Asset-pooling in uncertain times: Implications of small-group farming in the Kyrgyz Republic for agricultural restructuring

Prepared for DFID-funded research:
Institutional Complexity and Resource Access after Land Reform: The Challenges of Co-operation for Rural Livelihood Improvement in Transition Economies.

DRAFT- not for citation

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July 15, 2004

1. Introduction

During the last decade, as the former system of socialist collectivized agriculture has been broken up, official statistics show that private farms and household plots have become the dominant forms of agricultural production unit in Central Asia and the Caucasus, with the exception of Uzbekistan. This trend has major importance for efforts to alleviate poverty in the region, as well as implications for the development of governance and civil society. Rural poverty is acute in the region and has shown little change during recent years, even as countries have experienced relatively high overall growth.

The gross trend obscures a great deal of differentiation in both sectoral and farm performance throughout the region. Understanding this differentiation may be important for helping the region's rural areas become more dynamic and grow faster, and for helping farmers with fewer endowments to become competitive. Some observers and policy makers believe that individualization of production aligns incentives correctly and, when coupled with provision of inputs through competitive markets, offers the best pathway for improving productivity, incomes and living standards (Lerman, Csaki and Feder, 2004; Swinnen and Rozelle, 2004). Others see the atomization of small producers as an inefficient development, resulting in operations which cannot achieve cost-savings in input supply or scale efficiencies in production. The government of Kyrgyzstan, for example, is now heavily promoting "small-scale cooperatives" to overcome some of the perceived limitations of atomization, although it has yet to amend the Law on Cooperatives or the tax code in this direction.

Private farms have been formed under many different organizational arrangements and with many different sizes. Our working hypothesis proposes that a plethora of 'middle-ground' institutional arrangements have emerged to help poor rural households overcome farming constraints. These new arrangements have been largely overlooked in mainstream literature. Recently research from a variety of transition countries has begun to provide a more nuanced understanding of agricultural groups and cooperation in transition agriculture (Meurs 1999; Lerman 1998, Sabates-Wheeler 2001; 2002; Deininger 1995). These findings converge to suggest that there are productivity benefits to be found in small voluntary-associated farmer groups and that these groups attest to the advantages of cooperation in an uncertain environment with imperfect market services. This paper uses quantitative data to explain the emergence and rationale of these new types of small, multi-family enterprises in Kyrgyzstan, and provides evidence from a recent farm survey that the formation of groups at the local level reflect a response to uncertainty and asset portfolios.

The data used for the analysis were collected during a farm survey performed in 2001-2002 jointly by the University of Wisconsin-Madison, Center for Social and Economic Research CASE-Kyrgyzstan and Ministry of Agriculture and Water Resources of the Kyrgyz Republic under the umbrella of USAID-funded BASIS collaborative research project. The full sample consisted of 463 farms and is representative in terms of geography and different farm types. Descriptive statistics illustrate significant differences between individual farms and familial or multi-family farms ranging from 6-45 families in terms of their use of factors of production. These differences may be explained by asset constraints. One underlying motivation for cooperation appears to hinge on asset-pooling and this is confirmed by the analysis here. These results can contribute to formulating policies and support strategies for enhancing the performance of new farming institutions or groups, through analysing what processes work best to provide the most effective access to resources and livelihoods for the rural poor.

In this paper we provide quantitative analysis of these new types of farming units and thus, to provide a rationale for a deeper exploration into the nature of these groups.[1] Overall we find that the total factor productivity of small groups formed on familial and social ties is higher that that of individual farms. While this suggests that familial groups are more efficient at utilising their factors of

[1] Using qualitative methods, Sabates-Wheeler (2004) and forthcoming work by the authors explore these small to medium groups using institutional biographies, case studies and key informant interviews gathered in Kyrgyzstan during 2003.

production, non-parametric estimation illustrating the relationship between production, land and labour, suggests that these groups are not optimising production as they appear to be operating under increasing returns to scale. A parametric production function estimation and an analysis of total factor productivity provide further support of this. In conclusion, some discussion is provided to explain why groups may be operating under different returns to scale technology than individual farms. These explanations hinge primarily on understanding the asset-pooling, risk-sharing and labour specialisation functions of groups. In-depth qualitative fieldwork performed in conjunction with this study confirms these explanations (see Sabates-Wheeler, 2004).

2. History of land reform in Kyrgyzstan

Since 1991, the government of the Kyrgyz Republic has carried out a series of measures aimed at transforming its farm sector from a state-managed to a private, market-oriented one. Resource-poor Kyrgyzstan did not have the luxury of continuing to operate a large state agricultural sector based on state support after independence (although a variety of state supports did continue to some enterprises and in some sub-sectors for several years). Consequently, its agricultural restructuring moved relatively quickly, especially in the southern oblasts. Ninety percent of Kyrgyzstan is high mountains, suitable only for grazing. The ten percent of the country which is suitable for agriculture is chiefly found in the northern Chui Valley, the Talas Valley, and around Lake Issyk-Kul. In the south, the Ferghana Valley is the main area suitable for crops. Soviet-era irrigation works utilizing snow-melt are critical for the country's crop agriculture. Due to the limited cultivable area, the amount of arable land available per worker is low (averaging 1.1 ha), and irrigated land is even more limited.

