Labour time allocation of farm households

The case of volatile food prices

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Abstract

Subsistence farmers in low income countries are confronted with multiple risks. Hence, small scale farmers have developed several strategies to cope with yield risks in order to self-insure against income shocks. Recent developments on global food markets have increased food price volatility, which puts in particular low income households at risk. When small-scale farmers allocate their labour time over different income generating activities, they face the risk of uncertain purchasing power of income in the presence of food price variability. By using a simple household production model, the paper analysis the labour time allocation between self-employment and wage labour work taking into account uncertain purchasing power of wages. Theoretical predictions are being tested using an ICRISAT dataset for Indian farm households from eighteen villages in five different states. Finally, policy conclusions are drawn which point into the direction of insuring the purchasing power of income to thereby improve the allocation of labour time.

I. Introduction

Life in developing countries is marked by a risky environment: Weather induced hazards, like uncertain rainfall or floods, diseases or other family tragedies like death of the breadwinner, political unrest and riots put income streams at risk. Low income households have developed sophisticated risk management and risk coping strategies in order to get along with these risks to achieve a flat life time consumption path (Townsend (1994)). Among these strategies, Townsend identifies risk diversification strategies such as

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cropping different types of plants, exerting different income generating activities or to tap into financial markets etc.

A different possibility for land cultivating low income households is to allocate their time budget between self-employment on their own piece of land and to supply labour to the local agricultural labour market (Rose, 2001). However, in the face of volatile and unpredicted consumption good price changes, it means to change one income risk against the other, namely a yield risk against a purchasing power risk: If prices of goods which these households do not produce themselves rise unexpectedly, this devaluates wages in terms of their purchasing power. In particular, unexpectedly rising food prices put low income households at risk as they devote a large share of their household income on food consumption. Hence, volatile food prices might put these households into a situation where they are unable to purchase the amount of food necessary to substitute the amount of energy expended on the income generating wage labour work (Strulik and Dalgaard (2012)). This type of food insecurity affects in particular the accessibility dimension of food security (FAO, 2009). Furthermore, by decreasing the labour input on their own farm land, farmers decrease their yield even if no weather induced shock occurs. Hence, by shifting time to the labour market, these households reach the opposite result of what they initially were intended to reach. They do not diversify income but increase their overall risk by tapping into the risk of facing an uncertain purchasing power of income under an uncertain food price regime.

Table 1 summarizes the labour time distribution in terms of farming days as a share of total employment days of Indian farm households throughout the years 2009 to 2012. Starting in the upper left panel, the distribution is right skewed implying that the share of individuals allocating only small amounts of time towards farming is relatively higher. Over the course of the observation (top-right and bottom-left panel), the distribution gets more dispersed and relatively more symmetric with finally a twin-peak distribution at the lower and the upper end of the distribution. Hence, the overall fraction of labour time allocated towards farming activities increases while the allocation at the lower end of the distribution stays relatively constant.

