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

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Summary

Substantial theoretical and policy debate in the early 1990s led to an excessive focus on de-collectivisation and individualisation of land rights through privatisation across the former communist bloc. The objective of this paper is to examine "individualised" production systems more closely in order to understand better how certain specific organisational approaches to production differ with respect to a set of indicators of technical efficiency. In this paper we provide quantitative analysis of these new types of farming units and provide a rationale for a deeper exploration into the nature of these groups. Overall we find that the total factor productivity of small groups formed on familial and social ties is higher than that of individual farms, given the uncertain rural environment in Kyrgyzstan and the resource constraints facing landholders at this point in time. The explanation for this hinges 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). As transition agriculture continues to adapt to land reform choices that were made ten years ago, a major policy question facing the Kyrgyz government must be, what kind of agrarian structure should be facilitated in order to promote agricultural growth? Despite the push for de-collectivisation there remains a place for encouraging group farming, on grounds of both poverty alleviation and agricultural growth.

Keywords: Kyrgyzstan; agricultural restructuring; asset-pooling.

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1 Introduction

During the last decade, as the former system of socialist collectivised agriculture has been broken up, official statistics show that private farms and household plots are becoming the dominant forms of agricultural production unit in the majority of countries. Table 1.1 illustrates this trend through the late 1990s. By 1997, the proportion of land individualised in Central and Eastern Europe was much higher than in the Commonwealth of Independent States (CIS) countries, but in both sets the trend has been in the same direction and the contribution of individual production to total agricultural production has increased dramatically. In general the trend to individualisation is considered to be positive because it releases producers from the inefficient arrangements of the socialist state farms and creates the conditions in which markets for land and labour can allocate these resources more efficiently (Lerman *et al.* 2002; Frydman and Rapaczynski 1994). The argument that private small-scale farming is superior to cooperative farming proposes that incentive problems inherent in production cooperatives – such as "free-rider" externalities that result from weak supervisory authority – make them an inferior form of organising agricultural production, in efficiency terms. Cooperatives are also argued to be an inferior method for the allocation of land and labour for the household when compared to the use of markets (Binswanger, Deininger and Feder 1995; Lin 1988; Schmitt 1991).

The trend toward individualisation thus has major importance for agricultural growth and efforts to alleviate poverty in the region, as well as implications for the development of governance and civil society. Rural poverty remains acute in the CIS states, even as some countries have experienced relatively high overall growth and many are experiencing stable agricultural sector growth. This situation is particularly salient in Central Asia where the proportion of the population living in rural areas is the highest in the region. Sixty-five per cent of the rural population in Kyrgyzstan is considered poor, and 40 per cent in Kazakhstan (Asian Development Bank).[1] In these countries the trend towards individualization has not been equivalent to poverty reduction or widely distributed rural growth.

This fact suggests that the gross trend towards individualisation of agricultural production throughout the post-socialist world obscures a great deal of differentiation in both sectoral and farm performance. It should thus be interpreted as a starting point for understanding the progress toward rural development and poverty alleviation, not as an indicator of success. Although privatisation and individualisation create conditions for markets to lead to efficient farm sizes and managerial arrangements, these processes are far from automatic. They depend heavily on the smooth functioning of input and output markets, the availability and distribution of complementary assets, and the management of risks facing producers. Some observers and policymakers believe that individualisation 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. Others, however, have seen the atomisation of small producers as an inefficient development, resulting in operations which cannot achieve cost-savings in input supply or scale-efficiencies in production or achieve the volumes and

[1] www.adb.org/Documents/EDRC/Statistics/rt_06.xls (accessed August 2004).

standards of production necessary to make producers competitive in regional and global markets. Taking a middle ground between these positions, it is often proposed that there are efficiencies from cooperation in certain aspects of production and distribution, but not in others (Thiesenhusen 1989; Putterman 1985; Carter 1987; Vanek 1969). Within these debates, recent research from a variety of transition countries has begun to provide a more nuanced understanding of farming arrangements which are somewhere in-between individual and collective arrangements, such as small agricultural groups and cooperatives in transition agriculture. But farm-level analyses and findings from Central Asia about these arrangements are still largely absent from the published literature (Meurs 1999; Lerman 1998; Wheeler 2001, 2002; Deininger 1995; Verdery 1999; Stark 1996).

