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Determinants of Farm Revenue in Pakistan

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Will small farm viability decline with the reduction of average farm size in Pakistan? This paper addresses the determinants of rural household and farm-related income. Using the 2001 PIDE Household Survey, the approach developed captures the potential interactions between farm returns and household, farm, and factor market characteristics (schooling, family size, land tenure and operational size, access to water, credit, and capital). Econometric results show: (a) returns to additional schooling and the revenue elasticity of operated acres increase with farm size; (b) medium and large farm renters would be willing to pay more than observed rents, implying an incentive to increase farm size at the prevailing rental values; (c) owner-operated farms, landowners who also leases in, and fixed rental tenants earn higher revenues than sharecropping tenants. The difference, however, between landowner/fix-renter income and sharecropper income varies with family and farm size, as well as water use. While these results favour farm size increase, the results also show that off-farm and non-farm income sources are relatively more important for small farmers, contributing to their viability.

JEL classification: D13, Q12, Q15
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1. INTRODUCTION

Agriculture is an important sector in Pakistan's economy, accounting for a quarter of GDP and roughly two-thirds of exports value. Farming and its linked activities are the main economic activities in rural areas, where about two-thirds of Pakistanis live. During the previous decade, the sector grew at a healthy 4.5 percent per year, a rate higher than in other South Asian countries. Nevertheless, this expansion in agricultural GDP apparently did not reduce the poverty rate, which stalled at around 36 percent during the 1990s. Why did agricultural growth not lead to rural poverty reduction?[1]

This paper presents a quantitative analysis of the determinants of farm household income (and therefore poverty), emphasising the interactions between factor markets. The analysis takes a statistical approach that accounts for the various sources of farm income: farm production, off-farm employment, transfers and remittances, and returns to assets. It captures the interactions between farm size and other variables, such as labour education, land fragmentation, work outside the household, capital assets, water, and geographic location. The main results are in terms of the effects on farm-related revenues of changes in household characteristics

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[1]Recent studies suggest that part of the explanation has been an overestimation of the growth of agricultural output [Malik (2005)]. Another explanation is that the poverty to agricultural growth elasticity (alas, based in the overstated growth of the sector) has been falling, as Dorosh, *et al*. (2003) propose.

(education and family size) and quasi-fixed factors of production (land owned, land operated, water, credit, and capital). The interpretation of the results are in terms of elasticities (the percentage changes in farm revenue that results from an increase of some percentage in a variable of interest) and focuses on three farm sizes (up to four acres, between 4 and 20 acres, and greater than 20).

The analysis employs the Pakistan Rural Household Survey (PRHS), completed in 2001, which includes data on farm output and variable input quantities, product and factor prices, household characteristics, and quasi-fixed factors in the short-term (land, fixed capital, education, canal water, family labour and credit).

2. SOURCES OF INCOME OF RURAL HOUSEHOLDS

The PRHS allows a depiction of rural households according to farm land ownership, farm sizes, principal income sources and other characteristics. Table 1 summarises the main income sources of Pakistani rural households separated by size of farm operation in acres. The first three rows of Table 1 show income from farming; the fifth row, income from land leasing; rows six through eight, wage and non-farm enterprise income; and rows ten and eleven, pensions and transfers. Excluding the

Table 1

Average Income of Farm Households by Source and Farm Size (Rupees)

Income Source	Total Sample	Without Operated Land and Landless	Farm Size (in Acres) Small (<4)	Medium (4 - 20)	Large (>20)
Income from Field Crops	21,607	278	7,111	31,420	93,562
Income from Other Crops	44,626	196	26,821	61,686	145,197
Income from Livestock	17,688	14,586	13,907	20,811	29,303
Total Income from Farm Operation	83,921	15,060	47,839	113,917	268,062
Land Leasing	5,098	10,827	2,889	2,439	17,552
Off-farm Agricultural Income (Ag. Wages)	2,318	1,565	2,669	2,590	707
Income from Non-farm Enterprise	5,384	2,158	5,412	5,079	12,678
Non-farm Agricultural Wages	8,673	6,285	9,365	8,661	9,641
Wage and Enterprise Income	16,375	10,008	17,446	16,330	23,026
Pensions	1,261	1,306	302	1,637	4,488
Private Transfers	3,439	2,650	3,448	2,410	9,452
Public Transfers	2,537	1,954	1,435	274	19,397
Pensions and Transfers	7,237	5,910	5,185	4,321	33,337
Total Income	112,631	41,805	73,359	137,007	341,977
Source as Proportion of Total Income					
Total Income from Farm Operation	0.75	0.36	0.65	0.83	0.78
Land Leasing	0.05	0.26	0.04	0.02	0.05
Off-farm Wage and Enterprise Income	0.15	0.24	0.24	0.12	0.07
Pensions and Transfers	0.06	0.14	0.07	0.03	0.10

Source: Authors' calculations based on PIDE (2001). Note that averages are calculated excluding non-farm households. Note that farm revenues are net of variable purchased input, but not of land rental or sharecropping payments. Rental payments per acre decline with farm size.

category "landless", income from farm operations is the main source of total income: 65 percent for small farms, to 83 percent for medium, and 78 percent for large. Land leasing income is a relatively small proportion, between 2 percent and 5 percent, except for "landless", a category which includes households that lease-out all of their agricultural land. Off-farm wage and non-farm enterprise sources are relatively more important for small farmers (24 percent of total income for small farmers, 12 percent for medium and 7 percent for large). Notably, pensions and transfers for large farmers averages 10 percent of total income compared to 7 percent for small farmers. For households without operated agricultural land, non-farm sources of income are relatively more important. Notably, land leasing accounts for a quarter of their total income.