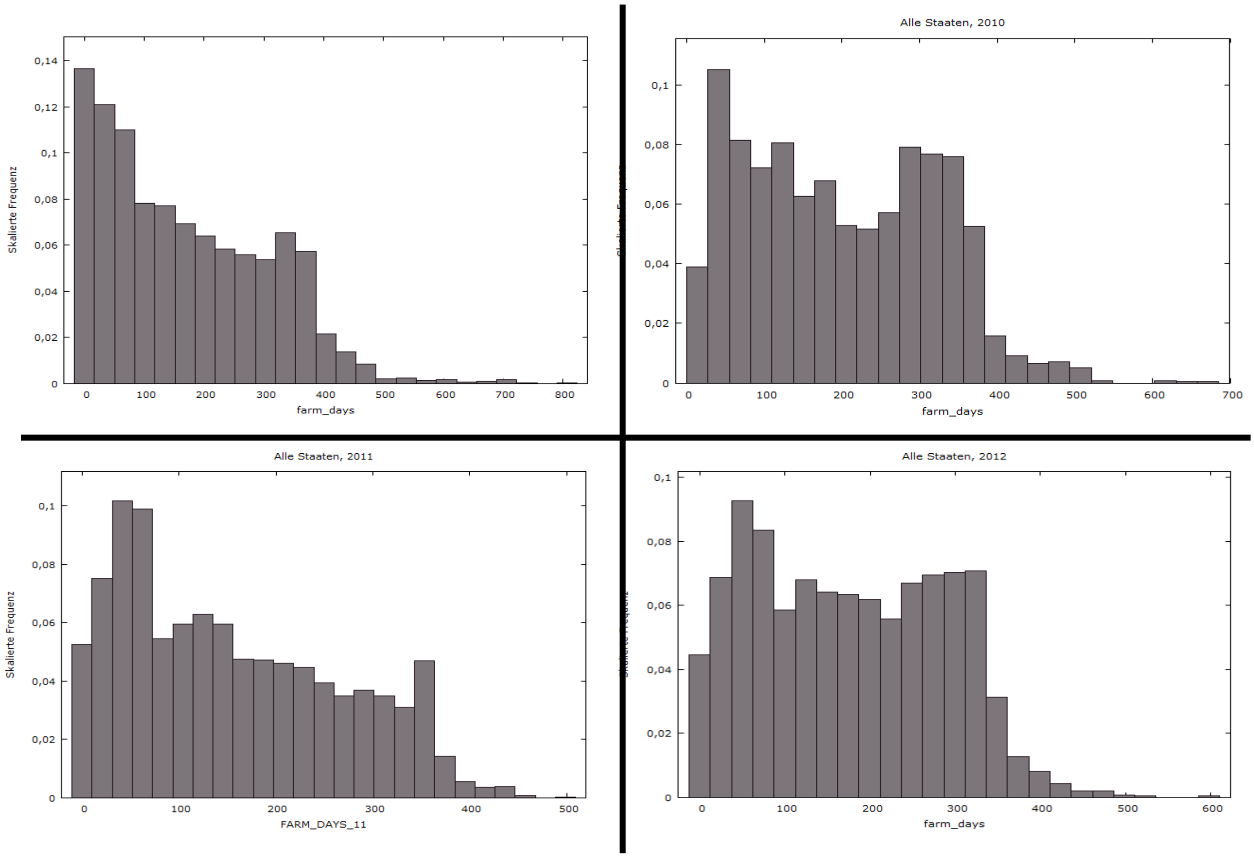

Table 1. Evolution of farming days as a share of employment days

Hence, the observed pattern of labour time allocation reveals evidence that there might be a mechanism at work –other than weather– altering the labour time allocation towards self-employed farming. One potential candidate for this development could be food price volatility as farm households prefer to produce a good which they are able to sell or to consume on their own instead of offering time to the labour market to thereby receiving a wage income. Thus, the descriptive analysis of labour time allocation indicates that households prefer to have a good at hand instead of having a wage income which might be devaluated by price shocks. Whether there is more sophisticated empirical evidence for that hypothesis will be part of the following analysis.

The study presented in this paper tries to answer the following questions: What is the effect of yield risks on on- and off-farm labour supply? What is the effect of consumer price variability on on- and off-farm labour supply? Can the increasing concentration in labour time allocation be explained by food price volatility and purchasing power risks of income?

The remainder of the paper is organised as follows: In a first step, a literature review of the labour time allocation literature as well as the theoretical framework of farm household production and labour time allocation according to a rational choice model will be illustrated and testable hypothesis will be derived. The second step consists of the description of the analysed data as well as the development of the empirical strategy to estimate the effects. The third step evolves policy implications and the last part concludes.

II. Theoretical background

II.1 Literature review

The decision making problem of farm-households is different from the one that consumer households are facing. The aspect of time allocation between self-employed land cultivation and labour market activity has received certain attention in the scientific literature: Fundamental work in the field of farm-time allocation has been made by Rosenzweig (1980) and Sumner (1982), although risk, either on or off-farm income uncertainty aspects, is largely excluded in their analysis.

In the following, several authors drew research on the allocation of labour time if farm-income or off-farm income is uncertain for reasons of farm-product price variability (Mishra and Godwin (1997)), uncertain rainfall (Bandyopadhyay et al. (2012)) or for reasons of uncertain labour market conditions and unemployment risks (Mishra and Goodwin (1998), Kanwar (1999)). Both sources of income risk, producer price variability and unemployment, have a significant impact on labour supply: Higher producer price variability increases the amount of time allocated towards labour market activity, whereas a higher unemployment rate decreases the amount of time allocated towards the labour market. The latter authors conducted their studies on the behaviour of US-farmers, hence for well developed markets and industrialized countries. Rose (2001) extended the analysis of farm household decision making on farm households in developing countries, in this case Indian farmers and their labour market participation in the face of lacking rainfall and induced drought risks. The author finds an increase in the *ex ante* likelihood of labour market participation for drought risks, as well as an *ex post* reaction with an increase in labour market participation probability as a risk coping strategy. However, Rose (2001) only considers a single source of income uncertainty, namely weather related yield risks. In her formulation, offering labour is a risk coping strategy in order to get along with weather-induced income shocks.

Ruben (2001) finds evidence that agricultural households do allocate their time endowment between work in the cooperative and work on their own field. However, the case of time allocation between self-employment and work in a cooperative is not comparable to the case where individuals hedge between self- and wage employment as long as the member of the cooperative produce food crops.

Food price volatility puts in particular those at risk that are net sellers of food and, in addition, are dependent on the purchasing power of labour income. Members of cooperatives face some sort of natural hedge against risks which have to be borne by smallholder farm households being active in the labour market. Kochar (1999) finds that agricultural labour markets are used as a means of coping with risks and idiosyncratic shocks. However, the author's analysis is restricted to idiosyncratic shocks whereas food price shocks have systemic character.

Risk-averse farm-households not only have to make decisions on their consumption plan but also allocate the household's resources, in particular time, across different income generating activities (Mishra and Goodwin (1997), Kanwar (1999)). This is all the more true if the economic environment in which the farm household lives is uncertain and is characterised by a lack of social security nets. In addition, agricultural households not only consume food but also produce it in order to sell it to the local market. In this sense, farm-households are twice affected by food price volatility. Assuming that the household produces a staple good, a price increase of commodities on the one hand will increase the profit from selling the output from farm activities. On the other hand, the same price increase deteriorates his position as a consumer as he now has to spend more in order to achieve the same consumption bundle as it was the case before the price increase.

Hence, the allocation of labour time to different income generating activities, such as farming or offering time to the labour market, might be affected not only by the wages or its shadow values, but it may also depend on price variability of goods that are produced and consumed by the household.