Table 1.1 Change in structure of landholdings over time for a range of CIS countries

	Individual land %			**Individual land%**		**Individual production %**	
CEE countries	**1990**	**1997**	**CIS countries**	**1990**	**1997**	**1990**	**1997**
Albania	4	100	Armenia	4	33	35	98
Slovenia	92	96	Georgia	7	24	48	76
Poland	77	82	Ukraine	7	17	27	53
Romania	12	67	Moldova	9	27	18	51
Hungary	6	54	Belarus	7	12	25	45
Bulgaria	13	52	Russia	2	11	22	45
Czech Republic	5	38	Kyrgyzstan	1	23	34	59
Slovakia	5	11	Kazakhstan	0.2	20	28	38
Latvia	5	95	Azerbaijan	3	9	35	63
Lithuania	9	67	Tajikistan	2	7	23	39
Estonia	6	63	Uzbekistán	2	4	28	52
			Turkmenistan	0.2	0.3	16	30
Ave CEE	21	66	Ave. CIS	4	16	28	55

Source: Table 3.2 in Lerman, Csaki, and Feder (2002).

The objective of this paper is to examine "individualised" production systems more closely in order to understand better how certain specific organisational approaches to "individualised" production differ with respect to a set of indicators of technical efficiency. Specifically the paper examines the differences between multi-household and small-group farming operations with those of single household (i.e. fully individualised) ones. Private farms have been formed under many different organisational arrangements and with many different sizes, but the differences among them have received little attention. Our working hypothesis proposes that a plethora of "middle-ground" institutional arrangements have emerged to help poor rural households overcome farming constraints. Although these new arrangements have been largely

overlooked in mainstream literature, they may be important for understanding the constraints and challenges facing rural households, and thus for creating the kinds of new market-led institutions which can lead to dynamic rural sectors and reduce poverty in the region.

Our findings converge to suggest that there are productivity benefits to be found in small voluntary-associated farmer groups (versus single-household farming arrangements) and that these groups attest to the advantages of cooperation in an uncertain environment with imperfect market services. That is, farmers normally cooperate voluntarily on activities, crops, etc. where this pays (via risk reduction or output enhancement) more than enough to cover the costs and risks of cooperation. 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 variation in 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, the 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.

In this paper we provide quantitative analysis of these new types of farming units and provide a rationale for a deeper exploration into the nature of these groups.[2] Overall we find that the total factor productivity of small groups formed on familial and social ties is higher than that of individual farms, given the specific rural environment in Kyrgyzstan and the resource constraints facing landholders at this point in time. While this suggests that familial groups are more efficient at utilising their factors of production, they also appear to be failing to utilise resources optimally. 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.

One reason for the persistence of these operating arrangements could be that they face constraints in acquiring land and other inputs. One way to overcome the labour constraint would be to increase the membership size; however this might undermine the trust and stability of the group, potentially with other detrimental effects on production. Another option to increasing production would be to acquire land through rental and land sales markets. Land markets, however, are currently relatively static in Kyrgyzstan, and major dynamism appears to be impeded by the lack of off-farm opportunities for farmers (see discussion at the end). A parametric production function estimation and an analysis of total factor productivity provide further support of these findings.

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[2] 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.

In conclusion, we try 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 per cent of Kyrgyzstan is high mountains, suitable only for grazing. The 10 per cent 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 utilising 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 breeding specialists, this initial phase created a relatively well-endowed initial group of about 10,000 so-called peasant farms averaging about 25 hectares of arable land. This first generation of peasant farm enterprises were given a number of privileges such access to farm inputs from state sources, subsidised loans and tax exemptions.

