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ACCESS TO CAPITAL, AGRARIAN CLASSES, AND RESOURCE ALLOCATION: THE PUNJAB, 1933-36

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Access to Capital, Agrarian Classes, and Resource Allocation: The Punjab, 1933-36[1]

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Abstract: In recent work Eswaran and Kotwal (1986) have shown how, in agrarian economies, patterns of organization and resource-use can be explained in terms of differences in access to capital and supervision costs. This paper generalizes the model to incorporate family size and applies it in the context of colonial Punjab, using data on 144 households over the years 1933-36.

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Introduction

How is production organized in poor agrarian economies? Do different forms of organization (say, the "family farm" versus "capitalist farming") lead to different patterns of resource use? These questions have been discussed at great length in many different contexts, ranging from the turn-of-the century Russia to colonial India. In this context, in recent work, Eswaran and Kotwal (1986, also Feder (1985)) have presented the following simple and intuitively appealing argument. Production organization and resource-use are determined by the interaction of two factors: Differences (by wealth status) in access to capital and the extent of difficulty in monitoring hired labor. Thus far there has been little empirical application of this model[1].In this paper I use the Eswaran-Kotwal model to understand the patterns in production organization and resource-use in the Punjab, 1933-36.

As in many other settings, there is, in the context of agrarian colonial Punjab, disagreement between scholars regarding how production was organized. Followers of Chayanov identify the basic unit of organization to be the "family farm." They argue that the scale of production depends primarily on the size of the family, and the household tries to avoid involvement in the labor market, either as buyer or seller. On the other hand, Marxist scholars typically emphasize the growth of "capitalist farming," with a relatively small group of rich farmers employing the relatively large numbers of landless or near-landless workers[2]. The Eswaran-Kotwal framework provides a general approach which explains why production may be organized differently in different settings.

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[1]Except for Carter and Wiebe (1990). An earlier application of a similar model (that of Roemer 1982) is Bardhan (1982).

[2]The Chayanovian perspective is represented in this literature by the work of Kessinger (1975), whereas the work of Bhattacharya (1983, 1986), Hamid (1982) and Mukherjee (1980) is closer to the Marxist perspective. Mukherjee argues that as more and more land passed into the hands of wealthy households, they chose to lease it to small tenants-at-will and charge high rents. Thus, according to her, the colonial period saw the growth of "landlordism." Bhattacharya argues that in focussing on the family farm Kessinger has identified only <u>one</u> category of farmer; he has ignored the small peasant who hired out part of his labor, and the richer peasants, who hired in labor.

The model gives us a framework in which there are several different "classes." It starts from the premise that the household's access to funds depends on its wealth, since loans are obtained only against collateral[3]. A very poor household ("small peasant"), which has few assets to provide as collateral, will not be able to raise enough funds, and will have a very small farm. It will have to hire out some of its labor[4]. At the other end of the spectrum ("large capitalists"), very wealthy households would have no difficulty obtaining funds (they are not credit-constrained, since they have plenty of collateral). They would operate relatively large farms, hiring in labor. The scale of their operation would be limited not by the availability of funds, but by the difficulties associated with supervising hired labor. In between these two extremes we would have the "family farmer," who is rationed in the credit market and neither hires in nor hires out labor, and the "small capitalist" who is rationed in the credit market and hires in labor. Thus, the interaction of credit constraints and supervision costs determines the way production is organized. Holding other things constant, the poorest households will be "small peasants," and, as wealth increases, the households move into the categories of "family farmer," "small capitalist," and "large capitalist," respectively.

The allocation of households across these categories will depend on the distribution of wealth in the economy. In a world in which wealth was very evenly distributed, we might see mainly "family farms." On the other hand, with a very skewed distribution of wealth, many households would fall into the "small peasant" category. Thus, the model can generate either the "family

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[3]This is because the lender is concerned about the possibility of default. The use of collateral is very common in South Asian agriculture. See Binswanger and Rosenzweig (1986), and, in the context of colonial Punjab, Bhattacharya (1986).

[4] It should be noted that in this model leasing land is treated as the same as purchasing any other input (say, fertilizer). The working capital constraint (wealthier households, which have more collateral, have better access to funds) limits not only the amount that can be spent on various purchased inputs, but also the amount of land that can be leased in. In South Asian agriculture landless laborers are rarely tenants. Typically, only landed households can lease in land (Bliss and Stern 1982).

farm" model as well as the other patterns discussed above.

Finally, the model predicts that the labor intensity of cultivation will vary across different categories of farmers, and also within different categories, as wealth and family size change. This is a consequence of the fact that the relative price of labor (including supervision costs) and non-labor inputs (including the shadow price of capital) depends on the wealth of the household and the size of the family. Thus, the model generates predictions regarding how production is organized as well as how resources are used.

