whether households switch out of work on the family farm and into market work (as may be optimal in response to a $v(\tau)$ type shock) or if they just take on extra work hours (as they would be more likely to do in response to a $u(\tau)$ type shock).

[3]For simplicity, we will represent the household as having only one member. However, allowing for multiple household members does not change the qualitative nature of the household responses.

[4]The concavity can be thought of as being due to land being a fixed factor in the production process.

Assuming interior solutions for $c(\tau)$, $h_w(\tau)$ and $h_f(\tau)$, the necessary conditions are:

$$U_c(\tau) = \lambda(\tau) \tag{2.5}$$

$$U_l(\tau) = \lambda(\tau)w(\tau) \tag{2.6}$$

$$U_l(\tau) = \lambda(\tau)e^{v(\tau)}f'(h_f(\tau)) \tag{2.7}$$

where $U_m(\tau)$ is the derivative of $U(\tau)$ with respect to m, for $m = c(\tau), l(\tau)$; $\lambda(\tau)$ is the multiplier for the period τ asset accumulation constraint; $f'(h_f(\tau))$ is the derivative of $f(h_f(\tau))$ with respect to $h_f(\tau)$.

The motion equation for the marginal utility of wealth, $\lambda(t)$, is:

$$\lambda(t) = \frac{1}{1+\rho}E_t\{\lambda(t+1)(1+r(t+1))\} + \gamma(t) \tag{2.8}$$

If the household is credit-constrained in period t, $\gamma(t) > 0$, otherwise $\gamma(t) = 0$. In order to interpret this condition, assume for the moment that the household is not credit-constrained in period t, which implies $\gamma(t) = 0$. In this case, the condition equates the expected present value of the increase in utility from another unit of wealth in period $t+1$, $(1+\rho)^{-1}E_t\{\lambda(t+1)(1+r(t+1))\}$, to the cost in terms of the decrease in utility in period t, $\lambda(t)$. If the household is credit-constrained in period t, the household would like to lower its end of period assets, $A(t)$, below zero by borrowing against future earnings.

From equation (2.7), it is clear that $v(\tau)$ affects the value of time devoted to agriculture; however, $u(\tau)$ 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 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 leading to smaller consumption and more hours of labor in both own farming and in wage labor.

In contrast, a positive or negative crop loss shock acting through $v(\tau)$ may have a large impact on hours in own farming and in wage employment even in the absence of credit-constraints. A negative shock of this kind reduces household's potential wealth leading to a 'small' decrease in consumption in the current and all future periods. However, given the drop in the value of time devoted to own-farming, we would expect a reallocation of time away from own-farming to wage labor since the drop in labor supply to the family farm reduces the marginal disutility to labor supply, ceteris paribus, making supplying more time to wage employment more attractive.

3. 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[5]. Together these provinces account for approximately 83 per cent 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 data set. 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.[6] They were then asked what measures the household took to overcome the shock. Forty-two per cent of households that experienced a crop loss 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.[7] These self-reported measures of crop loss and labor supply responses are used in the econometric analysis below.

4. Empirical Strategy and Results

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 Case (CLS). Following the existing literature, we obtain estimates of permanent and transitory income and estimate the household's 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.[8] In the second stage of the analysis, we explicitly allow households to change their labor supply when they experience a crop

[5]The survey was a collaborative effort of Lembaga Demografi of 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 Organisation. The provinces covered in the survey are in Java, Sumatra, Bali, West Nusa Tenggara, Kalimantan and Sulawesi.

[6]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 an unpredictable and short-lived shock and also to enhance comparability with earlier studies that have focussed on shocks to farming households.

[7]The possible responses were acquiring debt, selling assets, using savings, receiving gifts, cutting down on household expenditure or a householder taking an extra job.

[8]This follows the general framework of Paxson (1992).

loss and test whether this is what allows them to smooth. We call this the Variable labor Supply Case (VLS). 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.

