ECONOMIC ANALYSIS OF FACTOR ALLOCATION BY ZAMBIAN TOBACCO FARMERS

BY

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A Thesis Submitted To The Faculty Of Graduate Studies In Partial Fulfilment Of The Requirements For The Degree Of

MASTER OF SCIENCE

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Date: October 7, 1994

DEDICATION

To all those who have tried, and keep on trying, in our family; especially Derrick, Fatima and Roosevelt.

ABSTRACT

The purpose of this study is to construct and estimate a model of production behaviour for tobacco farmers in Zambia. Tobacco is a major export crop for Zambia. The final data set consisted of annual production and price data for fifty farmers over three seasons (1990/91 to 1992/93). Production behaviour is modeled in terms of a Translog dual cost function and an output supply response equation derived from the first order conditions for profit maximization.

Econometric results suggests that there are dis-economies of scale of in tobacco production. In addition estimated results suggest that marginal costs of production are increasing over the time period (as indicated by a negative coefficient for time trend in the output supply equation). Reciprocity conditions for cost minimization were not rejected. The elasticity of tobacco output supply response was estimated as +2.6. The high elasticity may be explained by a preponderance of commercial farms in the data set and by the seriousness of foreign exchange constraints to farmers over the period of study.

ACKNOWLEDGEMENTS

Many, many thanks to the Canadian International Development Agency (CIDA) for giving me a scholarship. I'm very grateful to Professor Len Siemens who has been there for me and the other CIDA-sponsored students from Zambia.

I would like to extend my special thanks to Gerry and Linda Penner who took me into their family upon arrival at Winnipeg International Airport. They certainly have been an excellent example of the Canadian way of living.

I would also like to specially thank my principle advisor Dr. Barry T. Coyle for advice, guidance and assurance, even during my anxious moments. Academic and support staff of the Department of Agricultural Economics, University of Manitoba, made my stay in Canada be filled with fond memories. I just wish I had attended a lot more of those social gatherings.

I would like to thank the members of my Thesis Committee for their effort in helping shape and improve the quality of this piece of work. However, I maintain the sole authorship of this thesis, and therefore bear full responsibility for any errors or mistakes contained in it.

ABBREVIATIONS

BOZ	Bank of Zambia
CFB	Commercial Farmers Bureau
EAZ	Economic Association Of Zambia
Ha	Hectares
Kg	Kilograms
lb(s)	Pound(s)
NATCO	National Tobacco Company (of Zambia)
TAZ	Tobacco Association of Zambia
TBZ	Tobacco Board of Zambia
USDA	United States Department of Agriculture
VTAZ	Virginia Tobacco Association of Zambia

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CHAPTER ONE

INTRODUCTION

This research is an economic analysis of allocation of scarce resources by the Zambian tobacco farmers. Zambia has been undergoing tremendous changes in its economic orientation - from socialist market economy to the capitalist market economy. Because the price controls were being done away with devaluation and high levels of inflation set in the economy. Credit to the farmers has become expensive. Since it takes at least six to eight months for farmers cultivating crops to realize some revenue, and the fact that they usually depend on weather, there is a greater risk in lending money to farmers.

1.1 PROBLEM STATEMENT

Foreign exchange shortages have been forcing people to engage in economic activities they would rather not engage in. Tobacco, being the second leading export crop, provides the much needed foreign exchange. Since all entrepreneurs are in business to maximize their welfare (profit) some farmers have been growing tobacco rather than food crops because tobacco has a relatively high profit margin. The limited resources at the disposal of farmers are diverted to tobacco production. This is the issue that is analysed in this research effort - whether tobacco farmers rationally allocate their resources.

1.2 OBJECTIVES

The main objective of this research is to apply a model that will closely describe tobacco farmers' behaviour. In determining whether these farmers are efficient resource allocators, comparative statics will be applied to analyse the impact of the variable costs, output prices, and factor prices on the tobacco farmers' behaviour. In so doing, I hope to come with some policy suggestions of allocating factors of production between the various competing end uses. The output will be important for the government policy makers who have to gauge priorities.

The output of this research will be in form of information on parameters such as elasticities and rates of change, which the government can use in its policy formulation. There is need to know the direction and magnitude of the tobacco farmers' responses to changes in factor prices or output prices or generally effects on output by changes in operating costs. The government should be concerned because tobacco has been the second largest (if not the first) foreign exchange earning crop for farmers. Policy implications of the results are to be seen in terms of the government devising and revising income stabilisation programmes to improve the welfare of the farmers. The government can make farmers switch from tobacco to some other agricultural activity deemed important and probably more or equally profitable by offering more information and incentives since the data on the magnitudes and directions of change needed will be available.

Although, it is difficult to make long-term investment plans involving larger amounts of capital or infrastructure movements under the current economic conditions in Zambia, at least the information should be there for use by tobacco farmers and those contemplating going into farming as such.

1.3 HYPOTHESES

The general hypothesis to be tested is whether tobacco farmers' behaviour is consistent with cost minimization theory. Specific hypotheses such as whether factor prices have any effect on the behaviour of farmers, whether tobacco price has any significant effect on tobacco output and cost will be tested.

Despite its importance to the farmers and the Zambian economy as a whole, tobacco has not received as much attention as other crops. Most of the initiatives come from tobacco farmers themselves. Whether it be marketing or provision of extension services or credit, tobacco farmers have not been affected much by government policy.

1.4 DATA

Primary data, collected from the farmers for the 1990/91-1992/93 crop seasons, was used in running the model. Data was collected on the following variables:

-Unit price and amounts produced of Tobacco,

-Unit price and quantity of Fertilizer,

-Unit price and quantity of Seed,

-Wage rate and number of workers,

-Unit price and quantity of Chemicals,

-Number of hectares and rental fees per hectare for tractor services, and

-Size of the farm.

Also some secondary (Time-series) data on the prices and quantities produced of maize and tobacco was collected. All this data is located at Appendix B.

1.5 METHODOLOGY/PROCEDURE

Analytical Procedure follows from Duality theory. The adopted mathematical form for the model is the transcendental logarithmic cost function suggested by Laurits Christensen. I opted to derive the factor share equations, which were used for estimating the elasticities of demand (or substitution), rates of technological change, etc by use of the Seemingly Unrelated Regression (SUR) method. SUR is equivalent to the maximum likelihood estimates, which yields more efficient estimates than OLS in cases involving simultaneous equations.

1.6 ORGANISATION OF THE THESIS

Major components of this thesis in terms of organisation are Chapter 1 which is serves as the introduction (and finishes with this paragraph); Chapter 2 carries the theory and model; chapter 3 is devoted to description of the data set and estimation procedure; Chapter 4 discusses the results of the estimated model while Chapter 5 is the conclusion/summary.

Chapter Six: Appendix A is where I have put the historical background of the tobacco industry of Zambia. Appendix B contains the results of most of the tests performed on the model to check whether it confirms with the economic theory. Appendix C contains the cross-section data that was collected from the farmers. There is also some secondary time-series data as well.

CHAPTER TWO

THEORY AND MODEL

2.1 THE THEORY

A production function can be defined as follows:

$$Y = f(\ L,\ K,\ F,\ H,\ W,\ ) \ .$$

Y is the amount of output produced, L is the number of workers, K is the amount of capital, F is the amount of fertilizers, H is the number of hectares, and W is the weather variable. In a more specific mathematical form, U is included as the error term to encompass all other variables not explicitly expressed in the model.

The production function is a purely technical relationship without economic content. It is required of a proper production function that for every combination of inputs there correspond a unique level of output. Since the entrepreneur will want to maximize output, we presume that the production function yields the maximum output for an input vector (Chambers, 1988).

The properties of the production function f(x), where x is a vector of input variables, are:

1. If $X' \geq X$, then $f(x') \geq f(x)$, a property referred to as monotonicity;
2. f(x) is quasi-convex;
3. f(x) is finite, non-negative, single, and real-valued for all non-negative, finite x; and

4. f(x) is a twice continuously differentiable function. All marginal productivities are positive. The input requirement set is convex i.e. law of diminishing marginal rate of technical substitution is satisfied.

In carrying out the analysis we make use of the measures of single input variation such as the average product and marginal product given respectively by $AP_i = \frac{f(x)}{x_i}$ and $MP_i = \frac{\partial f(x)}{\partial x_i}$. A unit-free measure of the marginal productivity is the elasticity of output with respect to x_i, whose formula is $\varepsilon_i = \frac{\partial f(x)}{\partial x_i} . \frac{x_i}{y}$. (Note that x_i is an input in the input vector X).

Elasticity of substitution between inputs x_i and x_j is given by $\sigma_{ij} = \frac{\partial(x_j/x_i)}{\partial(f_i/f_j)} . \frac{f_i/f_j}{x_j/x_i}$. The elasticity of substitution, σ, is interpreted as a measure of the curvature of the isoquant in the input space (Chambers, 1988). It is a symmetry measure of substitutability between two inputs.

