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A Profit Function Approach to the Efficiency Aspects of Land Reform in Zimbabwe[1]

Abstract: The purchase of commercial farm land in Zimbabwe for resettlement has been a factor in government policy since independence in 1980, but from 1980 to 1989 only 52 000 families were relocated. The Land Acquisition Bill of 1992 made compulsory purchase easier and at present the government has announced its intention to considerably increase the rate of resettlement. But Zimbabwe has a serious food security problem and the output effects of land redistribution are a matter of dispute. The World Bank estimate that 3 million hectares of commercial farmland are under-utilized is contested by the Commercial Farmer's Union. Fitting a normalized restricted profit function to the data for the commercial sector allows estimation of the shadow price of commercial farm land. We find that the model suggests that the World Bank is correct, in that the marginal value product of land is negative, meaning that there is under-utilization. However, negative values of capital assets are common when real interest rates are negative, so the result should be treated with some caution. Also, the problem of identifying the un-utilized land is not trivial and redistributing intra-marginal land would have output effects.

INTRODUCTION

'Zimbabwe's one million communal farm households are restricted to half of the total area suited for agricultural production. The other half is occupied by 4500 large-scale commercial farmers, most of whom are white. To compound this inequality, the communal lands have a much lower agricultural potential; 74 percent of communal land is in natural regions IV and V, and 51 percent of the commercial farming area is in natural regions I-III (CSO, 1989). This grossly unequal land distribution is the most fundamental and least tractable of all Zimbabwe's problems. It is also a significant cause of food insecurity in the rural areas.' (Christensen and Stack, 1992).

There is also, in theory, an efficiency argument for land redistribution, since in any dual economy output can be increased by redistributing resources until their marginal products are equal in the two sectors. But it is widely accepted that the communal farmers cannot produce at the same level as the commercial farmers, without considerable support, and the government is already under extreme pressure to cut expenditures. Without considerable investment, the expectation is that food production would decrease, exacerbating the food security problem. The cost of resettling 52 000 families in 1980–89 has been about $112 million (Bratton, 1991). Christensen and Stack (1992) estimate that 420 000 rural and 125 000 urban households are suffering from chronic food insecurity. In this respect the land reform issue in Zimbabwe is quite different from the situation in South Africa, where output exceeds consumption by a wide margin and food grains are exported at below cost. Self-sufficiency indexes for South Africa (100 = sufficiency), show grain production at 150, horticultural products at 132 and livestock production at 98 (van Zyl *et al.*, 1993). Thus, South Africa can afford to redistribute land, even if the result is a substantial decline in output, but Zimbabwe cannot ignore the possibility that land reform could result in even greater food security problems.

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The food output effect of reducing the commercial acreage is currently being disputed. The World Bank (1991) estimates that there are about 3 million hectares of unused, or under-utilized, commercial farmland, suitable for crop production, that would be suitable for resettlement. This contention is contested by the Commercial Farmers' Union.

Whereas many of the arguments over land reform are complex, the value of marginal land in the commercial sector can be estimated quite simply. One legacy of the colonial past is that Zimbabwe has a statistical system not much different from that of the UK, which has collected agricultural statistics for the national income accounts that can be used for the estimation of production relationships. The data for the commercial sector are qualitatively not much different from the information available in European countries (indeed, better than some). These data were used for the Total Factor Productivity estimates in Thirtle *et al.*, (1993), but direct comparison of the two sectors was deliberately avoided, on the grounds that they are too dissimilar. However, by fitting production, cost, or profit functions to the two sectors separately, estimates of variables such as marginal products and shadow prices of inputs can be derived. These indicate relative factor scarcities, allowing quantification of the costs and benefits of reallocating resources between the two sectors.