Farm Household Characteristics

Table 2 summarises the PRHS data for average household characteristics according to operated farm size, dividing farms into four separate categories: households without operated agricultural land (but with livestock or land leasing as main income source), small farms (up to 4 acres), medium farms (between 4 and 20 acres), and large farms (more than 20 acres). On average, households are large with almost 9 members per unit; and, in contrast to farm households in middle-income economies, wealthier Pakistani farm households are larger than poorer farm households. The average level of

Table 2

Household Characteristics by Operational Farm Size

	Total Sample	No Ag. Land Operated	Small Farms (>0 – 4 Acres)	Medium Farms (>4 –20 Acres)	Large Farms (>20 Acres)
Capital (Rp. 100's)	319	94	114	458	1,195
Capital (Rp. 100's/Acre)	32	N/A	54	50	17
Education (Years)	6.12	6.30	5.91	6.11	6.94
Household Size	9.08	8.22	8.51	9.52	11.67
Agricultural Investment from Formal Sources (Rp.)	10,373	4,636	4,298	14,914	32,584
Agricultural Investment from Formal Sources (Rp./Acre)	1,054	N/A	2,045	1,621	456
Investing Households %	13	7	9	17	25
Agricultural Investment from Informal Sources (Rp.)	3,392	209	1,046	7,427	3,674
Agricultural Investment from Informal Sources (Rp./Acre)	345	N/A	498	807	51
Investing Households %	8	2	8	11	6
Operational Farm Size (Acres)	10	0	2	9	71
Proportion of Net Revenues from (%):					
Livestock	21	97	29	18	11
Main Field Crops	26	2	15	28	35
Other Crops	53	1	56	54	54
Proportion of Sample %	100	15	41	35	8

Source: Authors' Calculations based on PIDE (2001).

formal education of the household head is about 6 years, and education levels increase by farm size[2]. Total non-land capital stock value is positively correlated with farm size, large farms having on average a capital stock valued 10 times greater than that of small farms. Medium farms, however, have larger capital stocks per unit of land.

Formal credit, usually tied to available collateral (mainly land), is positively correlated with agricultural operation size, but again medium-size farms realise larger agricultural investments. Informal credit is also positively correlated with land. Although formal credit is the main source of financing for farms of all sizes, informal sources are relatively more important for small and medium farms than for large farms. For large farms, informal sources represent about 10 percent of the value of funding from formal sources.

3. REVENUE FUNCTIONS FOR PAKISTANI FARM HOUSEHOLDS

The emphasis of this analysis is on the ability of households to generate net income from livestock and farming activities; that is, the focus is on the net returns to household farm-related assets, which include human and physical capital associated with the farm operations. Household income is defined here as farm-related income and excludes labour income from off-farm employment as well as pensions and transfers. For landowners, returns are generated from their own cultivation of their land, and from income derived from leasing-out land. For tenant households (both cash leasing and sharecropping), income is generated by their share in the farm operation, which yields returns to their on-farm labour and capital (off-farm income and remittances are excluded). For “landless” farm-operating households, income corresponds both to that generated from their own cattle and poultry production on common-property and owned non-cultivated land, and to that generated by leasing out all of their agricultural land.

Net farm-related household income is defined as gross farm revenues less the cost of purchased (i.e., variable) inputs. To analyse the determinants of net household income, we make use of the restricted revenue function.[3]

Algebraically, gross revenue from agricultural production activity can be represented in terms of two types of inputs: short-term fixed inputs, z, and variable inputs, x :

$$R(p;x,z) = \max_{q}\{pq \mid q \leq f(x,z)\} \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (1)$$

The restricted (net) revenue function is defined as gross revenues less the cost of purchased (variable) inputs, x:

$$\tilde{R}(p;x,z) = \max_{x}\{R(p;x,z) - wx\} \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (2)$$

Assuming that the household selects the level of variable inputs to maximise short-term net revenue, one can estimate the relationship between observed net revenues and

[2]This positive correlation between land size and head education is partly due to the way we imputed education for some heads. Please see Data Details section below.

[3]Diewert (1973) presents a formal treatment of the now frequently used revenue function approach.

levels of prices and fixed inputs.[4] The restricted revenue function, $\tilde{R}(p, w; z)$, is positively homogenous of degree 1 in output and variable input prices, continuous, increasing and convex in prices, and is continuous, increasing and concave in fixed inputs *z*.

In this analysis of the case of Pakistan, net revenues derive from many crops, and we assume that farmers choose an optimal combination of outputs. Crops include field crops (cotton, sugar, wheat and rice), other crops (including other cash crops, fruits), and livestock (which includes poultry and dairy revenues). Quasi-fixed inputs consist of land, canal water, non-land capital, education, own labour, and agricultural credit. To calculate net revenues, we subtract from gross revenues the variable input costs associated with hired labour, seeds, fertilisers (organic and chemical), pesticides, purchased tube-well water, and machinery and equipment rental; and add/subtract the revenue/cost of land leasing arrangements.

It is important to note that for Pakistan canal water can be considered a quasi-fixed input, because canal water is tied to land holdings and the market for water is limited. Normally, farms are endowed with one canal turn per week per acre of land in a rotational system, called *warabandi*, with turns usually lasting 20 minutes. These water endowments depend on land holdings, not crop area, and are independent of any other demand consideration, such as the type of crop under cultivation, terrain seepage, or seasonality. Farmers make some adjustments by trading their canal turns to adjust for peak crop demand, but these trades usually occur between neighbouring plots. Sales of canal turns are uncommon, and in any case not necessarily legal, a fact which may lead to some underreporting. Table 3 reports canal water usage and market transactions in the

Table 3

Canal Water Usage and Transactions by District Average Hours by Farm

District	Endowed	Given or Received	Sold or Purchased	Surveyed Farms with Canal Water
Faisalabad	525	6.30	1.99	56
Attock	0	0	0	0
Hafizabad	24	0.11	0.03	21
Vehari	37	0.03	1.75	52
Muzafar Garh	16	0.04	0.02	21
Bahawalpur	16	1.10	0.04	54
Badin	382	19.31	9.45	80
N. Shah	65	1.78	25.56	44
M. P. Khas	73	0.00	4.57	46
Larkana	143	8.00	0	6
Dir	0	0	0	0
Mardan	391	2.00	0.00	36
Total	204	5.19	5.52	416

Source: PIDE (2001).

[4]An interesting property of the restricted revenue function (2) is that, assuming variable inputs levels are optimally selected, revenues net of variable input costs can be written without explicit reference to the variable input. Partially differentiating with respect to *x* one obtains: $\partial\tilde{R}(p;x;z)/\partial x = \partial R(p;x,z)/\partial x - w = 0$. If the marginal returns of the variable input, $\partial R(p;x,z)/\partial x$, are not equal its opportunity cost, *w*, then the farmer will employ more or less of it, until its marginal returns equal its marginal cost.

different districts of rural Pakistan. Except for the districts of Badin, N. Shah, and M.P. Khas, there are very few market transactions of canal water.