We are interested in these comparative statics of a production function, and if we can derive them in another way with fewer econometric problems the better. An alternative to using the production function, for deriving the elasticities and factor demands, is the use of the dual cost function. The static cost minimization model imply long-run equilibrium, though not necessarily, and therefore extreme restrictions come into play.

The standard assumptions underlying this model are that:

(a) The economic agents (farmers) behave rationally,

(b) There is free entry and exit from the industry (tobacco sub-sector). There are no restrictions on any farmer to engage in or abandon production of tobacco.

(c) All the firms (farmers) are price-takers i.e. no farmer can be big enough to be a monopolist in the commodity market, or big enough to be a monopsonist in the input market.

(d) The dynamic process is assumed away because it requires modelling expectations and adjustment costs, which complicates our model.

The advantages of using the dual cost function are given below, but first here is the notation that will be used in the cost function: C^* is the minimum cost of producing a unit of tobacco, W the vector of factor prices, Y the output and X^* the vector of chosen input variables. The input variables X_i depend explicitly on exogenous variables W (factor prices) and the pre-determined output level (Y), and implicitly on the nature of technology. There is also a quasi-fixed input in the model - the amount of land put to tobacco. The properties of the dual cost function depend on production function.

The advantages of using the dual cost function are as follows:

1. There is greater flexibility in specification of input demand functions X(w,y)
2. Hypothesis of cost minimization is readily tested in the framework of input demand equations (functions)

3. Omitted variables from econometric model do not affect factor prices to the same extent they affect production decisions. In the production function if the covariance between the error term e and explanatory variables X_i is not equal to zero e.g. e may include managerial ability which influences the choice of X, then the simplest model estimators (OLS, SUR) are inconsistent.

On the other hand, within the dual approach, there is less likely to be a violation of the basic econometric assumption that the covariance between the error term and the factor price equals zero. In the cost function only one variable (output y) may covary with the disturbance e; whereas in the primal approach all explanatory variables X covary with e. However factor prices may be highly collinear in cross-sectional data.

The short-run cost function C(w,K,y) is defined at the industry level. It is assumed that the hypothesis of static competitive profit maximization and identical prices over firms holds. Thus, if rental prices and output prices are identical across firms, then the cost function C(w,K,y) for individual firms satisfy the conditions for consistent linear aggregation over static competitive profit maximizing combinations of K, y (Coyle, 1990).

Given an output level, we can explain input decisions made by the farmers in static terms. The objective function of the producer formally stated as a static cost minimization problem, is of the following form (long run):

Minimize $WX \qquad \equiv C(w,y)$

s.t. $f(X) = Y$

where X is the vector of input variables defined by least-cost combination on the expansion path; W is the vector of input prices; Y is the fixed level of output, and C is the total cost of production. The short-run cost minimization problem is

Minimize $WX \qquad \equiv C(w,y,\bar{k})$

s.t. $f(x,\bar{k}) = y$

$\bar{k}$ stands for the input which is fixed in the short-run.

There is no specification of how output is determined by the farmers in this case. The cost function, denoted by C(w,y), depends on the technology since the only constraint to the minimization problem is that X be capable of producing at least output y. If the production function satisfies properties of monotonicity, weak essentiality; and f(x) is finite, non-negative, real-valued for non-negative, finite x; then the cost function will satisfy the properties of an econometrically meaningful production function.

The properties of the cost function, briefly stated are (i) it is linear homogeneous of degree one in w, implying that the derived factor demands are homogenous of degree zero in input prices (the partial derivatives of the cost function). All derived demand responses to the input prices can be computed directly from the Hessian matrix of the cost function. (ii) it is non-decreasing in w, y. (iii) it is concave and twice-differentiable in w.

From the properties of the cost function, the following are supposed to hold:

1. Shepherd's lemma $\frac{\partial C(w,y)}{\partial w_i} = x_i$. It follows that $\frac{\partial x_i(w,y)}{\partial w_j} = \frac{\partial^2 C(w,y)}{\partial w_i \partial w_j}$.

2. By Euler's theorem and linear homogeneity of the cost function in w, it has been proven that $\sum_j^m \frac{\partial x_i(w,y)}{\partial w_j} w_j = 0$.

3. Reciprocity (or symmetry condition) imply $\frac{\partial x_i(w,y)}{\partial w_j} = \frac{\partial x_j(w,y)}{\partial w_i}$.

4. The unit-free measure of the derived price elasticity of demand is given by the formula $\sigma_{ij} = \frac{w_j}{x_i(w,y)} \cdot \frac{\partial x_i(w,y)}{\partial w_j}$.

Note that $\sum \sigma_{ij} = 0$ and own price elasticity of demand $\sigma_{ii} \leq 0$.

The derived demand elasticities are not symmetric, but $\frac{\partial x_i(w,y)}{\partial y} = \frac{\partial^2 C(w,y)}{\partial w_i \partial y} = \frac{\partial^2 C(w,y)}{\partial y \partial w_i} = \frac{\partial [\partial C(w,y)/\partial y]}{\partial w_i}$. When $\frac{\partial x_i(w,y)}{\partial y}$ is negative, the i th input is said to be inferior or regressive, but when this term is positive the i th input is normal.

Although the cost function is derived from theory of an individual firm, its application is usually done at industry level. The cost function is embedded within a broader behavioral model. For example, it can be derived from competitive profit maximization which implies that cost minimization with first order condition $\frac{\partial C(w,y)}{\partial y} = P$ (P is the output price, which is equal to the marginal cost). This implicitly defines the optimal level of y =

y(w,p) as long as f(x) does not show constant returns to scale. Actually, solving the static profit maximization problem will give us the output supply function, which is simultaneously estimated with the input demand functions. (See under the subheading "Output Supply Equation" in this chapter).

As mentioned above we are interested in estimating factor productivity, economies of scale, elasticities of factor substitution, price elasticities of factor demand and impact of technological change for policy purposes. The economies of scale, the ratio between marginal cost (MC) and average cost (AC), is given by $\varepsilon = \frac{\partial C(w,y)/\partial Y}{C/Y} = \frac{\partial \log C}{\partial \log Y}$. $\partial C/\partial Y$ is the marginal cost and C/Y is the average cost. When the average cost is equal to the marginal cost ($\varepsilon = 1$), then technology is said to exhibit constant returns to scale.

2.2 THE MODEL

The model employed in this research effort is the transcendental logarithmic cost function, otherwise referred to as the translog cost function. It is a flexible function in that it allows for simultaneous estimation of the elasticities of factor substitution, scale economies and technical change. No lagged variables or expectations are modelled in order to avoid complications that come along with the dynamic models. The mathematical form of the model adopted here is that proposed by Christensen, but with a few modifications, is as follows:

$$\log C_t = \alpha_o + \alpha_y \log Y + \sum_i^m \alpha_i \log W_i + \alpha_t T + \alpha_h \log H$$

$$+ \frac{1}{2}\beta_{tt}T^2 + \frac{1}{2}\beta_{yy}(\log Y)^2 + \frac{1}{2}\sum_i^m\sum_j^m \beta_{ij}\log W_i \log W_j + \frac{1}{2}\beta_{hh}(\log H)^2$$

$$+ \sum_i^m a_{yi}\log Y \log W_i + a_{yt}T\log Y + a_{yh}\log Y \log H + \sum_i^m b_{ti}T\log W_i$$

$$+ b_{th}T\log H + \sum_i^m c_{hi}\log H \log W_i + U_t$$

The variable Y is defined as the total output of tobacco, W_i is the i th factor price, T represents the season (time trend), C is the total cost of producing tobacco, H stands for the quasi-fixed input (land that is devoted to tobacco production), and U_t is the stochastic term. The α_0 in the short run acts as a proxy for fixed costs. From this specification we are able to derive and estimate the factor share equations, and hence the comparative statics which help describe the decisions made by the farmers.

The factor share equations Si are derived by applying the standard Shephard's lemma in expenditure function as being equal to $\frac{\partial \log C}{\partial \log W_i} = \frac{W}{C}\cdot\frac{\partial C}{\partial W_i} = \frac{W_i X_i}{C} = S_i$. That is,

$$S_i = \alpha_i + \sum_j^m \beta_{ij}\log W_j + a_{yi}\log Y + b_{ti}T + c_{hi}\log H.$$

Every factor employed in production contributes to the cost of production, and that share in total (variable) cost is S_i.

S_i is the proportion of the total cost spent on i th input to produce a unit of output. The change in S_i over time can be estimated by (Greene, 1983):

$$\frac{dS_i}{dt} = \frac{\partial S_i}{\partial \log Y}\frac{d\log Y}{dt} + \sum_j^m \frac{\partial S_i}{\partial \log w_j}\frac{d\log w_j}{dt} + \frac{\partial S_i}{dt},$$

where $\dfrac{\partial S_i}{\partial \log Y} = \dfrac{\partial[\partial \log C/\partial \log w_i]}{\partial \log Y}$, which is the same as $\dfrac{\partial^2 \log C}{\partial \log w_i \partial \log Y}$

or $\dfrac{\partial \varepsilon}{\partial \log w_i}$, since $\varepsilon = \dfrac{\partial \log C}{\partial \log Y}$.