The remainder of this paper is organized as follows. The first section presents a modified version of the Eswaran-Kotwal model. The two most important changes are the incorporation of family size and inclusion of a category of households ("large capitalist") which are not rationed in the credit market. The second section describes the data. The third section takes the model to the data and discusses the findings. The fourth and final section summarizes and concludes.

The Model

Notation:

A = Household wealth.

M = Number of working adults in the family. Each possesses one unit of labor.

X = Total amount of family labor supplied on and off the farm.

f = Total amount of family labor used on the farm.

H = Hired labor used on the farm.

K = Non-labor inputs (including land) used on the farm. I treat these as one composite input.

P = Price of non-labor inputs.

Y = Family Income.

i = rate of interest.

W = wage rate.

Assumptions

1. The production function $F(K,L)$ is CRS and strictly quasiconcave. I also assume that $F(0,L) = 0$, $F(K,0) = 0$.

2. The utility function $U(Y, M, X) = Y/M - dX/M$, where "d" is the disutility of a unit of labor. This utility function can be interpreted as: "Family utility equals per capita income minus per capita disutility of labor." I am making the strong assumption here that family size is exogenous. This is because the supervision problem is meaningful only if the family cannot costlessly vary its size according to its labor requirements. If the size of the family could be perfectly adjusted according to its labor requirements the monitoring problem could be eliminated, since all tasks which are difficult to monitor could be assigned to family members, rather than hired labor. I address the question of possible endogeneity of family size when I present the empirical results.

3. I assume that $W > d$, so that all the family labor which is not used on the family's own farm is hired out.

4. Each family faces an upper limit on the amount of capital that it can borrow. This is given by a function $G(A)$, $G'(A) > 0$. The maximum amount that can be borrowed by the household is an increasing function of its wealth.

5. Hired labor needs to be monitored. This monitoring may be undertaken by family members or by reliable hired workers. The cost of monitoring is the wage paid to the supervisor or the opportunity cost of family time spent on supervision. The total cost of an hour of hired labor is the wage paid for it plus the cost of monitoring. I assume that the cost of monitoring depends on the ratio of family to hired labor. The greater the ratio of hired to family labor, the higher the cost of monitoring each hired worker[5]. Also, as the ratio of hired to family labor increases, monitoring costs increase at an

[5] If most of the labor is provided by the family, the hired labor will need little explicit monitoring, since family members will watch the hired laborer who is working alongside. On the other hand, if most of the labor is hired, supervision may be necessary.

increasing rate. This assumption ensures that the farm is of finite size[6]. Thus, the total cost of hiring a unit of labor is $W(H/f) = W + s(H/f)$, where "s" is the supervision cost. I assume that $s(0) = 0$, $s' > 0$, $s'' > 0$, $s'(0) = 0$. These restrictions would be satisfied by a supervision cost function of the form $s(H/f) = a(H/f) + b(H/f)^2$, $a > 0$, $b > 0$.

The Household's Decision Problem

The household decides how much labor to hire in or out and how much of non-labor inputs to use, given the constraints on the availability of capital and family labor. The decision-problem of the household can be written as below.

$$\max_{K,\, f,\, H} \quad F(K,\ f + H) - W(H/f)H(1+i) - PK(1+i) + W(M - f)$$

$$\text{s.t} \quad G(A) - PK - W(H/f)H \geq 0$$

$$M - f \geq 0$$

$$K,\ f,\ H \geq 0$$

The first term in the objective function is the value of the output produced on the farm (assuming that its price is one). The second and third terms are the cost of hiring labor (including supervision costs) and the cost of purchasing the other inputs, respectively (including the cost of borrowing money for these purposes). The last term is the household's wage income. The first constraint states that the total expenditure on hiring labor (including the wages paid to supervisory workers) and purchasing the other inputs must be less than or equal to the maximum amount of funds available. The second constraint is on the availability of family labor.

[6]Eswaran and Kotwal (1986) make a similar assumption with the same justification.

Forms of production organization

Let us consider the different forms of organization that emerge from this framework. Under our assumptions on the production function all cultivators use positive amounts of labor and other inputs. Further, I assume that the households which are not rationed in the capital market do find it worthwhile to hire labor[7]. Finally, since hired labor is more costly than family labor, any family which hires labor must be using all of its own labor. We are then left with the following possibilities:[8]

Form of Organization	Capital Constraint	Hired Labor	Family Labor Constraint
Large Capitalist	Not Binding	+	Binding
Small Capitalist	Binding	+	Binding
Family Farm	Binding	0	Binding
Small Peasant	Binding	0	Not Binding

These cases can be understood as follows. The Large Capitalist is not constrained in the capital market. The size of the enterprise is ultimately constrained by the size of the family. He does not want to expand the size of his enterprise any further because it will become too costly to supervise labor, since the ratio of hired to family labor will become too high. The Small Capitalist also hires labor. However, given the marginal

[8] To assume otherwise would imply that no hired labor is used at all in this economy.