A point that has been neglected in the allocation of labour time is the issue of volatile and uncertain food prices in developing countries as an important source of off-farm income risk. By allocating labour time between self-employment and wage labour work, low income households enter into a risk dilemma: If they devote labour time to own farm work, they face a yield and price risk which puts their income from farm employment at risk. If these households diversify their activities and supply labour to the labour market, wages may not suffice to buy necessary amounts of food in case of adverse food price shocks. Hence, the strategy of dividing labour time between different activities may only change the composition of the risk but not its overall level. In this sense, it is hypothesized that unemployment is a considerable risk for those seeking for employment. However, food price volatility is hypothesized to represent the income risk of households that are in an employment relation. In addition, unemployment is not the major issue in Indian agricultural labour markets. It is rather a lack of labour due to growing urbanisation (ICRISAT, 2011). Thus, it is hypothesized that food price volatility is the predominant risk for labour-market related income whereas rainfall risks are the source of uncertainty that puts farm incomes under risk. This twofold threat to income streams has not been considered in the literature so fare to the best of my knowledge.

As both factor rewards –agricultural output and wage income– are related to agricultural activity, they are also highly dependent on weather related outcomes. Hence, economic theory would predict an inner solution with respect to labour time allocation over the different income generating activities. Thus, a certain proportion of labour time will be allocated towards the own farm whereas the remaining part would be used to offer time to the labour market. The initially presented descriptive panel data analysis from a household data set from India reveals that the labour time allocation is unstable throughout the observation period. Thus, the dataset is a suitable example to test the impact of purchasing power and rainfall risks on the labour time allocation.

II.2 Theoretical model

The model that is employed here is the farm household production model with complete markets in the short run such that capital inputs can be considered to be fixed (Taylor and Adelman, 2003). The assumption of complete markets is reasonable for India as farm-households can offer their farm output on agricultural markets to receive income. In addition, households are able to offer labour to the local labour market and receive a wage payment for that work. This also implies that all wages and prices are observable and not only preference dependant shadow values of wages and prices. In addition, this implies, that all households can observe these prices and wages without costs (Rosenzweig, 1980).

The representative farm household is assumed to maximize a twice differentiable utility function that has net household income and leisure consumption as its arguments (cf. Mishra and Goodwin (1997)):

$$U = E[U(\pi, L)] \tag{1}$$

where π is the net household income and L is the amount of consumed leisure. Input decisions of all household members are being made jointly, such that there is no distinction between male and female labour etc. Households are assumed to be risk averse and their utility function shall show the property of constant absolute risk aversion (CARA).

II.2.a Uncertainty about farm profitability

In the following section, the baseline specification of the model will be presented in order to be able to compare labour time allocation when price uncertainty is also being taken into account from the consumer's perspective. This scenario has been developed by Mishra and Goodwin (1998). It is assumed that only the value of agricultural output is uncertain such that the household's net income can be written as

$$\tilde{\pi} = \tilde{P}Q(F, K, \beta) - C(Q(F, K, \beta), r) + WS \qquad (2)$$

Overall household income $\tilde{\pi}$ is a concave function of included physical capital K, labour time of on-farm work F, off-farm work S and a vector β containing other factors that are eventually affecting agricultural production. Agricultural production induces costs C which are dependent on the amount of agricultural output Q and a vector of input prices r. However, income uncertainty is reflected through uncertain output and food prices whereas prices of agricultural inputs are certain. Households receive a nominal wage W per unit of off-farm labour supply which is assumed to be exogenously given. The product of nominal wage multiplied with the time allocated towards the labour market, S, is the household's wage income.

The household's time endowment is given by

$$T = L + F + S \qquad (3)$$

The household's time budget T is, in equilibrium, exhausted by the activities of consuming leisure L, working on the farm F and off-farm S. Farm-households are assumed to maximize expected utility. This is equivalent to say that constantly risk averse households maximize their certainty equivalent, formulated as expected net household income $E(\pi)$ reduced by the risk premium. The latter was derived by the Taylor approximation and is dependent on the risk's variance and the coefficient of risk aversion α which is constant. Hence, the income risk induced by price uncertainty is assumed to be a comparably small risk. The implications are summarized in expression (4):

$$\emptyset = E(\pi) - \frac{\alpha}{2} \times [Q^2(F, K, \beta) \times \sigma^2(P)\,] \quad (4)$$

Taking the first derivative with respect to F and fully differentiating the first order condition with respect to F and $\sigma^2(P)$ yields the following expression:

$$\frac{d^2F}{(d\sigma^2(P))^2} = \frac{\alpha Q\, {}^{\partial Q}/_{\partial F}}{\left({}^{\partial^2 Q}/_{\partial F^2}\right)\left[P - \frac{\partial C}{\partial Q}\right] - \left(\frac{\partial Q}{\partial F}\right)^2 \left({}^{\partial^2 C}/_{\partial Q^2}\right) - \alpha\sigma^2(P)\left(\left(\frac{\partial Q}{\partial F}\right)^2 + Q\left({}^{\partial^2 Q}/_{\partial F^2}\right)\right)} \quad (5)$$

This expression is negative since the denominator is below 0: By the assumption of perfectly competitive goods markets, marginal costs are equal to the price vector P. Hence, the first term in the denominator vanishes. Marginal costs are assumed to be constant and the farm production technology exhibits decreasing marginal returns of allocated time. Thus, $\frac{\partial Q}{\partial F}$ >0 and ${}^{\partial^2 Q}/_{\partial F^2}$ <0 holds. Hence, price volatility and uncertainty about the profit from agricultural activity decreases the amount of labour allocated towards the own farm.