The first term in $\dfrac{dS_i}{dt}$ is zero if the production function is homothetic i.e. if ε is independent of factor prices, W. The presence of this term is attributed to non-homotheticity of the production function. It indicates the bias of technical change; thus we can say that technology is factor i-using if this term is positive or i-saving if this term is negative.

The economies of scale given by $\varepsilon = \dfrac{\partial \log C}{\partial \log Y}$ is going to be as follows $\varepsilon = \alpha_y + \beta_{yy}\log Y + \sum_i^m a_{yi}\log W_i + a_{yt}T + a_{yh}\log H$.

An efficient scale at which average cost reaches its minimum occurs at a point where MC = AC (i.e. $\varepsilon = 1$). Rearranging the above equation (assuming that farmers operate at an efficient scale) we have the following result:

$$\log Y^* = \frac{1 - (\alpha_y + \sum_i^m a_{yi}\log W_i + a_{yt}T + a_{yh}\log H)}{\beta_{yy}}.$$

Following directly from this is the proportional growth rate of the efficient scale given by $\dfrac{\partial \log Y^*}{\partial t} = -\dfrac{a_{yt}}{\beta_{yy}}$, a constant. This result of a constant growth rate in efficiency seem too restrictive, however, since technical change may be different in different time periods.

The mathematical form of the model specified above will involve a lot of parameters when estimating. Before estimating the model, we test whether the symmetry and homogeneity conditions are satisfied. The equivalent null hypotheses are of the following form:

1. Symmetry of second order terms implies testing whether $\boldsymbol{\beta}_{ij} = \boldsymbol{\beta}_{ji}$
2. Linear homogeneity in the factor prices requires us to test

$$\sum_{i}^{m} \alpha_i = 1 \qquad \sum_{i}^{m} a_{yi} = 0$$

$$\sum_{i}^{m} a_{ti} = 0 \qquad \sum_{i}^{m} c_{hi} = 0$$

$$\sum_{i}^{m} \beta_{ij} = 0 \qquad \sum_{i}^{m} \beta_{ji} = 0$$

Binswanger (1974) writes, "Homogeneity of degree one in prices does not impose homogeneity of degree one of the production function in inputs. Almost no constraints are imposed on elasticities of substitution or of factor demand, which makes the function more general than other functional forms currently in use".

SUR method requires that we drop one share equation from the set of equations to be estimated. It does not matter which equation is dropped because there is no difference in estimates arrived at (in the absence of auto-correlation). For this reason SUR method is equivalent to maximum likelihood method which gives efficient estimates.

The disturbance terms u_i are correlated across equations; and given the above properties, SUR's estimates are asymptotically efficient.

$$E(u_{it}) = 0$$

$$E(u_{it}, u_{js}) = \sigma_{ij}, \qquad for\ t=s$$

$$E(u_{it}, u_{js}) = 0, \qquad for\ t \neq s$$

Alternatively, we can impose homogeneity by normalising the factor prices in the factor share equations using one of the factor prices; and Greene (1983) argues that "since the factor shares must sum up to one at every observation, one (equation) is redundant and will be dropped out. In order to ensure that the estimates are invariant to which equation is omitted, a maximum likelihood procedure will be employed. Estimates of the parameters of the omitted equation are obtained by using the linear homogeneity restriction".

The factor share equations, with normalized factor prices, are going to be of the following form:

$$S_i = \alpha_i + \sum_j^m \beta_{ij} \log \frac{W_j}{W_f} + a_{yi} \log Y + b_{ti} T + c_{hi} \log H + v_i \ ,$$

for i = 1, 2, ..., m-1.

V_i is the stochastic term in the transformed (or normalized) factor share equations. There are a lot of possible stochastic specifications that can be made, but for simplicity sake we assume that $E(v)=0$ and $E(v_i, v_j)=0$.

The coefficients for the omitted share equation are derived by use of the homogeneity property $S_f = 1 - \sum_{i}^{m-1} S_i$. The coefficients are

residuals from the SUR estimates.

2.2.1 Output Supply Equation

The output supply equation, derived from the static profit maximization condition, is to be estimated together with the factor share equations derived from the static cost minimization problem. The output supply equation captures the effect of the changes in input price on output. The cost minimization theory assumes that output is fixed from the producer's point of view, and therefore does not tell us much about effects of price changes on output. To check on the effects of the input price changes on output we make use of the profit function instead of the cost function to derive the output supply equation. The profit function is a mathematical representation of the solution to an economic agent's optimization problem. The following specification of the profit function imply existence of a cost function

$$\Pi(p, w) = \underset{y}{Max} \{PY - C(w, y)\}$$

$$\Pi(p, w, H) = \underset{x \geq 0}{Max} \; Pf(x, H) - \sum W^i X^i$$

We can separate the profit maximization problem into two stages according to Chambers (1988); "The first stage, which may be intuitively thought of as short-run, involves maximizing profit for a given output. The second stage (the long-run) is then to choose output to maximize long-run profit. When output is fixed, revenue is also fixed, and profits are maximized by minimizing costs." Then there is the relationship between cost minimization and profit maximization. In fact, the cost function appears on the right hand side of the profit function.

The properties of the dual profit function (Chambers, 1988) are as follows:

(i) $\Pi(p, w) \geq 0$

(ii) if $P^1 \geq P^2$, then $\Pi(p^1, w) \geq \Pi(p^2, w)$ i.e. the profit function is non-decreasing in P

(iii) if $w^1 \geq w^2$ then $\Pi(p, w^1) \leq \Pi(p, w^2)$ i.e. profit function is non-increasing in W

(iv) $\Pi(p, w)$ is convex and continuous in (p, w)

(v) $\Pi(tP, tW) = t\Pi(P, W)$, $t \succ 0$ (profit function is positive, linear homogeneous function of degree one)

(iv) if the profit function is differentiable in P and W, then by Hotelling's Lemma the unique profit maximizing supply and derived-demand functions are given respectively by

$$y(p, w) = \frac{\partial \Pi(p, w)}{\partial p} \text{ and } x_i(p, w) = -\frac{\partial \Pi(p, w)}{\partial w_i}, \quad \forall i .$$

$Y(p,w)$ and $X_i(p,w)$ are the respective profit maximizing quantities. Since we are going to use the demand functions already derived under cost minimization problem above, here we are only concerned with deriving $y(p,w)$. The properties of the output supply function $y(p,w)$ from the profit function are as follows:

(i) $y(p,w)$ is homogeneous of degree zero in P and W. Only relative price changes affect output supply.

(ii) The direct consequence of convexity of $\Pi(p, w)$ is that

$\frac{\partial y(p,w)}{\partial p} \geq 0$. Therefore the Hessian matrix is positive semi-definite.

(iii) $\frac{\partial y(p,w)}{\partial w_i} = - \frac{\partial x_i(p,w)}{\partial p}$ is the reciprocity condition attributable to the twice-continuous differentiability of the profit function.

Twice-differentiability of $\Pi(w, p, H)$ and Hotelling's lemma establish the following reciprocity condition in the restricted profit maximization model:

$$(i) \qquad \frac{\partial y(w,p,H)}{\partial H} = \frac{\partial}{\partial P}\left(\frac{\partial \pi(w,p,H)}{\partial H}\right)$$

$$(ii) \qquad \frac{\partial X_i(w,p,H)}{\partial H} = \frac{\partial}{\partial w_i}\left(\frac{\partial \pi(w,p,H)}{\partial H}\right),$$

$$i=1,\ldots.N.$$

The advantages of specifying a restricted profit function:

(i) $\Pi(w, p, H)$ is consistent with the short-run equilibrium,

(ii) It is more realistic to assume that firms are in short-run rather than long-run equilibrium,

(iii) Long-run equilibrium effects can be inferred (correctly) from the estimates of $\Pi(w, p, H)$ using the first order condition for the long-run equilibrium level of H-stock as

$\frac{\partial \pi(w,p,H^{**})}{\partial H} = W^H$, which is the rental price of the fixed input.

Together with other properties of the derived demand function not mentioned here, these properties are "exhaustive"; meaning that "they represent a set of conditions on smoothly differentiable supply and derived demand functions that ensure these functions can be integrated to recapture the technology, as represented by c(w,y), that generated them" (Chambers, 1988).

The first order conditions for profit maximization imply $P - \frac{\partial C(w,y,H)}{\partial y} = 0$. Multiplying both sides by y/c, we have $P \cdot \frac{y}{c} = \frac{\partial c}{\partial y} \cdot \frac{y}{c}$ which essentially becomes the ratio between total revenue and total variable cost. Simplifying further yield

$$S_y = \frac{py}{c} = \frac{\partial \log C_t}{\partial \log y} = \alpha_y + \beta_{yy} \log Y + \sum_i^m a_{yi} \log W_i + a_{yt} T + a_{yh} \log H + u_i$$

in logarithmic form. This equation will be estimated simultaneously with the factor share equations derived from the static cost minimization problem.