Given the importance of land transactions (sharecropping and fixed rental agreements), we treat land as a special input. Once the farm is in operation, cultivated land is a fixed input in the short-term, i.e. during the growing season. Farmers can adjust their land holdings (leasing in or out) in the medium term, but for a given season, the land available is a quasi-fixed input, unlike for example, the use of fertiliser, which can be optimally adjusted in the short run. The land operated includes owned land, as well as land operated through a fixed rental or sharecropping agreement.[5] As done with the variable inputs, we subtract the cost of use of land, but instead of assuming optimal usage (as we do with variable inputs) we test for optimal behaviour with land holdings. For fixed rental arrangements, the rental cost of not-owned, operated land is subtracted from household revenues. For tenant sharecroppers rental costs we subtract their agreed upon share of the value of output. The returns to household assets include revenues generated by the household's use of land, irrespective of the land's ownership. The returns to land specifically are distributed between the owner and the operator, who could be the same agent. Revenues and input costs and usage are calculated at the operated farm level. For landlords with tenants, operated land excludes that which is leased-out, but we include the revenues from those lease agreements (fixed rent received in cash or in kind), and the corresponding net value of output from their sharecropping contracts.

Agricultural land distribution is notably unequal in rural Pakistan. In the case of east and south Asia generally, the average Gini for operational holdings of agricultural land ranges between 0.52 and 0.56, and Pakistan specifically has Gini coefficients similar to the world's highest rates, which are found in Latin America. Table 4 shows the disparity between the mean and the median of farm sizes (owned and operational), reflecting the skewness of land distribution. In the case of owned land, for example, the mean is 10.17 acres in contrast to the median of 3 acres, and not surprisingly the Gini coefficient is high (0.82). Table 4 also shows that in terms of the operational size of farms land leasing offsets the inequality in land ownership, lowering the relative disparity between the mean and the median farm sizes, the coefficient of variability, and the Gini index for operational holding size.

Table 4

The Distribution of Farm Size and Land Ownership (Acres)

	Mean	Median	Coefficient of Variability	Gini
Land Ownership	10.17	3	4.62	0.824
Leased (Out) Land	1.93	3.71	4.40	0.894
Operational Farm	9.85	3.75	4.19	0.733

Source: PIDE (2001).

[5]The degree of involvement of the landlord in a sharecropping operation varies from that of an absentee owner to that of a manager making all farming decisions (the sharecropper being almost like a wage labourer paid in kind).

Other important determinants of household revenue that can be treated as fixed inputs in the short term include household head education, the household size (an indicator of own family labour supply) and the capital stock. Agricultural credit (formal and informal) may be thought of as a quasi-fixed input, fixed within a given year, although adjustable over a longer term. Treating credit as a separate fixed input serves to measure the marginal effect on profitability of the distribution of financial funds across farms[6].

The restricted revenue function we estimate below may be described by:

$$R(p; A, X, E, K, W, E, L) = \overline{R}\,(p; A, X, E, K, W, D;\ \textit{purchased inputs}) - C\,(\textit{purchased inputs}) + r(L - A) \qquad \ldots \qquad \ldots \qquad (3)$$

where $\overline{R}\,(\cdot)$ represents gross revenues from the farming operation-income from farming directly. A is land utilised in the farm operation, r is the rental rate per acre, L is total land owned, and $r(L - A)$ is earnings from leasing out or costs from leasing in land used in the farm operation. $C(\cdot)$ represents the costs of all purchased variable inputs. The quasi-fixed inputs that determine farm value are: X, which is family labour; E is education, K capital, W is water, and D is credit. Costs of purchased inputs and productivity could vary by district, and dummy variables (i.e. fixed effects) are included in the estimation to account for such differences.

The reader should note what income sources are excluded in this measure of income from farming: off-farm wage and non-farm enterprise income and income from pensions, government transfers and remittances. These exclusions influence the interpretation of the results, specifically the effects on farm income due to changes in household labour (reported here in terms of elasticities). The estimated marginal effect of household labour, X, on farm income should reflect, in equilibrium, the opportunity costs of working off the farm, which includes income money earnings net of transactions costs (likely non-trivial).

The estimated form of the net revenue function (3), should not be a function of operated land A if the land market was perfectly working. The estimated coefficients for operated land, A, should lead to the value of the marginal product equaling the rental rate, that is, from (3): $\frac{\partial R}{\partial A} = \frac{\partial \overline{R}}{\partial A} - r = 0$. If there are no constraints on land trades, the gross revenue of an additional acre of land should equal its rental rate. In the case of land owned, L, the marginal effect on revenues should be equal to the land rental rate: $\frac{\partial R}{\partial L} = r > 0$. Thus, if there are no non-market benefits or costs associated with land ownership, and if there are no constraints to land trades, the elasticity should be equal to the share of rental income in total net revenues: $\frac{\partial R}{\partial L} \cdot \frac{L}{R} = \frac{rL}{R} \geq 0$; positive but less than 1

[6]The use of credit as a quasi-fixed factor of production is problematic, because it may be argued that it is a variable input. We deal with this issue statistically performing an exogeneity test on this variable. To do so we sorted observations using the de Luna and Johansson (2000) *sorting score*, and then performed a Nyblom (1989), Hansen (1992) stability test, to check for exogeneity of that particular regressor. The null hypothesis of exogeneity was not rejected. For further details, please request a longer version of this paper, available from the authors.

(roughly 0.05 according to the values presented in Table 1). There is, however, a possibility of a negative elasticity with respect to land owned (L) if the owner perceives other (non-market) benefits to owning more land beyond the rental value, and/or there are constraints on renting out land. Such additional benefits might arise from expected land appreciation, land being a means of wealth accumulation (savings), easier credit terms, and non-pecuniary returns like social status. Additionally, a landowner may choose *not* to rent out land at the market rental rate if he perceives the risk of expropriation of land, or if there are significant search costs of finding trustworthy renters.

4. DATA DETAILS

Prices where first calculated on a per good/unit basis using the declared value of output, and where then aggregated weighing by revenue shares. For households with no available price information, i.e. those that did not produce any of the goods in any of the three aggregates, we used district level means.

Capital, measured in 100's Rp., was constructed with the declared value of machinery and equipment owned by the household. For shared property capital we used only the household's corresponding share. Capital goods include: tractors, tube-wells, lift pumps, machine pulled plows, animal pulled plows, mechanical water pumps, combine harvesters, motorised threshers, rice planters, manual corn shellers, mechanical corn shellers, chakki, fodder choppers, motorised biocide pumps, hand biocide pumps, tractor trolleys, bullock carts, generator engine, and other.

