7. Crops, Livestock, and Household Income-Consumption

7

Crops, Livestock, and Household Income-Consumption

Given the adjustments of crop choices according to households' characteristics such as consumption preferences and asset positions (Chapter 6), to what extent are sample households successful in stabilizing their income flows and consumption expenditure? This issue is important both theoretically and politically. As has been reviewed in Chapter 1, the extent to which rural households can smooth consumption is a well-debated issue in development economics. At the same time, the extent of consumption smoothing has important policy implications in practical fields such as crop insurance, calamity relief, targeted employment generation schemes, etc. Few existing studies have investigated this issue for the case of Pakistan's agriculture.

In this chapter, the performance of consumption smoothing in the study area was investigated.[1] In the first section, per capita household income was decomposed into enterprise sources and then each source was decomposed into deterministic and transient portions. The decomposition analysis quantitatively shows that livestock enable households to decrease their exposure to risk through diversification and asset decumulation. The second section investigated whether individual consumption closely tracks the fluctuation of income. In the third section, welfare implications of the empirical findings in the first and second sections were investigated.

I. Decomposition of Per Capita Income Variation

1. Income Sources

To emphasize the intertemporal changes, the data from the continuously surveyed households (fifty-nine households for three years) were used in this chapter. Real household income expressed in 1988/89 Pakistan rupees was decomposed into crop income, livestock income, and off-farm income as shown in Figure 2-3, Chapter 2. In this chapter, these figures were divided by the household size in adult-male equivalent units (1.0 for adult male, 0.9 for adult female, and 0.52 for children up to ten years old) to convert them to per capita terms. In the following, "per capita" refers to per adult-male equivalent unit.

To separate the effects of ex post insurance from that of ex ante diversification, per capita livestock income (Y_L) was further decomposed into milk income (Y_{LM}) and livestock-sale income (Y_{LS}). The sum of per capita crop income Y_C and Y_L is denoted by Y_F that stands for farm income. From the correlation between Y_F and Y_N, income diversification between on-farm and off-farm enterprises could be investigated.

2. A Model of Income Decomposition into Deterministic and Transient Portions

Per capita real-income variables thus defined were further decomposed into deterministic and transient portions. It is assumed that the mean of observed values reflects the deterministic part and the residual, zero-mean term reflects the transient shock. The transient portion consists of a shock common to sample households (e.g., rainfall, market price conditions, etc.) and an idiosyncratic shock that affects each household independently (e.g., field-specific production problems, disease affecting a household member, etc.). Assuming that there is an additive structure among the components, the empirical model is expressed as

$$Y_{sht} = f_s(Z_{ht}) + u_{st} + \varepsilon_{sht}, \qquad (7.1)$$

where Y_{sht} is per capita real income from sector s for household h in year t; $f_s(..)$ is a function of a vector of household characteristics Z_{ht} and corresponds to the deterministic portion of income[2]; u_{st} is a common shock with mean zero; and ε_{sht} is an idiosyncratic shock with mean zero. Two sources of the transient portion are independently distributed by definition so that $E(u_{st}\ \varepsilon_{sht}) = 0$.

The function $f_s(..)$ is approximated linearly with variables in the vector Z_{ht}