In 1992 government renewed its efforts to privatise and reorganise the unprofitable state and collective farm sector (except in Chui oblast). The State Property Committee (GosKomImushestvo or GKI) was mandated to reorganise 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 reorganise the farms along new corporate lines and created another body, the Republican Center for Land and Agrarian Reform (RCLAR), 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 programme, 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).[3]

Shareholders, under the supervision of the local commission and the Centers for Land and Agrarian Reform (the regional sub-offices of RCLAR), 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 establish 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 Contemporary agrarian structure and performance

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 3.1. These kinds of farms are the predominant farming enterprises type in the southern oblasts, where they control over 75 per cent 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 cultivable land area was 48.2 per cent.[4]

Only about 10 per cent of Kyrgyzstan's land area is arable with less than half of the cultivable land under irrigation. Pasture areas were not privatised and are managed by local and regional governments. As shown in the table above, privatisation has resulted in a large group of peasant farms, whose average size is slightly over 10 hectares, with much smaller farms in the densely populated south and larger ones in the northern oblasts. The number of members ranges widely, from one to over a hundred members. The successor enterprises to the state and collective farms have been renamed as joint stock companies, collective peasant farms and agricultural cooperatives. These still have average sizes in the range of 1000–2000 ha. and membership from a few hundred to over two thousand individuals.

The range of farm sizes resulting from the privatisation process in Kyrgyzstan is wide, but essentially bi-modal (Childress 2003). Data from a nationally representative sample shown in Table 3.2, indicate 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

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

[4] These totals show about 1.58 million hectares of arable land in the country. This diverges from estimates which indicate 1.8 million hectares. The discrepancy may be explained by the loss of cultivable land during the 1990s.

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.[5]

Table 3.1 Number of agricultural enterprises 1991–2000

	Farm enterprises created by the restructuring of state and collective farms						
Year (end)	**Total peasant private farms**	**of which:**		**Total collective enterprises**	**of which:**		
		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**	71,163	--	--	570	292	45	233
Hectares of arable land	765,425				267,033	69,212	484,039

* not available ** planned by end 2000 + 1 July 1 June
** Data are from 2000–2001 from Gos Register and Republican Center for Land Reform. The number of continuing state farms in 2000 was 61 (hectares 255,091)
Source: RCLAR.

Using the same data source that this paper draws upon, Mogilevski and Childress (2002) provide a comparison of small and large farms (100 hectares being the defining criteria).[6] Their results highlight a range of interesting differences between small and large farms in the North and South of Kyrgyzstan

[5] 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 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.

[6] Farm sizes in the 2002 paper are all based on arable land—pasture is a separate category under state ownership in KR.

based on asset ownership and access. Landowners choosing to leave their holdings in large cooperatives have, on average, less labour per hectare than small farmers. This probably reflects the older population which has remained in the traditional collective farms which tends to have fewer economically active family members. Similarly, the availability of agricultural machinery of each member per hectare is substantially less in large farms than small farms, again probably reflecting the dynamics of privatisation process which allotted machinery generously to an early group of private farmers and the subsequent deterioration of much equipment in the large farm sector. 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 remain in large cooperatives (and thus the dynamic of a persistent but shrinking large-farm sector with a high incidence of bankruptcy): an ageing population with fewer active workers and little machinery will tend to rely more on a few specialist managers under traditional management structures to ensure production and subsistence rather than restructure, in the absence of viable labour opportunities or social protection.

Unlike the analysis performed by Mogilevski and Childress (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 per cent of all peasant farms in the sample.

Table 3.2 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: Mogilevski and Childress (2002), Table 3.

4 Descriptive statistics: characteristics of small scale farming in Kyrgyzstan

There are several ways of classifying farm types, such as by area cultivated or by size of operation. In the 1990s in Kyrgyzstan farms were classified according to group formation (e.g. individual, multi-family, collective, state), 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 this paper we classify the farms into two categories: individual or one member farms (126 farms or 34 per cent of the sample) and groups, comprising between 2 and 48 families (242 farms or 66 per cent of the sample). Related families in Kyrgyzstan tend to live in separate households, retain separate incomes and eat separately, even when they are headed by two brothers. However it is common that related families will live within close proximity within any given village. Furthermore, due to the way in which land was distributed many times related families would request adjacent plots.