Land reforms began in 1991, with the issuance of the Law on Peasant Farms. This Law permitted individuals and groups to request land and other assets from the parent state or collective farm to establish peasant farms. Typically making land available to trained technical personnel like agronomists and zootechnicians, this initial phase created a relatively well-endowed initial group of about 10,000 so-called peasant farms covering 3.3 million hectares of total land, by 1994. This first generation of peasant farm enterprises were given a number of privileges such access to farm inputs from state sources, subsidized loans and tax exemptions.

In 1992 government renewed its efforts to privatize and reorganize the unprofitable state and collective farm sector (except in Chui oblast). The State Property Committee (GosKomImushestvo or GKI) was mandated to reorganize these farms into joint-stock companies, agricultural cooperatives, and associations of peasant farms. A presidential decree issued in 1992 established local commissions to undertake the evaluation of land shares and other assets and to reorganize the farms along new corporate lines and created another body, the Republican Center for Land and Agrarian Reform, to oversee the process. Like most of the former Soviet republic, land shares and other assets were distributed on paper to farm members and others working in the rural area. The Kyrgyz Republic was more proactive than other countries, however, in permitting workers to claim the land share in a specific location and establish individual or peasant farm.

In early 1994 a new presidential decree established the procedures and approach for the final stage of the land reform and farm restructuring program, which was nominally completed in 2001. Under these provisions, all collective and state farms, and ultimately even experimental and breeding farms, distributed shares of their arable land to all farm residents and shares of non-land assets to farm employees based on the number of family members and years of service of the individual worker. Land shares could be physically withdrawn (theoretically at any time although this was resisted by some managers.[2]

[2] Pasture land is not included for distribution in the reforms.

Shareholders, under the supervision of the local commission and the Centers for Land and Agrarian Reform, either put their shares into a restructured version of the parent farm as a joint-stock company or cooperative, so-called association of peasant farms, or separated from the parent enterprises pool their shares to establish group farming enterprises (usually referred to as peasant farms) or individual family farms. Both land shares and asset shares could be withdrawn to estabish these new farms, but indivisible assets were primarily kept intact on the parent farms. After the passage of the Land Code in 2000 these land shares were converted into private ownership, but per the Agricultural Land Law of 2001 they can only be transacted with another certificate holder.

3. Agrarian Structure and Performance Today

The main trend in farm restructuring since 1994 has been the rapid growth of private enterprises (individual and peasant farms), which are now all legally grouped into the category of "peasant farms" (*krestianshyie khozyaistva*). This category includes a range of farm institutions ranging from individuals owning and/or working land to family farms and group farms of different kinds. The numbers continue to grow each year, as illustrated in table 1 below. These kinds of farms are the predominant farming enterprises type in the southern oblasts, where they control over 75 percent of arable land (317,941 hectares; Gos Register, 2000). In Chui oblast in the north, larger farm enterprises remain, often containing higher proportions of ethnic Russians and retirees. In 2000 it was estimated that the share of peasant farms in the total land area (1840,800 hectares) was 41.6 percent.

Table 1: Number of Agricultural Enterprises, 1991-2000

	Farm enterprises created by the restructuring of State and Collective Farms						
	Total Peasant private farms	of which:		Total Collective Enterprises	of which:		
Year (end)		Individual farms	Group farms		Agricultural Cooperatives	Joint Stock Companies	Other collective peasant enterprises
1991	4,567	--*	--	--	--	--	--
1992	8.695	--	--	170	125	--	45
1993	18,269	--	--	239	160	--	79
1994	21,264	--	--	340	152	72	116
1995	23,180	--	--	909	608	74	227
1996	31,078	9,576	21,502	995	639	61	295
1997+	38,218	13,505	24,713	672	327	45	300
2000	66,555	--	--	661	281	46	314

* not available ** planned by end 2000 + July 1 @ June 1
Source: RCLAR

The range of farm sizes in Kyrgyzstan is enormous and essentially bi-modal (Childress 2003). Table 2, below, indicates that the majority of landholdings under 100 hectares are peasant farms (individual or multi-family grouping), whereas the larger farms, over 100 hectares, are collective and state farm enterprises. These larger farms include restructured state and collective farms from the former socialist period, but also more recently established joint stock companies and other enterprises. The farm size differential between large and small farms is enormous. The average area of agricultural land in the large farms in the North (1399 hectares) exceeds by 100 times that of the neighbouring small and medium farms; this difference is not so big in the South, but still significant. The average size in the small and medium category is between 15 and 20 hectares. Basic estimates of farm performance, calculated as profit per hectare, showed that smaller farmers are substantially more profitable that larger ones.[3]