II.2.b Uncertainty about farm profitability and purchasing power

In the next section, the model of Mishra and Goodwin will be extended by considering that price variability not only jeopardizes farm profits but also perils the purchasing power of work income. In this respect, farm households aim to maximize expected utility from net income and leisure consumption, where they only take the monetary value of marketing farm output and wage income as decisive for their time allocation decision. If one assumes that food prices and rainfall variability follow a normal distribution and are uncorrelated, the decision problem of the household can likewise be solved by expected utility maximization or maximization of the certainty equivalent (cf. Laux et al. 2014).

Thus, a closer look will be taken on the effect of yield variability with respect to labour time allocation.The second component of household's income, next to farm income, is the income from devoting time to the labour market. Here, it is assumed that the household not only cares of the nominal wage he can achieve but also on the calorie-exchange rate which defines the amount of food that can be achieved with a given unit of wages, thus the real wage. Due to volatile food prices, income uncertainty from off-farm labour work stems from uncertain purchasing power of incomes and not from wage uncertainty.

Formally, the farm-household income function with joint farm income and purchasing power uncertainty can be summarized by the following equation:

$$\pi = \tilde{\eta} PQ(F,K,\beta) - C(Q(F,K,\beta),r) + WS\tilde{\epsilon} \qquad (6)$$

$\tilde{\eta}$ and $\tilde{\epsilon}$ are proportional disturbance terms and shall follow a normal distribution with the following properties: $\tilde{\eta} \sim N(0,\sigma^2)$ and $\tilde{\epsilon} \sim N(0,\sigma^2)$. Moreover, $Cov(\eta,\epsilon) = 0$ shall hold. One could imagine that farm income uncertainty is induced by uncertain rainfalls whereas purchasing income uncertainty stems from food price volatility induced by world market movements. Hence, it is assumed in a first stage that both sources of income uncertainty do not interact.

Physical capital inputs K in production are assumed to be constant as the perspective is on the short run production and input decision. The control variables are therefore F and S.

Hence, income risk stems now from two different sources: Farm income variability induced by uncertain rainfall and food price fluctuations induced by world market movements. Again, it is assumed that household's time budget will exactly be exhausted by the activities of on-farm and off-farm work and leisure.

Farm-households are assumed to maximize expected utility. This is equivalent to say that constantly risk averse households maximize their certainty equivalent if the risks follow a normal distribution (Freund (1956)). The certainty equivalent is the difference between the expected value of net income and the risk premium. The risk premium was derived by the Taylor approximation and is dependent on the risk's variance and the coefficient of risk aversion α which is constant. Thus, it is assumed that both risk types follow a normal distribution and that the income risk is a sufficiently small risk. The income's variance is given by

$$\sigma_{\pi}^{2} = \sigma^{2}(\tilde{\eta} PQ(F,K,\beta) + WS\tilde{\epsilon}) \tag{7.1}$$

$$\sigma_{\pi}^{2} = P^{2}Q^{2}(F,K,\beta) \times \sigma^{2}(\tilde{\eta}) + W^{2}S^{2}\sigma^{2}(\tilde{\epsilon}) \tag{7.2}$$

Hence, one ends up with the rewritten optimization problem of maximizing the certainty equivalent under producer and consumer price variability.

$$\emptyset = E(\pi) - \frac{\alpha}{2} \times [P^{2}Q^{2}(F,K,\beta) \times \sigma^{2}(\tilde{\eta}) + W^{2}S^{2}\sigma^{2}(\tilde{\epsilon})\ ] \tag{8}$$

where $E(\pi)$ is the expected value of (2).

By taking the first derivative of (8) with respect to F and fully differentiating it with respect to F and $\sigma^{2}(\tilde{\eta})$, one ends up with the following expression:

$$\frac{d^{2}F}{(d\sigma^{2}(\tilde{\eta}))^{2}} = \frac{Q\alpha P^{2}\, \partial^{2}Q / \partial F^{2}}{\left(\partial^{2}Q / \partial F^{2}\right)\left[P - \frac{\partial C}{\partial Q}\right] - \frac{\partial Q}{\partial F}\left(\partial^{2}C / \partial Q^{2}\right) - Q\alpha\sigma^{2}(\tilde{\eta})P^{2}\, \partial^{2}Q / \partial F^{2}} \tag{9}$$

Interpreting the marginal effect is not trivial: Assuming that farm work is relatively more labour intensive compared to capital, $\left(\partial^{2}Q / \partial F^{2}\right)$ is relatively small as the change in the marginal product of labor in farm product decreases only slowly due to high labor intensity. If this is the case, all terms of the denominator of (9) are negative except for the last one which is positive. Under the assumption of high labour intensity in farm production, the negative effect overweighs the positive impact such that the denominator of (9) is negative. By the same reasoning, the nominator of (9) is negative as well such that the overall expression (9) is positive. Formally, this gives

$$\partial^2 F / \partial^2 \sigma^2(\tilde{\eta}) > 0 \tag{10}$$

under the assumption of high labour intensity in agricultural production.
Hence, if farm income uncertainty increases, on-farm labour supply increases as well. This theoretical prediction stands in contrast to the original model of Mishra and Godwin which predicted a negative effect of increased farm income variability. Hence, agricultural farm households will increase the amount of time working on their own farm whenever farm revenues get more uncertain.
It needs to be checked how the time allocated to off-farm labour supply changes if the purchasing power risk increases. In order to draw conclusions on this aspect, eq. (8) needs to be evaluated with respect to $\frac{dS}{d\sigma^2(\tilde{\epsilon})}$.
Deriving the first order condition of (8) with respect to S and totally differentiating with respect to S and $\sigma^2(\tilde{\epsilon})$ gives the following expression:

$$\frac{d^2 S}{(d\sigma^2(\tilde{\epsilon}))^2} = -\frac{S}{\sigma^2(\widetilde{\epsilon)}} \tag{11}$$

