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A MICRO LEVEL STUDY OF CAPITAL FORMATION IN THE PUNJAB AGRICULTURE

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Capital is one of the most crucial factors which sets the pace and pattern of economic growth in a country. The interaction of capital with all other factors is too obvious and, therefore, forms the basic theme of growth economists. It is the net increase in capital stock along with its efficiency that directly influences the productive capacity of the economy for increasing the total output or income.

There is thus an imperative need to study capital formation and particularly the factors that affect capital formation. Since the relative significance of factors affecting capital formation changes over time, it will be useful to extend the study to at least two time periods. In this paper, an attempt has been made to examine the relative significance of different variables in affecting capital formation over time, *e.g.*, from 1967-68 to 1969-70 and from 1969-70 to 1973-74. More specifically, the objectives of the study were to examine the factors affecting capital formation in the Punjab and to analyse the changes in the relative significance of different variables affecting capital formation over time.

METHODS AND MATERIAL

To study capital formation over time, time-series data were used from the Studies in the Economics of Farm Management in the Ferozepur district for the period 1967-68 through 1969-70. More recent data on capital formation were collected by repeating the old sample of 150 farmers for 1973-74. As many as 148 farmers were interviewed, only two had left farming.

Functional Approach

In this approach, capital formation as a dependent variable was expressed as a function of the following determining variables:

X_1 = Operational farm size during the base year,
X_2 = Net farm income (lagged),
X_3 = Base year capital inventory,
X_4 = Family size,
X_5 = Percentage irrigated area during the base year,
D_i = Dummies for draft power. These are explained in a later paragraph.

In order to examine the changes in the effect of different variables on capital formation over time, the functional analysis was done for the following

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two periods: Period I: 1967-68 to 1969-70 and Period II: 1969-70 to 1973-74.

Hereafter, these periods are referred to as 1967-70 and 1969-74 respectively. The base year for these periods was 1967-68 and 1969-70 respectively.

Specification of Variables

The variables included in the study were specified as follows:

Y:*Additional capital investment*

The dependent variable was the yearly additional capital investment. This included (*i*) investment made in such land improvements as levelling and fencing, (*ii*) such irrigation structures as installation of tubewells, pumping sets, underground and open irrigation channels, (*iii*) investment made in machinery and major implements which included tractors, threshers, shellers, crushers, seed drills, trolley, cultivators, disc harrows, (*iv*) plant protection equipment such as sprayers, dusters and such other major implements as trifali, cart, fodder cutter, bar harrow, improved ploughs, hand hoes, etc. In addition to these, the dependent variable also included investment made in livestock, farm buildings and structures.

X_1:*Farm size*

This variable was measured as the operational farm size which incorporated land owned plus land leased in minus land leased out. It may be mentioned that tenancy was at a very low ebb in the area, as high as 91 per cent of the operated area was owned. As such, tenancy was not expected to affect capital investment to a great extent.

X_2:*Net farm income*

The net farm income was derived by deducting cost C[1] from the gross income of the farm. Since lagged net income formed the relevant variable, the average net income during 1967-68 and 1968-69 was used for period I. The income figures for 1970-71 through 1972-73 were not available. Therefore, the average net income available for 1969-70 and estimated for 1973-74 was taken as the independent variable affecting capital formation during this period. This limitation should not impinge upon the results in so far as the average of the extreme years, instead of the intervening years is included, provided there was a straight line relationship of income with time.

1. Cost C includes wages of hired human labour, value of bullock labour (owned and hired), seed, manures, fertilizers, insecticides and pesticides, irrigation charges, water rates, interest paid on working capital, depreciation and other repairing charges, rent paid for leased-in land, rental value of owned land and interest on fixed capital and imputed value of family labour.

X_3:*Base year capital investment*

Capital inventory during the base year also affected capital formation. This was built by pooling investments made in land improvements, irrigation structure, implements and machinery, livestock and farm buildings, etc.

X_4:*Family size*

Family size affects total earnings, family expenses and hence availability of earnings for capital formation. Family members contributed more than 50 per cent of the total labour input in the study area. To the extent labour and capital inputs were considered as complementary to each other, more specifically in the study area, where all available literature shows increased labour use as well as increased capital investments including mechanization, the positive coefficient of this variable would be an indirect indication of the complementarity of the two inputs.