With respect to the education of the household head we had to make an special treatment given the high degree of non-response to this question. For the missing observations we used the previously found correlation between land holdings and education of the head of household and estimated the following equation:[7]

$$\underset{}{\ln(\text{Education})} = \underset{(0.63)}{1.86}\,(\text{Punjab Dummy}) + \underset{(0.059)}{1.51}\,(\text{Sindh Dummy}) + \underset{(0.070)}{1.75}\,(\text{NWFP Dummy})$$

$$\underset{(0.143)}{1.83}\,(\text{Balochistan Dummy}) + \underset{(0.023)}{0.051}\,\ln(\text{Land Operated}) \quad \ldots \quad (4)$$

$R^2 = 0.90$; Std. errors in paranthesis.

Thus for the missing education values we used the predicted values from the above equation.

As explained above, we specifically differentiate between land owned and land operated. Land operated is defined as agricultural land (in acres) operated by the household; and it is calculated from the identity:

$$\text{Land Operated} = \text{Land Owned} + \text{Land Leased-In} - \text{Land Leased-Out} \quad \ldots \quad (5)$$

Land owned (in acres), on the other hand, corresponds to the agricultural land the household declares to own.

[7]The correlation between land holdings and education of the head has been consistently found in rural studies around the world. López and Valdés (2000), for example, offer several cases of this correlation from different Latin American countries.

Table 5

Regression Variables Summary Statistics, by Farm Category
(Means and Standard Deviation in Parenthesis)

		Farm Size in Acres			
	Landless	Small <4	Medium 4-20	Large >20	Total Sample
Revenues	67.267	141.002	358.382	727.903	339.181
(Normalised)	(83.60)	(433.02)	(767.94)	(1,427)	(1,427)
p1	2.441	1.983	2.986	2.573	2.564
	(0.454)	(1.271)	(17.279)	(2.334)	(11.435)
p2	9.987	8.008	26.392	13.075	17.069
	(19.417)	(21.031)	(339.974)	(29.313)	(224.403)
Household Size	7.295	8.435	9.114	10.780	9.078
	(3.627)	(4.604)	(4.611)	(5.866)	(4.891)
Capital (Value in 100's Rp.)	1.068	83.818	270.712	940.300	318.578
	(6.229)	(384.772)	(861.687)	(2,338.553)	(1,218.058)
Education of the Head	6.155	5.911	6.009	6.749	6.130
	(2.164)	(2.552)	(2.144)	(2.517)	(2.363)
Land Owned	0.000	0.981	4.732	41.815	10.174
(Acres)	(0.000)	(0.873)	(3.293)	(93.079)	(43.073)
Land Operated	0.000	1.423	5.674	37.224	9.855
	(0.000)	(1.123)	(3.453)	(90.315)	(41.282)
Canal Turns	0.662	33.954	47.967	150.435	59.208
	(3.851)	(188.952)	(241.065)	(753.714)	(379.343)
Informal Credit (100's Rp.)	2.443	9.051	22.079	114.211	33.862
	(16.678)	(54.342)	(123.249)	(1,388.138)	(607.019)
Observations	88	336	483	209	1116

Note: Authors' calculations from PIDE 2001 data. Note, this table is not *exactly* comparable to Table 2, because this table includes only observations included in the regressions.

Water corresponds to canal water usage. It was calculated in terms of canal water turns (hours). The variable measures total canal water used (total hours) per plot per agricultural season (rabi and kharif).

Credit, measured in 100's Rp. corresponds to the value of loans from informal sources (family, friends, village lender) used for purposes of the agricultural operation.

Net Revenues (Rp.) is the declared value of all the rents from the agricultural operation after discounting the cost of use of variable inputs and land. Thus, net revenues may be expressed as:

Net Revenues = Gross Revenues from Agricultural Output – Cost of Usage of Variable Inputs + Rents from Land Lease-Out Arrangements – Cost of Land Lease-In Arrangements … … … … … … (6)

The costs of variable inputs discounted are: hired labour, seeds, fertilisers (organic and chemical), pesticides, purchased tube-well water, and machinery and equipment rental.

5. ECONOMETRIC SPECIFICATION

To estimate the restricted revenue function, we choose a generalised quadratic specification. This flexible functional form does not impose any restriction on the underlying technology in terms of elasticities of substitution, and, in principle, all theoretical properties can be tested.[8] The revenue maximisation assumption does not impose restrictions on the underlying technologies; it implicitly assumes that the production possibilities are available to all farmers, and that they rationally adjust the output mix to maximise revenues, and hence returns to assets. The underlying restricted revenue function can be approximated linearly:

$$\tilde{R}(p;Z) = \sum_{i=1}^{3}\sum_{j=1}^{3}\beta_{ij}(p_i \cdot p_j) + \sum_{i=1}^{3}\sum_{k=1}^{6}\gamma_{ik}(p_i \cdot Z_k) + \sum_{k=1}^{6}\sum_{l=1}^{6}\delta_{kl}(Z_k \cdot Z_l) \quad \ldots \quad (7)$$

where indexes i and j refer to output prices $p \equiv$\{1. field crops, 2. livestock, and 3. other crops\} and indexes k, l refer to quasi fixed inputs $Z \equiv$\{1. Capital, 2. Education, 3. Household Size, 4. Land, 5. Water, and 6. Credit\}. To reduce the number of estimated parameters, we use the property of linear homogeneity in prices of the function and divide by the price of other crops:

$$\tilde{R}(p_1;p_2;Z) \equiv \tilde{R}(p;Z)/p_1 = \sum_{i=1}^{2}\sum_{j=1}^{2}\beta_{ij}(\tilde{p}_i \cdot \tilde{p}_j) + \sum_{i=1}^{2}\sum_{k=1}^{6}\gamma_{ik}(\tilde{p}_i \cdot Z_k)$$
$$+ \sum_{k=1}^{6}\sum_{l=1}^{6}\delta_{kl}(Z_k \cdot Z_l) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

where p_1 is the price of other crops, and $\tilde{p}_1$ and $\tilde{p}_2$ are price of field crops divided by price of other crops and price of livestock divided by price of other crops, respectively.[9] District dummies capture region-specific differences between farms, such as land fertility, climate and other unobservable farm characteristics correlated with the district in which the household lives. Additionally, we include type-of-tenancy dummies (i.e. owner operated, sharecropping tenant operated, etc.) to test for tenancy specific differences in revenues. The results of the estimated regression are presented in Table 6, and the implicit elasticities from this regression are presented in Table 7.