4.1. 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:

$$Y_i = \alpha_0 + \alpha_1 X_i^P + \alpha_2 X_i^T + \varepsilon_i \tag{4.1}$$

where X_i^P is a vector of variables that one would expect to permanently and predictably affect income, X_i^T is a vector of variables that are correlated with transitory income, α_0, α_1 and α_2 are parameters, and ε_i is a mean zero error term. The estimates of permanent income, Y_i^P, and transitory income, Y_i^T, are then obtained as follows:

$$\widehat{Y_i^P} = \widehat{\alpha_0} + \widehat{\alpha_1} X_i^P \tag{4.2}$$

$$\widehat{Y_i^T} = \widehat{\alpha_2} X_i^T \tag{4.3}$$

To identify transitory income, Y_i^T, Paxson (1992) 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 (1992) shows that the assumption of quadratic utility generates a savings equation of the form:

$$S_i = \beta_0 + \beta_1 Y_i^P + \beta_2 Y_i^T + \beta_3 \varepsilon_i + \beta_4 W_i + e_i \tag{4.4}$$

where W_i is a vector of variables that control for the lifecycle characteristics of the household.[9] The variable ε_i is the residual from equation (2.9):

$$\widehat{\varepsilon_i} = Y_i - \widehat{\alpha_0} - \widehat{\alpha_1} X_i^P - \widehat{\alpha_2} X_i^T \tag{4.5}$$

[9]The model also predicts that the variance of transitory shocks be included in (2.13) as a regressor. The data set used in this study is not well suited to developing a variable of this kind.

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 4.4 is estimated using the predicted estimates: $\widehat{Y_i^P}$, $\widehat{Y_i^T}$ and $\widehat{\varepsilon_i}$. If households can smooth consumption then β_1 should be close to 0 and β_2 should be close to 1. Also, since $\widehat{\varepsilon_i}$ is an estimate of both unobserved variation in Y_i^T and unobserved variation in 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 Y_i^T and Y_i^P following Equations 2.10 and 2.11. Table 4 reports the mean and standard deviation of the transitory income estimates. The mean of the Y_i^T estimates is Rp -83,920.[10][11]

The estimates of transitory income and permanent income are next used in the estimation of the savings equation. The saving measure used is annual income less total annual expenditure. 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 non-durables. Estimation using this variable produced very similar results. The results for the second saving measure are available upon request from the authors.[12] 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) non-food expenditure on non-durables over the last month, and 3) non-food expenditure on durables over the last year.[13]

[10]The Indonesian currency is the Rupiah.

[11]The IFLS only provides information 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 Y_i^P. However, if the incidence of positive shocks is symmetrical to that of negative shocks, less than five percent 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. In any case, the same bias will persist when we control for labour supply responses as when we do not and so will not affect the comparison of the results from the different methods. 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.

[12]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. These results are available from the authors on request.

[13]As an example, annual food expenditure, F_A, was calculated from weekly food expenditure, F_W,

Column 1 of Table 5 reports the results. The point estimate of the marginal propensity to save (MPS) out of permanent income is 0.1633 and statistically significant. The point estimate of the MPS out of transitory income under the CLS method is 1.9004 and also significant. The coefficient on Y^P is consistent with the permanent income hypothesis prediction that the MPS out of permanent income should be near zero. There is however no economic rationale for the coefficient on Y^T being greater than 1. Note however that we cannot reject the hypothesis that the coefficient is equal to one. In addition, the hypothesis that the response of savings to changes in permanent income is the same as that on transitory income is rejected at the 5 per cent level. The CLS results are thus similar to those of Paxson (1992) and like many others in the literature, are consistent with the hypothesis that households can smooth consumption in the face of crop losses.[14]

4.2. Implications of Labor Supply Responses

We now consider the implications of the assumption that labor supply is exogenous for the empirical model presented above. First, let us consider the case of a crop loss that does not affect the marginal product of labor in own-farming. In this case, the household will reduce consumption and increase hours of work in both own-farming and wage labor relative to what would have been the case in the absence of the shock. This effect is due to the loss of lifetime wealth from the shock. This increase in labor supply results in a smaller drop in consumption relative to the case where labor supply is exogenous.[15]

If instead the crop loss reduces the marginal productivity of labor supplied to the family farm, then households will choose to re-allocate time away from own-farming

in the following way.

$$F_{\mathsf{A}} = F_{\mathsf{W}} \sum_{\mathsf{j}=0}^{51} [P_{\mathsf{t}-\mathsf{j}} \ / \ P_{\mathsf{t}}]$$

where P_{t} is a price index at time t. The annual rate of inflation in Indonesia was 10 per cent in 1993 (Fane, BIES, 1994) and was assumed to be constant over the year.