[9] Formal analysis of these cases and the comparative static propositions discussed in the remainder of this paper are available from the author upon request.

cost of hiring labor and the price of other inputs he would like to borrow more, and increase the scale of production, but is rationed in the capital market. The family farm household cannot borrow enough capital to obtain enough complementary inputs for it to be worth hiring labor. It puts all the capital it can borrow into the inputs other than labor, and uses all the family labor on the farm. The small peasant household has so little capital (in relation to family size), that even after it puts all the capital it can borrow into other inputs, it is not worth using all the family labor on the farm. Family labor on the household's own farm is used up to the point where its marginal product equals the wage rate W. The remainder finds employment as hired labor.

Comparative Static Propositions

We need three sets of results here before we can turn to the data. First, we need to see how changes in wealth and family size lead to transitions across regimes. Second, we need to compare resource-use (labor intensity and the use of hired labor) across regimes. Finally, we need to look at variation in resource-use (in response to changes in wealth and family size) within regimes. These results are presented below. In the results stated below M_i and A_i are, respectively, the number of working members in family "i" and its wealth. These results are summarized in figures 1 and 2.

Proposition 1 Suppose family 1 is in the small peasant regime, family 2 is in the family farm regime, family 3 is in the small capitalist regime and family 4 is in the large capitalist regime. If $M_1 = M_2 = M_3 = M_4$, then $A_4 > A_3 > A_2 > A_1$.

Proposition 1 is along the lines of Proposition 1 of Eswaran and Kotwal (1986). If the family is very poor (A is small), and hence has very limited access to capital, it will put all the money it can borrow into non-labor inputs and it may still not be worthwhile using all the family labor on the farm. This is the case for the small peasant household. For larger values

of A, more capital can be borrowed. Since family labor is being combined with more complementary non-labor inputs, it may be worthwhile using all the family labor on the farm. This is the family farm case. For even larger values of A it may be worth hiring labor. It will no longer be optimal to put all the borrowed capital into non-labor inputs. This is the small capitalist case. Finally, beyond some level of A the maximum amount that can be borrowed is sufficiently large, so that the capital constraint does not bind. This is the large capitalist case. Along similar lines we have Proposition 2.

Proposition 2 Suppose family 1 is in the small peasant regime, family 2 is in the family farm regime, family 3 is in the small capitalist regime and family 4 is in the large capitalist regime. If $A_1 = A_2 = A_3 = A_4$, then $M_1 > M_2 > M_3 > M_4$.

Proposition 3 Suppose family 1 is in the small peasant regime, family 2 is in the family farm regime, family 3 is in the small capitalist regime, and family 4 is in the large capitalist regime. Then, if l is the labor/other inputs ratio, $l_1 > l_2 > l_3 > l_4$.

The results follow from differences in the relative price of labor (including supervision costs) and non-labor inputs (including the shadow price of capital) for these classes.

Proposition 4

(a) In the small peasant and large capitalist regimes, changes in family size and wealth have no impact on the labor/other inputs ratio.

(b) In the family farm and small capitalist regimes the labor/other inputs ratio is increasing in family size and decreasing in wealth.

Proposition 4 can be understood as follows. The small peasant household, for which the family labor constraint does not bind, uses labor up to the point where the marginal product of labor equals the wage rate. Under our assumptions on the production function a fixed marginal product of labor

implies a fixed labor intensity. Thus, labor intensity will not vary with wealth or family size. The large capitalist household is not rationed in the capital market. It will always use non-labor inputs up to the point where the marginal product equals $P(1 + i)$. Again, this implies a fixed labor intensity. Thus, labor intensity will not vary with wealth or family size.

The family farm uses all its family labor and puts all the capital that it can borrow into non-labor inputs. If family size increases, the ratio of labor to non-labor inputs must rise. On the other hand if wealth increases more capital can be borrowed. Since all of this is put into non-labor inputs (by definition, the family farm does not hire in labor) the amount of non-labor inputs will increase and the labor intensity will fall. In the small capitalist regime, when wealth increases, the scale of production increases because of the increased availability of capital. Labor intensity declines because of the increasing marginal cost of hired labor. On the other hand, when family size increases the marginal cost of hired labor decreases (because of lower monitoring costs) and labor intensity increases.

Proposition 5 (a) The ratio of hired labor to family labor is zero in the small peasant and family farm regimes and is highest in the large capitalist regimes.

(b) The ratio of hired labor to family labor decreases with family size and increases with wealth in the small capitalist regime and is constant in the other three regimes.

These comparative static propositions are summarized in figures 1 and 2. We can now turn to the empirical evidence, beginning with a description of the data source.