As an example of the process of calculating elasticities, consider the elasticity of the revenue function with respect to education:

$$\frac{\partial\tilde{R}(\square)}{\partial Z_2}\frac{Z_2}{\tilde{R}(\square)} \equiv \left(\hat{\gamma}_{12}\bar{p}_1 + \hat{\gamma}_{22}\bar{p}_2 + \hat{\delta}_{22}\bar{Z}_2 + \sum_{k=1}^{6}\hat{\delta}_{2k}\bar{Z}_k\right) \cdot \frac{\bar{Z}_2}{\hat{\bar{R}}(\square)} \quad \ldots \quad \ldots \quad (9)$$

[8]For more details on flexible functional forms see Diewert and Wales (1987), for more details on the theoretical properties of the revenue function see Chambers (1988). This functional form also has the advantage that it does not make logarithmic transformations that cannot be applied to variables with zeros like in our data set.

[9]We assume that price variability is the result of exogenous conditions (such as distance to markets) and not correlated with farm characteristics or product quality.

Table 6

Net Farm Revenue Regressions

Faisalabad District Dummy	911.953	296.536***
Attock District Dummy	127.294	274.423
Hafizabad District Dummy	479.423	267.350*
Vehari District Dummy	399.374	247.395
Muzafar Garh District Dummy	106.752	254.797
Bahawalpur District Dummy	89.888	243.989
Badin District Dummy	92.993	259.873
N. Shah District Dummy	–6.581	247.579
M. P. Khas District Dummy	189.806	242.024
Larkana District Dummy	104.409	251.371
Dir District Dummy	–12.319	253.987
Mardan District Dummy	–91.265	254.289
L. Marwat District Dummy	–6.192	261.175
Loralai District Dummy	–208.439	304.532
Khuzdar District Dummy	52.925	262.278
Gawadar District Dummy	–259.975	295.381
Owner Operated Farm	161.021	49.169***
Owner Operated Farm and Landowner	180.960	67.586***
Owner Operated and Tenant	65.525	66.985
Sharecropping Tenant	299.608	123.349**
Tenant with Fixed Rent Agreement	162.377	156.617
Female Headed Household	72.458	100.993
p1	–112.567	93.415
p1 x p1	9.610	3.264***
p1 x p2	–0.058	0.368
p1 x Capital Stock	0.111	0.052**
p1 x Education	24.721	11.991**
p1 x Household Size	0.994	5.315
p1 x Water	0.136	0.183
p1 x Credit	–0.635	0.426
p1 x Operated Land	1.832	1.929
p2	4.910	4.929
p2 x p2	–0.023	0.018
p2 x Capital Stock	–0.001	0.002
p2 x Education	0.937	0.519*
p2 x Household Size	–0.522	0.418

Continued—

Table 6—(*Continued*)

p2 x Water	1.867E-04	8.636E-03
p2 x Credit	0.023	0.018
p2 x Operated Land	0.215	0.113*
Capital Stock	–0.077	0.118
Household Size	17.743	19.806
Education	–84.131	35.211**
Land Owned	–6.980	4.664
Land Operated	0.719	7.936
Land Operated x Land Operated	0.003	0.039
Education x Education	0.065	0.798
Water	–0.625	0.638
Household Size x Household Size	–0.713	0.482
Land Owned x Land Owned	–0.006	0.040
Capital Stock x Capital Stock	–2.140E-05	1.110E-05*
Water x Water	–5.660E-05	3.130E-05*
Water x Capital Stock	–1.392E-04	1.170E-04
Water x Education	0.110	0.082
Water x Household Size	0.009	0.030
Education x Capital Stock	0.044	0.017***
Education x Household Size	3.098	1.955
Capital x Household Size	–0.019	0.006***
Credit	0.074	0.608
Credit x Credit	2.500E-05	7.520E-05
Credit x Capital Stock	3.160E-04	4.013E-04
Credit x Education	–0.014	0.144
Credit x Household Size	0.025	0.074
Credit x Water	–2.490E-05	2.896E-04
Land Operated x Capital Stock	3.593E-04	1.520E-03
Land Operated x Education	0.126	0.260
Land Operated x Household Size	0.229	0.373
Land Operated x Water	1.834E-04	1.098E-02
Land Operated x Credit	0.078	0.053
Sharecropping x Household Size	–27.769	19.418
Sharecropping x Land Operated	–31.732	20.134
Sharecropper x Water	0.511	0.276*

1115 Observations.
R^2=0.65.
Std. error reported are White's heteroscedasticity consistent.
*, **, *** Denotes parameter is significant at the 10, 5 and 1 percent level respectively.

Table 7

Elasticities of Household Farm Revenue with Respect to Quasi-fixed Factors

	Total Sample	Landless Workers	Small Farms (>0 – 4 Acres)	Medium Farms (>4 –20 Acres)	Large Farms (>20 Acres)
Capital	0.267***	0.220***	0.133**	0.345***	0.268*
	(0.104)	(0.089)	(0.055)	(0.139)	(0.151)
Education	0.814***	0.873*	0.242	1.124***	0.845***
	(0.236)	(0.458)	(0.225)	(0.331)	(0.250)
Own Labour	0.320	1.200***	0.716***	0.047	0.204
	(0.206)	(0.430)	(0.233)	(0.271)	(0.313)
Land (Owned)	–0.214	–0.247	–0.070	–0.123	–0.632
	(0.131)	(0.158)	(0.046)	(0.076)	(0.432)
Land(Operated)	0.325**	N/A	0.052	0.373***	1.135***
	(0.135)		(0.052)	(0.134)	(0.420)
Water	0.082**	N/A	0.071**	0.077**	0.110
	(0.036)		(0.033)	(0.036)	(0.219)
Credit (Informal)	–0.014	–0.018**	–0.036*	–0.042	0.204
	(0.080)	(0.008)	(0.021)	(0.165)	(0.139)

Note: Standard errors in parenthesis. * Implies significant at the 10 percent level, ** implies significant at the 5 percent level, and *** implies significance at the 1 percent level.

where the bar over the variable indicates sample means, and the $\hat{\gamma}_{ij}$ and $\hat{\delta}_{ij}$ are the regression estimated coefficients of Equation (8). If instead of sample means we use means by farm size, we can approximate the elasticities for the different farm groups.[10]

6. MAIN FINDINGS

The detailed results of estimating Equation (8) are presented in Table 6. In general, the results are satisfactory, with a reasonable fit considering the purely cross-sectional nature of the data (R^2 = 65 percent); and all the first order and second order theoretical curvature properties of a revenue function are met. Although, due to multicollinearity few individual coefficients are significant, the elasticities of the revenue function with respect to the quasi-fixed inputs are in general significant as reported in Table 7. Below the results are discussed in terms of individual factors of production.