[14] 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: $\varepsilon_{\mathsf{i}}^{+}$ which contains the positive residuals (and zeroes if the residual was negative) and $\varepsilon_{\mathsf{i}}^{-}$ which contains the negative residuals (and zeroes otherwise). The coefficient on ε^{+} was only slightly, and insignificantly, closer to one than the coefficient on $\varepsilon_{\mathsf{i}}^{-}$.

[15] The effect will be magnified if the household is credit-constrained.

towards other labor market activities. Similarly, the extra income that is generated in this way may allow consumption smoothing that wouldn't otherwise be possible. As discussed above, the welfare implications of this reshuffling of time are less clear.

As part of our investigation of the importance of labor supply responses we carry out two exercises using the Indonesian data. First, we estimate the size of the income generated from the labor supply response by including controls for a household labor supply response in the reduced form income equation:

$$Y_i = \gamma_0 + \gamma_1 X_i^P + \gamma_2 X_i^T + \gamma_3 X_i^{LS} + u_{li} \tag{4.6}$$

where u_{li} 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 (4.6) would lead to biased estimates of the parameters.[16] We control for the endogeneity of the labor supply response by employing a switching regression model with endogenous switching. In this way we obtain estimates of permanent income, the income drop due to the crop losses holding labor supply constant, and the amount of income generated from the labor supply response.

If we first ignore the endogeneity of the labor supply response and estimate Equation (4.6) by ordinary least squares (as shown in Column 2 of Table 3) the estimated coefficient on X^{LS} indicates that households that report a crop loss and have a labor supply response have income that is Rp 184, 126 larger on average per household member aged 12 to 64 than would an otherwise similar household that reported a crop loss and did not have a labor supply response. This is consistent with the idea that households use labor supply responses to smooth consumption when hit with a crop loss.

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 Appendix 1. 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. We use the number of members age 18 to 65 with secondary education. This was found to have a significant and negative effect on the likelihood of a labor supply response for households facing a crop loss. These household members are more likely to be in the formal job market and so may be less able to take on extra work.

[16] This is due to the fact that X_i^{LS} and u_{li} are not independent. For example, if households with larger losses in income due to the crop loss are more likely to need to respond with an increase in labor supply, then this would be represented in the model as a larger value of the error term, u_{li}.

Alternatively, it may be that these households have better access to credit because of the stability of income generated by their members' human capital. We also included the number of household members 65 years or over which was significant and also negative. This may reflect the fact that households with older members have built up savings and assets to fund the older members' consumption. These funds can be used by the household to smooth the transitory income shock therefore, a labor supply response is not necessary. 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.[17]

Column 3 of Table 3 presents the results from the income equation when the selection terms are included.[18] As in columns 1 and 2, 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 per cent level.[19] The

[17]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 the in the income equation. The IFLS provides a limited amount of retrospective data. The 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.

[18]Under the assumption that the error term in the income equation and the error term in the index determining the decision to have a labour supply response when a crop loss occurs are distributed according to the joint Normal distribution, equation (4.6) can be rewritten to account for the endogeneity of the labour supply response as:

$$Y_{\mathsf{i}} = \gamma_0 + \gamma_1 X_{\mathsf{i}}^{\mathsf{P}} + \gamma_2 X_{\mathsf{i}}^{\mathsf{T}} + \gamma_3 X_{\mathsf{i}}^{\mathsf{LS}} + \sigma_{\mathsf{lu}} \left(\frac{\phi(-Z_{\mathsf{i}}\delta)}{1 - \Phi(-Z_{\mathsf{i}}\delta)} \right) LS_{\mathsf{i}} - \sigma_{\mathsf{nu}} \left(\frac{\phi(-Z_{\mathsf{i}}\delta)}{\Phi(-Z_{\mathsf{i}}\delta)} \right) CL_{\mathsf{i}}(1 - LS_{\mathsf{i}}) + u_{\mathsf{i}} \quad (4.7)$$

where $Z_{\mathsf{i}}\delta$ is the deterministic component of the index over the decision to have a labour supply response when a crop loss occurs, LS_{i} is a dummy variable identifying households that reported a labour supply response, ϕ and Φ are the probability density function and cumulative distribution function of the standard Normal distribution, respectively.