The nominator of expression (11) is positive as there are no negative values of labour time allocated towards off-farm labour supply. The denominator is positive as it is a variance.
Formally, this gives

$$\partial^2 S / \partial^2 \sigma^2(\tilde{\epsilon}) < 0 \tag{12}$$

To conclude, risk-averse farm households will increase on-farm labor supply if farm profit variability increases as well as they will likely decrease off-farm labor supply if price variability increases. Thus there is a reallocation from offering time to the labour market towards increasing the time allocated towards farming whenever two uncorrelated risk factors are being taken into account.

III. Hypotheses Development

In the previous section, testable hypothesis have been derived which try to capture the behaviour of farm-households under joint farm profit and purchasing power uncertainty.
In order to confront the available data with the theoretical predictions of farm-household behaviour, the above made conclusions will be summarized in testable hypothesis.

H1: Farm income variability has an increasing effect on the amount of time allocated towards on-farm labour supply

Farm-income uncertainty has a positive effect on the on-farm labour supply. This prediction stands in contrast to the prior theoretical model where only one source of income risk had been taken into account.

H2: Price variability decreases the amount of time allocated towards off-farm labour supply.

By considering the purchasing power risk induced by volatile food prices on the consumer side, time allocation towards off-farm labour supply decreases under reasonable assumptions.

IV. Data description

After outlining the theoretical framework and formulating the related hypothesis, a description of the data source as well as the empirical specification will be given in what follows.

Data is taken from the ICRISAT-panel which continuously surveys households in several states of India with respect to cropping patterns, input purchase, sold outputs and consumption expenditures etc. Agricultural activity in these states is highly dependent on the amount and correct timing of the monsoon. Hence, agricultural income is periled whenever rainfall fails.

In this study, the last waves of 2009 to 2012 are being used, which comprise a total of almost 19,600 observation points and taking into account the decisions of almost 4,900 individuals per period. The study analyses labour time allocation on the individual level.

Eighteen villages in the states of Andhra Pradesh, Karnataka, Gujarat, Maharashtra and Madhya Pradesh have been chosen as they are located in remote areas such that households under consideration have only limited opportunities to consume at different markets in the case of adverse price shocks.

Data does not reveal whether farming activity of the observed households is exclusively targeted on crop cultivation in order to reach food self-sufficiency or whether farmers rather cultivate cash crops like cotton or coffee. What can be said is that households under consideration are not self-sufficient in food production such that all of them are net buyers of food. Table 3 shows the sample's summary statistics. All variables described below were measured on a yearly basis such that there is no difference between cropping and planting season, the time allocation decision is considered to be constant throughout the whole agricultural year.

It can be seen from Table 2 that the overall educational level is rather low but compared to other variables symmetrically distributed. This changes if it comes to the land distribution or to the allocation of working days supplied. All of these variables show a highly skewed distribution such that there is a certain amount of variability in the related variables across households.

Summary statistics		
Variable	**Mean**	**Median**
Household Size	6.06	5.0
Age	30.72	27.0
Years of Education	5.28	5.0
Landholdings [Ac]	6.07	4.0
Wage Income [Rupies]	17,233	3,717
Labour supply [days per year]	101.38	35

Table 2. Summary Statistics

V. Empirical specification

As it has been stated above, the theoretical framework will be tested using a fixed effects (FE) panel model using the fixed effects transformation by demeaning the explanatory variables and thereby eliminating fixed effects. The original regression equation, before demeaning, is given by (14.1):

$$y_{it} = \beta_0 + \beta_{1t} RAINFALL\_RZD_{kt} + \beta_{2t} WHEAT\_DIFF_{kt} + \beta_{3t} MAIZE\_DIFF_{kt} + \beta_{4t} RICE\_DIFF_{kt} + \Gamma X + \epsilon_{it} \quad (14.1)$$

where y_{it} is equal to the number of farm days except housework (farming and livestock rearing) during one year per individual. In order to account for the effects of farm income uncertainty and uncertainty about the purchasing power of income, two risk-modelling variables for farm income variability $\tilde{\eta}$ and one measure for purchasing power uncertainty $\tilde{\varepsilon}$ have been used.

In a first specification, farm income risk has been measured by the absolute level of $RAINFALL\_RZD_{kt}$ during the year under consideration in each of the villages under study. Thus, it is hypothesized that farm productivity mainly depends on the correct amount and timing of rainfall. By taking the level of rainfall, a risk measure is used in order to account for the uncertainty of farm profits. Results are reported in Table 4, equation (2). As a second modelling of farm income uncertainty, the yearly rainfall deviation from the long run average has been taken into consideration such that the variable either takes positive values (sum of yearly rainfalls above average) or negative values (sum of yearly rainfalls below average). The related model to be estimated is given by the following equation:

$$y_{it} = \beta_0 + \beta_{1t}RAINFALL\_DIFF_{kt} + \beta_{2t}WHEAT\_DIFF_{kt} + \beta_{3t}MAIZE\_DIFF_{kt} + \beta_{4t}RICE\_DIFF_{kt} + \Gamma X + \epsilon_{it} \quad (14.2)$$

The results of this model are represented in Table 4, equation (2). This modelling of farm-income variability is measured by $RAINFALL\_DIFFk_t$.