The Data

The data are from the Report on the Cost of Production of Crops in the Principal Sugarcane and Cotton Producing Tracts in India, published by the Imperial Council of Agricultural Research in Delhi in 1938. The report was a product of a study specially commissioned by the Indian Sugarcane Committee

and the Indian Cotton Committee, the top decision-making bodies in the sugarcane and cotton industries, respectively. The study focussed on regions in which cotton and sugarcane were grown, but collected data for all crops. Data were collected for eight households each in six villages each in three districts (counties) of Punjab (Lyallpur, Jullunder, and Gurdaspur), over the years 1933-34, 1934-35, 1935-36. Thus, we have data for each of 144 households, over a period of 3 years, for a total of 432 observations[9].

Summary statistics for the main variables of interest are presented in table 1. As can be seen mean land owned is 20 acres, mean cropped area (gross) is 25.47 acres, on average each holding has 2.58 adult family working men, and uses 32 days of human labor per acre, and 11.77 days of bullock labor per acre. The ratio of hired to family labor shows huge variation, ranging from 0.09 at the tenth percentile to 1.87 at the 90th percentile.

Empirical Testing

As figures 1 and 2, indicate, the relationships between resource-use and wealth or family size are different across different regimes. Since we do not know when the transition occurs from one regime to the other, we will need to employ a switching regression technique in which the switch point is also estimated. Such models are notoriously difficult to work with, especially with multiple regimes, and, given the small number of observations, it may be better to work with simpler specifications. I rely on the use of interaction and squared terms in the estimated equations to reflect the variations in behavior across regimes.

If we look at the relationship between wealth and family size and the ratio of hired to family labor in figures 1 and 2, it is clear that the impact of wealth depends on which regime the household is in. For small families, which are in the large capitalist regime, an increase in wealth will

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[9] The ICAR's sample excludes very small farms. For example, none of the households included in Jullunder has a gross cropped area of less than five acres, and none of the households included in the other two districts has a gross cropped area of less than 10 acres. In terms of our model, it is very likely that the small peasant regime has been underrepresented. A more detailed discussion of this issue is in Swamy (1993).

not have any impact on the ratio of hired to family labor. When the family size increases, and the household enters the small capitalist regime, the ratio of hired to family labor increases with wealth. We might therefore expect the coefficient on wealth to be positive. For further increases in family size, the household enters the family farm and small peasant regimes and wealth again has no effect. Thus, while we know that we should have an interaction term in the equation, the theory does not tell us what the expected sign should be. We might expect the squared term for wealth to enter with a negative sign. This is because, beyond a point, the use of hired labor will not increase with wealth, once the household does not face any constraints in the capital market (large capitalist regime). The model also predicts that the ratio of hired to family labor decreases with family size in the small capitalist regime, and the decline tapers off as family size increases further, and household ceases to hire labor (family farm and small peasant regimes). We might, therefore expect the linear term in family size to enter negatively and the squared term to enter positively, reflecting the fact that the impact of family labor tapers off.

Table 2a reports the results of a test of the predictions of the model regarding the impact of wealth and family size on the ratio of hired to family labor. Our measure of wealth is the amount of land owned by the household, and our measure of family labor availability is the number of adult male family workers. The OLS results indicate that when the household owns an extra acre of land, the ratio of hired to family labor increases by 0.08. The amount of increase is reduced by 0.01 for each additional adult working male in the family (the interaction term enters negatively). As predicted by the model, the square of land owned enters negatively, consistent with the argument that the effect of wealth tapers off as the household enters the large capitalist regime. One extra male in the family leads to a decline of 0.72 units in the ratio of hired to family labor. The decline is more negative by 0.014 for each additional unit of land owned (the negative interaction term). Finally, the squared term for family size enters positively, which is

consistent with the idea that once family size rises beyond a point, the household is relying almost exclusively on family labor (small peasant and family farm regimes) so that further increases in family size have no impact on the hired labor/family labor ratio.

We need to, however, address the possibility that we are ignoring other relevant household-specific variables such as (say) managerial skills, which do belong in the equation. Since we have three years of data for each household, for a given household the error term for each of the three years will include the contribution of the omitted household characteristic. Thus, the error term for a given household will be correlated (across years). The appropriate specification in this case is to use generalized least squares (random effects); the left and right-hand side variables are pre-multiplied by a matrix so that with the transformed equation the error term no longer exhibits this within household correlation. In order to choose between OLS and random effects I use the Breusch-Pagan test. The null hypothesis is that error terms for each household are not correlated; high values of the Chi-squared statistic reject the null and favor random effects. The Breusch-Pagan test (reported at the bottom of table 2a) rejects OLS in favor of GLS. However, the GLS results are quite similar to the OLS results.

There still remains the issue of possible correlation between the unobserved variables and our explanatory variables, leading to bias in both the OLS and the GLS estimates. For example, land owned and family size may be correlated with unobserved managerial ability. It could be that (say) families which have more managerial ability choose to have larger farms and therefore use more hired labor and buy more land. Given that we have panel data, we would typically address this problem by introducing a dummy variable for each household on order to pick up its unobserved characteristics (the fixed effects approach). We would then choose between GLS and fixed effects using the Hausman test. The null hypothesis for the Hausman test is that the unobserved variable is uncorrelated with our regressors. A high value for the Chi-squared statistic which we compute for this test would lead us to reject

the null and favor the fixed effects approach.