CHAPTER THREE

DATA SET AND PROCEDURE

3.1 Data set

Over hundred farmers responded to the questionnaire, through the mail or directly interviewed by the author. Initially I required data for six-year period, but because of the problems I encountered when administering the first few questionnaires, I revised the time period and the amount of information I could ask for in the three months I had. Instead, information for the last three seasons (1990/91 to 1992/93) was gathered, and less information on maize (the competing food crop) was gathered than I had planned. A number of explanations could have been made using data on maize regarding allocation of factors between maize and tobacco by farmers. I found that only 50 of about 120 questionnaires had substantial information that could be used because there were a lot of missing data-points. By the time the model was to be run, only thirty-six observations out of the possible seventy-eighty observations were used because observations with missing data points were removed (Econometric program, Shazam version 6.2, does not differentiate between zero and unobserved data points). The kind of data I ended up using was a combination of information from farmers who had been growing tobacco for a long time and others who have only grown it for two years or just one year and probably stopped.

The pooled time-series/cross-sectional data was collected on the following variables:

1. Tobacco seed: prices and quantities used
2. Maize: hectarage and quantity produced
3. Fertilizer: prices and quantities
4. Labour: number of workers and wage rates
5. Tractor Hire: rates and number of hectares
6. Other inputs: unit prices and quantities used
7. Chemicals: prices and amounts used
8. Tobacco: quantity produced and unit price
9. The size of the farm. Land devoted to tobacco only was used as a quasi-fixed input in the model.

The data was collected from farmers in three major producing areas - Central, Eastern and Southern provinces. Problems which arose during data collection were,

1. Most of the farmers do not keep records for a long time. Therefore meaningful data was only available for three years at most, but mostly for two years. Even then, there were a lot of missing data
2. There were differences in the format in which the farmers keep their data and the way I would have liked them to report.
3. Slight misunderstanding of the operational definitions of some of the variables I was interested in.

For each of the variables on which data was collected, the following should be noted about their unit price and the amounts used. There is high variation in the price of all the inputs mostly because of the high inflation that Zambia has been experiencing.

The official rate of inflation in Zambia was around 160 per cent for most of the 1992/93 season.

3.1.1 Seed

The high fluctuations in the price of seed that was recorded is partially a result of the difference arising from the high cost paid for seedlings by farmers who do not prepare their own. The farmers who do not prepare their own seedlings spend less on chemicals since they do not use any chemicals on seedlings. For those who raise their own seedlings, subsequent chemical expenses follow when the crop is transplanted. In order to calculate the unit price of tobacco seed paid by farmers who do not prepare their own seedlings, the following crude conversions are used:

(i) 2 grammes of seed are used per standard seedbed, and

(ii) 6 grammes of seed can cover 1 hectare. This means that 3 standard seed-beds can cover 1 hectare).

For uniformity the prices paid for each seedbed are converted to the standard units used for all seed - price per gramme. The contract farmers pay a lot more on the inputs provided by the companies administering the credit/loan packages. For contract farmers, after the crop is harvested, it is taken by the agents for sale. The input and administrative costs are deducted from the revenue before handing the remainder to the farmers. Small farmers pay more for seedlings because of their ignorance about input prices. Relatively large, independent farmers pay substantially little for their seed.

3.1.2 Chemicals

A lot of different chemicals, measured in different units, are used in tobacco production. Choice of chemical used in research was one used in large quantities; and those with the same units and end uses. Expenditure on chemicals was not representative of what the average farmer spends on chemicals. Aside from under-reporting on amounts of chemicals used, there was high variation in the unit price. The reasons for this are inflation and the distance from the official agricultural distributing centres.

3.1.3 Machinery/Tractor Hire

It was not possible to go around asking each farmer how much they spent on vehicles, fuel and maintenance given the short time in which data was to be collected. The rough estimate of this would have been depreciation of the farm machinery, which is about 10 per cent of all capital investment according to the Tobacco Association of Zambia (TAZ). Since the total amount invested in machinery was/is difficult to come by, I decided to work with the amount a farmer would spend if he hired a tractor to prepare his land. The fee will include payments for the fuel, oil, etc. The official fees were provided by the Mechanical Services Division (MSD) and the Department of Agriculture. But since these services are mostly provided by farmers with machinery and time to spare the fees differ from farmer to farmer and region to region. The large farmers had little knowledge about the cost of hiring tractors because they did not participate in this business.

Land preparation involves four stages: ridging, discing, ploughing and stamping by tractor. A farmer is likely to spend the same amount on each of these stages. On the "virgin" or new land, farmers spend a lot on tractor services, but less on chemicals and fertilizers. If it is old land then the farmer just spends on ploughing, but a lot more on chemicals and fertilizers. The difference in preparation costs can be very big depending on state of the land. However, a lot of tobacco farmers are of modest means, they own most of the major equipment they use on the farm.

3.1.4 Fertilizer

The standard packaging for fertilizers in Zambia is 50 kg/bag whether it is Ammonia, compound A, B, C, D, or X. Farmers pay different prices for the different types of fertilizers, from top dressing (Urea, ammonium nitrate) compared to bottom dressing (D, C, X) fertilizer. The difference in price is insignificant. In order to avoid the problem of introducing too many variables in the model to accommodate the different types of "fertilizer" only one price was recorded. It is not unusual to have at least two increases in input price in a season because of the high inflation. The input prices reported depend on when the farmer actually purchased his inputs. A month's difference in purchasing time might translate into big differences in prices paid for inputs.

3.1.5 Labour

A lot of labour is required for tobacco production because it is a labour-intensive crop. Right from the time seed-beds are prepared to the time of harvesting a lot of labour should be around. At harvest time a lot more labour is required to pick up and cure tobacco leaves. Tobacco curing is almost a 24-hour job. For this reason tobacco hectarage tend to be small.

The wage rate for farm-labour has also been changing more often in these inflationary times. On average, wages would go up at least two times in a season. Since the devaluation and inflationary pressures set in on the Zambian Kwacha, the wage rate goes up by about 50 % every time new wages are announced.

The differences in wages occur, depending on the size of the farm and competition for labour where there are a lot of farmers needing labour. Bigger farmers pay government-approved higher wages, while the smaller family-based and contracted farmers (who usually hire labour during critical moments), tend to pay lower wages for the same work. In the agricultural sector wages are generally low, and most farmers can not revise the wages regularly to keep up with the rate of inflation.

In this research, no difference has been made between hired labour and operator labour. Hired and operator (or family) labour react differently to changes in prices. Whilst hired labour receives some fixed wage, operator labour participates in general revenue or profits. Hired labour is more responsive to price changes than operator labour.

3.1.6 Tobacco Price

It should be noted that the selling price of tobacco varies a lot, but for different reasons however. First the prices differ because there are a lot of different grades of tobacco. Grading of tobacco is very subjective. For Zambian farmers, the prices offered are about 10% lower than those offered in neighbouring countries of Zimbabwe and Malawi. The Zambian crop is too small and therefore does not attract a lot of foreign buyers. As such there is literally no competition among the buyers at the auction floors.

The other major input not discussed is firewood. It is a very important input when finally curing tobacco leaf, but there is literally no price on it. It is left at the discretion of the farmer to decide how much of it he can gather. Also, data on buildings (shades, barns, etc) was not collected because it would have required a lot more time for farmers to give reliable information. Figures on fixed assets would have required adjusting for inflation.

3.2 ESTIMATION PROCEDURE

Factor efficiency and substitution could be estimated from the cost function directly, but the estimates are less efficient than those obtained by Shepherd's lemma. Therefore factor share equations will be estimated using the Zellner's Seemingly Unrelated Regression (SUR) method. The fertilizer share equation will be dropped from the set of equations to be estimated since only n-1 equations are linearly independent. This method is equivalent to the maximum likelihood method since the estimates are invariant to which equation is dropped, as long as SUR is iterative and there is no auto-correlation in the model.

Strategy of normalizing factor prices in factor demand share equations and output supply equation led to lower R^2 in regression results for the individual share equations. Therefore estimation of the model was done using un-normalized factor prices. Before going ahead with the actual estimation of the model the following tests were performed:

(1) Test for symmetry condition, whose null hypothesis is:

$$H_o: \begin{array}{l} \beta_{ij} = \beta_{ji} \\ a_{iy} = a_{yi} \end{array}$$

The second part of this null hypothesis actually also tests whether the output-supply share equation belongs in the model. However, the most reliable or complete test for checking this aspect would be to perform the Hausman specification test.

(2) Test for homogeneity condition,

$$H_o: \sum_{j=1}^{5} \beta_{ij} = 0 \quad .$$

Symmetry and homogeneity restrictions were tested. Homogeneity condition was rejected (See detailed results in Appendix B). I therefore imposed only the symmetry restrictions on the system of equations to be estimated. Since the homogeneity condition did not hold with this data it means that the equi-proportional changes in all factor prices W lead to change in relative factor prices, and hence changes the cost minimizing level of inputs X in the objective function of the farmer. It also follows that the technology does not have constant returns to scale as we would have liked it to be.