TABLE 7-1

REGRESSION RESULTS OF INCOME DECOMPOSITION

Dependent Variables (*Y*) / Independent Variables	Milk Income (1)	Livestock-Sale Income (2)	Total Livestock Income (3) [(1)+(2)]	Crop Income (4)	Farm Income (5) [(3)+(4)]	Off-Farm Income (6)	Total Household Income (7) [(5)+(6)]	Consumption Expenditure (8)
C	1,178.0**	431.0	1,609.0	–1,780.8	–171.8	1,533.3***	1,361.5	4,149.8***
	(2.371)	(0.861)	(2.202)	(–1.476)	(–0.137)	(2.622)	(0.961)	(17.418)
DRAFT	496.9	–62.0	434.9	–326.4	108.5	–45.2	63.3	–289.6*
	(1.554)	(–0.192)	(0.924)	(–0.420)	(0.134)	(–0.120)	(0.069)	(–1.888)
MILCH	1,269.0***	195.6	1,464.6***	1,069.1**	2,533.7***	–204.0	2,329.7***	–0.2
	(7.019)	(1.074)	(5.508)	(2.435)	(5.538)	(–0.959)	(4.517)	(–0.002)
AOPE	–260.2**	30.8	–229.4	2,664.0***	2,434.5***	–242.4*	2,192.1***	222.5***
	(–2.100)	(0.246)	(–1.259)	(8.850)	(7.762)	(–1.662)	(6.200)	(3.744)
AOWN	–132.4	100.8	–31.5	184.6	153.1	–68.6	84.5	37.8
	(–0.991)	(0.749)	(–0.161)	(0.569)	(0.453)	(–0.436)	(0.222)	(0.590)
HOUSV	22.9	32.9	55.9*	–26.2	29.7	128.3***	158.0***	50.2***
	(1.104)	(1.575)	(1.830)	(–0.519)	(0.565)	(5.253)	(2.669)	(5.043)
EDU	3.5	11.7	15.2	108.1***	123.3**	–14.8	108.5**	–19.6**
	(0.214)	(0.704)	(0.628)	(2.707)	(2.963)	(–0.764)	(2.313)	(–2.480)
WAM	–938.9*	–633.0	–1,572.0*	977.6	–594.4	–763.9	–1,358.3	–1,835.6**
	(–1.711)	(–1.145)	(–1.948)	(0.734)	(–0.428)	(–1.183)	(–0.868)	(–6.977)
WAF	–635.1	–84.3	–719.4	245.0	–474.4	–155.3	–629.7	–1,195.0***
	(–1.122)	(–0.148)	(–0.864)	(0.178)	(–0.331)	(–0.233)	(–0.390)	(–4.404)
WCM	–180.8	–226.8	–407.6	333.5	–74.1	–601.2	–675.3	–236.3
	(–0.414)	(–0.515)	(–0.634)	(0.314)	(–0.067)	(–1.168)	(–0.541)	(–1.127)

TABLE 7-1 (Continued)

Dependent Variables (*Y*) / Independent Variables	Milk Income (1)	Livestock-Sale Income (2)	Total Livestock Income (3) [(1)+(2)]	Crop Income (4)	Farm Income (5) [(3)+(4)]	Off-Farm Income (6)	Total Household Income (7) [(5)+(6)]	Consumption Expenditure (8)
D_{13}	–32.5	–71.0	–103.6	831.2***	727.6***	94.5	822.1***	–190.4***
	(–0.385)	(–0.833)	(–0.832)	(4.047)	(3.400)	(0.950)	(3.408)	(–4.694)
D_{23}	–48.1	–194.5**	–242.6**	14.3	–228.3	–97.0	–325.3	137.4***
	(–0.579)	(–2.320)	(–1.984)	(0.071)	(–1.085)	(–0.991)	(–1.371)	(3.446)
Mean of *Y*	1,087.4	605.7	1,693.1	3,899.2	5,592.3	1,130.4	6,722.7	3,355.2
Standard deviation of *Y*	940.6	836.0	1,344.4	3,905.5	4,110.9	973.8	4,145.2	601.1
R^2	0.379	0.202	0.343	0.788	0.792	0.198	0.740	0.651
Adjusted R^2	0.338	0.149	0.299	0.774	0.778	0.145	0.723	0.627

Notes: 1. OLS is used in the regression and the number of observations was 177.
2. *t*-statistics are given in the parenthesis.
3. All the dependent variables are given in real price at 1988/89 Rs. and in per capita term defined by adult-male equivalent units.
4. Definitions of independent variables are: *C* = Intercept, *DRAFT* = Draft animal in adult equivalent units per capita, *MILCH* = Milch animal in adult equivalent units per capita, *AOPE* = Acreage of operated agricultural land per capita, *AOWN* = Acreage of owned agricultural land per capita, *HOUSV* = Value of house building in 1988/89 Rs. per capita, *EDU* = Years of education of household head, *WAM* = adult-male equivalent units (AMEU) of adult males in total AMEU, *WAF* = AMEU of adult females in total AMEU, *WCM* = AMEU of children males in total AMEU, $D_{13} = D_1 - D_3$ and $D_{23} = D_2 - D_3$ where D_i is a dummy variable for year *i*.