In order to separate the effects of farm profit and purchasing power uncertainty, a measure for uncertain consumer prices has been used by considering representative food prices of basic commodities such as rice, wheat and maize. Price uncertainty has been measured by taking the deviation from prices measured at the closest market to the respective village (referred to as centre market prices) and the village itself. Centre markets are thus markets, which constitute the shortest air distance between two GPS-points: the village and potential centre market candidates. Village prices were used according to the ICRISAT-terminology as non-subsidized shop prices at the local village trader.

As with rainfall deviations, the respective variable may take positive (negative) values whenever village prices are above (below) centre market prices. The reasoning behind this modelling procedure is the following: Centre markets are considered to be markets with a large number of participants on the demand and supply side of food and commodities alike. Any deviation of this price reflects transaction costs induced by poor infrastructure, monopolistic market structures in the villages or information costs etc. Thus, a larger positive deviation from equilibrium prices – proxied by centre market prices – reflects higher transaction costs and therefore higher costs to cope with adverse events. On the one hand, higher positive deviations reflect the risk that adverse events translate into higher price spikes due to lacking possibilities of balancing trade. On the other hand, negative deviations reflect lower price levels in the village compared to centre markets, reflecting a higher ability to cope with adverse events impacting on commodity prices.

Additionally, centre market prices are a fairly well proxy for world market prices as it is shown for the market of Bhopal for the commodity wheat (see Table 3, below). Facing a deviation from centre market prices on the village level constitutes a food measure of food price risk: An individual under consideration is forced to consume at the village level. Thus, under circumstances, the price he has to pay for the same commodity is higher at the village level than at the centre market or world market level. In this sense, the risk measure gives no exact reason for why these prices deviate. It simply states, that prices may be different and if they are different, this is due to unobserved factors which impact on the individual's income. Thus, deviations can be considered as a risk to purchasing power of wage income.

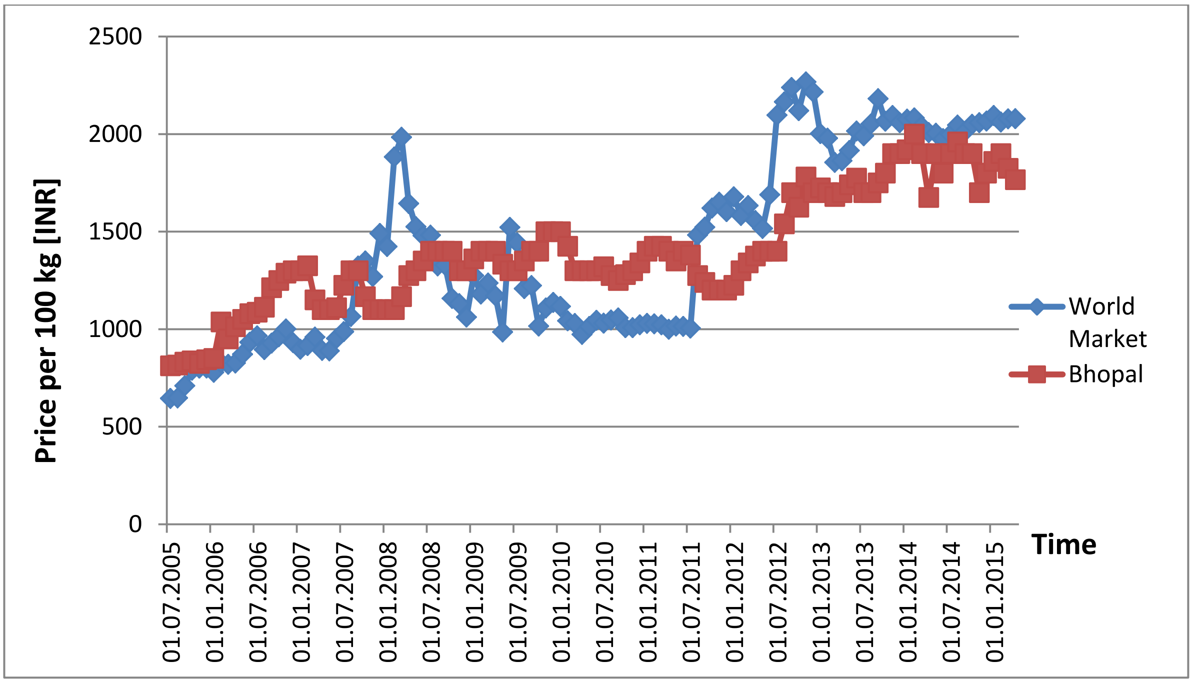

Table 3. Relation between world market prices and centre market prices for Bhopal (Madhya Pradesh) and wheat

In order to prevent from endogeneity biases, all food prices have been orthogonalized[2] with respect to rainfall deviations (cf. Bekaert et al. 2009).

Next to the major explanatory variables, the matrix X contains several control variables such as household size, age, education, physical ability etc. The matrix Γ is the related matrix of coefficients to be estimated across the different time periods.

In the empirical analysis, no difference has been made between different stages of the agricultural year such that average annual prices have been used in order to calculate the respective deviations.

VI. Results

In the following section, the results of the fixed effects estimation will be presented. As it has been pointed out in the previous section, the dependant variable is in all regressions equal to the number of farm days which an individual works on his own farm, including plant cropping and livestock rearing but excluding homework. Thus, a focus is laid on paid activities in order to account for purely monetary risks induced by weather shocks and food price spikes.