[19]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 1000 replications. They are very similar to those generated from the OLS formula or using the method of White (1980).

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 Rp 265,109 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). 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 from zero in the selection model. This may be due to the relatively small number of observations 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 it 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 both VLS specifications 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 both VLS specifications, 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, (4.4), 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.[20] We do not actually know if these

[20]Note that we are increasing the magnitude of the transitory income shock (by ignoring the labour supply response income) but we are not adjusting any of the variables such as the dependent variable,

households are credit constrained although it seems likely that they are. Maitra (1997) 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 second column of Table 5 presents the VLS method savings equation results using the OLS-based VLS method estimates of transitory and permanent income from column (2) of Table 3. The estimation results show that the coefficient on transitory income in the saving equation falls from 1.9004 under the CLS estimation to 0.8182. Therefore, controlling for labor supply responses results in a smaller marginal propensity to save out of transitory income; however, it is still near to one in value. The only change to our inference compared with the results of column (1) is that we now cannot reject the hypothesis that the marginal propensity to save out of transitory income equals the marginal propensity to save out of permanent income (with a p-value of 0.174).[21]

The preceding analysis ignores the potential endogeneity of the labor supply responses and therefore the analysis is replicated using the estimates from column (3) of Table 3. Using the larger estimates of the unconditional crop losses generated from the selection model, the results are similar in terms of the marginal propensities to save out of permanent income and the residual income variable, but there is now a much smaller estimate of the marginal propensity to save out of transitory income, 0.2093. Furthermore, we can reject the hypothesis that the marginal propensity to save out of transitory income equals one and we cannot reject the hypothesis that it equals the MPS out of permanent income (p-value of 0.681).

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 percent of the value of the crop loss shock to income in this case. Expenditure would then need to fall by

savings. This is because if they are credit constrained, their income and consumption would have been lower by the same amount and so their saving would have been unaffected.

[21] 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 hypothesised for crop loss households. However, because non-crop loss households are a much larger proportion of the sample, ε_i more closely reflects a mix of permanent, transitory and labour supply response income components of those households. The coefficient on ε_i of 0.6828 does not therefore reflect the marginal propensity to save out of residual income for crop loss households and so needn't lie between the other two estimates. By interacting ε_i with a crop loss dummy, the marginal propensity to consume out of residual income for crop loss households is obtained. These results ae available from the authors on request. The coefficient on ε_i is insignificantly different from the coefficients on both Y^P and Y^T.

the equivalent of 79 percent of the loss in income due to the crop loss. This is consistent with the estimates found by Kochar (1999) of a 44 to 83 percent 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. Alternatively, it may be that households are not credit constrained and are merely reallocating labor time from relatively unproductive farming activities to relatively productive time spent in wage employment. In the next section, we investigate the behaviour of total hours of work devoted to income-generating activities in order to differentiate between these two cases.

4.3. 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 implies 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. We use hours of work information for household members to explore whether total hours of work in own-farming or in wage employment change in the year of the crop loss relative to a five year average of total hours of work based on retrospective questions on their activities over the previous five years. The IFLS provides information on some household member's current annual hours in all income-generating activities over the last five years.

Equation (2.6) relates leisure to the marginal utility of income and the wage rate. Given that total hours of work (in farming or in some other labor market activity) equals total hours in the period minus hours of leisure, it is possible to derive an expression for total hours of work in the period from (2.6). Our approach is to take the natural logarithm of both sides of (2.6), and then take a first order approximation of the left hand side with respect to total hours of work, $h_j(\tau) \equiv h_{jw}(\tau) + h_{jf}(\tau)$. Taking the first difference of this gives:

$$h_j(\tau) - h_j(\tau - 1) = \ln \lambda(\tau) - \ln \lambda(\tau - 1) + \ln w(\tau) - \ln w(\tau - 1) \tag{4.8}$$

Next, 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:

$$h_j(\tau) - h_j(\tau - 1) = \theta_0 + \theta_1 CL_j + u_{hj} \tag{4.9}$$

where u_{hj} is a mean zero error term. The intuition for this simple specification is that household heterogeneity is being eliminated by taking the first difference and what remains is the credit constraint effect showing up in the change in the marginal utility of income term from (2.8).