THE DUAL PROFIT FUNCTION APPROACH

The profit function provides estimates of a full range of economic variables, whereas the production function and the TFP index concentrate only on the physical relationships between inputs and outputs. The commercial and communal sectors (Jayne, *et al.*, 1993) are treated as single production units to which the restricted or variable profit function (Lau 1972, 1976) is applied. Consider a multiple output technology producing $Y(y_1,...,y_m)$, with the respective expected output prices $P(p_1,...,p_m)$, using n variable inputs $X(x_1,...,x_m)$, with prices $W(w_1,...,w_m)$. Define variable expected profits as:

$$(1)\quad \pi = m\sum_{i=1}^{m} p_i y_i - \sum_{j=1}^{n} w_j x_j = P'Y - W'X$$

Normalising the profit function with respect to an output or input price has the practical advantages of ensuring that the homogeneity requirement is met and reducing the number of parameters to be estimated. The normalized expected profit function can be represented as:

$$(2)\quad \prod^{*} = \prod^{*}\left(\frac{P}{w_0}, \frac{W}{w_0}; Z, \Theta\right) = \frac{\pi^{*}(P, W; Z, \Theta)}{w_0}$$

where w_0 is the price used for normalization, P is the output price vector, W is input prices, Z is a vector of fixed inputs, Θ is the vector of 'shift' variables (such as R&D) that increase productivity over time, and '*' indicates optimized levels. The numeraire input demand can be obtained residually from Equation 2 as:

$$(3)\quad x_0^{*} = -\prod^{*} + P'Y^{*} - W'X^{*}$$

The functional form employed is the generalized quadratic, which is defined as:

$$(4)\quad \prod = \alpha_0 + \alpha'\hat{P} + \delta'\Theta + \frac{1}{2}\hat{P}'\beta\hat{P} + \frac{1}{2}\Theta'\Phi\Theta + \hat{P}'\gamma\Theta$$

where $\hat{P}$ is the stacked vector of normalized output and input prices, $(P,R)'$ and Θ is the stacked vector of quasi-fixed, fixed and conditioning factors $(Z,\theta)'$. The vector $\alpha\,(\alpha_1,..,\alpha_{m+n-1})$ and matrices $\beta(\beta_{ij};\ i,j=1,...,m+n-1)$, $\varnothing(\varnothing_{gh};\ g,h=1,...,K+L)$ and $\gamma(\gamma_{ig};\ i=1,...,m+n-1,\ g=1,...,k+1)$ contain the parameter coefficients to be estimated. Applying Hotelling's lemma, we derive the optimal levels of output supply and input demand:

$$(5)\quad y_i^* = \alpha_i + \sum_{j=1}^{m}\beta_{ij}p_j + \sum_{j=m+1}^{m+n-1}\beta_{ij}w_j + \sum_{g=1}^{k+1}\gamma_{ig}\Theta_g,\quad i=1,...,m$$

$$(6)\quad -x_i^* = \alpha_i + \sum_{j=1}^{m}\beta_{ij}p_j + \sum_{j=m+1}^{m+n-1}\beta_{ij}w_j + \sum_{g=1}^{k+1}\gamma_{ig}\Theta_g,\quad i=m+1,..,m+n-1$$

and the level of the numeraire input can be derived residually from Equation 2.

Denoting non-normalized or actual expected prices with a superscript '^{A}', the elasticities of outputs and inputs to prices for the non-numeraire cases are:

$$(7)\quad \eta_{ij} = \frac{1}{w_0}\beta_{ij}\frac{p_j^A}{y_i},\quad i,j=1,...,m$$

$$\eta_{ij} = -\frac{1}{w_0}\beta_{ij}\frac{w_j^A}{x_i},\quad i,j=m+1,...,m+n-1$$

and the price elasticities relating to the numeraire are derived from Equation (3).

Convexity of the profit function with respect to prices requires that the own-price elasticities should be positive for an output and negative for an input. The cross-price elasticities for pairs of inputs are negative for complementary inputs and positive for substitutes. For pairs of outputs, positive cross-price elasticities imply complementarity in supply and output substitutes are indicated by negative cross-products.