*** Significant at 1% level, ** at 5% level, and * at 10% level (two-sided test).

defined as: (i) livestock assets (per capita adult-equivalent-units of draft and milch animals); (ii) crop production assets (per capita acreage of operated and owned farm land); (iii) per capita real value of house building; (iv) years of completed education of household head as a proxy for human asset position; and (v) household demographic composition (shares in the total adult equivalents of adult male, adult female, and children-male). Though these variables might be endogenous to household production decisions in the long run, they are treated in the regression as predetermined because the focus is on the short-run fluctuations. Since the data set covers only three years, it is not possible to decompose the residual into u_{st} and ε_{sht} precisely. Year dummies are included for a rough estimation for u_{st}. Market prices are not included because the anticipated portion of price variability is perfectly collinear with year dummies. The estimated model thus becomes

$$Y_{sht} = \beta_{s0} + \sum_k \beta_{sk} Z_{hkt} + u_{s1}(D_1 - D_3) + u_{s2}(D_2 - D_3) + \varepsilon_{sht}, \qquad (7.2)$$

where β's, u_{s1}, and u_{s2} are coefficients to be estimated.

The regression results are given in Table 7-1. Overall, their signs are as expected—those on land assets are significantly positive in determining crop income and those on livestock assets are significantly positive in determining livestock income. Coefficient estimates on $D_1 - D_3$ and $D_2 - D_3$ show that crop income was high in the first year and livestock-sale income increased in the last year.

3. Correlation among the Decomposed Components

To investigate the household strategy of risk management, correlation coefficients among the components of per capita household income were estimated based on the regression results presented above. Table 7-2 analyzes the relationship among deterministic portions, or the inter-household variation, in income generating positions. The upper half gives statistics of the estimated deterministic portion. The lower half shows the correlation matrix among them. The correlation coefficients between a component and its sum (e.g., between crop income and farm income) are omitted because they are only a weighted sum of the components.

The negative correlation (–0.27) between $E(Y_N)$ and $E(Y_F)$ suggests that off-farm income reduces the inter-household disparity in farm production assets. The negative relationship stems from the negative correlation coefficient (–0.34) between $E(Y_N)$ and $E(Y_C)$. Thus, off-farm income contributes to a reduction in inequality among households through the negative correlation with crop income. On the other hand, the correlation between $E(Y_L)$ and $E(Y_C)$ is significantly positive, which reflects the complementary nature of crops and

TABLE 7-2

INTER-HOUSEHOLD DETERMINISTIC VARIATION OF INCOME
$E(Y_s) = f_s(Z)$ IN EQUATION (7.1)

a. Key Statistics

		Mean	Standard Deviation	Minimum	Maximum
$E(Y_{LM})$	Milk income (1)	1,087.4	565.8	–448.6	3,793.8
$E(Y_{LS})$	Livestock sale (2)	605.7	303.3	134.5	1,862.8
$E(Y_L)$	Total livestock (3) = (1) + (2)	1,693.1	700.1	215.3	5,441.5
$E(Y_C)$	Total crop income (4)	3,899.2	3,411.0	–504.8	20,082.9
$E(Y_F)$	Farm income (5) = (3) + (4)	5,592.3	3,643.8	530.1	22,752.9
$E(Y_N)$	Off-farm income (6)	1,130.4	434.5	–307.2	2,753.7
$E(Y)$	Household income (7) = (5) + (6)	6,722.7	3,551.6	1,736.0	22,877.3