[10]Furthermore, to test if the elasticity is significantly different from zero, we divide the elasticity by its standard error, which can be obtained by applying the variance operator to the random variable defined in (9), and is equal to the square root of:

$$V\left(\frac{\partial \ln \tilde{R}(\square)}{\partial \ln Z_2}\right) \equiv \left(\frac{\bar{Z}_2}{\bar{\tilde{R}}(\square)}\right)^2 \cdot \left(\begin{array}{l} \sum_{i=1}^{2} V(\hat{\gamma}_{i2})\bar{p}_i^2 + V(\hat{\delta}_{22})\bar{Z}_2^2 + \sum_{k=1}^{6} V(\hat{\delta}_{2k})\bar{Z}_k^2 + 2\sum_{i=1}^{2}\sum_{j \neq i} \bar{p}_i \bar{p}_j Cov(\hat{\gamma}_{i2}, \hat{\gamma}_{j2}) \\ + 2\sum_{i=1}^{2} \bar{p}_i \bar{Z}_2 Cov(\hat{\gamma}_{i2}, \hat{\delta}_{22}) + 2\sum_{i=1}^{2}\sum_{k=1}^{6} \bar{p}_i \bar{Z}_k Cov(\hat{\gamma}_{i2}, \hat{\delta}_{2k}) \end{array}\right)$$

Human Capital

Using the entire sample, we find that the input with the highest elasticity is human capital (education), with a value of 0.8.[11] This estimate implies that if the education level of the household head were to rise by 10 percent then overall net revenues would rise by about 8 percent. Using the average education level of 6.16 years (from Table 5), another year of education would represent an increase of approximately 16 percent in the education level, which would translate into a 13 percent increase in net revenues:

$$\%\Delta\tilde{R}(\cdot) = \%\Delta E \cdot \frac{d \ln \tilde{R}(\cdot)}{d \ln E}$$

$$\%\Delta\tilde{R}(\cdot) = 0.162 \cdot 0.814 \approx 0.13$$

In terms of present value, using a 10 percent discount rate (ρ), the benefit of an additional year of education would result in an increase in wealth that is 130 percent of yearly revenues:

$$PV = \sum_t \frac{0.13}{(1+\rho)^t} \approx \frac{0.13}{\rho} = \frac{0.13}{0.1} = 1.3.$$

More realistically, for younger generations, for which the opportunity cost of one more year of schooling is the foregone returns associated with family labour, this elasticity suggests notably high potential rates of returns in farming, perhaps even higher if they migrate to off-farm employment.

But it is notable that the elasticity with respect to education is much smaller for small farms (0.2), and greatest for medium sized farms (1.1). This suggests an important and positive interaction between human capital and operational scale. Constraints to enlarging farm size would be a bottleneck to improving farm-generated incomes via improvements in educational levels, which in turn would tend to reduce the demand by small farm households for education of their children. A factor that might counteract the negative effect of scale is the opportunity to obtain returns to better education levels in the generation of income from non-farm enterprises. Supporting this possibility is the much higher elasticity (0.9 in Table 7) of revenue with respect to education that is estimated for households with no operational land.

Farm Operation Size

The elasticity of operated farm size is increasing with farm size. Because net revenues account for the cost of the use of land (and hence the expected elasticity with respect to land in an efficiently working land market should be zero) the results suggest a greater deviation from the efficient allocation of land in the case of larger farms. The

[11] Hampering the precision of the estimates of returns to education, and for that matter the reliability of the education figures in Table 1, is the unsatisfactory level of response to the question of education of the household head in the survey, and the use of imputed values as explained above.

elasticity of revenues with respect to operational size for small farm is 0.05, while medium farms have an elasticity of 0.37 and large farms of 1.13. In a well-functioning market, *a priori* one would expect that increasing the farmer's and sharecropper's operational land by one acre (by leasing in) would increase income by its marginal value product and decrease income by its rental rate. It would not affect income directly attributable to farming—because the marginal product of land should equal the rental rate. Therefore, the measured elasticity should be zero, and that is what the elasticity estimate suggests for small farmers. This is gratifying result, implying that, on average, small farmers are rationally allocating land, given the levels of other variable and quasi-fixed inputs.

By contrast, the positive and higher elasticities for medium and larger farms suggest that for those farms the marginal benefits from scale expansion are higher than the observed marginal cost (the rental rate), and those farms should expand. Although we expect the net revenue elasticity with respect to operated land to be zero in a well-functioning land market, this does not imply that rental rates should be the same across farm sizes. Hypothetically, if small farmers were side by side with larger farmers, the higher elasticity of returns for larger farmers would provide an incentive for large farms to expand, bidding up rental rates and inducing a transfer of land from the small to the larger operations.

In areas where small and larger farmers are not side by side, the differences in elasticities by farm size could also be due to differences in output mix (and different marginal revenue curves with respect to land). If small farmers are concentrated in areas where their smaller size is more appropriate for the more profitable product mix (for example horticulture, being produced closer to towns), land transfers would be between small farmers and not between small and larger operations outside those areas. Land markets might be better developed in those areas where small farmers concentrate. The concentration of small farms in areas producing high-valued (per-acre) products would explain the differences in rental rates, but not the positive elasticities for larger farmers. In fact, average observed land rental rates per acre for small farms (15,400 rupees) are 2.2 times larger than rental rates for medium farms (4,800 rupees). Why might this be so?

Consistent both with large rental rate difference and with non-zero revenue-land elasticities is the hypothesis that land owners set rental rates for larger operations below those for smaller farmers, and below the larger renter's short-run marginal product. This would require a rationing of total land rented out at that lower rate. Land owners might ration land in this way in a similar manner as employers offer so-called efficiency wages, extracting renter loyalty and more efficient land and water use, and reducing supervision costs. Efficiency rental rates would also tend to induce a larger pool of potential renters from which to select, including tenants with more working capital.