If the elements of Θ are treated as short-run constraints on production, we can derive the effects of relaxing the Θ variable constraints on the output and variable input levels. We can derive these effects in elasticity form by logarithmic differentiation of Equations 5 and 6 (and Equation 3 for the numeraire input) with respect to the elements of Θ:

$$\varepsilon_{ih} = -\frac{\Theta_h}{y_i}\gamma_{ih},\quad i=1,...,m;\ h=1,...,k+1$$

$$(8)\quad \varepsilon_{jh} = -\frac{\Theta_h}{x_j}\gamma_{jh},\quad j=m+1,...,m+n-1;h=1,...,k+1$$

$$\varepsilon_{og} = -(\delta_g + \sum_{j=1}^{k+1} \Phi_{gj}\Theta_j)\frac{\Theta_g}{x_0}, \quad g = 1,..,k+1$$

Shadow prices for the variables in the Θ vector can be derived as partial derivatives of the profit function (Diewert, 1974; Huffman, 1987). The derived shadow values can be interpreted equivalently as (a) the marginal change in profits for an increment in a particular element of Θ (b) as the imputed rental value for an additional unit of that factor or (c) the effects on expected profit of relaxing the particular constraint represented by each Θ variable. The shadow value equations are:

$$(9) \quad \lambda_g = \frac{\partial \pi}{\partial \Theta_g} = w_0 \frac{\partial \prod}{\partial \Theta_g} = w_0(\delta_g + \sum_{h=1}^{k+1} \Phi_{gh}\Theta_g + \sum_{i=1}^{m} \gamma_{ig} p_i + \sum_{j=m+1}^{m+n-1} \gamma_{jg} w_j$$

The shadow value of land (treated as fixed) provides the implicit value in production as opposed to the market price. The difference between the market price and shadow value indicates whether land is over, under or optimally utilized. The shadow prices of the other conditioning factors (such as R&D) can be used to assess their effectiveness.

RESULTS AND INTERPRETATION

The data are described in some detail in Thirtle *et al.* (1992). For the commercial sector the outputs are; food crops (Y1), industrial crops (Y2) and livestock and livestock products (Y3). The variable inputs are hired labour (XL), livestock inputs (XV), chemical/crop inputs (XC), and running costs (XO). The two capital inputs, farm vehicles (CAP) and Buildings (BLD) are treated as quasi-fixed. The total area of land (LAND) in the commercial sector is included as a fixed input. Other fixed, exogenous or conditioning factors included are, research and extension (RES), rainfall (RAIN), world agricultural patents (PAT) (included to catch the effects of technological spillovers).

Table 1 summarizes the short-run elasticities of supply and variable input demand with respect to prices, quasi-fixed inputs and conditioning factors at the variable means. The significant own-price supply and demand elasticities (on the diagonal) have the expected sign and are of plausible magnitudes[2]. The own-price elasticity of the industrial crop aggregate has the wrong sign, but the *t*-statistic indicates that the elasticity is not significantly different from zero. Apart from livestock-related inputs (not significant), the variable input own-price elasticities have the expected signs. All the own-price output supply and input demands are inelastic.

For the outputs, complementarity (substitutability) is indicated by a positive (negative) cross-price elasticity. Thus, industrial crops and livestock are complements and food crops are not related to industrial crops or livestock, due to the *t* values. Input complementarity (substitutability) is indicated by a negative (positive) cross-price elasticity. Thus, livestock inputs and running costs are complementary and crop inputs and running costs are substitutes. Labour, livestock inputs and crop inputs are all substitutes for one another.