b. Correlation Coefficients

		(1) $E(Y_{LM})$	(2) $E(Y_{LS})$	(4) $E(Y_C)$	(6) $E(Y_N)$
$E(Y_{LM})$	Milk income (1)	1.000	0.227*	–0.133	0.250*
$E(Y_{LS})$	Livestock sale (2)		1.000	0.805*	0.151*
$E(Y_L)$	Total livestock (3) = (1) + (2)			0.241*	0.267*
$E(Y_C)$	Total crop income (4)			1.000	–0.342*
$E(Y_F)$	Farm income (5) = (3) + (4)				–0.269*
$E(Y_N)$	Off-farm income (6)				1.000

Notes: 1. The numbers in the table are estimated from the regression results shown in Table 7-1.
2. Number of observations is 177.
3. The correlation table reports the coefficients between two income sources that are exclusive of each other only. For example, since milk income (1) is included in total livestock income (3), correlation between (1) and (3) does not provide useful information on risk-control effects. Therefore, it is omitted.

* Significant at 5% level (two-sided test).

livestock in mixed farming in the study area. Although it is true that livestock income is relatively more important in farm households with smaller landholding, the absolute level of livestock activity is higher for households with larger landholding since land is an integral part of livestock activity.

Table 7-3 shows the results for the transient portion of income. The transient portion is defined as the fitted values of $u_{st} + \varepsilon_{sht}$ in equation (7.1) and denoted by e_s for short. The negative correlation (–0.27) between e_C and e_L is consistent with the hypothesis that crops are chosen in such a way that crop income is negatively correlated with livestock income. Chapter 5 has shown that fodder profits are negatively correlated with milk profits via input effects.

TABLE 7-3

TRANSIENT VARIATION OF INCOME
$e_S = u_S + \varepsilon$ IN EQUATION (7.1)

a. Key Statistics

		Mean	Standard Deviation	Minimum	Maximum
e_{LM}	Milk income (1)	0.0	743.2	–2,363.1	2,419.7
e_{LS}	Livestock sale(2)	0.0	771.9	–1,789.9	3,387.8
e_L	Total livestock (3) = (1) + (2)	0.0	1,118.6	–3,792.7	5,258.8
e_C	Total crop income (4)	0.0	1,925.9	–8,491.0	8,860.4
e_F	Farm income (5) = (3) + (4)	0.0	1,947.9	–8,147.9	8,720.3
e_N	Off-Farm income (6)	0.0	875.5	–1,292.9	4,305.0
e	Household income (7) = (5) + (6)	0.0	2,193.6	–8,214.4	9,113.5

b. Correlation Coefficients

		(1) e_{LM}	(2) e_{LS}	(4) e_C	(6) e_N
e_{LM}	Milk income (1)	1.000	0.090	–0.157*	0.140
e_{LS}	Livestock sale(2)		1.000	–0.241*	0.017
e_L	Total livestock(3) = (1) + (2)			–0.271*	0.104
e_C	Total crop income (4)			1.000	0.014
e_F	Farm income (5) = (3) + (4)				0.074
e_N	Off-Farm income (6)				1.000

Note: See Table 6-2.

This is the major reason for the negative correlation. Chapter 6 has shown that crop choices are made considering their risk-management effects. This household behavior results in the observation in Table 7-3 that crops and livestock are combined to reduce the annual variability of household income.

The coefficient is more negative between e_C and e_{LS} (livestock-sale income) than between e_C and e_{LM} (milk income). The transient portion of livestock-sale income should reflect ex post decumulation of assets as a substitute for insurance. The estimation results here support the ex post consumption smoothing role of livestock from an angle different from that described in the seminal work of Rosenzweig and Wolpin (1993). Furthermore, the correlation between e_C and e_{LM} (milk income) is significantly negative, reflecting the ex ante income-smoothing, risk-management role of livestock income.