Table 4 summarizes the results of the estimation procedure and shows the most important explanatory variables. A complete list of the regression results is available in the appendix.

Farm income variability, measured by rainfall deviations from average [RAIN_DEV] show negative and significant effects on the extent of farming activity: The more rainfall deviates negatively (positively) from the average, the more (less) resources will be allocated towards farming, everything else held equal. Thus, in years of drought, households increase farm time allocation to thereby compensate the lack of rain by an increase in hours worked on-farm.

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[2] Food prices have been regressed in an auxiliary binary regression model on rainfall level deviations. Then the residuals of the auxiliary binary regression have been used as dependent variables and measures of food price variability independent of rainfall variation.

Another explanation for the effect of rainfall variability on labour time allocation has been found by Kanwar (1999): Rainfall shocks translate into deteriorating labour market opportunities as labour market activity in rural areas is also weather dependant. In drought years, labour market opportunities decrease such that farm households have no other option but to increase farm time.

	(1) FE		(3) FE	
AGE	0.793		0,799	
	(2.03)		(2.03)	
sq_AGE	-0.131	***	-0,131	***
	(0.02)		(0.02)	
WHEAT_DIFF	-2.104	***	-2.098	***
	(0.61)		(0.61)	
MAIZE_DIFF	3.421	***	3.423	***
	(0.96)		(0.96)	
RICE_DIFF	-0.044		-0.047	
	(0.28)		(0.28)	
HH_SIZE	1.834		1.833	
	(1.36)		(1.36)	
RAIN_DEV	-0.054	***		
	(0.008)			
RAIN_REALIZED			-0.054	***
			(0.008)	
YRS_EDU	3.080		3.079	
	(3.66)		(3.66)	
INV_UNEMPL	-15.965	***	-15.963	***
	(3.12)		(3.12)	
TOT_AREA	0.704		0.704	
	(0.50)		(0.50)	
IRRI_AREA	15.694	***	15.688	***
	(3.99)		(3.99)	
FAM_DISPERS				
Observations	5318		5318	
R^2 (adjusted)	0,7716		0,771	
F-Statistic	8,53		8,53	
P (F-Test)	0,000		0,000	

Table 4. Regression results

Food price volatility as a measure of purchasing power uncertainty of wage income shows ambiguous results: If wheat [WHEAT_DIFF] is considered, it can be seen that the effect on farming activities is positive as long as village prices are below centre market prices, everything else being equal.

In case that village prices are above centre market prices, the effect on farming activities is negative. Thus, whenever wheat prices are below the benchmark price at the centre market, households allocate more resources towards farming and whenever wheat prices are below the benchmark price, it allocates time away from farming, everything else being equal. Thus, if deviations from centre market prices are considered as a measure of food price volatility, positive price shocks are being compensated by a higher amount of labour supplied. Wheat can therefore be considered as a typical consumption good: Wheat price spikes are being compensated by an increase in labour supply in order to increase wage earnings.

If one considers maize prices [MAIZE_DIFF], the situation turns around compared to wheat prices: Whenever maize prices are below (above) centre market prices, this discourages (encourages) farming activities, everything else being equal. Thus, maize could be seen as a production good that is transported to the centre market. Hence, whenever prices are above centre market prices, this encourages investing more in farming in order to produce more maize and to sell it to centre markets. Adding a commodity production dummy[3] and interact it with measures of food price volatility supports the statements made above, although the interaction terms are insignificant. Therefore, the results are not reported in the output table.

The interpretation for rice price fluctuations [RICE_DIFF] is similar; however, the effects are insignificant.

To summarize, depending on the risk measure of farm income variability, food prices are crucial for the determination of labour input in agriculture. Depending on the underlying commodity, labour market participation is increased and therefore, households mitigate food price spikes by a higher amount of labour time allocated towards the labour market. Hence, households are aware of the purchasing power risk of income as soon as consumption goods are considered.

Other significant effects can be found with respect to irrigation [IRRI_AREA]: Farm households that have a strictly positive fraction of irrigable farming area distribute more time resources towards their own farm, everything else being

[3] This dummy takes on the value 1 whenever the considered household cultivated wheat, rice or maize respectively in at least one of the periods under study.

equal. Thus, labour market activity and irrigation can be considered as substitutes as self-insurance against farm income risk.

Age [AGE] has a positive but insignificant influence on farm work, everything else being equal. Maximum farm activity is reached at an age of about 33 years, thereafter, additional years of age decrease the amount of time allocated towards farming. Age effects, however, do not reveal systematic patterns of labour time allocation across the individuals under study.

The fact that a household member experienced involuntary unemployment [INV_UNPLYM] reduces the amount of time allocated to farming drastically. This seems to be quite obvious at a first glance, however, the fact that one had been involuntary unemployed does not stimulate the individual to work on farm. There is no information on part-time migration, but this might be an explanation for this observation. In this sense, individuals would migrate out of their village to work in a different place, where they have no chance to work on-farm in case that they are involuntary unemployed.

A second interpretation is that offering off-farm labour is just a residual of the time which the household did not spend on his own farm.

From an econometric point of view, [IRRI_AREA] and [INV_UNPLYM] are highly significant dummy variables with a large impact on the dependant variable. A sensitivity analysis does not induce values of other coefficient to change drastically, when these dummy variables are excluded from the analysis. With respect to [IRRI_AREA], technological selection effects can be excluded as all individuals of the sample are farmers. Thus there is no selection bias in the sense, that the variable only catches the professional farmers and overestimates results.