4.1. Distribution of physical resources

The most important factors which determine the production capacities of crop farming in Kyrgyzstan is the availability of productive resources, namely: (1) labour; (2) land; (3) machinery and equipment; (4) fertilizers; and (5) irrigation. According to the legal formulas which regulated land distribution during the privatisation phase, land, labour and capital were to be distributed within the agricultural regions of Kyrgyzstan (North and South), based on the size of the existing population of the state and collective farms at the time of privatisation, family size and the years of experience and position of the agricultural workers. Less tangible assets, such as farming skill and connections with elites and political structures, were much more heterogeneously distributed, tending to be concentrated in farm managers and technical specialists. To the extent that resources were distributed in an equitable fashion we would expect to see little difference in terms of the productive resource distribution after privatisation. Table 4.1, however, shows that, on average, group members own, cultivate and rent less land than individual farmers. This suggests that it was families/households of smaller size, and so less labour per hectare, that tended to pool and form groups. On average, the individual farmer cultivates nine hectares of arable land and the familial-group member, 3.7 hectares. The pattern of asset ownership and access per family is strikingly consistent across all asset types, with individual farmers owning and accessing more than familial group members.[7] This suggests that members in groups farms cooperate due to asset constraints problems that would pertain if they were to farm individually.

The last four rows of Table 4.1 show the average assets per hectare for the different farm categories. Here we see both that group farmers have higher labour per hectare and a higher percent of group

[7] 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, machinery ownership and equipment value.

farmers own equipment. This suggests that the pooled assets under group farming are spread over a smaller area that those under individual farming, again reinforcing the interpretation that asset-constrained farmers relieve this constraint by working together.

Table 4.1 Farm characteristics: mean and median values for land and labour per farm and per member

Group type	Unit	Individual	Group	Sign?
Land cultivated per family	Hectares	9.06 8.28	3.74 2.94	S
Arable area owned/family	Hectares	4.27 3.5	2.52 2.08	S
Available family labour per member	Days per year	1054.7 900	666.47 600	S
Hired labour per member	Days per year	20.29 1.72	12.75 0.955	NS
Own equip/member (unconditional)	Som/1000	8.175 3.297	3.229 1.099	S
Own equip/ member*	Som/1000	14.50 55%	4.597 70%	S
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%	
Mean area cultivated by farm type	Hectares	9.06 8.28	16.19 13.65	S
Mean number of workers	Persons	3.51 3	12.74 10	S
Quantities below are per hectare for the farm type				
Workers	Persons	1.14 0.654	1.52 0.869	NS
Days of family and hired labour	Days	346.24 196.7	463.28 266.62	NS
Equipment	Ucc/1000	1.047 0.410	0.992 0.489	NS

- the percentage indicates the percentage of farmers in the samples owning any particular asset.
- sign? Indicates whether the individual and group means are significantly different from one another.
- indicates a conditional mean – conditional on the individuals owning equipment.
- Ucc refers to the User Cost of Capital.

This finding suggests that asset-pooling is a key 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. The assumption that there is an implied causation from asset scarcity to group formation, and not the other way around, is reasonable on a number of grounds. First, due to the way in which assets were distributed post-1990 it is very unlikely that landowners, whether involved in a group or working individually, would have been interested in shedding assets for any reason. On the contrary, qualitative evidence suggests that asset accumulation is the primary concern of most landholders (Sabates-Wheeler 2004). The same study provides evidence to support the view that at the moment of choosing to enter group farming, landowners who chose group farming had less access to resources than those choosing to remain as independent farmers. Second, due to the sluggish land markets and the lack of opportunities for off-farm employment over the last ten years, agriculture has remained relatively static in terms of structure and there has been little incentive for landowners and their families to reduce their assets. In essence, what we are hypothesising is that a shortage of assets-per-member increases the likelihood of achieving economies of scale, asset access or insurance via asset pooling.