In our context, we need to be cautious when we use the fixed effects approach, because of the fact that our specification has been chosen to reflect the differences in the behavior of households when they are in different regimes. So, for example, we have a linear term and a squared term for family size because we expect that the ratio of hired to family labor decreases in the small capitalist regime and that the effect tapers off as the family grows larger and enters the family farm and small peasant regimes. When we use fixed effects, the dependent and explanatory variables have been transformed. They are now the deviations from the household mean. Thus, we are now focussing entirely on variation <u>within</u> households (across the three years), rather than variation across households. The typical household will remain in the same regime over the three years, since there is very little variation in family size over such a small periods. For example, when a household which is in the small peasant regime grows by one unit it may continue to be in the small peasant regime. In this regime the model predicts a coefficient of zero for family size and the square of family size. On the other hand, if the household was in the small capitalist regime we might expect a negative coefficient for family size. If we lump together all these households and run a fixed effects regression the model does not tell use what to expect, when we include squared and interaction terms. It would be appropriate to use the fixed effects approach with our specification involving squared and interaction terms only if we had a much longer panel (more time periods) so that there was enough variation within each household, so that it made transitions across regimes.

The question of omitted variable bias is, however, extremely important, and needs to be addressed. The approach taken in this paper is to estimace a simple linear relationship between our dependent and explanatory variables using the fixed effects and random effects approaches. If we look at figure 2 we see that family size would enter negatively in the small capitalist regime and have no impact in the other regimes. A fixed effects

regression for the sample as a whole should give us a negative coefficient for family size. We then compare the GLS and fixed effects estimates of the linear relationship using the Hausman test to look for evidence of correlation between our regressors and the unobserved household-specific attribute.

Table 2(b) presents results of a comparison of GLS and fixed effects using the Hausman test. The chi-squared statistic obtained is very small, suggesting that the GLS results for the impact of family size are reliable. Unfortunately, since there is no variation in the amount of land owned within households across the three years of the sample, we cannot compute the fixed effects estimates for the impact of the amount of land owned or test for the correlation of land owned with unobserved household characteristics.

The strongest indication that labor and capital market imperfections are present is evidence of resource misallocation. Our model of labor and capital market imperfections suggests that labor intensity increases with family size and decreases with wealth in the small capitalist and family farm regimes. I now turn to testing this prediction.

One difficulty which presents itself when we test this prediction is that the supervision problem is absent (or is relatively small) for some agricultural operations and not for others. For example, harvesting is a task which is often performed for a piece-rate (the worker gets a fraction of the output which he harvests). There is no real need for supervision. On the other hand, operations which involve the use of farm animals (plowing, for example) are typically more sensitive and are performed by family members or by more trusted workers. In part this is because proper care of the animals is very important (Bardhan 1984, Bliss and Stern 1982). Therefore, ideally, we would like to have data on labor use for different tasks. The data available are only for total labor use and bullock labor use. Since a man always works with the bullocks if supervision is a problem for these operations we would expect the predictions of the model to hold for the intensity of bullock labor use. I therefore test the predictions of the model regarding the labor intensity of

cultivation using two different dependent variables, (human) labor use per acre, and bullock labor use per acre.

Tables 3a analyzes the variation in bullock labor use per acre. Our model predicts that bullock labor use per acre decreases with wealth and increases with family size in the family farm and small capitalist regimes. Again, the results of the Breusch-Pagan test favor GLS. The GLS results indicate that a one acre increase in the amount of land owned leads to a decrease of 0.23 units in bullock labor use per acre. The impact tapers off at higher levels. This is consistent with our model because when wealth increases beyond a point the household is no longer constrained in the capital market (the large capitalist regime) and further increases in wealth have no impact on resource-use. When the number of adult working men in the family increases by one unit, the number of days of bullock labor per acre increases by 1.85 units. Again, the effect tapers off at higher levels. This is consistent with the view that once household size increases to the point where the household hires out labor (the small peasant regime), further increases in family size have no impact on resource-use.

The problem of omitted variable bias is potentially very serious in this context. For instance, our estimates could be biased because of the omission of land quality or bullock quality. Larger families may have more fertile land, which warrants use of more bullock labor per acre. As I have earlier argued, however, given that we have a short panel, it is not appropriate to implement a fixed effects regression with the squared and interaction terms included, since we do not expect a given household to be making transitions across regimes. Therefore, as before, I estimate a simple linear relationship. I expect that family size should enter positively when I run fixed effects across the sample as whole.

A comparison of the fixed and random effects results (table 4b) via the Hausman test gives us a Chi-squared statistic of 2.27, which is well short of the 3.84, which is the value required for us to reject the null of no correlation at the 5% level. The results suggest that our GLS estimates (for

family size) are reliable. As we have seen above, at smaller levels of family size bullock labor use per acre increases strongly with family size. This result is consistent with our model but not with a model of perfect markets.