[3] Childress' and Moglivesky's farm budget comparison takes account of incomes from crop production, livestock production and additional sources, and also direct and indirect production costs. Indirect costs include

Using the same data source that this paper draws upon, Childress and Mogilevsky (2002) provide a comparison of small and large farms (100 hectares being the defining criteria). Their results highlight a range of interesting differences between small and large farms in the North and South of Kyrgyzstan based on asset ownership and access. Landowners placing their holdings in large cooperatives have, on average, less labour per hectare than small farmers. Similarly, the availability of agricultural machinery of each member per hectare is substantially less in large farms than small farms. An analysis of aggregate fixed production assets shows the same pattern. These results suggest that landholders in larger cooperatives are more asset-constrained than small peasant enterprise landholders. This may explain why they choose to join large cooperatives.

Unlike the analysis performed by Childress and Mogilevsky (2002), the primary interest of this paper is to compare individual farming with familial group farming, thus we restrict our analysis to peasant private enterprises. Due to the clear bimodal structure of land holdings and farm organisation, as shown in the data below, we restrict our sample to peasant farms that are less than or equal to 100 hectares. Our total sample is therefore 368 farms, which represent 98 percent of all peasant farms in the sample.

Table 2: Distribution of Land Resources by Size, 1999

Land Area, ha.	All farms	Individual	Multi-Family	Collective	State
<1	11	8	3	0	0
1-3	52	36	16	0	0
3-5	46	32	14	0	0
5-10	80	34	46	0	0
10-20	84	27	57	0	0
20-50	85	10	73	1	1
50-100	31	1	18	11	2
100-500	39	1	10	22	6
500-1000	13	0	0	12	1
1000-5000	20	0	0	12	8
>5000	6	0	0	2	4
TOTAL	468	149	237	60	22

Source: Mogilevsky and Childress, Table 3

3. Descriptive Statistics: Characteristics of small scale farming in the Krygyz Republic

There are several ways of classifying farm types, such as by area cultivated or by size of operation. Farms are classified according to group formation, therefore we use the number of members as a proxy for farm size. In Kyrgyzstan typically a member represents an entire family so counting members approximates with the number of families participating in a given farm. In accordance with the aim of the paper we classify the farms into two categories: individual or one member farms (126 farms or 34 percent of the sample) and groups, comprising between 2 and 48 families (242 farms or 66 percent of the sample).

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expenses related to the operation of the farm as a whole and can't be attributed to a certain type of activity. They include land tax and Social Fund payments, interest on credit, payments for electricity, pastures etc. Net margin generated by the farm is calculated as the difference between gross income and direct and indirect costs. It should be noted that the way net margin calculation is not a complete economic description of the farm's marginal efficiency of resource use, because this would need to include the value of the farm owners' labor as well as fixed assets depreciation. This calculation provides a summary indicator of current-period profitability to compare operating margins across different farms.

Distribution of Physical Resources

The most important factor which determines the production capacities of arable farming is the availability of productive resources, namely: 1) labor; 2) land; and 3) machinery and equipment. Due to the nature of the land distribution post-socialism these assets were distributed relatively equally within the agricultural regions of Kyrgyzstan (North and South), based on the existing population of the state and collective farms at the time of privatization. Non-physical assets, of course, such as farming skill and connections with elites and political structures, are much more heterogenously and idiosyncratically distributed. To the extent that resources were distributed in an equitable fashion we would expect to see little difference in terms of productive resource distribution; however, table 3 shows that, on average, group members own, cultivate and rent less land than individual farmers. For instance, on average, the individual farmer cultivates nine hectares of arable land and the familial member, 3.7 hectares. The pattern of asset ownership and access is strikingly consistent across all asset types, with individual farmers owning and accessing more than familial group members[4].

Table 4 presents a comparison of the land areas and land/member ratios at the sample mean of each of these farming categories.

Table 3: Farm Characteristics: mean values of land, labour and assets

Group Type	Unit	Individual	Group
Mean Area Cultivated	Hectares	9.06	16.19
Mean number of workers	Persons	3.51	12.74
Land cultivated per member	Hectares	9.06	3.74
Arable area owned/member	Hectares	4.27	2.52
Available family labor per member	Days per year	1054.7	666.47
Hired labor per member	Days per year	20.29	12.75
Workers per hectare	Persons	1.52	1.148
Days of family and hired labour/ hectare	Days	463	346
Own equip/ member*	Som/1000	19.50 55%	6.17 70%
Tractors/member*	Number	1.11 28%	0.30 38%
Plough/ member*	Number	1.04 19%	0.29 33%
Truck/ member*	Number	1 13%	0.29 27%

* - the percentage indicates the percentage of farmers in the samples owning any particular asset

This finding is suggestive of an asset pooling incentive for group formation. Households with small asset endowments or opportunities for expansion may seek to pool to reduce transaction costs, risk or access complementary assets by pooling their resources with similarly placed individuals, while farmers with an adequate portfolio of resources are more likely to remain as independent farmers.