In summary, there are two hypothesis (not necessarily exclusive) for these results regarding operation size: the first is that small farmers are geographically concentrated in areas with higher-valued products and well-functioning land markets; and the second is that landlords ration land to medium and large tenants.

Land Ownership

The marginal effect of owned land on household net revenues deriving from farm production and land rental (positive for land owners, negative for renters) appears to be negative although not statistically significant. This result, which might appear surprising at first given that the marginal value product of owned land ought to equal the rental rate, suggests that owning land (in contrast to the land input in farm production) has a value that is not fully accounted by the agricultural or rental income it generates. That is if land has a value beyond its employment as crop production input (say as an instrument for access to credit and markets, as a store of wealth, as a speculative investment, and as a source of social power), then agricultural revenues would not fully account the returns to land. Landowners would perceive a marginal utility associated with an additional owned acre that is greater than the marginal revenues it generates in cultivation or in the rental market.

But the possibility of renting out land should, in a perfectly working market, offer constant returns to scale in terms of net revenue generation. Logically, therefore, some constraints on land rental (in terms of the optimisation of the farm revenues we are measuring) must exist for the farmer simply not to rent out an additional acre at the rental rate. As in the case of the results for operational size above, these results for scale of ownership suggest some imperfections in the land rental market. The owner might not rent out due to a perceived risk of expropriation of land, and/or to the search costs of finding trustworthy renters. For medium and large farms, the estimates suggest that tenants would be willing to pay more than the observed rental rate, while land owners would be willing to accept less. Other benefits and costs are involved in the land market that are not fully reflected in the observed rental rates.[12]

Family Size

Both using all observations, and in the case of the specific estimates for medium and large farms, the effect on household revenue of family size is not statistically different from zero. To the extent that family size is a proxy for family labour employed in the farm operation, this result suggests that own labour is employed up to the point where marginal gross revenue is zero. But the reader should note that the absence of data on the quantities of family labour effectively employed in the farm operation is a major weakness. If family size is a good proxy for family labour employed in production, then the result suggests a near-zero opportunity cost of family labour in medium and large farms; but a much higher and significant opportunity cost in the case of small farms. More likely, however, for medium and large farms, family size is weakly correlated with family labour actually employed in farm production; while for smaller farms, family size is a better indicator of actual household agricultural labour.[13] An increase in the number

[12]Note that neither the elasticity of revenues with respect to owned land nor the elasticity with respect to operational land are measuring the marginal products of land in cultivation, as would be obtained from a production function. Using net revenues at the level of individual plot, another study by the World Bank (2002) based on a preliminary version of the same data set, found decreasing returns of land with respect to farm operational size.

[13]Furthermore, in the case of this Pakistani sample, family size is positively correlated with wealth and wealth with farm size. The dependency ratio (family dependents relative to family workers) will likely increase with family size. To the extent that family size is positively correlated with both children and aged grandparents (and other relatives), there would be a lower correlation between family size and the family labour effectively employed on the farm.

of family members for larger farms is perhaps directed to leisure or to non-farm-production work (activities with benefits not accounted in the net revenue measure used).

By contrast, in the case of small farms and landless households, the estimates of the household income elasticity with respect to family size (labour) are positive and significant. The effect of family labour is particularly high for the landless group. It is highly likely that such families have less opportunity of employing non-family labour and less income to afford leisure.[14]

Surface Water

Turning to the water input, the revenue elasticity with respect to surface water is increasing with farm size, although the estimates are significant only for small and medium sized farms. There is no out-of-pocket expense to the use of surface water, and farmers are endowed with a given number of canal turns per week, which depends on farm size. Therefore the positive and significant elasticities for small and medium size farms can be directly interpreted as reflecting the marginal value of relaxing the constraint to canal water use. This result supports the idea that larger farms face less constraint to water use; and it could be socially efficient to induce transactions that result in water transfers from larger farms to smaller. More developed water markets would facilitate such transactions. A working water market would also provide incentives for water saving measures and make more likely the private investments necessary to improve a deteriorating irrigation infrastructure, and water quality as previously reported in the literature [cf. Ali and Byerlee (2000) and World Bank (1997)].

Credit

In Pakistan, previous authors have noted that small farmers have limited access to institutional credit, relying on non-institutional sources; larger operations are more favoured by formal credit lenders [Malik (2003)]. Farmers who are poorer and small rely primarily on informal credit markets. As shown in Table 7, the elasticity with respect to informal credit is insignificantly different from zero for the entire sample and negative (and statistically significant) for small farms. The cost of credit is not explicitly accounted for in the net revenue measure, but to the extent that informal credit costs are reflected in purchased input costs, the low elasticity of informal credit to recipients implies less significant constraints to credit use. At the margin, farmers on average have adjusted informal credit use such that the addition to gross revenues from an increase in informal credit is offset by the addition to the costs of variable purchased inputs. Therefore, an increase in informal credit would produce little in terms of additional net revenues, and one would expect an elasticity of zero. In the case of small farmers, the negative and statistically significant elasticity may imply over-borrowing, with negative impacts on production value, which is difficult to justify. More likely, the result reflects reverse causality in the credit variable, where *ceteris paribus* less productive farmers have less access to formal credit and substitute for informal credit. The direction of causality may run from low production revenues to borrowing in informal markets.

[14]The higher correlation of family size with agricultural labour of small farm households could be partially explained by lack of transport and communication facilities to find and travel to part-time jobs beyond their immediate vicinity.

In Table 8 we compare this base result using informal credit to estimates using both formal credit alone and the sum of formal and informal credit. One should note first that the estimated elasticities for the other inputs, using the alternative indicators of credit use, are not statistically different from the base case estimates, which indicates some overall robustness in the estimated elasticities. The elasticity with respect to formal credit is not statistically significant, but using the total credit available yields a positive and statistically significant elasticity (0.059). It is worth noting that formal credit is a larger source of funding of agricultural borrowing, as indicated in Table 1. The insignificance of the two estimated elasticities (for the entire sample) of both informal credit alone (negative) and formal credit alone (positive), and the positive and statistically significant estimate using the sum of two sources, suggests that the two credit types are substitutes.