Tables 4a and 4b examine the impact of wealth and family size on human labor use per acre. Again, the results of the Breusch-Pagan test favor GLS. In the GLS estimates one extra adult male worker is associated with an extra 3.96 days of human labor use per acre, with the effect tapering off at higher levels. Wealth has a negative impact; one extra acre of land owned is associated with a decrease of 0.37 days of labor per acre. Again, the effect tapers off at higher levels. As before, we need to be concerned about the impact of omitted variables. Table 4b reports results of the Hausman test. These results strongly reject the GLS specification in favor of fixed effects. In the fixed effects estimates family size enters negatively, though this effect is not statistically significant. This does not provide any support for our model[10]. The fact that family size positively impacts bullock labor use but not the use of total human labor is consistent with the view that the monitoring problem may be mainly relevant for tasks involving the use of bullocks.

Summary and Conclusion

Our model of capital constraints and supervision costs is broadly consistent with the observed patterns in production organization and resource-use. Wealthier households rely more on hired labor, and use less bullock labor per acre. Further, as the model predicts, beyond a certain level wealth ceases to have any impact. It is true, however, that, our estimates of the impact of land owned could be biased due to correlation with unobserved household-specific attributes. Our results regarding the impact of changes in family size are more robust. Increases in family size are associated with less reliance on hired labor and greater use of bullock labor per acre. Again, as our model suggests, the effect tapers off at higher levels. Thus, as I argued

[10] Our results regarding the impact of family size on labor use per acre echo those of Benjamin (1991), who concluded, using data from Indonesia, that family size did not have any impact on labor demand.

at the outset, our version of the Eswaran-Kotwal model, in which production activity is constrained by access to capital for poorer households and by supervision costs for richer households explains why agriculture in colonial Punjab was characterized by the co-existence of "small peasant" farms, "capitalist" farms, and "family farms," with different patterns of resource-use.