In contrast to Table 7-2, the residuals from Y_N (off-farm income) are not negatively correlated with the residuals from farm income sources (see the last column in Table 7-3). The signs of correlation coefficients are positive but not statistically significant. Thus, the role of off-farm income in income-smoothing is less important than that of livestock income for this sample.

II. Testing for the Co-movement of Income and Consumption

It may be argued that the results presented in the previous section are incidental and not related to households' optimizing behavior to control their exposure to risk. To refute the argument, it is necessary to show that sample households are risk-averse and insurance markets are incomplete. If the households are risk-neutral or insurance markets are complete, the households may maximize expected profit without caring about the correlation coefficients estimated above. Chapter 6 has already confirmed that all the sample households behaved in a risk-averse way. In this section, the incompleteness in insurance markets is demonstrated from a different angle, focusing on consumption expenditure.

When insurance markets are incomplete, the transient variation in income of individual households should be transmitted to their consumption expenditure. If there is a mechanism whereby all the income variation is absorbed and households are guaranteed a completely smoothed consumption, insurance markets can be considered to be complete.

1. Correlation of the Transient Income and Consumption Variation

In the household data set, consumption expenditure was computed by summing up expenditures on major consumption items. For those commodities produced from households' farms, their opportunity costs were imputed using actual village prices and added to other, actually paid expenditures. Since the variable may not include some minor consumption items, the level of total expenditure is underestimated. Over the three-year study period, the variable was relatively more stable than household income, which suggests that expenditures not covered by the survey may have acted as a cushion for accommodating income variability. Nevertheless, it is interesting to investigate the effects of income variation on this (potentially underestimated) variable.

For this purpose, the model in expression (7.2) was estimated for the total consumption expenditure also (Table 7-1). The correlation coefficient between the deterministic portion of consumption and that of household income was found to be 0.80. This number is large since it corresponds to the inter-household co-movement of income and consumption. It simply confirms that households with higher income spend more on consumption on average.

The correlation coefficient between the transient portion of consumption and that of total income was estimated to be 0.20 and significantly positive at 5 per cent level. Thus, the variation in transient income was transmitted to that in consumption although the relation was weaker than in the case of inter-household variation. In other words, households with a windfall gain in income spend more on consumption and households with an unpredicted loss in income spend less, but this relation is only weakly observed. It should be remembered, however, that this finding is consistent not only with partial risk-sharing but also with permanent income models (Alderman and Paxson 1992). What is important is the finding of *partial* co-movement of income and consumption.

2. Testing for Village-Level Risk Sharing

Townsend (1994) presented a formal model to test econometrically the necessary conditions for optimal risk-sharing in a village. He showed that households in semiarid India were well insured though the full insurance hypothesis was rejected in many cases (Chapter 1).

The current data set is too short in time scale to run the same tests. Instead, a simplified version of Townsend's model was estimated using pooled data of continuously surveyed households. Under the assumption of separable utility function between leisure and consumption and of homogeneous risk preferences among households, Townsend's model for constant absolute risk aversion can be expressed as

$$c_{ht} = \alpha_h + \beta c_t^* + \zeta X_{ht} + \varepsilon_{ht}, \tag{7.3}$$

where c_{ht} is per capita consumption; α_h is the fixed household effect on consumption, i.e., the weight of household *h* in income redistribution relative to the village average; c_t^* is the average village consumption each year; X_{ht} is the household income; and ε_{ht} is a disturbance term with zero mean.[3] Under the assumption of full village insurance, β should be unity and ζ should be zero. Households are fully insured at the village level when their own income does not account for their consumption ($\zeta = 0$) once the village-average consumption level is included and household fixed effects are controlled.