While these descriptive indicators suggest a potentially important story about initial asset distribution, they tell us little about relative efficiency of the different kinds of farming arrangements which have emerged. The following sections of this paper deal with the efficiency question.

4.2 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 4.1 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 4.1 reports on the x-axis total area measured in hectares and on the z-axis labour, measured as total labour days (scaled down by 1,000). 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 a given land 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 does not appear to be enough labour available to enter into the increasing marginal returns to labour for individual farmers. This points to a possible inefficiency in the labour market.

Figure 4.1 Perspective plot for the local linear regression of production on the total farming area and total labour for individual farmers

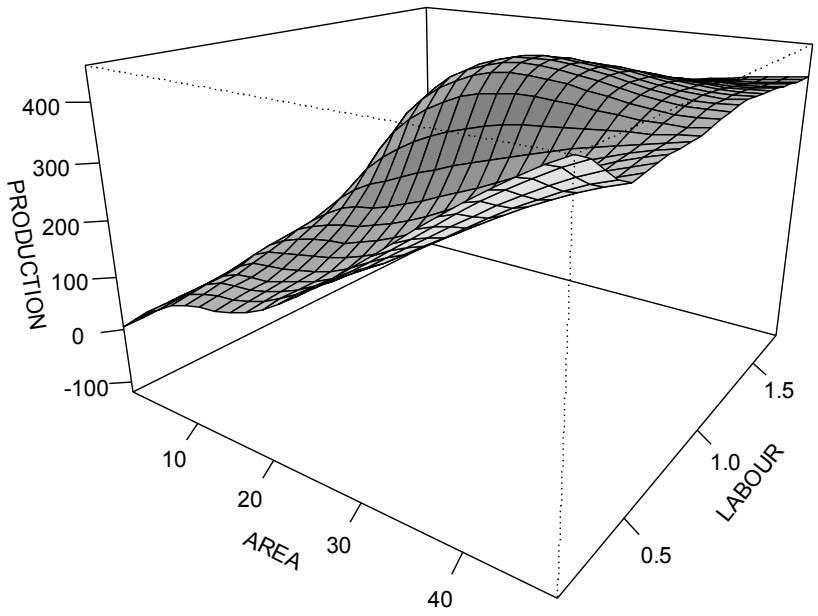

Figure 4.2 Perspective plot for the local linear regression of production on the total farming area and total labour for familial group farms