[4] The pattern across farm types was consistent across a wide range of asset indicators, such as amount of arable land owned, amount of rented land,

Non-parametric methods as an insight into farming systems

Asset pooling appears to provide a strong explanation for cooperation in agriculture; however, can we say anything about the production techniques and relative advantages of one type of farm over another? Using non-parametric methods we can obtain more useful, descriptive insights into the relationships between different factors of production and output. Due to large inefficiencies in physical capital markets and chemical input markets, the factors of production most readily available to farmers in Kyrgyzstan are land and labour. Figure 1, below, shows the relationship of the predicted values of output for different combinations of land and labour in the Kyrgyz Republic for individual farmers. To generate this plot we estimate a nonparametric local polynomial regression (loess) for total income utilising only individual farmers. Figure 1 reports on the x-axis total area measured in hectares and on the z-axis labour, measured as total labour days (scaled down by 1000). As we move along the z-axis individual farmers' labour increases. We can see that increasing farmed area for given level of labour reaches a maximum level of production and then decreases. Similarly, for given area increasing labour shows a diminishing marginal productivity of labour. It is interesting to note that for high holdings of land under individual farming there is not enough labour available to enter into the increasing marginal returns to labour for individual farmers. This points to an inefficiency in the labour market.

FIGURE 1 Perspective plot for the local linear regression of production on the total farming area and total labour for individual farmers

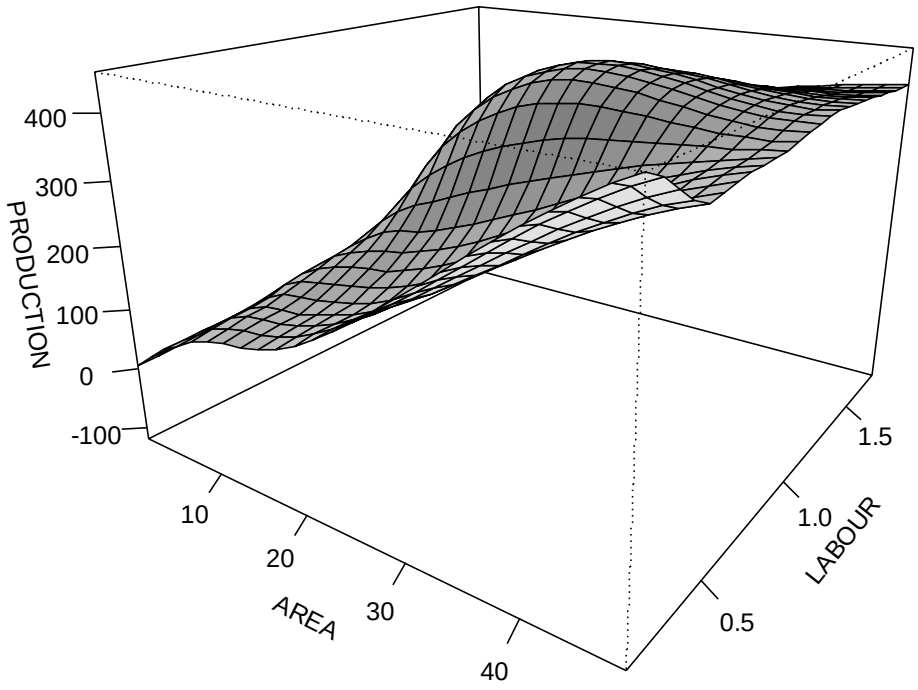
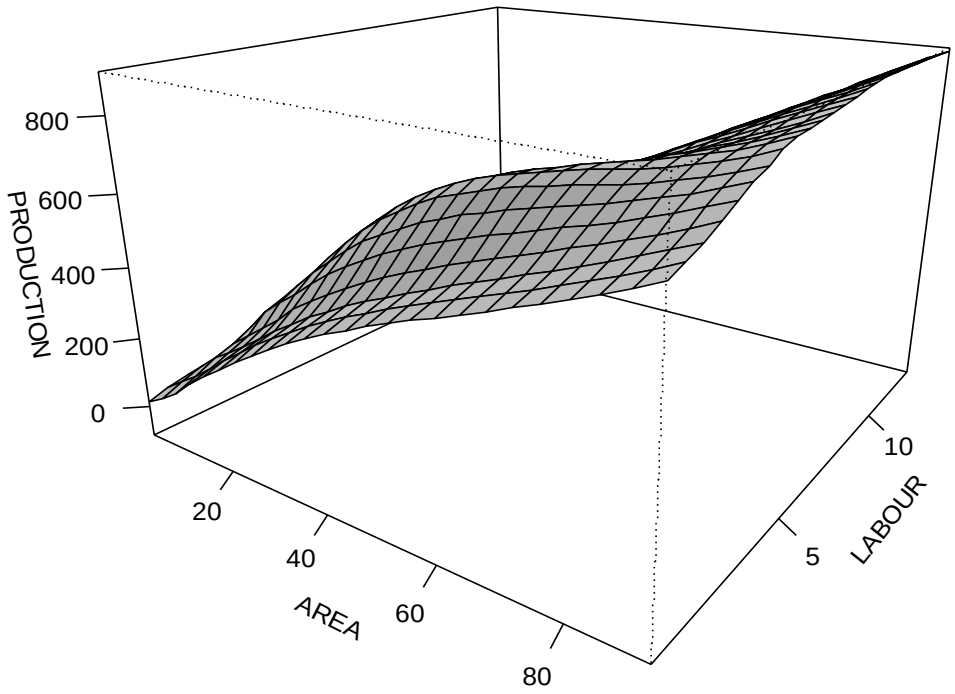