X_5:*Percentage irrigated area in the base year*

Irrigation is an important item of capital investment and additional investment in this item depends upon the existing availability of irrigation at the farm. The percentage irrigated area during the base year was, therefore, included as one of the determinants of capital formation.

D_i:*Dummy variables*

In economic analysis, some variables are such that they affect the dependent variable significantly but are difficult to be quantified for the functional analysis. At the same time, such variables cannot be ignored and can be incorporated in the form of dummy variables in the analysis. Tractorisation is an important variable which was considered as a dummy variable in this analysis; D=1 for tractor farms, zero otherwise.

Aggregation and Disaggregation of Variables

1. The dependent variable in the basic function was expressed as total additional capital investment. Since over time there were changes in farm size, to account for this change, the dependent variable was expressed on per hectare basis, *i.e.*, capital formation per hectare.
2. Both the family size and the number of earners were tested as independent variables to find out which gave better results.
3. (*a*) Two dummies were used for draft power:—
   D_1 =Dummy for tractor in the base year,
   D_2 =Dummy for the introduction of tractor on the farm during the period because this change gives a big jump in the capital formation which can be captured by this dummy variable.

(*b*) Using only one dummy for draft power, *i.e.*,

D_3=Dummy for tractor in the last year of the period.

4. In order to examine the change in the effect of a variable on capital formation on tractor versus non-tractor farms, the interactions of dummy variable for tractor with the other variables were also included as separate variables.

Keeping in view that the dependent variable was negative in the case of those farms which did not make any additional investment during the period studied, the appropriate choice of model was a linear function. Thus the complete model takes the following form:

$$C = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6D.$$

Before extending this aggregation and disaggregation scheme, the correlations between different independent variables were examined for multicollinearity. Also, the coefficients of multiple determination and significance of regression coefficients of these functions were examined in detail.

RESULT AND DISCUSSION

Period I (1967-68 to 1969-70)

The regression coefficients, their standard errors and coefficient of multiple determination of pooled capital formation functions for period I and between different independent variables were examined and the following general conclusions were drawn.[2]

(*i*) It was found that total capital formation as dependent variable gave better results in terms of significance of the regression coefficients. The independent variables used were base year capital, family size, lagged net income and dummy for tractor. On the other hand, when the dependent variable was capital formation per hectare, it gave higher R^2 value, but in this case, only dummy for tractor was found to be significant. Therefore, the functions with total capital formation as dependent variable were considered for further analysis.

(*ii*) Regarding family size and number of earners as alternative independent variables, the family size turned out to be better both in terms of significance of its coefficient and R^2 value. It might be due to more variation existing in the family size than in the number of earners.

(*iii*) The percentage area under irrigation was not significant because there was little variation in this variable. It was, therefore, deleted.

(*iv*) The interaction of dummy for tractor with all other independent variables was first included in the analysis. It was found that only the interaction with base year capital was significant which was quite logical. However, the interaction with lagged net income, recognizing its economic importance, was also retained. All other interactions were deleted.

The total capital formation functions estimated after using the above line of reasoning are given in Table I.

2. These functions and correlation matrices are not given here for the sake of brevity. The interested reader may request these from the authors.

TABLE I—CAPITAL FORMATION FUNCTIONS, PERIOD I (1967-68 TO 1969-70)

Variable	Regression coefficient in Function No.		
	9	10	11
1. Intercept	—132.7427	199.2419	—599.3323
	(574.1526)	(631.9677)	(660.9588)
2. Base year capital	—0.1870***	—0.2693***	—0.0463
	(0.0418)	(0.0466)	(0.0829)
3. Farm size	11.0349	17.5797	12.4345
	(38.6155)	(42.6587)	(41.3923)
4. Family size	176.5669**	189.1471**	163.3148**
	(80.9396)	(88.7998)	(80.6004)
5. Lagged net income	0.1566***	0.1546***	0.0576
	(0.0523)	(0.0574)	(0.0873)
6. Dummy for tractors			
(*a*) In the base year (1967-68) ..	1147.7795*	—	—
	(872.8780)		
(*b*) Introduction till last year ..	6517.9768***	—	—
	(753.7216)		
(*c*) In the last year (1969-70) ..	—	4529.8672***	6594.3516***
		(733.8222)	(1096.6294)
7. Interaction of dummy for tractor with			
(*a*) Base year capital (2).. ..	—	—	—0.3088***
			(0.0991)
(*b*) Lagged net income (5) ..	—	—	0.1409*
			(0.0798)
R^2	0.6401@	0.5186@	0.5708@

Note:—Figures in parentheses indicate standard errors of the regression coefficients.
***, ** and * indicate that the regression coefficient was significant at .01, .05 and .10 probability level respectively.
@ Indicates that the F-statistic was significant at 1 per cent level.