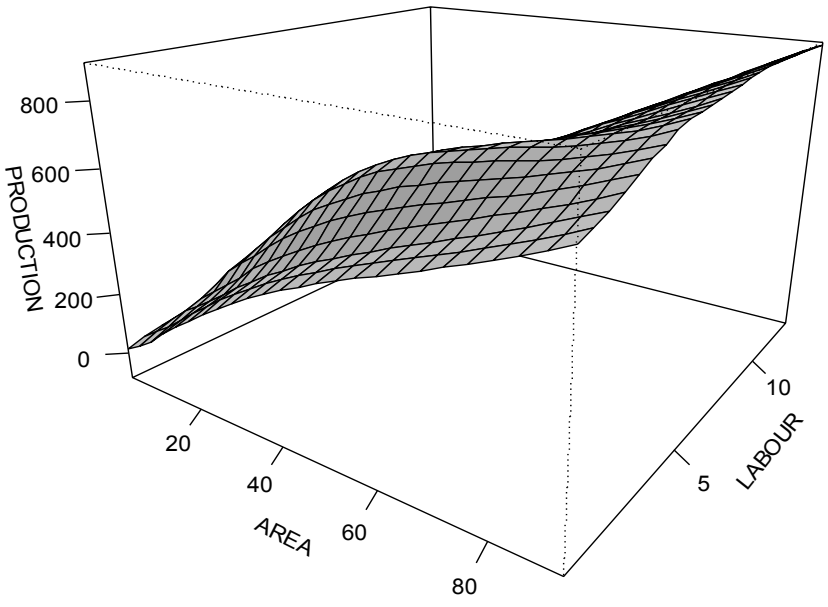

Figure 4.2 presents the same non-parametric regression for familial groups. These again present results which indicate that optimal levels of factor use are not being achieved. First, it seems that these farmers are producing in the region where the observed combinations of land and labour continue to increase production. It does not appear that production values reach 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 increases in production from additional land likewise appears to slow above approximately 40 hectares. There is also a slowing of production incomes after those sizes. These results appear to indicate that small groups are closer to an extension of individual production logic which takes advantage of labour specialisation and asset pooling, than to a corporate or collective production model.

The non-parametric graphs reveal that the individual farmers appear to reach maxima for both land and labour endowments within the band of land sizes distributed during privatisation. 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 continue to increase total agricultural income and create some employment). The shape of the function suggests that individual farmers have little scope for 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.

The advantage of viewing the relationships between outputs and inputs in the above fashion is that we are not imposing a functional form 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 with only land and labour, it is logical to ask what would happen to the relationship between land area, labour, machinery, chemical inputs and other factors of production. These variables interact in more than a simple three-dimensional space, as shown in our graph above. To investigate the more complex relationships between input factors we 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.

4.3 Measuring productivity

Productivity is defined by the amount or value of output produced by a given bundle of inputs. Productivity levels are derived by estimating production functions, which are multiple regress models relating output to all relevant inputs or factors of production (land, labour, machinery, fertilisers, etc). Here we specify 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 4.2.

Table 4.2 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
Machinery	User cost of capital a year (10,000 soms)	2.46	3.54
Irrigate	Area in hectares of cultivated arable land that is irrigated	7.44	11.94
Non-irrigate	Area in hectares of cultivated arable land that is non-irrigated	1.66	4.19
Fertiliser	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
Individual	Dummy variable: 1= individual; 0 = group	1	0

Dependent variable

The dependent variable, output value, is *total value of production from all crops*. Produce from animal production was not included. 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).

$$UCC1=(\delta + i)v$$

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

As is typical in specifying depreciation rates, we assume an annual depreciation rate of 0.12. The value of machinery, v, is a variable collected in the survey, thus the only unknown variable is the interest rate. There are two possible solutions for finding an appropriate interest rate. First, we can use the official annual interest rate in the year that the data was collected, which was approximately 32 per cent. Second, on the basis that rural farmers do not have consistent access to formal credit markets, and very little access to informal credit, we can estimate the interest rate from the survey data using matching methods.[8] The interest rate in this second case was found to be approximately 129 per cent. As this second interest rate seemed unrealistically high we opted for using the official rate. The following results are based on a 32 per cent interest rate.[9]

The variable **irrigate** refers to the land area in hectares of cultivated arable land that is irrigated. **Nonirr** refers to land area in hectares of cultivated arable land that is not irrigated. The total of the two areas comprises the total land area cultivated to arable crops (this is the variable that was used for the non-parametric graphs). This includes land rented-in. In other words, only crop land and crop-related output are included in this analysis. Absent is animal production. We include these variables as an attempt to control for land quality.

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

Labour days*:* this variable refers to the number of labour days that were used in crop production activities last year. It aggregates labour days of the family and labour days from hired workers. The survey obtained data on labour 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 labour 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 labour days per year for hired labour we divided the costs of hired labour by the average daily agricultural wage for 2001: 23 soms/day (source: Kyrgyz National Statistical Committee) to obtain a annual amount of labour days.[10] Family and hired labour were then aggregated. It is often argued that hired labour effort should be valued lower than family labour effort due to a variety of labour monitoring problems and moral hazard problems. However, I did not account for this when aggregating labour for two reasons. First, in Kyrgyzstan hired labour for small-scale

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

[9] We also estimated the regression and TFP using the high interest rate and the signs on the parameters and their significance did not change. Similarly, the TFP results remained the same, with group farms showing a higher productivity that individual farms.