Table 7-4 presents the regression results estimated by OLS by replacing α_h in equation (7.3) by household dummy variables. Numbers here are different from those reported by Kurosaki (1995a) because the definitions of the variables were corrected properly.[4] The columns under "Model 1" apply to a model with total household income in X_{ht} and the columns under "Model 2" apply to a model in which three sources of income are distinguished. In "Model 1," the hypothesis of full village insurance is not rejected. The coefficient on household income is not significant. In "Model 2," the coefficients on livestock and crop income are not significant, while the coefficient on off-farm income is significantly positive.

To examine the robustness of these findings, the model was re-estimated

TABLE 7-4

REGRESSION RESULTS OF INCOME-CONSUMPTION CO-MOVEMENT

Independent Variables	Model 1		Model 2	
	Estimated Coefficient	*t*-statistic	Estimated Coefficient	*t*-statistic
Intercept	(Fifty-nine household dummy variables)			
c_t^*	0.992	6.42***	0.948	6.42***
X_{ht} : Total household income	0.014	1.01		
: Livestock income			0.012	0.52
: Crop income			–0.008	–0.55
: Off-farm income			0.282	4.62***
R^2	0.822		0.849	
Adjusted R^2	0.731		0.767	

Notes: 1. The dependent variable is c_{ht} (per capita expenditure). To avoid the endogeneity problem, c_{ht} is excluded each time when c_t^* is calculated.
2. *** indicates that the coefficient is significant at 1% level (two-sided test). When the coefficient on X_{ht} is significantly positive, the village-level full insurance hypothesis is rejected.
3. OLS is used in the estimation and the number of observations is 177.

using yearly-change variables, which is another way to control household fixed effects. The results were similar to those reported in Table 7-4. Other specifications for c_t^* were tested, yielding similar results, but sometimes with significantly positive coefficients on household income in "Model 1."[5]

These findings suggest that idiosyncratic shocks to crop and livestock income are efficiently insured among villagers. Since our measure of off-farm income includes remittances, which are amply used to smooth consumption ex post, its positive coefficient in "Model 2" is justifiable.

How are the findings consistent with village-level full risk-sharing compatible with those in Chapter 6 where it was indicated that households behave in a risk-averse way? Our interpretation is that the risk-averse behavior of sample farmers (Chapter 6) is mostly due to insufficient channels for sharing aggregate risk at the village level with the rest of the world. This interpretation is consistent with other studies that have demonstrated that household consumption in South Asia is largely, though not perfectly, insulated from idiosyncratic shocks (Townsend 1994; Ligon 1993; Morduch 1991; Rashid 1991). Another possibility is that, since the variable of total expenditure is underestimated, including only major expenditure items, the actual consumption expenditure might have followed individual income more closely than estimated here.

III. Incidence of Risk and Role of Livestock

Since the transient variation in income (at least that attributable to aggregate shocks) is transmitted to consumption, income variation should affect sample households. Then, to what extent? In Chapter 8, this issue will be investigated rigorously in terms of household welfare. Instead, in this section, the variability of income was analyzed because it is one of the major factors that affect household welfare under uncertainty.

Adding all income sources yields total household income (Y_{ht}). By removing subscripts h and t for simplicity, the coefficient of variation (CV_Y) is given by

$$CV_Y = \frac{1}{E(Y)}\sqrt{\mathrm{Var}\left(\sum_s Y_s\right)} = \frac{1}{E(Y)}\sqrt{\sum_s \mathrm{Var}(Y_s) + \sum_s \sum_{r \neq s} \mathrm{Cov}(Y_s, Y_r)}$$