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FIGURE ONE

WEALTH AND RESOURCE-USE

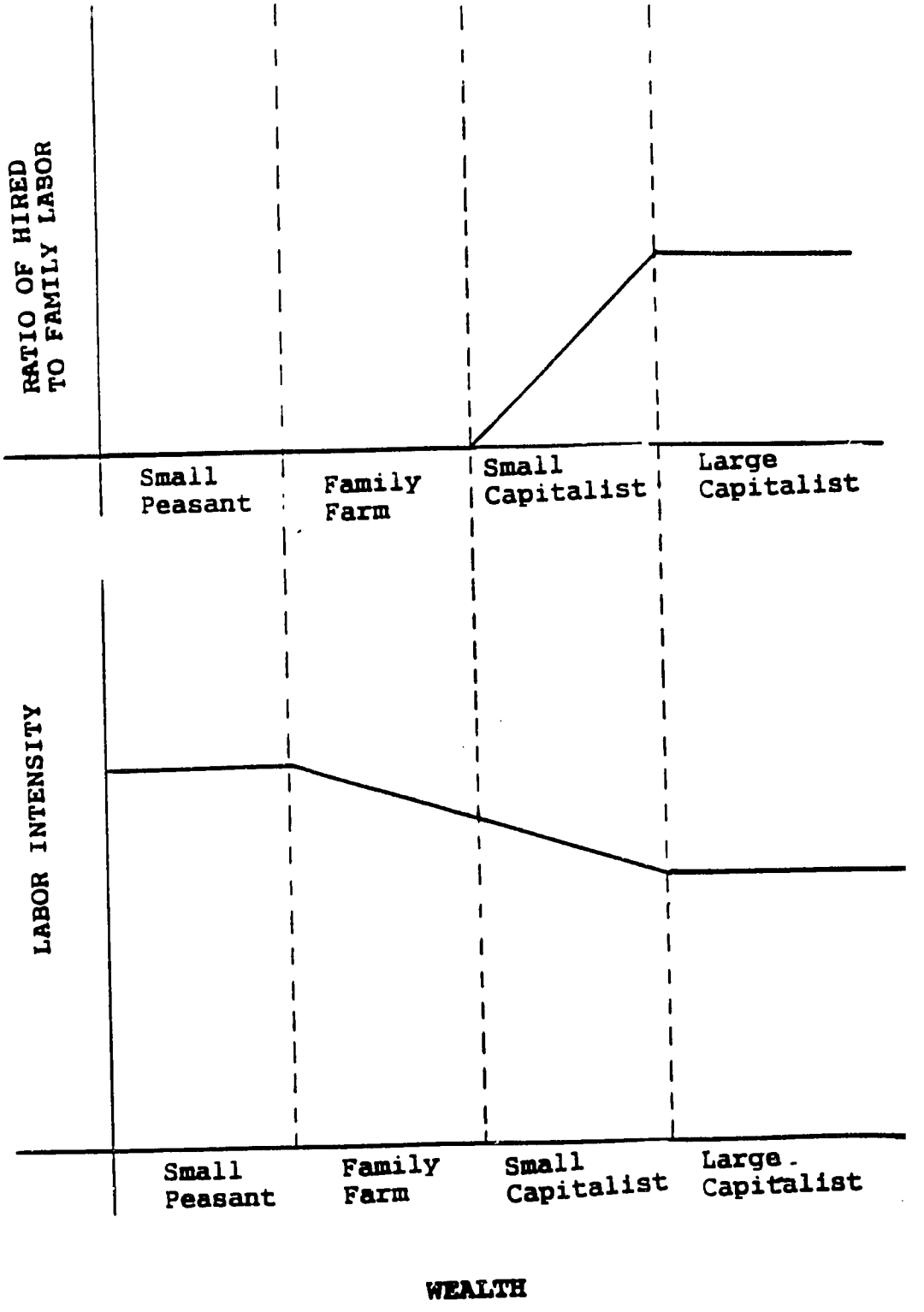

FIGURE TWO

FAMILY SIZE AND RESOURCE-USE

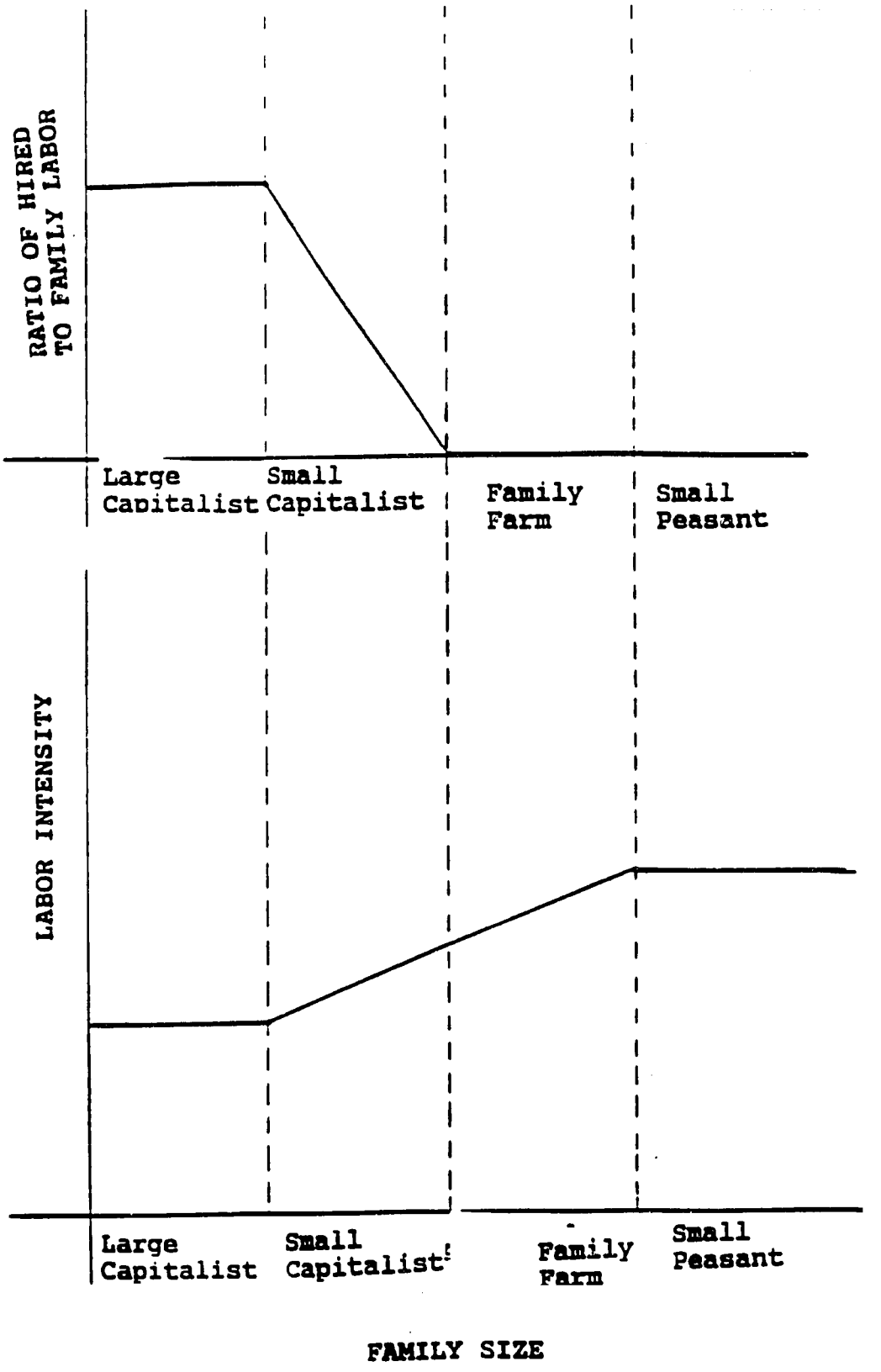

Table 1

Summary Statistics

	N	Mean	10%	25%	50%	75%	90%
Land owned (acres)	432	20.3	4.46	8.41	13.14	26.53	42.99
# adult male family workers	432	2.58	1	2	2	3	4
Gross Cropped Area (acres)	432	25.48	11.94	15.37	21.51	29.56	44.33
Human labor days per Acre	432	32.28	20.3	24.58	30.72	38.79	47.26
Bullock labor days per acre	432	11.77	5.67	6.99	11.21	15.82	18.8
Ratio of Hired to Family Labor	432	0.80	0.09	0.17	0.35	0.73	1.87

Table 2(a)

Determinants of Ratio of Hired to Family Labor

Dependent Variable: Ratio of Hired to Family Labor
(Abs. value of t-stats are in parentheses)

Explanatory Variables	OLS	GLS
land owned	0.08 (10.33)	0.096 (8.91)
# adult family working men	-0.72 (3.97)	-0.66 (3.15)
land owned x # adult family working men	-0.014 (6.3)	-0.019 (7.11)
land owned squared	-0.0000915 (1.73)	-0.000057 (0.77)
# adult family working men squared	0.115 (4.18)	0.1312 (4.03)
Mean dep. var.	0.80	0.40
R-squared	0.36	0.26
R-bar squared	0.353	-0.121
Breusch-Pagan test (OLS vs GLS)	Chi-squared (one d.f) 79.8 (rejects OLS)	

Table 2(b)

Fixed Versus Random Effects

Dependent variable: Ratio of Hired to Family Labor
(Abs. value of t-stat in parentheses)

	GLS	FIXED EFFECTS
# adult family working men	-0.323 (4.79)	-0.26 (2.08)
Land owned	0.032 (8.1)	
R-squared	0.159	0.0149
R-bar squared	-0.266	-0.479
Mean of dep. var.	0.43	-0.59E-17
Hausman test (Fixed versus Random Effects)	Chi-squared (1 d.f.) = 0.349	

Table 3(a)

Determinants of Bullock Labor Use Per Acre

Dependent Variable: Bullock Labor Use Per Acre
(Abs. value of t-stats are in parentheses)