A positive coefficient on the crop loss dummy variable would indicate that individuals in households that experience a crop loss work more hours than they would in the absence of the crop loss. This would indicate that crop losses do not free up time from the family farm and that there may be important welfare losses for households that experience a crop loss. However, if it is the case that the coefficient is insignificantly different from zero or negative then that would indicate that increases in hours supplied to the labor market do not exceed the reduction in hours spent on the family farm. Thus, the household is less likely to have experienced a large drop in its welfare due to the crop loss.[22] It is important to note that in this section we are constrained in one respect by the data. The IFLS only reports data on the number of hours worked 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 over 50 and above and his/her spouse and 25 percent of households had an additional individual aged 15 to 49 and their spouse interviewed. Hence, for many households we have information on most and for some, all of the individuals of working age in the household. We hence believe that the behaviour of the respondents is a good indication of the experience of the household as a whole.[23]

The data used in the analysis are: 1) the total hours in income-generating activities in the survey year and 2) the average of hours spent in income-generating activities in each of the previous five years. We define our hours difference measure as the difference between 1) and 2). Our intention is to have 2) represent the usual hours of the individual in a year without a crop loss and for 1) to represent the current hours that may be affected by the crop loss.[24]

[22]Ideally, we would analyse both annual hours spent working on family farm and annual hours spent working in labour market separately; however, the data do not allow us to separate time spent in each of these types of activities.

[23]The most common household structure in Indonesia consists of an elderly couple, their children and their grandchildren.

[24]An issue is whether previous years were also crop loss years. Given that only five percent of

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. However, we have elected not to do this for two reasons. First, our pseudo-panel would, like Kochar's consist of 5 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 behaviour 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, we have decided that instead of endeavouring to correct for the existence of zeros econometrically, we will 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 6 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. The results supports the idea that crop losses reduce the marginal productivity of labor on the family farm leading to an efficient redistribution of labor out of own farming and into the labor market. In column (3), the model is re-estimated with a dummy variable included for whether the household reported a labor supply response if a crop loss occurred. Both coefficients are negative and insignificant indicating that total hours of work are not rising significantly in the year of the crop loss, for both those households who reported responding by taking on extra jobs and those who did not.

Finally, in the third column we present results that control for selectivity into having a labor supply response. The selection terms are defined in the same way as in column 3 of Table 3.[25] The coefficient on the crop loss dummy is again negative and insignificant from zero. In stark contrast however to the results in column 2, the coefficient on the

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.

[25]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 labour 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.

labor supply response dummy variable is positive, large and significant at the five percent 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.[26] This is consistent with a $v(\tau)$ shock in the theoretical model. The estimate of column (3) indicates that the average change in annual hours is substantial at 475 hours. However, consistent with the theoretical model, this does not represent an increase in the total labor supplied. We can see this by referring back to the results of column (2) which show that total hours of work do not rise for members of households that have a crop loss and have 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.

5. Conclusions and Implications for Public Policy

The self-reported measures taken to overcome crop loss suggest that forty-two percent of rural households in Indonesia increase labor supply when faced with a crop loss. Estimation based on a model of savings 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 thirty-four per cent 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 model we present also allows for the possibility that the crop loss reduces the marginal product of labor devoted to the family farm. In this case, if wage rates in the labor market remain unchanged there is an incentive for the household to shift labor supply out of the family farm's activities and into the labor market. We explore this

[26]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 labour supply response relative to the households that do not.

possibility by estimating a difference equation for total hours of work in all income-generating activities in the current year versus an average of the total hours variable in the preceding five years at the individual level. 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. This indicates that the crop loss reduced the value of time spent in own farming and that some households were able to reallocate their members' time into the labor market.