It can be seen from Table I that the regression coefficients of base year capital and lagged net income variables were highly significant at .01 probability level. The coefficient of family size was significant at .05 probability level. All the dummies for tractor were statistically significant but the dummy for addition of tractor during the period was highly significant. And when this dummy along with dummy for tractor in the base year was included, the coefficient of multiple determination was higher at 0.6401 than when only one dummy for tractor, *i.e.*, tractor in the last year was included with R^2 at 0.5186. The interaction of dummy for tractor in the last year with base year capital was found to be highly significant but in this case the coefficient of base year capital itself was not significant. Similarly, the interaction of dummy for tractor in the last year with lagged net income was significant but that of lagged net income became non-significant. Therefore, only the original function including the dummies for tractor in the base year and its addition till last year is discussed in detail.

The coefficient of base year capital was negative at —0.1870 which indicated that higher the base year capital, lower would be the additional capital investment. This conformed to the hypothesis that capital investment on those farms declined which had higher base year capital investment. When farmers, who made capital investment during the period, were

separated from those who did not invest, it was found that the base year capital investment was generally lower in the case of those farmers whose capital investment increased than that of those who did not invest.[3] The logic of this phenomenon runs like this: capital formation is a discrete phenomenon and farmers invest on the principle of "catch-as-catch-can". Thus in the case of a farmer who makes investment in a year with his owned and borrowed funds, his total capital investment increased and in the following year he may not be able to invest because of the repayment of loans, etc. And thus, owing to depreciation, his total capital investment in the following year might show a decline.

The coefficient of farm size was 11.0349 which indicated that an increase in the farm size by one hectare would increase capital formation by Rs. 11.03. Likewise, an increase in lagged net income by one rupee would increase capital formation by Re. 0.16. The positive effect of the family size variable indirectly established the complementarity between capital investment and labour input in the study area. The alternative approach to handle this problem would be to segregate capital formation according to whether it is in the labour substituting form. The investment in machinery and major implements like threshers, shellers, crushers, seed drills, etc., could be considered as belonging to this type and was accordingly separated[4] (Appendix). It was found that capital formation in labour substituting items was less than 5 per cent during period I. It was even negative in such situations where old stocks depreciated more than their replacement plus new additions. In fact, in some cases, it did not have definite relationship with farm size. Separate functions could not, therefore, be fitted for different competitive and complementary forms of capital with labour.

In order to compare the relative importance of different variables in determining capital formation, the elasticities of capital formation for these variables were estimated at the mean levels of dependent and independent variables[5] and are given in Table II.

TABLE II—MEANS OF DEPENDENT AND INDEPENDENT VARIABLES, AND ELASTICITIES OF CAPITAL FORMATION, PERIOD I (1967-68 TO 1969-70)

Variable	Mean value	Elasticity
1. Total capital formation during the period (dependent variable) (Rs.)	1,275.0405	—
2. Base year capital (Rs.)	11,957.8160	—1.7538
3. Farm size (hectares)	12.6071	0.1092
4. Family size (No.)	6.7703	0.9375
5. Lagged net income (Rs.)	11,137.0740	1.3670

3. For details, see Bhupinder Singh: A Micro Level Study of Capital Formation in the Punjab Agriculture, Doctoral Dissertation, Punjab Agricultural University, Ludhiana, 1976, unpublished, p. 76.

4. Although investment in tractor is the most important item from this angle, but because it was handled through a dummy variable, it was not considered here along with other items.

5. Elasticity $= \frac{dy}{dx} \cdot \frac{X}{Y} = \frac{MPP}{APP}$.

Table II shows that the elasticity of capital formation with respect to base year capital was negative and more than unity, being—1.7538. This indicated that one per cent increase in the base year capital would lead to decrease in capital formation by more than one per cent, *i.e.*, equal to the magnitude of the elasticity. However, the lumpiness of the capital should warrant a caution here. We cannot ignore the fact that those farmers who had a low base year capital might be induced to make some capital investment.