Figure 2 presents the same non-parametric regression for familial groups. These are again very interesting results. First, it seems that these farmers are producing in the region where the combination

of land and labour increases production. It does not seem that production values have reached a maximum level (possibly due to inefficiencies or inexistence of markets), although the rate of increase for additional labour appears to markedly slow above the 5 unit cost level . The rate of increase to additional land likewise appears to slow above approximately 40 hectares .

Figure 2. **Perspective plot for the local linear regression of production on the total farming area and total labour for familial group farms.**



The advantage of viewing the relationships between outputs and inputs in the above fashion is that we are not imposing a functional from on our data. It also allows us to gain insights into the dynamic interactions of inputs over a range of input levels. However, having seen these effects represented graphically in the non-parametric estimation, it is logical to ask what would happen to the relationship between land area, machinery, chemical inputs and other factors of production. These variables interact in more than a simple 3-dimensional space. Thus to understand these relationships, non-parametric estimation is not appropriate. Therefore we will utilise a parametric estimation to model the relationship between farm production and inputs, by farm type. Furthermore, our intention is to analyse total factor productivity and so a specific functional form is required.

Measuring Productivity

Productivity is defined by the amount or value of output produced by a given bundle of inputs. Productiivy levels are derived by estimating production functions, which are multiple regress models relating output to all relevant inputs or factors of production (land, labor, machinery, fertilizers, etc).

Here we specifiy a Cobb Douglas production function. After taking a logarithmic transformation the basic regression equation has the following form:

$$Log(Output) = \beta_0 + \sum_{j=1}^{M} \beta_j Log(Inputs_j) + \varepsilon$$

where j = 1……..M refers to M inputs of production and ε is the error term in the regression. The error term is assumed to be independent of the inputs and normally distributed around zero.

The variables in the equation and their mean values are listed in Table 4.

Table 4: Production Function variable names and definitions

Variable Name	Definition	Individual (means)	Group (means)
Output value	Total annual income from crop production (‘000s soms)	120.26	212.15
MACHINE	User cost of capital a year (10,000 soms)	2.46	3.54
AREA	Area in hectares of cultivated arable land	9.06	16.19
FERT	Total annual costs of chemical fertilisers/10,000	0.33	0.87
LABOUR	Total labour-days a year (hired and family)/1000	0.58	2.01
TYPE	Dummy variable: 1= individual; 0 = group		

Dependant variable:

The dependent variable, output value, is *total value of production from all crops*. The sample prices of crops, where reported, did not vary dramatically. When prices were reported these were used to value production. Where prices were not reported, the median sample price for each crop was used to value farm output. In cases where this data was insufficient to determine a “representative” median sample price, national level prices were used. This variable was constructed by summing the value of: raw sold products, raw self-consumed products, processed sold products and processed self-consumed products.

Explanatory variables

Machine: to compute a variable for machinery the value of different types of agricultural machinery owned and the costs of various types of machinery services rented in were aggregated into one equipment cost variable, expressed in terms of user costs or capital (UCC). In Kyrgyzstan farmers who hire capital services do so for only short periods, that is they do not rent them out yearly. This time frame becomes important when estimating the interest rate. As is typical in specifying depreciation rates, we assume an annual depreciation rate of 0.12. Assuming that farmers only hire

machinery on average for three months a year the relevant depreciation rate became 0.04. The value v is a variable collected in the survey, thus the only unknown variable is the interest rate. As rural farmers do not currently have access to formal credit markets, and very little access to informal credit it is not appropriate to use the official Central Bank interest and inflation rate to determine the interest rate. Instead we estimated the interest rate from the survey data using matching methods.[5] The interest rate was found to be approximately 33 percent for 3 months; thus the annual interest rate use to calculate the user cost of capital was 129 percent. This value was used as the interest rate for all equipment and UCC was calculated using the following formula:

$UCC1=(\delta + i)v$

where: δ: annual depreciation rate, i: interest rate and v: present value of capital.