If we consider the quasi-fixed, fixed and conditioning factors as constraints in production, the long-run output and variable input elasticities with respect to these factors can be regarded as the responses to relaxing these constraints. The quasi-fixed inputs are stock variables that are endogenous in the long-run, but changing their levels requires

investment. Thus, in the short-run, the costs of adjusting these stock levels may be considered in terms of foregone production. The levels of the conditioning variables are assumed to be beyond the control of farmers and the costs of adjustment are not considered to be incurred by farmers. Thus, since the reported elasticities are short-run, we might predict net negative output elasticities with respect to fixed and quasi-fixed factors and positive output elasticities with respect to the conditioning factors representing technology. However, the effect on individual outputs cannot easily be predicted, as changing capital stock levels or technology levels may favour certain outputs and also affect the variable input levels, which in turn affects output.

Table 1 *Estimated Elasticities*[a]

Exp	Dependant Variable						
Var	Y1	Y2	Y3	XL	XV	XC	XO[b]
P1	**0.8**	**−0.08**	**−0.10**	−0.15	−0.44	0.36	0.33
	(4.4)	(−0.99)	(−1.2)	(−3.8)	(−4.4)	(2.92)	(1.6)
P2	**−0.19**	**−0.31**	**0.47**	0.33	0.68	−0.29	0.37
	(−0.98)	(−1.6)	(2.8)	(4.1)	(3.6)	(−1.8)	(0.73)
P3	**−0.14**	**0.28**	**0.83**	−0.44	−0.21	−0.53	0.49
	(−1.2)	(2.8)	(3.4)	(−3.9)	(−0.74)	(−3.9)	(1.5)
WL	−0.24	0.22	−0.5	**−0.11**	**0.33**	**0.27**	**0.06**
	(−3.8)	(4.1)	(−3.9)	(−1.4)	(1.95)	(2.97)	(0.34)
WV	−0.34	0.22	0.11	**0.16**	**0.33**	**0.3**	**−0.84**
	(−4.4)	(3.6)	(0.74)	(1.95)	(0.97)	(2.76)	(−3.2)
WC	0.34	−0.11	−0.35	**0.16**	**0.36**	**−0.4**	**0.32**
	(2.9)	(−1.8)	(−3.9)	(2.97)	(2.76)	(−3.8)	(1.9)
WO	−0.32	−0.15	−0.34	**0.04**	**−1.1**	**0.33**	**−0.84**
	(−1.6)	(−0.73)	(−1.5)	(0.34)	(−3.2)	(1.9)	(−1.2)
CAP	**−1.29**	**0.33**	**1.4**	**0.34**	**2.1**	**−0.46**	**11.9**
	(−1.8)	(0.78)	(3.6)	(1.8)	(4.5)	(−0.9)	(3.4)
BLD	**−0.14**	**−0.69**	**−1.88**	**0.07**	**−0.74**	**0.99**	**−6.2**
	(−0.2)	(−1.8)	(−4.4)	(0.37)	(−1.54)	(2.0)	(−3.4)
LAN	**−0.24**	**−0.54**	**1.0**	**1.1**	**0.6**	**0.14**	**4.7**
D	(−0.49)	(−2.0)	(3.4)	(7.8)	(1.7)	(0.4)	(3.1)
RES	**0.9**	**−0.12**	**−0.16**	**−0.04**	**0.5**	**0.96**	**−1.6**
	(2.1)	(−0.5)	(−0.64)	(−0.39)	(1.8)	(3.2)	(−1.2)
PAT	**0.58**	**−0.07**	**−0.24**	**−0.27**	**0.06**	**0.48**	**−2.7**
	(1.7)	(−0.4)	(−1.4)	(−3.4)	(0.3)	(2.1)	(−2.2)

Notes: [a] *t*-values are in parentheses; the critical value is taken to be 2.26.

[b] *t*-values are not computed for numeraire input elasticities as the numeraire input and the derived elasticities are gained residually from Equation (6).

The food crop output elasticities follow the predicted pattern; with respect to machinery, building stock and land the elasticities are negative (but insignificant), and positive with respect to research and international technology spillovers. All the elasticities for the industrial crops are insignificant and for livestock, machinery and land appear to increase output, even in the short-run.