Put another way, rejection of homogeneity implies that cost minimizing solution X* does not depend on the relative factor prices. However since symmetry holds, it means that the system of Xi integrate up to the cost function C(w,y) (Frobenius theorem).

$$\frac{\partial C(w,y)}{\partial w_i} \equiv X_i(w,y) + \sum w_j \frac{\partial x_i(w,y)}{\partial w_i}$$

If homogeneity condition had held then by Euler's theorem

$$\sum \frac{\partial X_i(w,y)}{\partial w_i} w_j = 0$$

The variable cost function is non-linear in Y.

Other hypotheses are indirectly tested in the dual approach e.g. the hypothesis that farmers are cost minimizers was indirectly tested using the symmetry and homogeneity conditions, since this is one of the conditions that the cost function should meet in this theory. Once these properties of the cost function hold it is deduced that the function makes economic sense, and that the data could have been generated from the farmers with technology which makes it possible to be profit maximizers (or cost minimizers).

The other condition the cost function has to meet is that the second order derivatives with respect to (factor) price should be negative semi-definite. It has been shown (Chambers, 1988) that the second-order derivatives of the translog cost function with respect to price can be manipulated to yield the following $C_{ww} = \frac{\partial^2 C}{\partial w_i \, \partial w_i} = \frac{2\beta_{ii}}{w_i^2}(1-\log w_i)$ for the diagonal elements. It is required that $\frac{\partial^2 C}{\partial w_i \partial w_j}$ be negative semi-definite in the case of the cost minimizing firm. All the diagonal elements of this Hessian matrix are negative, but cost function need not be globally concave. In Appendix B, I have only shown that the diagonal elements are all negative because this is important for establishing the negative semi-definite property , and therefore that farmers are cost minimizers as the theory says.

The other individual hypotheses of whether prices, output or time had any effect on individual factors are revealed by checking the significance of the corresponding coefficients in Table 4.1.

The OLS method is not efficient for estimating the simultaneous equations in our model despite the fact that all equations contain the same explanatory variables on the right-hand side. The complete set of (econometric) system of equations that was estimated is as follows:

$$\frac{W_i X_i}{C} = S_i = \boldsymbol{\alpha}_i + \sum_{i=1}^{5} \boldsymbol{\beta}_{ij} \log W_j + a_{yi} \log Y + b_{ti} T + c_{hi} \log H + u_i, \quad i = 1, 2, 3, 5.$$

$$\frac{PY}{C} = S_y = \boldsymbol{\alpha}_y + \boldsymbol{\beta}_{yy} \log Y + \sum_{i=1}^{5} a_{yi} \log W_i + a_{yt} T + a_{yh} \log H + u_h$$

CHAPTER FOUR

ESTIMATION AND RESULTS

Since the symmetry condition was not rejected, it was imposed on the equations that were being estimated. The results were not very different from those where both symmetry and homogeneity conditions were imposed. The resulting estimated share equations (see Table 4.1 for details) are as follows:

$$S_1 = 0.865 + 0.036\log W_1 - 0.01\log W_2 - 0.048\log W_3 - 0.032\log W_4$$
$$-0.007\log W_5 - 0.058\log Y + 0.034\,T + 0.036\log H$$

$$S_2 = -0.296 - 0.01\log W_1 + 0.053\log W_2 - 0.005\log W_3 + 0.004\log W_4$$
$$+0.009\log W_5 - 0.017\log Y - 0.03\,T + 0.025\log H$$

$$S_3 = 0.662 - 0.048\log W_1 - 0.005\log W_2 + 0.129\log W_3 + 0.032\log W_4$$
$$-0.079\log W_5 + 0.001\log Y + 0.036\,T - 0.064\log H$$

$$S_5 = -0.059 - 0.007\log w_1 + 0.009\log W_2 - 0.079\log W_3 - 0.012\log W_4$$
$$+0.169\log W_5 - 0.09\log Y - 0.062\,T + 0.181\log H$$

$$S_Y = -1.667 - 0.058\log W_1 - 0.017\log W_2 + 0.001\log W_3 + 0.192\log W_4$$
$$-0.09\log W_5 + 0.511\log Y - 0.566\,T - 0.182\log H$$

and of course recalling that $S_4 = 1 - \sum_{i=1}^{5} S_i \quad (i \neq 4)$, and the coefficients of the omitted share equation are derived by use of the homogeneity conditions:

$$\sum_{j=1}^{5} \beta_{ij} = 0\ ; \quad \sum_{j=1}^{5} \alpha_j = 1\ ; \quad \sum_{j=1}^{5} a_{yj} = 0\ ; \quad \sum_{j=1}^{5} b_{tj} = 0\ ; \quad \sum_{j=1}^{5} c_{hj} = 0\ .$$

We get the estimate of $\beta_{4j} = -\sum_{i \neq 4}^{5} \beta_{ij}$ by rearranging the first homogeneity condition, and using the same principle a_{y4}, b_{t4} and c_{h4} are derived. α_4 is given by $1 - \sum_{i \neq 4}^{5} \alpha_i$. The complete Chemical share equation, when all this is done, is:

$$S_4 = -1.132 + 0.029 \log W_1 - 0.056 \log W_2 + 0.003 \log W_3 + 0.008 \log W_4$$
$$-0.092 \log W_5 + 0.164 \log Y + 0.022\, T - 0.178 \log H$$

Stevenson (1980) argues that given technological advancement, the measure of input bias is $I_{bi} = \frac{\partial S_i}{\partial T}\Big|_{yw}$, assuming technology is homothetic. A positive I_{bi} implies that technological change is relatively factor i-using. $I_{bi} = 0$ implies neutrality (there are no changes in input proportions or factor shares) while $I_{bi} < 0$ implies factor i-saving technological advancement.

Technological change may also be biased to the returns-to-scale, altering the range over which returns-to-scale of a given degree could be realized and possibly altering the output level at which minimum average cost is attained. The measure of Scale Economies is given by $\varepsilon = \frac{\partial \log C}{\partial \log Y} = \frac{\partial C}{\partial Y} \cdot \frac{Y}{C}$.

When $\varepsilon \leq 1$ it means technology exhibits economies of scale,

$\varepsilon = 1$ implies constant returns to scale, and

$\varepsilon \geq 1$ implies dis-economies of scale.

All the coefficients which capture technological input bias are very insignificant, except for output and fertilizer. Both of them are negative and significant, meaning that technical change is associated with a fall in output of tobacco and less use of fertilizer.

Remember that $\varepsilon = \frac{\partial C/\partial Y}{C/Y} = \frac{\partial \log C}{\partial \log Y}$ is the measure of economies of scale. It has also been shown that output supply function from the profit maximization objective function $S_y = \frac{PY}{C} = \frac{\partial \log C}{\partial \log Y} = \frac{\partial C}{\partial Y}\frac{Y}{C}$. Therefore, the S_y equation can yield estimate of ε since they are of the same form i.e. they contain the same explanatory variables

$$\varepsilon = \alpha_y + \beta_{yy}\log Y + \sum_i^m a_{yi}\log W_i + a_{yt}T + a_{yh}\log H$$

$$\varepsilon = -1.667 - 0.058(6.32) - 0.017(9.70) + 0.001(5.04) + 0.192(7.69$$
$$- 0.09(8.25) + 0.511(9.1) - 0.566(2.47) - 0.182(2.08)$$

$$= -1.667 - 0.366 - 0.16 + 0.003 + 1.476$$
$$-0.745 + 4.65 - 1.398 - 0.378$$

$$= 1.415$$

Since the value of ε is greater than one, marginal cost is greater than the average cost, and therefore there are dis-economies of scale in tobacco sector.

A measure of technological scale bias in Stevenson's work is $T\varepsilon = \frac{\partial \varepsilon}{\partial T}|_{y,w}$. Assuming $T\varepsilon$ is the same over the output range, its negative value implies that the minimum efficient firm size has increased. Efficiency can only be attained at higher output levels. Therefore, production of tobacco by smaller farmers is costly.

The coefficients from the individual share equations in this model have no economic meaning of their own. Differentiating the factor share equations,

(i) $$\frac{\partial S_i}{\partial \log w_i} = \frac{\partial[\partial \log C/\partial \log w_i]}{\partial \log w_j} = \frac{\partial[\partial \log C/\partial \log w_j]}{\partial \log w_i}$$

(ii) $$\frac{\partial S_i}{\partial \log Y} = \frac{[\partial \log C/\partial \log w_i]}{\partial \log Y} = \frac{\partial[\partial \log C/\partial \log y]}{\partial \log w_i}$$ which reduces to

$\frac{\partial \varepsilon}{\partial \log w_i}$, the impact of log w_i on economies of scale.

The Estimated Share Equations

Table 4.1: The Coefficients Of The Transcendental Logarithmic Cost Function Using Pooled Cross-Section/Time-Series Data For The 1990/91-1992/93 Crop Seasons.