Area: this variable subtracts the land dedicated to pastures and hayfields from total land cultivated (including rented-in land and subtracting rented-out land).

The variable **Fertilizers** expresses the annual cost of chemical inputs used, and is an aggregated variable composed of the following 4 chemical inputs: ammoniac nitrate, organic manure, other fertilizers and chemicals. The reason why these variables have not been introduced separately in the production function is to gain degrees of freedom.

Labour days*:* this variable refers to the number of labor days that were used in crop production activities last year. It aggregates labor days of the family and labor days from hired workers. The survey obtained data on labor according to the number of family workers each member has (assumed to work in the farm on a full time basis during the year) and the survey collected aggregate annual hired labor costs for each farm. In order to create a composite variable we assumed that, on average, family full-time workers work for 150 days a year. In order to find the labor days per year for hired labor we divided the costs of hired labor by the average daily agricultural wage for 2001: 23 soms/day (source: Kyrgyz National Statistical Committee) to obtain a annual amount of labour days.[6] Family and hired labour were then aggregated.

Estimation Results

Table 5 below shows the results of three estimations using a Cobb Douglas production function. The first two columns show a separate estimation of the basic production function for individual and group farmers. We see that all the factor elasticities have the expected positive, and significant signs, indicating that a percentage change in any of the factor inputs leads to a corresponding positive change in total output. The R-squareds are high, indicating that the models are well fitted. The reason we have run the two models separately is to highlight an interesting result. Comparing the parameters of the two models it is clear that the elasticities for machinery, fertiliser and land area for both groups and individuals are equal to each other (that is, the parameters are not significantly different). What is striking if the large difference with respect to the labour elasticity for individual and group. The parameter for individual is approximately four times higher that for groups, indicating that the percentage change in output for a percent change in labour is four times higher in individual farms. This result is suggestive of a labour constraint/labour pooling story that was discussed in relation to the descriptive statistics earlier. By increasing labour individual farmers could, on average, get a very high productivity return. Why is it that these farmers do not engage more labour? We know from the descriptive statistics that on average individual farmers have less family labour per

[5] See Sbates-Wheeler (2004) for a full description of this methodology.

[6] It could be argued that this wage rate is not representative of local level wage rates. To deal with this concern we did two things. First, we obtained our own estimates of a daily wage rate from the data and found that the average rate ranged from 24 to 35 som (not so dis-similar to the national rate). Second we ran the regressions using different labour variables created with a range of wage rates and found the results to be robust.

hectare than group farmers. It is likely because labour markets in rural Kyrgyzstan are sticky and furthermore there are financial constraints for poor farmers which means they cannot afford to hire-in labour. On the other hand, group farmers get less return for marginal increases in labour. This is because one of the main rationales for group farming in Kyrgyzstan in labour pooling and labour specialisation, thus group farmers are already using this factor input more efficiently.

Table 5. Quadratic production function coefficient values for total sample

	Group	**Individual**	**Pooled**
	N=242	N=126	N=368
Ln(AREA)	0.396***	0.447***	0.416***
	(0.060)	(0.092)	(0.050)
Ln(MACHINERY)	0.546***	0.556***	0.556***
	(0.087)	(0.130)	(0.072)
Ln(FERTILISER)	0.392***	0.549***	0.418***
	(0.072)	(0.157)	(0.065)
Ln(LABOUR)	0.141***	0.409**	0.116**
	(0.059)	(0.210)	(0.058)
Ln(LABOUR) * Type			0.379*
			(0.197)
Type			-0.366**
			(0.161)
Constant	2.867***	2.437***	2.828***
	(0.10)	(0.171)	(0.094)
R-Squared	0.745	0.739	
*** (significant at 1% level); ** (significant at 5% level); * (significant at 10% level)			

Given the striking difference in the labour elasticities and not in other factors, a more parsimonious model was specified. Column three of table 5 shows the results of this model: a pooled regression, including an interaction effect for farm type and labour and an intercept dummy for group type. The underlying assumption here is that labour and farm type are differentiating factors for the production in individual and group farms. The results of this model will be used to test the total factor productivity of farm types.

The results of the third model show a significant impact of the interaction of labour and farm type and of farm type. As expected we see that changes in labour inputs in individual farms has a significantly greater impact on productivity that increases in labour in group farms. The dummy variable for farm type indicates that there is a significant difference in productivity between individual and group farms, with individual farms being significantly less productive. This is due to institutional factors, such as labour monitoring, economies of scale in land pooling and machinery usage. A further understanding of exactly what is driving these differences is presented in forthcoming work by the authors.