The effects of changes in the fixed inputs and technology variables on the variable inputs are mostly insignificant, but increasing machinery increases livestock inputs and running costs. Increasing buildings reduces running costs and increasing land raises both labour inputs and running costs. For the technology variables, R&D increases crop inputs (which is reasonable, since improved varieties use more fertilizer and pesticide), but technology spillovers reduce both labour inputs and running costs. This is entirely sensible, since the majority of patents are for machinery.

SHADOW PRICES

The shadow prices for the quasi-fixed, fixed and conditioning factors provide measures of the implicit value in production of additional units of the factors. In equilibrium, the shadow price of a quasi-fixed factor should equal its opportunity cost, or rental value. Excess capacity or under-utilization of a quasi-fixed input would be indicated by an estimated shadow price less than the opportunity cost. Similarly, under investment is indicated by a shadow value greater than the opportunity cost, indicating that revenue can potentially be increased by increasing the stock of the quasi-fixed factor until the shadow price equals the opportunity cost (Berndt and Fuss, 1986; Morrison, 1986).

The economic reasoning behind these propositions is sound enough, but does not take good account of economies with persistent high inflation and negative interest rates. In such circumstances, the opportunity cost of capital investment is negative, but rental rates are not. For Zimbabwe, the opportunity cost is taken to be the real return on bank deposits: the rate has been negative since 1976. For long-term investments, such as 25–year government stock, the average real rate of interest has been negative since the mid-1980s.

This implies that a rational farmer should invest in capital up to the point where the return is negative. The Zimbabwe case is further complicated by rationing and allocation of farm machinery, which would suggest that the supply is inadequate (at these prices). These factors should be taken into account in interpreting Table 2, which reports the mean values of the estimated shadow prices of capital, buildings, land and the technology variables. As the capital stocks are derived as aggregate values divided by capital price *indexes*, there are no appropriate and observable corresponding market rental prices. The appropriate opportunity cost of machinery capital is assumed to be proportionate to and the same sign as the real rate of return on bank deposits (Bouchet, 1987) and similarly, we expect the opportunity cost of buildings to be proportionate to and the same sign as the real rate of interest on 25–year stock.

There is no simple way to interpret the results. The estimated shadow price of capital was negative throughout the period, but was increasingly negative post-independence. This is wholey consistent with the increasingly negative real interest rate, post-1976. With no further information this should be taken to mean over-investment in machinery in the early part of the period. The annual series cannot be reported here, but the opportunity cost criterion shows over-capitalization up to 1976. This is not surprising, since sanctions were in force until independence and since then the shortage of foreign exchange has limited imports. From the employment viewpoint, the 'shortage' of machinery is a positive factor, as an increasingly negative opportunity cost of capital implies that machinery should have

been further substituted for labour. The employment consequences of getting prices wrong to this extent are shown in Thirtle *et al.*, (1993b), for South African agriculture.

For buildings, the results are not significant, but if they were, the shadow price is positive up to 1981 and negative thereafter and is thus consistent with the real returns on long term financial investments. The shadow price of land is negative and highly significant. A negative shadow price for land implies that land area is not an effective constraint to production in the commercial sector. The shadow values become even more negative over the period, even after the policy of land redistribution from the commercial sector to the communal areas. Possible reasons for this include the adoption of new chemical and biological technologies that effectively substitute for land. This is supported with respect to the food crop and industrial crop outputs by the negative elasticities of these outputs with respect to land area. It is also possible that the land redistribution has only removed under-utilized or low quality land from the commercial sector. Even after about 15 percent of the commercial land has been purchased for resettlement, land still does not represent an effective constraint to production.