Education [YRS_EDU], taking on the value 1 if the household has more than four years of education and 0 otherwise, on the other hand has no significant effect in explaining the labour time allocation, everything else being equal.

Due to the panel structure and the fixed effects estimation procedure and the fact that none of the individuals migrated within the villages of the sample, variables like gender or village specific effects captured by village-level dummies vanish and are irresponsible for the regression results presented above.

VII. Conclusions

The study presented in the paper has shown that food price volatility has a significant influence on the time allocation of agricultural households. Previous studies took output price uncertainty and unemployment into account when it came to draw research on the effects of uncertain farm income on off-farm labour supply. According to the present study, in the case of developing countries, food price volatility is another factor that puts farm-household income at risk by devaluating the purchasing power of work income, in particular in the context of developing and emerging countries. Purchasing power of income risks are being taken into consideration by the households under study when determining their labour time allocation. Depending on the underlying commodity, individuals seem to have preferences for having a good at hand – the case of maize prices – or to have money at hand by increasing labour supply – the case of wheat prices.

This study reveals important policy implications. Increased food price volatility may force households to specialise in farming. Such a concentration in income generating activities, however, is problematic as farm income is subject to weather outcomes. Thus, food price volatility forces households to concentrate their income sources to thereby increase vulnerability with respect to weather outcomes.

Existing insurance products to insure income of farming households neglect the purchasing power uncertainty of incomes, which forces individuals to alter labour time allocation. Existing insurance products, like index-based crop failure insurance, only insures losses from agricultural activities whereas the income from off-farm work is entirely unprotected but periled by food price volatility. Thus, one potential countermeasure could be to more carefully consider the term *income* of farm households and to recognize that income is composed out of several factors. Hence, by enlarging traditional index-based crop insurance with measures accounting for food price volatility, one could more closely trace the true income risk of farm households. At the same time, enlarging the notion of income could also contribute to a higher demand of index-based insurance such that vulnerability could be reduced. In addition, this would push labour time allocation towards the optimal allocation, the one that would persist without food price volatility.

Thus, better understanding the true livelihood and the process by which income is generated might be crucial to understand microinsurance demand of farming households. The study presented here is a first attempt to follow this approach. However, future research needs to be done on the question of how strong income changes when prices change in order to gain further insight into microinsurance demand and potential of improving existing products to thereby decrease vulnerability and poverty.

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Appendix

	(1) FE		(2) FE	
age	0.793		0,799	
	(2.03)		(2.03)	
sq_age	-0.131	***	-0,131	***
	(0.02)		(0.02)	
Resid_wheat_diff	-2.104	***	-2.098	***
	(0.61)		(0.61)	
Resid_maize_diff	3.421	***	3.423	***
	(0.96)		(0.96)	
Resid_rice_f_diff	-0.044		-0.047	
	(0.28)		(0.28)	
Dmari_stat_2	6.580		6.576	
	(18.53)		(18.53)	
Dmari_stat_3	16.658		16.655	
	(11.99)		(11.99)	
Dmari_stat_4	-28.368		-28.369	
	(29.15)		(29.15)	
Dmari_stat_5	-20.033		-20.05	
	(13.66)		(13.67)	
Ddeg_disab_2	-26.315	***	-26.309	***
	(5.00)		(5.00)	
Ddeg_disab_3	-11.163	*	-11.158	*
	(5.89)		(5.89)	
Ddeg_disab_4	-12.784	***	-12.782	***
	(4.76)		(4.76)	
Ddeg_disab_5	-17.049	***	-17.043	***
	(4.53)		(4.53)	
Ddeg_disab_6	-11.680	*	-11.673	*
	(6.55)		(6.55)	
Dcaste_group_2	26.862	***	26.860	***
	(9.73)		(9.73)	
Dcaste_group_4	13.774		13.790	
	(10.13)		(10.13)	
Dcaste_group_5	45.035	***	45.024	***
	(10.83)		(10.83)	
Dcaste_group_6	18.545	*	18.545	*
	(10.28)		(10.28)	
Dcaste_group_7	12.686		12.701	
	(10.77)		(10.77)	
Dcaste_group_8	32.306	**	32.327	**
	(12.66)		(12.66)	
Dsoil_fert_2	3.934		3.940	
	(7.58)		(7.58)	
Dsoil_fert_3	-9.701	*	-9.688	*
	(5.83)		(5.83)	
Dsoil_fert_4	-13.842	***	-13.827	***
	(4.66)		(4.66)	
seri_ill_n_dummy	-8.839	***	-8.833	***
	(2.30)		(2.30)	
hh_size	1.834		1.833	
	(1.36)		(1.36)	
rain_dev	-0.054	***		
	(0.008)			
rain_realized			-0.054	***
			(0.008)	
yrs_edu_n	3.080		3.079	
	(3.66)		(3.66)	
inv_unplym_n	-15.965	***	-15.963	***
	(3.12)		(3.12)	
tot_area_n	0.704		0.704	
	(0.50)		(0.50)	
irri_area_n_dummy	15.694	***	15.688	***
	(3.99)		(3.99)	
raindev_maizediff				
raindev_wheatdiff				
raindev_rice_f_diff				
Os_dist				
Observations	5318		5318	
Cross-Sectional units	2355		2355	
R^2 (adjusted)	0,7716		0,771	
F-Statistic	8,53		8,53	
P (F-Test)	0,000		0,000	

A.1 Complete regression results