	Variable							
Equation	Const	Seed	Machinery	Labour	Chemical	Fertil.	Output	Time
Seed	0.865*** (2.88)	0.036*** (2.34)	-0.010 (-1.295)	-0.048*** (-2.199)	-0.032* (-1.69)	-0.007 (-0.465)	-0.058* (-1.617)	0.034 (0.98)
Machinery	-0.296* (-1.699)	-0.010 (-1.295)	0.053*** (4.40)	-0.0051 (-0.30)	0.004 (0.52)	0.009 (0.656)	-0.017 (-0.922)	-0.03* (-1.55)
Labour	0.622 (1.18)	-0.048*** (-2.199)	-0.005 (-0.30)	0.129** (1.969)	0.032 (1.05)	-0.079*** (-2.48)	0.001 (0.012)	0.036 (0.609)
Chemical	-1.132	0.029	-0.056	0.003	0.008	-0.092	0.164	0.022
Fertilizer	-0.059 (-0.166)	-0.007 (-0.465)	0.009 (0.66)	-0.079*** (-2.48)	-0.012 (-0.63)	0.169*** (4.94)	-0.09*** (-2.46)	-0.062* (-1.57)
Output	-1.667 (-0.744)	-0.058* (-1.617)	-0.017 (-0.92)	0.001 (0.012)	0.192* (1.43)	-0.09*** (-2.46)	0.511** (1.808)	-0.566*** (-2.28)
(quasi-fixed var.)		S1	S2	S3	S4	S5	Sy	
Hectares		0.036 (0.93)	0.025* (1.278)	-0.064 (-0.99)	-0.788	0.181*** (4.608)	-0.182 (-0.611)	

Figures in parentheses are t-ratios, $t_{\alpha,n-k}$.

Critical Points:

$t_{0.025,28} = 2.048 \Rightarrow (***)$

$t_{0.05,28} = 1.701 \Rightarrow (**)$

$t_{0.10,28} = 1.313 \Rightarrow (*)$

Almost half of the coefficients in the share equations resulted in estimates with significant effect on the cost function at 90 percent level of confidence. Chemical coefficient is significant at 90 per cent level of confidence in output and seed share equations only. It is surprising that machinery coefficient is only significant in machinery share equation; I expected it to be significant at least in output share equation as well.

Technology coefficient (captured by the variable Time) is significant in the output share equation at 97.5 per cent level of confidence, and in machinery and fertilizer share equations 90 per cent level of confidence. The period over which the data was collected is too short for any significant technical change to have occurred that would lead to significant changes in use of inputs.

Table 4.2: Basic statistics from the share equations

Share Eqn.	**Means**	σ^2	**D-W**	R^2
Seed	0.075	0.013	1.56	0.36
Machinery	0.071	0.001	1.34	0.62
Labour	0.47	0.032	1.36	0.15
Chemical	0.094			
Fertilizer	0.29	0.009	1.64	0.74
Output	1.41	0.855	2.35	0.26

Absolute shares shown above indicate that Labour has the largest share of the total (variable) cost of tobacco production, followed by fertilizer, Seed and machinery. However, this might not be the case if you consider the fact that the same labour does other duties on the farm for the same wage, viz production of other crops or livestock. The cost of chemicals was not properly accounted for because many chemicals which go into tobacco production were not included by the questionnaire. It should also be noted that the ratio of total revenue to cost is more than 1, an indication that farmers are making some profit.

4.1 The Elasticities Of Substitution

It has been shown by Binswanger (1974) that Allen partial elasticities of factor substitution, given by

$$\sigma_{ij} = \sigma_{ji} = \frac{\sum X_i W_i}{X_i X_j} \frac{\partial^2 C}{\partial w_i \partial w_j}$$, or put another way (Uzawa, 1962)

$$\sigma_{ij}(w,y) = \frac{C(w,y)\dfrac{\partial^2 C(w,y)}{\partial w_i \partial w_j}}{\dfrac{\partial C(w,y)}{\partial w_i}\dfrac{\partial C(w,y)}{\partial w_j}}$$, can be simplified further to yield the following formulae:

$$(a) \quad \sigma_{ij} = \frac{1}{s_i s_j}\beta_{ij} + 1, \qquad i \neq j$$

$$(b) \quad \sigma_{ii} = \frac{1}{s_i^2}(\beta_{ii} + s_i^2 - s_i), \qquad i=j$$

Elasticity of substitution is the rate at which one factor is substituted for another with output held constant. In the primal model its formula is $e = \dfrac{\%\Delta(k/l)}{\%\Delta(MPP_k/MPP_l)}$. The denominator is referred to as the marginal rate of technical of substitution (MRTS).

Table 4.3: Allen Partial Elasticities of Substitution, σ_{ij}

Factor i	Factor j Seed	Machinery	Labour	Chemical	Fertilizers
Seed	-5.93				
Machinery	0.81	-2.57			
Labour	-0.36	0.85	-0.54		
Chemical	-3.54	1.60	1.72	-8.73	
Fertilizer	0.68	1.44	-0.58	-3.37	-0.44

Own-price elasticities of substitution are all negative, which is consistent with cost minimization behaviour. Chemical, seed and machinery have the highest absolute own-elasticities of substitution. Labour and fertilizers have lower own-price elasticities. When the cross-price elasticity of substitution is positive it means the factors are substitutes, but if it is negative then they are complements. Therefore, seed and labour are complements, but the relationship is weak; meaning that complementarity can only be done to a very limited extent. Labour has positive substitutability relationship with the chemical inputs, but has a complementary relationship with fertilizer.

At 1.72, the cross-price elasticity of substitution between labour and chemicals is the strongest/highest followed by that between machinery and chemicals (1.60) and machinery/fertilizer

(1.44). High complementary relations are that of seed/chemical (-3.54) and seed/fertilizers (-3.37). Except for four complementary relationships (Seed/Machinery, Fertilizer/Labour and Fertilizers/Chemicals) all the factors in the model are substitutes for each other.

4.2 Elasticities Of Factor Demand:

Price theory suggests that there is generally an inverse relationship between price and quantity demanded of a commodity. The own-price elasticity of demand is the ratio between the percentage change in quantity demanded and the percentage change in that factor's price, and it is normally negative. In the primal model, the mathematical formula for the price elasticity of factor demand is $\eta_{ij} = \frac{\%\,\Delta\ quantity\ demanded\ of\ factor\ i}{\%\,\Delta\,Price\ of\ factor\ j}$

In the dual model the price elasticity of factor demand, $\eta_{ij} = \frac{\partial X_i}{\partial w_j}\frac{w_j}{X_j}$ has also been simplified by Binswanger to yield the following:

$$(a) \quad \eta_{ij} = \frac{\beta_{ij}}{s_i} + s_j\ , \qquad i \neq j$$

$$(b) \quad \eta_{ii} = \frac{\beta_{ii}}{s_i} + s_i - 1\ , \qquad i = j$$

The resulting estimates of the price elasticities of factor demand from the estimated nodel are given in the table below:

Table 4.4: Price Elasticities of Factor Demand, η_{ij}

Price i	Factor j Seed	Machinery	Labour	Chemicals	Fertilizer
Seed	-0.445	0.058	-0.17	-0.332	0.196
Machinery	-0.066	-0.182	0.399	0.150	0.416
Labour	-0.027	0.060	-0.256	0.162	0.122
Chemicals	0.384	-0.524	0.502	-0.820	-0.688
Fertilizer	0.050	0.102	0.198	0.052	-0.127

Note that all the absolute price elasticities of demand are less than 1. Own-price elasticities of factor demand are all negative, and therefore conform with the economic theory, and all the factors in the model can be referred to as normal goods in the factor market. The cross-price elasticities of demand are not symmetrical because of the presence of other competing factors which have different degrees of substitutability and/or complementarity. Therefore, although the signs of the cross-price elasticity of demand between any two factors are usually the same, there are instances when substitutability/complementarity is invoked depending on which factor's price has changed. Therefore even very small differences between two estimates of price elasticities of demand for two factors might have bigger implications. For example the price elasticity of demand of seed for machinery (-0.066) suggests complementary relationship, but that of machinery for seed (0.058) suggests substitutability relationship between them. The other pairs of factors with such reversible relationships in the results are seed/chemical, chemical/machinery, and fertilizer/chemicals. The changes in substitutability/complementary relation between any two factors depends on the following factors which influence the consumers' (farmers) response to change in price:

(i) magnitude of the change in price,

(ii) availability of substitutes or complements,

(iii) quantities involved of both factors for a farmer to restore that desired level of input proportions, and

(iv) the importance of that factor in the production process, and the price the farmer is willing to pay for it.

Therefore, when labour's price changes the response by farmers in substituting or complementing it is very low compared to a factor such as chemical when its price changes (check the horizontal figures for labour and chemical price elasticities of demand in Table 4.4 above).

However, even within these very low elasticities we can say that the largest difference (in absolute terms) in the elasticities of demand are between the following pairs: chemicals/fertilizers, chemicals/seed, chemical/machinery, fertilizer/machinery, chemical/labour and labour/machinery, in that order.