Table 2 *Shadow Prices of Fixed Inputs and Conditioning Factors*

SP of CAP	OC of CAP	SP of BLD	OC of BLD	SP of LAND	SP of R&D	SP of PAT
–0.82	–2.27	0.0105	1.02	–72.4	1.5	108.8
(–8.44)		(0.13)		(–8.2)	(0.74)	(4.2)

Note: *t*-values in parentheses.

Lastly, the shadow price of patents is positive and significant, indicating that international spillovers are important. This cannot be easily quantified because the series is the number of patents registered, which has no obvious connotations, in terms of financial magnitudes. However, R&D, which has an insignificant shadow price, was significant for food crops (Table 1), and for this a rate of return can be estimated (Stranaham and Stonkwiler, 1986). Assuming a lag of five years we derive an estimated internal rate of return to public sector research of 36 percent.

Thirtle *et al.*, (1993) derived an IRR of 43 percent using the same approach, in a primal translog production function model. However, no account was taken of international spillovers in that model, implying that some upward bias existed in the estimated IRR due to the omission of international spillovers.

CONCLUSIONS

The model suggests that the World Bank is correct, in that the marginal value product of land is negative, meaning that there is under-utilization. However, negative values of capital assets are common when real interest rates are negative, so the result should be treated with some caution. The extent of the distortions of macroeconomic variables, such as the interest rate, must have a considerable effect on the efficiency of resource allocation in the agricultural sector. The combination of the over-valued exchange rate and negative real interest rates would lead to undue substitution of capital for labour. With

unemployment estimated at about one million, minimising employment in agriculture makes no sense at all, and has only been restricted by the shortage of foreign exchange.

NOTES

[1] The authors would like to thank USAID for generous financial support for part of this work.

[2] The elasticities that are meaningful are in bold print; the others are not discussed.

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DISCUSSION OPENING — Mamou K. Ehui *(United Nations Econonomic Commission For Africa)*

The paper written by Dr Khatri *et al.*, is an important and interesting piece of work, both conceptually and empirically. It is interesting conceptually because the application of duality theory to the agriculture sector has become very popular recently. This is due to many of its advantages in terms of flexibility in the specification of factor demand and output equations use for policy analysis, and mainly because duality permits a very close relationship between economic theory and practice. Empirically the paper is an important piece of work because it raises the very important concern of Zimbabwean policymakers; that of land redistribution and its eventual consequences on the food security situation. The paper thus provides both a theoretical and an empirical contribution to the understanding of implications of land reforms. I read the paper with respect and I must congratulate the authors on their success in obtaining fairly satisfactory results that are consistent with a priori expectations and findings of the World Bank. However, since the paper treats an important policy issue and involves many explanatory variables, its results also lead to several conflicting and unanswered questions.

To open the discussion, I want to raise a series of questions which hopefully will help us to reconsider their conclusions or reanalyse the study. Starting with the data, I would like to know more about the type of data, the quality and how it has been analyzed. I can understand that space limitations did not allow presentation of some details. But, for this type of analysis, aggregation problems must be expected. How are variables like capital and buildings measured? Improper measurements can lead to inconsistency of the coefficients. I consider these issues to be an important because elasticity estimates are usually very sensitive to data construction.

The second point that is worth raising is linked to the model specification and the regression technique used. There are some dynamic issues that should have been modelled explicitly. For example, the effects of R&D or the generation of new technologies on hired labour and prices must be questioned, especially the long run effects. Changes in fixed variables such as vehicles and buildings are likely to be driven by both productivity and price indices. My suggestion is that the profit function and the demand and supply fuctions could have been estimated simultaneously.

The third point that I would like to raise is related to the interpretation of the results. It seems to me that the authors have derived theory and the empirical evidence from the model. It should have been the other way around. For example, it is said that industrial crops and livestock are complements and food crops are not related to industrial crops or livestock due to *t*-values. The authors went even further by indicating that input complementarity is indicated by the negative cross price elasticity. Thus livestock inputs and running costs are complementary and crop inputs and running costs are substitutes. And all these are based on the significance of t values. These conclusions could be true, but I would like the author to consider the following questions. What if the model is mispecified? What if the data are not reliable? What if we have opposite signs, would the conclusion be the same? I think it could have been better to compare the results with real life situations. I leave this to people who know Zimbabwe very well to testify. The authors could have gone further by asking what would have happened to the shadow price of land if all government subsidies were removed? Would communal land owners be able to exploit unutilized land at its optimal capacity?