The elasticity of capital formation with respect to lagged net income was greater than unity (1.3670). Being positive, it indicated that one per cent increse in lagged net income would lead to an increase in capital formation by 1.37 per cent.

Period II (1969-70 to 1973-74)

The following general conclusions could be drawn from the basic capital formation functions and the correlations between independent variables.

(*i*) It was found that in period II, capital formaion per hectare as dependent variable turned out to be better in terms of significance of the regression coefficients. It was due to more significant changes in the farm size during this period.[6] The independent variable which had significant regression coefficients were capital in the base year, farm size, family size lagged net income and dummy for tractor. On the other hand, when total capital formation during the period 1969-70 to 1973-74 was considered as dependent variable, the coefficient of multiple determination was higher but only a few variables were found to have significant regression coefficients. Thus the more appropriate choice of dependent variable in period II was capital formation per hectare. It was in contrast to period I where total capital formation as dependent variable turned out to be better. This could be ascribed to a relatively shorter time span of period I which was only two years and sub-division of certain holdings and assets in period II as compared to period I.

(*ii*) The family size and number of earners gave almost similar results in period II. Hence, in order to make a comparison of the two periods, the family size was selected as an independent variable instead of number of earners.

(*iii*) Again, the percentage area under irrigation was found to be insignificant due to little variation in this variable, hence it was deleted.

(*iv*) The interaction of dummy for tractor with all independent variables was first included in the analysis. It was found that interactions with capital in the base year and family size were not significant. These were, therefore, deleted.

Per hectare capital formation functions estimated after using the above line of reasoning are given in Table III.

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6. Bhupinder Singh: *op. cit.*

TABLE III—CAPITAL FORMATION FUNCTIONS, PERIOD II (1969-70 TO 1973-74)

Variable	Regression coefficient in Function No.		
	56	57	58
1. Intercept	56.3351 (47.9017)	106.6225 (50.2093)	64.7057 (52.7329)
2. Base year capital	—0.0025 (0.0027)	—0.0110*** (0.0024)	—0.0088*** (0.0023)
3. Farm size	7.2714*** (3.3796)	8.9243*** (3.5797)	17.2541*** (4.7677)
4. Family size	11.5464* (6.7658)	13.8404* (7.2035)	10.9677*** (6.8689)
5. Lagged net income	—0.0049** (0.0021)	—0.0056** (0.0022)	—0.0097** (0.0038)
6. Dummy for tractor			
(*a*) In the base year (1969-70) ..	65.2043 (67.7272)	—	—
(*b*) Introduction till last year ..	446.4106** (49.2520)	—	—
(*c*) In the last year (1973-74) ..	—	359.6040*** (48.1966)	1161.5466*** (210.8670)
7. Interaction of dummy for tractor with			
(*a*) Farm size	—	—	—24.8353*** (6.8532)
(*b*) Lagged net income (5)	—	—	0.0099** (0.0046)
(*c*) Irrigation	—	—	—7.2025*** (2.0847)
R^2	0.6015@	0.5143@	0.5984@

Note:—Figures in parentheses indicate standard errors of the regression coefficients.
***, ** and * indicate that the regression coefficient was significant at 0.01,0.05 and 0.10 probability level respectively.
@ indicates that the F-statistic was significant at 1 per cent level.

It will be seen from Table III that in period II, the base year capital, farm size and family size had highly significant regression coefficients at 0.01 probability level. The coefficient of lagged net income was significant at 0.05 probability level. The dummy for the introduction of tractor and dummy for tractor in the base year in one function and the dummy for tractor in the last year in the other function were found to be highly significant. The coefficient of multiple determination was the highest at 0.6015 when the dummy for the introduction of tractor along with that of tractor in the base year was included as independent variables. In the situation when only one dummy for tractor in the last year was included, R^2 was only 0.5143. The interactions of dummy for tractor in the last year were found to be statistically significant with farm size, lagged net income and irrigation.

The coefficient of base year capital was negative (—0.0088), thus indicating that higher the base year capital the lower would be the additional capital investment. The coefficient of farm size at 17.2541 indicated that as the farm size increased by one hectare, capital formation per hectare would increase by Rs. 17.25.

The effect of lagged net income in period II was found to be negative. An increase in lagged net income in period II by Rs. 100 would lead to a decline in capital formation by Re. 0.97 per hectare. This was indicative of the phenomenon observed in period II when most of the farmers in the high income group did not make substantial investments, even some of the old stocks were not replaced.