The reversal relationship between fertilizers and chemicals assume the extreme. A lot of money is spent on chemicals as it is very expensive and very necessary in tobacco production. The chemical price to some extent determines even the hectarage that is put to tobacco. There is a very strong complementary relationship between chemicals and fertilizers (Table 4.3), but a relatively weak substitutability relationship when the order of change in price is reversed. The functions of the chemical input (protecting plants from pesticide, weeds, insects, etc) are different from fertilizers (nourishment of the plants).

4.3 The Elasticities from The Output-Supply Equation:

The economic meaning of the elasticities from the output supply equation can be derived as follows:

$$S_y = \frac{PY}{C} = \frac{\partial \log C(w, y^*)}{\partial \log Y}$$

$$\Rightarrow Y = \frac{\partial \log C}{\partial \log Y} \frac{C(w, y*)}{P}$$

Taking the derivative of Y with respect to P we have, knowing that $y^* = y(p)$ and $\frac{\partial y}{\partial P}\frac{1}{y} = \frac{\partial \log y}{\partial P}$, results into

$$\frac{\partial y}{\partial P} = -\frac{\partial \log C(w, y^*)}{\partial \log y} \frac{C(w, y)}{P^2} + \frac{\partial^2 \log C}{\partial \log y^2} \frac{\partial \log y}{\partial P}$$

$$+ \frac{\partial \log C}{\partial \log y} \frac{1}{P} \frac{\partial C(w, y^*)}{\partial y} \frac{\partial y}{\partial P}$$

Rearranging the equation we have

$$\frac{\partial y}{\partial P}\left[1 - \frac{\partial^2 \log C}{\partial \log y^2}\frac{1}{y} - \frac{\partial \log C}{\partial \log y}\frac{\partial C}{\partial y}\frac{1}{P}\right] = -\frac{\partial \log C}{\partial \log y}\frac{C}{P^2}$$

$$\frac{\partial y}{\partial P} = \left[\frac{-\dfrac{\partial \log C}{\partial \log y}\dfrac{C}{P^2}}{1 - \dfrac{\partial^2 \log C}{\partial \log y^2}\dfrac{1}{y} - \dfrac{\partial \log C}{\partial \log y}\dfrac{\partial C}{\partial y}\dfrac{1}{P}} \right]$$

Multiply both sides by P/Y and make substitutions for the following $\frac{\partial S_y}{\partial \log y} = \frac{\partial^2 \log C}{\partial \log y^2}$, $\varepsilon = \frac{\partial \log C}{\partial \log y} = S_y$ and $\frac{\partial C}{\partial y} = P$. From the right hand side we end up with the price elasticity of supply,

$$\frac{\partial y}{\partial p}\frac{p}{y} = \left[\frac{-\varepsilon \dfrac{C}{p^2}}{1 - \dfrac{\partial S_y}{\partial \log y}\dfrac{1}{y} - \varepsilon} \right] \frac{p}{y}$$

$$\frac{\partial y}{\partial P}\frac{P}{Y} = \left[\frac{-1.415(44.92)}{1 - 0.511\left(\dfrac{1}{20{,}139}\right) - 1.415} \right] \frac{347.73}{20{,}139}$$

$$= 2.64$$

Price elasticity of supply suggests that farmers respond very well to increases in tobacco price. We can not compute $\frac{\partial y}{\partial w_i}\frac{w_i}{y}$ because we have assumed that output in the profit function (from which the output supply equation was derived) is not affected by changes in factor prices.

The shadow price of the quasi-fixed input can be computed from the first-order derivative of the static competitive profit maximization problem (Coyle, 1990).

$$\underset{H,y}{Max}\ Py - C(w, H, y) - w^H H.$$

This implies the following first-order conditions for an interior solution $(i)\ \dfrac{\partial C(w, H*, y*)}{\partial H} + w^H = 0$

and $(ii)\ \dfrac{\partial C(w, H*, y*)}{\partial y} - P = 0.$

We are interested in the first result, which is multiplied by H/C to yield $-\dfrac{\partial C}{\partial H}\dfrac{H}{C} = w^H \dfrac{H}{C}$ or $-\dfrac{\partial \log C}{\partial \log H} = w^H \dfrac{H}{C}.$ From the cost function, derive and estimate $\dfrac{\partial \log C}{\partial \log H}$ using OLS.

Then we will have the following estimated value for the shadow price of land in tobacco:

$$-\frac{\partial \log C}{\partial \log H}\frac{C}{H} = w^H$$

$$-(-0.00866)\left(\frac{5{,}432{,}300}{18.528}\right)$$

$$= ZK\ 2{,}539.06\,/\,ha$$

CHAPTER FIVE

CONCLUSION

5.1 SUMMARY OF THE RESULTS AND IMPLICATIONS

The computations show that there are dis-economies of scale (1.415) in tobacco production in Zambia since the marginal cost is greater than average cost as has been shown on P.34. This suggests that further expansion of production will increase average costs and lower the profit margin at industry level. Technical Scale Bias of -0.566 tells that the minimum efficient farm size has gone up. efficient producers are those producing larger quantities of tobacco.

This study also provided an estimate of the shadow price of land, which should be another important source of revenue for the government. Up to now, tax is not collected from all those who own agricultural land. This has encouraged speculation on the land by businessmen who do not have anything to do with farming. Charging a small user/rental fee (as indicated by the computed price of the quasi-fixed variable) on the land that a farmer holds will discourage many speculators who have so far paid only the initial application fees, made a few cosmetic changes and sold the land as developed land/property to those who are serious about farming.

The following can be said about the other factors: labour is available at very reasonable prices, and seem to be relatively fixed. Fertilizer is manufactured by one factory that is being considered for closure. It used to operate under full capacity and could not compete with imported fertilizers. Domestic demand was never met and always forced the price to be going upwards. Agro-chemicals are manufactured by two companies, but because of the high import content the prices are usually very high. All the major machinery employed on farms are imported using the costly foreign exchange.

Although tobacco production could still be attractive to most farmers because of the larger profit margin it offers and the relatively efficient, ready international market that exist(ed), there is so much uncertainty over its future. The sub-sector continues to go down because of the shrinking international market, a result of the changing attitude towards tobacco products.

In 1993 marketing season the tobacco market in Zambia crushed for the first time. Almost all the farmers made losses because of the low prices that were offered for the crop. At the end of 1993 marketing season a lot of farmers were contemplating quitting farming altogether because other agricultural activities were also not as promising, except for livestock farming. Maize, the staple crop, was also not doing well because its marketing was being reorganised - private individuals were allowed to carry out the marketing of the crop. This was followed by drastic fall of the price. Maize production is the first alternative that is usually considered by those who grow tobacco whenever they want to switch. But at the end of 1993 maize was not so much of an alternative.

Officials in the tobacco industry believe that the problem in Zambia is not with the prices offered for the crop, but the low yields and small production realized by most farmers. It is difficult to attract many international buyers if production is low and therefore there is very little competition for the crop among the buyers. This leads to the fall in prices that are offered for the produce.

Whilst the government of Zambia is currently interested in promoting food self-sufficiency, it might not be in agreement with the farmers who might devote their resources and time producing something else that has a higher return (tobacco being one of these). Output elasticity of 2.64 certainly points towards an increase in tobacco output if its price went up. For tobacco farmers in Zambia, maize and tobacco literally used to compete for the limited resources. Farmers getting tobacco loans from NATCO were required, as a matter of policy, to devote some inputs to maize production. For every two hectares of inputs given out for tobacco, one hectare worth of inputs were to be devoted to maize production. This way food self-sufficiency was maintained at the farm level. Today, both tobacco and maize are not as promising as they were a few years ago.

The econometric results from this research could be of great use to government policy makers. They can strengthen/rationalise their decisions using the information provided here. In the short run government devote some time to seriously look at alternatives to tobacco production as it won't be long before the resources in this sector are underemployed or altogether declared unemployed. For labour, rural-urban migration might go up as people start looking for work elsewhere. Apart from loss of employment, there is the reduction of agriculture's contribution to GNP. Farmers in Zambia have very limited success with other cash crops and therefore they do not offer a long term solution; cotton production is likely to be headed downwards as textile plants are closing down because of the stiff competition from South Africa whose goods are allowed to come with minimum restrictions now. wheat and rice stand a good chance although their marketing infrastructure has yet to be well established. Because of the small domestic market, success here will require exporting to neighbouring countries whose climatic conditions do not allow for cheap production of these crops (e.g. Botswana). We have to compete with the technologically efficient South Africans.

5.2 LIMITATIONS OF THE MODEL

Briefly stated, the most important limitations of the model which are not likely to hold are: (a) The assumption of weak separability between included inputs and all the other inputs not included in the model (Applebaum, 1977); (b) Specification of the model whose true mathematical form can not be known; and (c) The conditions for consistent aggregation over firms and inputs are very stringent (farmers facing identical prices), and I do not expect them to hold.

These problems probably explain rejection of the homogeneity condition. It could be that I had applied a wrong theory altogether, or if the theory is alright then the mathematical form of the empirical model is wrong. The behaviour of farmers might be influenced by risk and not so much by the need to minimize costs or maximize profits. There is also the high probability of errors in data that was collected that would lead to rejection of homogeneity condition.