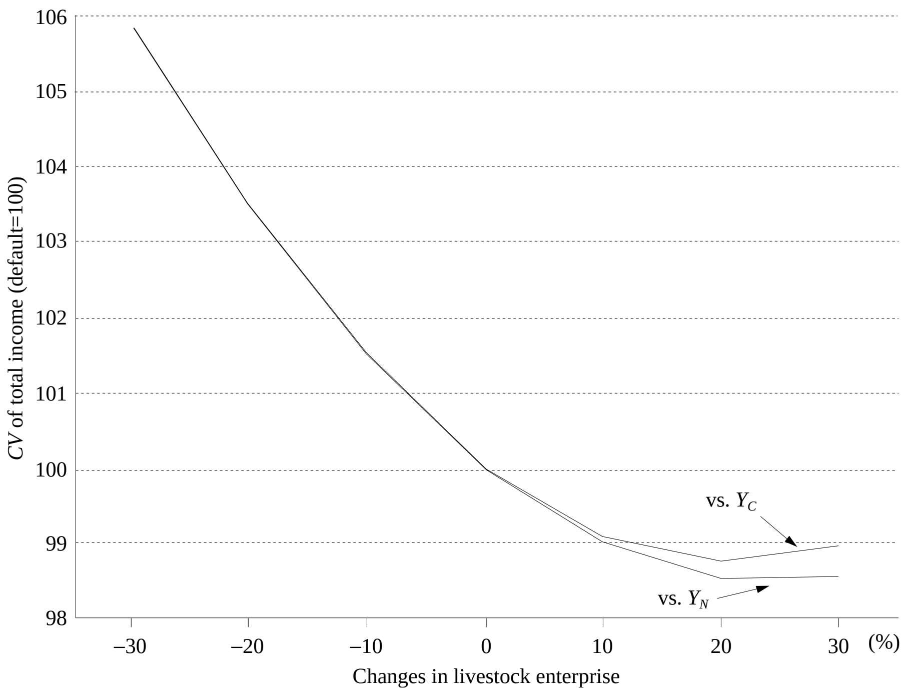
$$= \sqrt{\sum_s h_s^2 \cdot CV_{Y_s}^2 + \sum_s \sum_{r \neq s} h_s \cdot h_r \cdot CV_{Y_s} \cdot CV_{Y_r} \cdot \rho_{Y_s,Y_r}}\,, \qquad (7.4)$$

where h_s is an enterprise composition weight defined as $E(Y_s)/E(Y)$, and $\rho_{Ys,Yr}$ is a correlation coefficient. For each sample household, the value of CV_Y was calculated. The estimates were distributed between 0.16 and 0.53 with a mean of 0.34 and standard deviation of 0.06. These numbers were quite high and comparable to those reported for semiarid India (Walker and Ryan 1990, Figure 4.7). Although yield risk is reduced in the study area due to irrigation compared with semiarid India, higher crop production costs decrease crop profit margins and increase the risk in Pakistan (Chapter 5), resulting in comparable values of income variability in the two regions.

To investigate the income-smoothing role of livestock income in Pakistan, the effect on CV_Y of a change in h_s in equation (7.4) was simulated. In the simulation, CV_{Ys} was approximated by the standard deviation of e_s from Table 7-3 divided by the value of $E(Y_s)$ from Table 7-2 and assumed to be constant, and h_s's were changed with the restriction that their sum was unity and the mean household income remained the same. Although households can adjust crop choices when their production asset composition or relative prices are changed, so that $E(Y_s)$ and $\rho_{Ys,Yr}$ should also change (Chapter 8), it was assumed that these adjustments did not take place [$E(Y_s)$ and $\rho_{Ys,Yr}$ are kept constant]. In other words, the simulation shows a very short-run effect on CV_Y of a change in relative prices in favor of livestock products.

Figure 7-1 plots the results of a change in the weight of the livestock sector evaluated at sample mean. The vertical axis shows an index of CV_Y with its

Fig. 7-1. Effects of Changes in Household Income Composition



starting value equal to 100. The two curves in the figure represent, respectively, a case in which the change in the livestock weight replaces the crop income and a case in which the change replaces the off-farm income.

Both curves are downward sloping, indicating that a marginal increase in livestock income stabilizes household income. The two curves are very similar in the left half of the figure, or in the region where the livestock share decreased compared with the default. A shift of income from the livestock source to the crop source by 7.6 points increases the coefficient of variation of income by 5.9 per cent.[6] The slope is more gentle in the right half of the figure, with a reversed direction in the end. Thus, a further increase of livestock weight from the default may lead to an increase in income variability.