[10] 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 dissimilar 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.

farming is not a common phenomenon and where labour is utilised it is hired on a daily, or even hourly basis. If the same labour wishes to be hired in the next period there is little advantage to be gained from the "slacking" that is often associated with permanent labour. Second, hired labour typically works alongside family labour (the supervisor) thus minimising its chances of slacking. More realistically, the composite variable we use may not be optimal as it is likely to underestimate labour usage due to exchange labour. This is especially true of family farm labour

5 Estimation results

Table 5.1 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 reason we have run the two models separately is to highlight an interesting result. Comparing the parameters of the two models we ran a two-sample t-test to test for the equality of parameters. The results show that the elasticities for machinery, fertiliser and land areas for both groups and individuals are equal to each other (that is, the parameters are not significantly different). What is striking is the large and significant difference with respect to the labour elasticity for individual and group. The parameter for individual is approximately three times higher than for groups, indicating that the percentage change in output for a percent change in labour is three times higher in individual farms, given land size. 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 hectare than group farmers. It may be that hired labour is costlier to supervise than family labour. If group farms could usually rely on group-family labour, but individual farms at the margin had to hire in, that could discourage individual farms from hire and hence labour use. 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.

Given the difference in the labour elasticities and not in other factors, a more parsimonious model was specified. Column three of Table 5.1 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. As expected, we see that changes in labour inputs in individual farms have a significantly greater impact on

productivity than 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 likely to be due to institutional factors, such as labour monitoring and supervision, economies of scale in land pooling and machinery usage. A further understanding of exactly what is driving these differences is presented in complementary work by the Sabates-Wheeler (2004).

Table 5.1 Quadratic production function coefficient values for total sample

	Group	**Individual**	**Pooled**
	N=241	N=126	N=367
Ln(non-irrigate)	0.067**	0.145**	0.085***
	(.0343)	(.0689)	(.0311)
Ln(irrigate)	0.343***	0.453***	0.368***
	(.0530)	(.0934)	(.0463)
Ln(machinery)	0.584***	0.535***	0.591***
	(.0844)	(.1314)	(.0706)
Ln(fertiliser)	0.326***	0.538***	0.359***
	(.0709)	(.1564)	(.065)
Ln(labour)	0.269***	0.715**	0.222***
	(.0749)	(.2834)	(.0736)
Ln(labour) * Type			0.682**
			(.263)
Individual dummy			-0.409***
			(.1383)
Constant	2.966***	2.444***	2.919***
	(.0909)	(.153)	(.0859)
R-Squared	0.739	0.729	0.764
*** (significant at 1% level); ** (significant at 5% level); * (significant at 10% level)			
Performing a two-sample t-test between the parameters shows that labour is the only variable where the group and individual elasticities are significantly different at the 5% level.			

5.1 Post-estimation: total factor productivity

In productivity analysis if 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 included 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:

$$Log(Y_i) = \beta_{0i} + \beta_{1i} Ln(Labour)_i + \beta_2 Ln(Machine) + \beta_3 Ln(Fertiliser) + \beta_4 Ln(Non-irrigate) + \beta_5 Ln(Irrigate) + \varepsilon_i$$

For group farms:

$$Log(Y_g) = \beta_{0g} + \beta_{1g} Ln(Labour)_g + \beta_2 Ln(Machine) + \beta_3 Ln(Fertiliser) + \beta_4 Ln(Non-irrigate) + \beta_5 Ln(Irrigate)\varepsilon_g$$

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:

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

Inputting the estimated values from Table 5.1:

$$Y_g / Y_i = 1.245$$

The results indicate that the output level in group farms is 25 per cent higher than in individual farms. This indicates that group farms utilise their factors of production more efficiently than individual farming. This result is significant at the 5 per cent level.