Explanatory Variables	OLS	GLS
land owned	-0.216 (7.28)	-0.23 (5.43)
# adult family working men	3.70 (5.56)	1.85 (2.79)
land owned x # adult family working men	-0.0096 (1.18)	-0.0039 (0.417)
land owned squared	0.0012 (6.56)	0.00125 (4.11)
# adult family working men squared	-0.435 (4.30)	-0.202 (1.94)
Mean dep. var.	11.77	3.60
R-squared	0.308	0.139
R-bar squared	0.299	-0.31
Breusch-Pagan test (OLS vs GLS)	Chi-squared (one d.f)= 243.56 (rejects OLS)	

Table 3(b)

Fixed Versus Random Effects

Dependent variable: Bullock Labor Per Acre
(Abs. value of t-stats are in parentheses)

	GLS	FIXED EFFECTS
# adult family working men	0.501 (2.309)	0.233 (0.832)
Land owned	-0.105 (6.156)	
R-squared	0.08	0.0024
R-bar squared	-0.375	-0.49
Mean of dep. var.	3.316	-0.82E-17
Hausman test (Fixed versus Random Effects)	Chi-squared (1 d.f.) 2.27	

Table 4a

Determinants of Human Labor Use Per Acre

Dependent Variable: Human labor use per acre
(Abs. value of t-stats in parentheses)

Explanatory Variables	OLS	GLS
land owned	-0.34 (5.76)	-0.37 (4.36)
# adult family working men	7.58 (5.67)	3.96 (2.71)
land owned x # adult family working men	-0.014 (0.84)	-0.00105 (0.05)
land owned squared	0.002 (5.41)	0.00204 (3.46)
# adult family working men squared	-0.77 (3.8)	-0.45 (1.98)
Mean dep. var.	32.29	12.15
R-squared	0.25	0.093
R-bar squared	0.24	-0.381
Breusch-Pagan test (OLS vs GLS)	Chi-squared (one d.f)= 171.32 (rejects OLS)	

Table 4(b)

Fixed Versus Random Effects

Dependent variable: Human Labor Per Acre
(Absolute values of t-stats are in parentheses)

	GLS	FIXED EFFECTS
# adult family working men	1.05 (2.26)	-0.977 (1.46)
Land owned	-0.148 (4.55)	
R-squared	0.051	0.0.0074
R-bar squared	-0.428	-0.49
Mean of dep. var.	11.38	-0.78E-16
Hausman test (Fixed versus Random Effects)	Chi-squared (1 d.f.) 18.08	