Post-estimation

Productivity is defined by the amount or value of output produced by a given bundle of inputs. In only one input is considered, the result is partial productivity. If all inputs of production are considered together we can estimate total factor productivity. Total factor productivity (TFP) is one of the most common measurements of technical efficiency (Sadoulet and De Janvry, 1995). Production levels are derived by estimating production functions, as above, which include dummy

variables that reflect differences in productivity levels. Typically only an intercept dummy is include in the regression and all slope coefficients are assumed homogeneous, or equal. However, for reasons given above, we include both an intercept and a slope shifter. The separate equations for each farm type are:

For individual farms:

$$Log(Y_i) = \beta_{0i} + \beta_{1i} Ln(Labour)_i + \beta_2 Ln(Machine) + \beta_3 Ln(Fertiliser) + \beta_4 Ln(Area) + \varepsilon_i$$

For group farms:

$$Log(Y_g) = \beta_{0g} + \beta_{1g} Ln(Labour)_g + \beta_2 Ln(Machine) + \beta_3 Ln(Fertiliser) + \beta_4 Ln(Area) + \varepsilon_g$$

where subscript i refers to individual and subscript g refers to group.

When the equations are differenced and antilogs are taken, terms corresponding to machine, fertiliser and area drop out. We are left with:

$$Y_g \big/ Y_i = \exp\left[(\beta_{og} - \beta_{oi}) + (\beta_{1g} * Ln(Labour)_g - \beta_{1i} * Ln(Labour)_i)\right]$$

Inputting the estimated values from table 5:

$$Y_g \big/ Y_i = 1.19$$

The results indicate that the output level in group farms in 19% higher than in individual farms. This indicates that group farms utilize their factors of production more efficiently than individual farming. This result, although not very high, is still significant at the 5 percent level.

6. Interpreting Results: Relevance for Policy and Need for Qualitative Understanding

The estimations from these data appear to confirm the hypothesis that there are some production efficiency advantages occurring in the familial and small cooperative groups. What might be explaining these differences, especially given that the descriptive statistics portray relatively similar levels of input use (except for labour) and output per hectare? Certainly, labour access appears to be driving much of this result. Groups are able to pool labour and specialise tasks thus allowing them to make more efficient use of their factors of production. There are also likely to be institutional factors that allow group farmers to better utilise their factors of production. We believe that three processes are at work. The familial and medium group farms are likely able to a) specialize their labour effort better, both by dividing tasks within the work force and by uniting groups of workers around the relatively highly capable or skilled farmers (which could also be viewed as a self-selection effect); b) they are likely able to pool assets such as labour and machinery; and c) they are able to mitigate production risks better.

As the non-parametric graphs reveal, the individual farmers appear to reach maximum for both land and labour endowments within the band of land sizes distributed during privatization. At low levels of land and labour an increase in labour increases output substantially, but after a point labour is not expected to increase production efficiency (although it could increase total agricultural income and create some employment). The shape of the function suggests that individual farmers have little

scope of increasing agricultural productivity through land and resource expansion, but rather though a shift in underlying technology and farming skill (technical efficiency), which would cause the production function to move upwards. In contrast the production functions predict that the familial and group farms would likely be able to profitably expand both the operational size of their landholdings and their labour force, although the production functions indicate that the rate of this increase would be predicted to slow as either land or labour increases.

These conjectures are consistent with the history of agricultural restructuring. The incentives for small and medium-size grouping reflect the unique distributional characteristics of the mass privatization and farm restructuring processes and the parallel underdevelopment of factor markets in Kyrgyzstan. While land assets were distributed in a highly equitable fashion in each region, non-divisible physical assets like machinery and buildings were distributed to groups of shareholders. Furthermore, non-physical, but equally crucial assets—technical and entrpreneurial skills, physical ability, networks of trust, contacts and influence, proximity to markets, agroclimatological attributes —were *a priori* distributed in a much more heterogeneous and idiosyncratic manner which, for any specific individual or household give significantly differ value and functionality to the land and physical assets received in privatization and restructuring. Endowments of non-physical resources can be expected to vary significantly within families and within outwardly homogeneous communities.

In a theoretical world of perfect factor markets (especially for labour) the varying quantities and qualities of non-physical assets would be priced and allocated on the basis of a large number of transactions and allocated the full spectrum of productive sectors. But such a market solution is thus far impossible in Kyrgyzstan. When the seasonal, episodic, and specialized labour demands of agricultural production are taken into account, grouping may provide a way to ensure efficient use of land, equipment and non-physical assets while maximizing the non-farm opportunity set for the groups' members.

The second factor creating an incentive to work in family and medium-sized groups is risk. There is no agricultural insurance market in Kyrgyzstan and thin state-sponsored social protection, so individuals in agriculture face the full risk and uncertainty of climactic events, market fluctuations and institutional/legal changes. Land markets are only beginning to operate, although most of the activity is restricted to the Land Redistribution Fun (Childress and Giovarelli, 2003). Pooling of resources and mutual assistance can lower the risk for a particular or household from certain conditions, although it may create others. (Further qualitative work by the authors support this hypothesis).