The simulation result has a clear implication for what had occurred during the 1980s (Chapter 2). The shift in the macrostructure of Pakistan's agriculture from the crop sector to the livestock sector (Figure 2-1) was associated with the increasing weight of the livestock sector within each agricultural household. Thus, the change should have decreased the income variability of individual households. A decrease in income variability ceteris paribus improves household welfare. It is true that the net welfare effect is not determined since the change in relative prices might have resulted in a change in expected income. Nevertheless, the simulation suggests that a rise in prices of livestock products should have had a positive welfare effect by providing a more stabilized income than before. Considering the fact that livestock income is more important in smaller farms, the change should have benefitted them more. In that sense, the change, ceteris paribus, might have improved rural equity also.

IV. Summary and Conclusions

How do agricultural households in Pakistan control their exposure to risk through enterprise selection and asset accumulation/decumulation? The analysis in this chapter has attempted to address this issue using the variation in income and consumption recorded over a three-year period. Decomposition of per capita income into deterministic and transient portions has shown that livestock holding contributes to a reduction in income variability through the negative correlation of livestock income with crop income and through ex post decumulation of livestock assets contingent on a realized income in the crop sector.

An analysis of per capita consumption expenditure covering major consumption items has shown that individual consumption levels co-move with individual income levels mainly due to aggregate risk at the village level. It is likely that the risk-averse behavior of sample households is due to insufficient channels for sharing collective price and yield risk with the rest of the world. Therefore, a reduction in income variability has a welfare-improving effect. A simulation based on the income decomposition showed that a shift in enterprise composition toward livestock products reduces household income variability.

These empirical results suggest that the rises in the share of the livestock subsector in agricultural value added in Pakistan should have improved the welfare position of households with substantial livestock holding. Since smaller farms have a relatively larger livestock herd in the Pakistan Punjab, the recent phenomenon might have had an equity-improving effect as well. Furthermore, because livestock have an additional welfare value as an effective insurance measure, farmers might have had a stronger incentive to accumulate livestock than those who maximize expected profit from agriculture. In other words, too large livestock holding from a criterion of profit-maximizing efficiency might be a rational and efficient size for a poor, risk-averse household. Therefore, a welfare component of on-farm and off-farm diversification should be considered in formulating a policy that attempts to change the agricultural structure of the country.

The adjustments toward risk analyzed in this chapter are possible because agricultural households decide on consumption and production jointly. Especially, they can use production adjustments to control their exposure to risk according to their preferences and they can use production assets to smooth consumption ex post. In that sense, agricultural households as an organizational institution have an advantage to overcome the incompleteness in insurance markets.

Notes

1 This chapter is based on Kurosaki (1995a) with some of the estimation results corrected.

2 As in the second section of Chapter 3, function $f_s(..)$ could be interpreted as a reduced-form equation of household income-generation decisions. If the theory of duality holds, $f_s(..)$ becomes a profit function with the vector Z_{ht} consisting of market prices and household characteristics of fixed production assets, augmented by an additive term that corresponds to the sum of rents to owned assets. However, since the duality theory usually breaks down under uncertainty, household consumption characteristics are also included in the vector Z_{ht} to allow for the non-separability of production decisions from consumption preferences.

3 Townsend's model included a higher order demographic adjustment term which was omitted since it is not important for the purposes here.

4 Kurosaki's (1995a) estimation procedure was biased in favor of rejecting the full village insurance, since both $c_{ht} - \alpha$ on the left-hand-side and X_{ht} on the right-hand-side were incorrectly defined so that they were affected by variation due to unobserved household characteristics.

5 Full results can be obtained from the author upon request.

6 The starting value of the livestock weight is 0.252. The weight becomes 0.176 after a 30 per cent decrease. This is equivalent to a shift of 7.6 points (25.2 per cent − 17.6 per cent) of expected income from the livestock sector to the crop sector.