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 re-allocate 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.

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Table 1: Responses to a Crop Loss

Measure Taken	no. of households	% of households
Extra Job	62	41.61
Acquire Debt	44	29.53
Sell Assets	36	24.16
Use Savings	9	6.04
Receive Gifts	18	12.08
Cut down on Household Expenses	50	33.56

Table 2: Sample Means of Key Variables

Variable (N=3073)	Mean	Std. Dev.	Min	Max
crop loss	0.0485	0.215	0	1
crop loss x land value (Rp)/10 000	26.818	326.735	0	10 000
LS Response	0.0202	0.1406	0	1
land value/10 000	292.334	1 070	0	20 000
# aged 0 to 5	0.6476	0.8023	0	5
# aged 6 to 11	0.7013	0.8462	0	4
# aged 12 to 17	0.6196	0.8170	0	5
# aged 18 to 64	2.2994	1.0720	0	12
# aged over 64	0.2099	0.4840	0	4
# males over 18 /primary school	0.7878	0.6740	0	5
# females over 18 /primary school	0.9925	0.5997	0	5
# males over 18 /secondary school	0.2929	0.5775	0	5
# females over 18 /secondary school	0.1894	0.4463	0	4
# males over 18 /post-secondary school	0.0254	0.1693	0	3
# females over 18 /post-secondary school	0.01237	0.1134	0	2
Savings	-884520	2201140	-6.21e+07	1.20e+07
Income	1108956	1620035	-103948	2.01e+07

Table 3: Income Equation Estimates

	Income CLS		Income VLS (OLS)		Income 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	(-3.358)
crop loss* land value/10 000	-163.59	(-2.299)	-119.51	(-1.675)		
LS response*(household members 12-64)			184 366	(2.123)	265 109	(1.428)
LS response*1st selection term					799 187	(1.007)
(No LS response)*2nd selection 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-square	.353		.355		.355	
Sample size	3073		3073		3073	

Note: Each equation also contains controls for the number of household members between the ages of 18 and 64 by gender and by 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 the first and second columns allow for heteroskedasticity of unknown form (see White, 1980). The standard errors in the third column are derived using a Bootstrap method.

Table 4: Means of Predicted Transitory Income

and Labour Supply Response Income Variables

CLS Method	VLS Method (OLS)		VLS Method (Sel.)	
YT if $\theta=0$	YT if $\theta=0$	YLS if $\theta=0$	YT if $\theta=0$	YLS if $\theta=0$
-83 920	-331 552	582 833	-1 235 107	838 088
N=149	N=149	N=61	N=149	N=61

Table 5: Savings Equation Estimates

Save = Y - C

	Save CLS		Save VLS (1)		Save VLS (2)	
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)	.6831	(14.97)	0.6807	(15.06)
R^2	0.1894		0.1880		0.1864	
N	3073		3073		3073	
F-Tests:	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 number of household members by age categories as defined in Table 3. The standard errors allow for heteroskedasticity of unknown form (see White, 1980).

Table 6: Hours Difference Estimates

ΔHours = Annual Hours in 93 - Average of Annual Hours (1988-92)

	ΔHours		ΔHours		ΔHours	
Variable	Estimate	t	Estimate	t	Estimate	t
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 resp.* selec. term			.		-607.567	(-2.513)
no LS resp.*selec. term					-14.593	(-0.103)
R^2	0.0002		0.0002		0.0004	
N	11 867		11 867		11 867	

Note: The standard errors allow for heteroskedasticity of unknown form (see White, 1980).

Appendix 1: Probit Estimates from
Labour Supply Response Equation

Variable	Estimate	t
intercept	0.2246	2.980
number of people 65 years or over	-0.4171	-2.981
number of people age 18 to 65 with secondary	-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	

Appendix 2

Definitions of Key Variables Listed in Tables

1) Y^{P}: Estimate from income equation of permanent income..

2) Y^{T}: Estimate from income equation of transitory income (based on reported information on crop loss and land value.

3) ε: residual from income equation.

4) LS: Dummy variable =1 if reported taking an extra job, zero otherwise.