6 Interpreting results: relevance for policy and the need for qualitative understanding

The non-parametric estimation of the different shape of returns to land and labour, the Cobb Douglas production function estimation and the TFP calculations all suggest that the small and medium-sized group farming formations in Kyrgyzstan provide efficiency advantages versus fully individualised farming. This paper does not attempt to model the causality of these differences. This is done in complementary qualitative work. But the results presented here merit discussion and have some relevance for the set of policies regulating agricultural restructuring and the broader development and poverty reduction framework of the country.

A couple of interesting questions emerge from this analysis. First, is the superior TFP result being driven mainly by the "group" factor and inherent qualities of group activity, or is it being driven by the farm-size factor? The problem with determining this is that farm size has been largely static in Kyrgyzstan and so it is difficult to find a sample of large individual farms that can be compared to family groups. Furthermore, it is almost impossible to untangle the effects of farm size and the group as the grouping

enables individual members to take advantage of factor inputs and production channels due to the larger pool of resources. It is possible that the result is due to farm size rather than grouping, but in the short to medium term this is not a major point because it is grouping which provides the crucial avenue to increasing farm size within static labour and land markets. Second, is it not possible to fully discern whether group arrangements necessarily lead to higher productivity outcomes under the types of conditions characterising Kyrgyz agriculture, or whether small equal family farms will often voluntarily choose methods of cooperation suitable to specific activities, inputs or outputs with scale economies exceeding costs and risks of cooperation. The two ways of looking at this question have quite different policy implications. The first (grouping itself leads to higher productivity) implies a need to encourage group formation and the second a need to encourage grouping around specific activities. This paper has little to say about the specific activities that groups engage in that may be different to individual farms. However complementary qualitative work shows that landholders will group around specific activities where there is a pay-off to cooperative efforts. (Sabates-Wheeler 2004).

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 as compared with individual farms. 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. This is likely to reflect that labour markets are not dynamic or fluid at the moment and thus supervision, screening and search costs in labour markets are high. 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) specialise 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.

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 privatisation and farm restructuring processes and the parallel underdevelopment of factor markets in Kyrgyzstan. While land assets were distributed to households in a relatively equitable fashion in each region on the basis of family size and experience, non-divisible physical assets like machinery and buildings were distributed to groups of shareholders. This "lumpy" distribution of equipment and non-physical assets in a context of limited markets probably encourages grouping. 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 thus provides and 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. The scarcity of machinery thus creates a situation in

which there are obvious incentives to internalise the allocation of these assets within the productive unit (rather than fully marketise them through leasing arrangements), especially for expanding market-oriented production.

Likewise, non-physical, but equally crucial assets – technical and entrepreneurial 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 privatisation and restructuring. It is thus natural that households with fewer physical assets or fewer intangible assets would seek to either exit the sector or form groups with households and individuals with more of these assets. In a 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, including non-farm activities. But such a market solution is impossible in Kyrgyzstan where urban unemployment is high and the agricultural sector actually expanded by about 30 per cent after independence as non-farm work opportunities disappeared.

Another 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 Fund (Childress and Giovarelli 2003). Pooling of resources and mutual assistance can lower the risk for a particular individual or household from certain conditions, although it may create others (further qualitative work by the authors support this hypothesis).

Re-organising 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. 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 individualised production.

In this situation a fully individualised 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 specialisation), 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 2003), and the larger process of disintegration of the old collectives and formation of individualised and small-group production units is the biggest single trend in the country's agriculture.

A question emerges from the above argument: what sort of "intermediation failure" has caused markets not to come up with service providers that will permit small individual farms to obtain the advantages – regarding labour, risk and machinery – that they are driven to obtain by grouping? While the evidence is anecdotal, the explanation seems to be that risks in contracting for payment in the future are very high in Kyrgyz agriculture and that risks for long-term lending are also perceived to very high.

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 neighbours to assure their subsistence, or to reach higher levels of agricultural income, rather than seeking off-farm labour 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 organisation. 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.

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