Again, the positive effect of the family size variable indirectly pointed to the complementarity of labour and capital inputs in this period too. It was found that capital formation in the labour substituting items was 14.80 per cent in period II which was higher than that of period I. Also it had some positive association with farm size and increased from 9.40 per cent in the smallest farm size-group of upto 6 hectares to 22.26 per cent in the size-group of 14-26 hectares, with the exception of the largest farm size-group of above 24 hectares where it was the lowest at 8.34 per cent (Appendix).

The elasticities of capital formation were estimated at the mean levels of different variables. It was found that the base year capital and lagged net income had negative elasticities at —0.6321 and —0.6828 respectively (Table IV), which indicated that one per cent increase in the values of these variables would lead to a decline in capital formation by the respective percentage figures. The elasticity of capital formation with respect to farm size was found to be the highest and more than unity at 1.0533, which indicated that one per cent increase in the farm size would lead to an increase in capital formation by 1.0533 per cent. Likewise, the elasticity of capital formation with respect to family size was 0.3438.

TABLE IV—MEANS OF DEPENDENT AND INDEPENDENT VARIABLES AND ELASTICITIES OF CAPITAL FORMATION, PERIOD II (1969-70 TO 1973-74)

Variable	Mean value	Elasticities
1. Total capital formation during the period (dependent variable) (Rs.)	201.9658	—
2. Base year capital (Rs.)	14,507.8980	—0.6321
3. Farm size (hectares)	12.3291	1.0533
4. Family size (No.)	6.3311	0.3438
5. Lagged net income (Rs.)	14,216.6680	—0.6828

The relative importance of different variables in determining capital formation over time was studied by comparing the magnitude of elasticities (Tables II and IV). It was found that the elasticity of capital formation with respect to base year capital was negative in both the periods but it was more than unity in period I and less than unity in period II, being —1.7538 and —0.6321 respectively. On the other hand, the elasticity of capital

formation with respect to farm size, which was positive in both the periods, was only 0.1092 in period I but more than unity at 1.0533 in period II. This indicated the increasing role of farm size in capital formation over time. The elasticity of capital formation with respect to lagged net income presented a contrast in the two periods. It was positive and more than unity in period I (1.3670) but negative (—0.6828) and less than unity in period II. The importance of family size in determining capital formation also declined over time. Its elasticity was 0.9375 in period I and only 0.3438 in period II.

CONCLUSION

This study which examined the pace and pattern of capital formation in the Punjab over two time periods, *viz.*, 1967-68 to 1969-70 and 1969-70 to 1973-74 revealed that the base year capital, farm size, lagged net income and family size were the important variables that affected capital formation. The change from bullocks to tractor made a substantial difference to capital formation and it was captured through a dummy variable which was highly significant. The base year capital had negative impact on capital formation, which meant that the higher the base year capital, the lower would be the capital formation. However, its elasticity declined from—1.7538 in period I to —0.6321 in period II. The elasticity of farm size increased from 0.1092 in period I to 1.0533 in period II. The importance of family size in determining capital formation declined over time, its elasticity being 0.9375 and 0.3438 in period I and II respectively. The lagged net income presented a contrast for the two periods. It had positive and more than unity elasticity in period I but negative and less than unity in period II. This was indicative of the phenomenon observed in period II when the farmers in the high income group did not make substantial capital investments. The results of this study could thus be used to promote capital formation at the farm firm level in the Punjab.

APPENDIX

SHARE OF LABOUR SUBSTITUTING CAPITAL (MACHINERY AND MAJOR IMPLEMENTS) IN TOTAL CAPITAL FORMATION ON DIFFERENT SIZED HOLDINGS, PUNJAB

(*Rs.*)

Farm size (hectares)	Total capital formation		Capital formation in labour substituting items			
			Absolute		As percentage of total capital formation	
	Period I	Period II	Period I	Period II	Period I	Period II
Up to 6	602.70	3,382.94	—29.57	318.11	—4.90	9.40
6-9	3,286.57	3,856.35	193.61	628.03	5.89	16.28
9-14	1,822.21	15,561.13	245.47	2,627.58	13.47	16.88
14-24	3,167.11	14,644.47	—237.59	3,259.58	—7.50	22.26
Above 24	5,465.78	11,835.69	1,215.93	986.85	22.25	8.34
Overall	2,550.26	8,499.95	117.34	1,258.08	4.60	14.80