Table 8

Return on Credit (Elasticities)

	Base Case Informal Credit	Formal Credit	Informal + Formal Credit
Capital	0.267***	0.198*	0.207**
	(0.104)	(0.105)	(0.105)
Education	0.814***	0.831***	0.777***
	(0.236)	(0.224)	(0.219)
Own Labour	0.320	0.271	0.247
	(0.206)	(0.192)	(0.195)
Land	–0.214*	–0.290*	–0.282*
(Owned)	(0.131)	(0.149)	(0.148)
Land	0.325**	0.334**	0.340**
(Operated)	(0.135)	(0.140)	(0.139)
Water	0.082**	0.091***	0.095***
	(0.036)	(0.036)	(0.037)
Credit	–0.014	0.031	0.059**
	(0.080)	(0.046)	(0.026)

Note: Standard errors in parenthesis. * Implies significant at the 10 percent level, ** implies significant at the 5 percent level, and *** implies significance at the 1 percent level.
None of the elasticities are different from their base case values at the 10 percent significance level.

We should emphasise, however, that these results reflect an average for farmers of all sizes, and smaller farmers receive a small share of formal credit. Small farmers apparently enjoy on average little gain to a marginal increase in informal credit, but informal credit is usually more expensive; so this evidence does not contradict the possibility that small farmers might benefit from greater access to formal credit, which is usually offered at lower interest rates. Khandker and Faruqee (2000) have shown that in spite of the fact that the recovery rate of loans is much higher for small farmers, the lending of the largest institutional lender, the Agricultural Development Bank of Pakistan ADBP, is highly biased towards larger farms.

Other Results

Contrary to what was expected, there are few statistically significant interactions between output prices and factor returns. Perhaps the only strong interaction we find is between the relative prices of output and education. An increase in the prices of field crops and livestock, relative to the price of other crops, would increase the elasticity of net revenues with respect to education. A deeper interpretation of this result in a cross-section analysis is problematic, because it depends on the mix of "other crops," and also could be a result of the distribution of prices across regions. In any case, this is a noteworthy result deserving more attention in future research. We also find that the elasticity with respect to capital increases with the price of field crops and decreases with the price of other crops. To the extent that present policies offer protection to field crops relative to other crops, farmers have an increased incentive to invest, most likely in the protected activities. Field crops are usually more intensive in the use of physical capital.

The Effects of Tenancy Type

The coefficients on the dummy variables representing different tenancy types are all positive, implying greater revenues due to access to agricultural land compared to those without operational farmland (some landless). We find, that, controlling for farm size, education and the other variables, landlords who are also tenants leasing in, and fixed rental tenants earn more revenues than sharecropping tenants, who earn only slightly more (6,365 rupees) than those without operational farmland.[15] For a small farmer, controlling for all other variables in the revenue function, simply being a fixed-rent tenant raises per-acre revenues by 35,000 rupees (75 percent of an average small farm's total farm income, or 49 percent of the household's total income).

Does this imply that sharecropping is an inefficient contract compared to fixed rental? Possible inefficiencies associated with sharecropping arise due to the sub-optimal provision of hidden or non-contractible inputs (not subject to monitoring by the landlord).[16] The incentive to under-provide variable inputs arises because the sharecropper only earns a fraction of the marginal value product of the operation. Where monitoring of input use by landowners is effective, one would not expect under-provision. In our study possible "hidden" inputs (or hard to monitor) are own family labour (measured by family size) and surface water use. We find that this type of inefficiency exists in the provision of surface water as indicated by the positive coefficient on the interaction of sharecropper dummy with water. Since the marginal returns of canal water are greater for sharecropper tenants, this implies that there is an effective under-provision of this input. The marginal product of an additional unit of surface water is, *ceteris paribus*, greater for the sharecropper than for other tenancy types.

[15]The marginal effect on revenues of being a sharecropper (relative to those without operational farmland) is a function of several coefficients, and is calculated using the average values of sharecroppers for household size, operational farm size and hours of water use: (299.6) + 8.51*(–27.77) + 2*(–31.73) + 56*(0.51) = 13.3 (with estimated coefficients in parenthesis). To get the value in Rupees we multiply by the mean price of "other crops" yielding 13.3* 480 = 6,365 Rp.

[16]In a longer version of this paper, available from the authors, we provide a theoretical discussion of the efficiency of sharecropping contracts.

In addition to this short-term inefficiency, there are also longer-term considerations. Land leasing arrangements as they prevail in Pakistan apparently do not provide land tenancy security or a mechanism to foment longer-term investments by the tenant. Such investments might be in soil-improvement, land leveling, fixed structures and orchards, and water-saving projects. All of these are projects that provide longer-term benefits but over which the tenant (sharecropper or fixed rent) has no ownership rights.

7. CONCLUSIONS

Perhaps the most important result we found in this study is that land markets are not working efficiently in rural Pakistan. This result was consistently found not only in the regressions presented, but in all the statistical analysis that led to those results. Are our conclusions mis-guided by the fact that land decisions are endogenous? We do not believe so, because in the short term, land tenure (owned, rented or sharecropped) is fixed, i.e. for the agricultural season. Land holdings adjust in the medium term, while variable inputs (labour, fertiliser, capital equipment rental, etc.) are adjusted in the short term. Obviously, the fact that land resources may not be used to their full potential has enormous consequences for rural income, and thus for poverty in Pakistan. However, our results create a number of questions that we unfortunately cannot answer and should guide future research. Is there a problem of fragmentation between small land plots markets and large farms? Does land have important non-pecuniary value? Are there relevant search costs involved in the leasing process or is the threat of land reform/expropriation blocking land transactions?

In the case of surface water use, we found that medium and small farm show a higher productivity of water than large farms. This result is encouraging, because it provides empirical foundations for the proposition that creating a surface water market would improve farm revenues.

A comparison of sharecroppers and other tenancy types yields interesting insights. Controlling for farm size, education and other variables, land owner-operators, landlords who are also tenants leasing in, and fixed rental tenants earn more revenues than sharecropping tenants, who in turn earn only slightly more than those without operational farmland. Finally, with respect to efficiency losses of sharecropping contracts, we find that this hypothesis does not hold with respect to own (family) labour as is usually assumed, but applies to the use of surface water. Sharecroppers are slightly less efficient in the use of that resource compared to other tenancy-type farmers. Of course, other longer-term inefficiencies associated to sharecropping contracts, like the lack of incentives to implement resource (soil and water) enhancing investments are not captured in our short-run analysis.

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