The "lumpy" distribution of equipment and non-physical assets in a context of limited markets is a third factor. Most of the former state and collective farms were reluctant to physically part with commonly owned machinery, and only a few scarce, and often deteriorated pieces were made available to farms splitting off from the former large farms. Many small and medium farms have no machinery at all and must purchase machinery services on the spot during the season. Accessing this spot market for machinery hire in a timely manner is another incentive to work together, because more land can be prepared, tilled or harvested at one time, and the transaction cost of contracting the machinery is spread over multiple individuals or households. Machinery's scarcity thus creates a situation in which there are obvious incentives to internalize the allocation of these assets within the productive unit (rather than fully marketize them through leasing arrangements), especially for expanding market-oriented production.

Re-organizing agricultural production in Kyrgyzstan during a period in which these three factors are present create incentives for grouping in agricultural production, but it is unlikely to be a very stable structural arrangement, because it is apparently based on medium-term deficiencies in other markets which are expected to change. While land and physical assets are relatively equitably, although lumpily, distributed within each region, the distribution of non-physical assets is unobservable but heterogeneous. Individuals whose physical and non-physical endowments are insufficient to ensure a subsistence threshold of risk-adjusted agricultural income have incentives to group with others in the

context of constrained labor markets if successful grouping can really raise income or lower risk. The transaction costs of grouping with family and neighbours can be hypothesized to be the lowest available because of interlocking self-interest, fuller information and physical proximity.

Likewise for individuals above the threshold of subsistence whose endowments of physical and non-physical endowments are insufficient to move them toward a higher threshold agricultural income or asset accumulation, generally with a more market-oriented production regime will be likely to seek group membership. On the other hand of course, individuals whose own endowments are sufficient to overcome these thresholds by themselves, will have no incentive for grouping. Grouping does have costs and risks of its own—essentially risks of non-cooperation--not found in fully individualized production.

The farm structure observed in Kyrgyzstan confirms this heterogeneity and it is intuitively easy to see that in such a situation, a fully individualized structure of production is unlikely. Individuals with partial shares in physical assets like farm equipment, and individuals with low or heterogeneous endowments of non-physical assets will have incentives to work together (to group). Likewise individuals with complementary endowments have incentives to share them (e.g. through asset pooling or labour specialization), up to the point at which the internal management costs of sharing them overcome the efficiency gains. These group formations may also be more or less stable of course, first because information about different individuals and preferences for specific activities requires time and experience to be revealed, and secondly because market and institutional conditions (including non-farm labour opportunities) change from season to season. In fact a lot of yearly change in farm structure has been observed in Kyrgyz agriculture (Childress 1999), and the larger process of disintegration of the old collectives and formation of individualized and small-group production units is the biggest single trend in the country's agriculture.

Intuitively, it would by predicted that there are diminishing returns to this type of group formation as the group size increases, because of labour supervision, free-riding and trust issues as the number of members increases. This intuition corresponds with the results depicted in the group-farming production function graph. The graph suggests a rapid increase in production income up to a the range of land size and labour of what is considered a mid-size farm operation in Kyrgyzstan (40 ha and 5 members), and a slowing of production incomes after those sizes. These results therefore depict a completely different production regime than that of large collective farms, and indeed appear to represent that small groups are closer to an extension of individual production logic which takes advantage of labor specialization and asset pooling, than to a corporate or collective production model.

The evidence presented in this paper, based on a few strong, but not unambiguous quantitative indicators is largely suggestive. While the efficiency in production is a strong result from the estimations, the causal factors underlying group formation and description of benefits and costs of grouping are inferred on the basis of economic theory and results emerging from complementary qualitative fieldwork.

What does this transitional agricultural structure mean for policies? First, the results point to the weakness of the Kyrgyz non-farm labour market and the need to focus public and private investments in non-farm employment generating activities. Grouping for agricultural production indirectly suggests that individuals with fewer non-physical assets are staying in agriculture, linking themselves with relatives and neighbors to assure their subsistence, or to reach higher levels of agricultural income, rather than seeking off-farm labor opportunities. Throughout the post-independence period Kyrgyzstan has struggled to find non-agricultural employment. Greater articulation of downstream processing and marketing activities to raw material production appears to point the way forward, and Kyrgyzstan now has a number of promising examples of how to do this.

Second, the results suggest that factor markets for land, equipment and technical agricultural advice remain underdeveloped. Making more machinery available through longer-term loan schemes,

public-private partnerships with local government and integration with foreign suppliers of parts and equipment would take pressure off the machinery scarcity and promote a growing private sector involvement in supply chains for parts and maintenance.

Third, and more positively, the results argue for a mild encouragement of grouping as a transitional form of agricultural organization. Flexible mechanisms for farm structures, joint credits, and tax incentives could all be positive measures in this context which would be beneficial to agricultural efficiency and the non-farm labour market.