The question of food security does not seem to be addressed. Does the expected ouptut increase from land reform contribute to acheiving greater food security? As you know, food security is not only a matter of increasing production, but also of improving support services such as credit, infrastructure and policies so that less fortunate people can have access to minimun requirements. The issue is of capital importance because food security problem is likely to be more acute for communal land users to whom unutilized land is being redistributed. Perhaps in this case, and given that implications for food security issue have been raised, the duality problem should account for both price as well as non price factors.

In my opinion, the questions that I have raised have important implications both for the model and the conclusion. I leave these open for discussion.

GENERAL DISCUSSION — Terrence S. Veeman, Rapporteur *(University of Alberta, Canada)*

All the papers in this session, as the Chair, H. Behrmann (South Africa) noted, dealt with land issues: land rental markets in sub-Saharan Africa where land was scarce but underutilized; impacts of property rights, market access and food transfers on the technical efficiency of small scale farms in north-east Argentina where land is plentiful; and efficiency aspects of land reform in Zimbabwe where land is currently very inequitably distributed and large-scale commercial farming by a tiny racial minority occurs on the nation's best land.

It was suggested that the initial presentation on land rental market in sub-Saharan Africa used the tools of the transactions cost approach to arrive at its conclusions, rather than denying that approach to the analysis of land tenure and institutional change. It was also queried whether the policy recommendations, while sensible, arose tightly out of the analytical framework. Debate also ensued on whether widows on customary land could retain use rights and utilize land rental as a vehicle for cash flow on whether use rights and rental income would revert back to the headman. In any event, it was concluded that an evolutionary shift to more exclusive and assured property rights in land would foster a more active land rental market in the region.

The paper on Argentina, ably presented by H. Pagoulotos in the absence of the authors, focussed on small scale farming, largely by squatters, in a slash-and-burn type of cultivation. The main concern of the audience, echoed by the discussant, was that such shifting cultivation was unlikely to be sustainable in the long run. The short-run static conclusion that property rights were not a significant institutional influence on technical efficiency of these small scale farms was very unlikely to hold in a dynamic and long-run setting. It was noted, however, that the paper involved interesting econometric techiques for isolating the influence of institutional factors such as ownership and food transfers on technical inefficiency.

The most lively audience reaction was to the paper on land reform in Zimbabwe, the host country. There can be no denying the equity rationale for land reform in Zimbabwe. What is less clear is the efficiency impact of land reform and whether (and to what extent) land held by the commercial farming elite is under-utilized, as alleged by the World Bank. There were varying critiques of the profit function (duality) approach used by the authors, including the lack of attention to institutional detail (such as the inability to sub-divide land) historic input market distortions, concerns about unreliable data, the lack of consideration of risk and dynamic features, and the general applicability of such sophisticated models to the conditions of less developed countries. The author, in trying to use the duality approach to estimate the shadow prices of factors including land, cautioned that the finding of a negative shadow price for land did not necessarily imply the underutilization of land but might have resulted from the very adverse macro-economic conditions which had often prevailed during the time period in southern Africa.

Taking part in the discussion were M. Hubbard (UK), G. Rozell (Malawi), F. Mucavele (Mozambique), R. Johnson (New Zealand), S. Dittoh (Ghana), O. Mbatia (Kenya), K. Muir-Leresche (Zimbabwe), H. Walker (Zimbabwe), S. Ehui (Côte d'Ivoire), C. Mataya (Malawi) and M. Lyne (South Africa).