Since the data used was pooled cross-sectional data from the three time periods there is room for error interdependence over time to occur i.e.it is possible that $\boldsymbol{\beta}_{ij}$ may be different in different time periods, contrary to what has been implicitly assumed. This could be handled by specifying a share equation for each time period; then testing and probably imposing the symmetry and homogeneity constraints. We can also test whether the parameters $\boldsymbol{\beta}_{ij}$ are constants over time, given enough degrees of freedom. It should also be noted that these results generally apply to commercial and emergent farmers, but not small scale farmers whose data did not account for much in the estimated model.

Limitations of the results from the research arise mainly from the data utilized. The data was collected at the time when farmers were going through their worst experience - collapse of the tobacco market in Zambia because of global over production. Liberalization of the economy paved way for more competition from neighbouring countries leading to the fall in agricultural produce prices. There was just so much uncertainty among the investors during this period, but more so for farmers whose stock turns over slowly, but had to contend with high rates of inflation.

Consequently it is difficult to model farmers' expectations for tobacco prices, and they are unlikely to behave as risk-neutral profit maximizers. However, the assumption of risk neutral behaviour is imposed in the model by the equation relating (expected) output price to marginal cost of production. If Risk-aversion is taken into consideration, it will mean that output price is going to be an endogenous variable. Cost minimization hypothesis is consistent with risk-averse behaviour, but profit maximization is not. As such, the output supply function will not enter our model since we will not be assuming yield risk. The high variance in the prices that were recorded was mostly attributed to the high rate of inflation in the country. Official inflation rates for most of the early 1990's was over 100 per cent.

The absence of data for some of the variables like buildings,vehicles and other fixed assets might have required modifying the model to incorporate this aspect. Then we would have had long run and short run estimates of the factor efficiency and elasticities which can be varied for a reasonable time period. Instability of the Zambian political-economy for the past four or so years has had an adverse effect on the behaviour of the people in terms of taking risks. I'm not sure whether the data generated could have been any different under stable economic and political conditions.

Serious limitation of the model itself (dual cost function) is that it assumes output levels are not affected by factor price changes, and therefore indirect effects (via output level) of factor price changes on factor demands are ignored. "Moreover, inclusion of output levels as explanatory variables may lead to simultaneous equation biases if output levels are not indeed exogenous. This problem is certainly compounded if a multi-output cost function is estimated" (Lopez, 1982a).

The model employed is constrained in that it assumes that coefficients of translog function estimated on cross-sectional data do not change as one moves from period t to t+j. In other words it is implicitly assumed that non-time second-order coefficients do not change over time (Stevenson, 1980). In his study, Stevenson suggested a truncated third-order Taylor-series expansion in order to measure rates of technological change over a given time period.

However, a third-order truncated Taylor-series expansion would imply a lot of coefficients would have to be estimated, and given the limited data that was collected this is not possible since the degrees of freedom would literally vanish and no econometric tests would be performed. In fact introducing a lot of variables in the model raises the level of multicollinearity among the explanatory variables (Stevenson, 1980).

In the case of resource-competing crops like maize and tobacco, it might have been more reasonable to have gone with the multi-output model. In the single output model, we are faced with the problem of having to separate inputs utilized by each of the outputs (or crops), but in multi-output approach you do not require any knowledge regarding the allocation of different inputs to each of the outputs (Lopez, 1982a).

5.3 SUGGESTIONS FOR FURTHER RESEARCH

Further interesting research could be done from where I left. An assessment of food security by looking at resource/factor allocation between maize and tobacco is an obvious extension that would elevate the value of this research. This is more important given the current health concerns by most countries where tobacco products are consumed, and this is of equal importance in countries like Zambia that consider tobacco as one of their major generators of income and employment. However, an even more valid reason is concern over food security in Zambia which from time to time experiences some food shortages because of low food crop production. Tobacco farmers are of modest means, and if given the incentives they can divert their resources to food crop production.

CHAPTER SIX

APPENDIX A: BACKGROUND INFORMATION

The Ministry of Agriculture categorises Zambian farmers into three groups on the basis of the amount of land put under cultivation. The **Small-scale** farmers are all those farmers who cultivate less than five hectares of land; **Emergent** farmers are those with anything between five and twenty hectares, while the **Commercial** farmers have more than twenty hectares of land under cultivation. The other characteristics and types of farming are not considered in this classification. Of approximately 45 million hectares of Zambia's arable land only 4.5 million hectares are put to agricultural use. And less than one per cent of the cultivated land is under irrigation, mostly by (large scale) wheat farmers.

Small-scale farmers grow a lot of the staple crop (maize) which accounts for over 70 per cent of the marketed agricultural produce. So much importance is attached to maize by the Zambian government because it is a measure of the food security position of the country.

In 1974 the government introduced the policy of uniform pricing for all crops. No matter where one resided, he paid the same price for most of the agricultural commodities. The uniform prices do not reflect the difference in cost of production, or costs incurred for handling, storage and transportation. Therefore, the high-bulk, low-value crops and those with a large foreign exchange bill for inputs and/or transport costs were not priced properly. This led to uneconomic allocation of resources as farmers were encouraged to produce even when the conditions were not favourable, or in the case of maize the producers were encouraged to sell everything they produced because of the high price while at the same time they could buy the same produce at very low subsidized prices.

Agricultural sector contribution to the GDP is between 10 to 15 per cent, and provides about 8 per cent of the formal employment. The most important sector in the Zambian economy is mining, which generates over 90 per cent of the foreign exchange earnings, and provides a lot of employment. In agriculture, the most important foreign-exchange earning crops are cotton and tobacco.

As the relative price of maize in terms of tobacco went up, more maize was produced whilst production of tobacco went down as shown in Table 1. With falling tobacco output, tobacco exports went down just as the volume of maize imports went down following increased maize production.

Table 6.1: Marketed Maize And Tobacco

YEAR	MAIZE ('000 90KG BAGS)	VIRGINIA TOBACCO ('000 KG)	BURLEY TOBACCO ('000 KG)
1964	2,202	10,962	1,993
1965	2,864	6,600	855
1966	4,300	6,267	224
1970	1,468	4,794	387
1975	6,216	6,466	501
1980	4,247	4,126	654
1985	7,069	2,132	565
1988	15,000	3,515	525

SOURCE: Shawa, J.J. "Structural Adjustment In The Agricultural Sector: The Case Of Maize And Tobacco In Zambia" (Unpublished

Paper, 198..)

Some of the reasons for the decline in tobacco exports are:

(i) expatriate farmers who were the major producers started leaving the country in the early 1960's.

(ii) Government incentives were directed towards attaining self-reliance in food crops.

(iii) In recent times, there is a consented effort in tobacco importing countries to disapprove of tobacco products for health reasons which has led to drastic fall in demand.

- Smaller farmers do not have the resources to produce optimal quantities from which they can profit. This resulted in the steady fall in tobacco exports. Therefore tobacco is a crop produced by farmers with some modest capital to invest in the inputs.

GRZ Policy has been geared to increasing agricultural output and enhancing self-sufficiency in food. The government would also like to reduce the excessive dependence on copper exports for foreign exchange by increasing agricultural exports. In order to stabilize farmers' incomes diversify agricultural activities. Tobacco was to be introduced to rural population because it had more potential of increasing rural income than the other cash crops.

Since tobacco is labour-intensive, government policy requires that all producers to produce some significant amounts of maize for their labour force to ensure food security. Thus credit given out by TBZ, NATCO and private companies has to include inputs for maize production as well. This works well since maize benefits from being grown on land previously put to tobacco. This ensures some self-reliance in terms of food.

6.1 Production

Tobacco production in Zambia started shortly after World War I, but it was early 1950's when acceptable quality tobacco was produced in significant quantities. In 1955 the British government undertook to buy 4.5 million lbs of flue-cured Virginia tobacco to stimulate production. The industry expanded reaching a record high of 24 million lbs in 1964 (TBZ, 1971).

Before independence in 1964, the Federation of Nyasaland (now Malawi), Northern Rhodesia (now Zambia) and Southern Rhodesia (present day Zimbabwe) had established a reputation at international market as the following remark regarding the competitiveness of the Federation tobacco implies "..... the price of the United States tobacco relative to competing tobacco was quite high. In 1965, the net export price of U.S. flue-cured tobacco was approximately twice that of Rhodesian tobacco, which was generally acknowledged to be the next highest quality tobacco after the United States" (Johnson, 1984). In 1954 leaf tobacco was second in generating income for the Federation. Over 90 per cent of the tobacco was exported, approximately worth US $ 70 million. This represented 3/4 of the total agricultural earnings of the Federation. The principal markets included the U.K., Australia, Union of South Africa and West Germany. In 1954 the Federation exports reached 70 per cent of the total world tobacco exports, four times the average of the 1935-39 period (USDA, 1956).

However in 1967 production went down because of a government enactment to increase farm wage rates and fringe benefits (housing or rent allowance). This combined with an attractive maize producer price led to a fall in tobacco output in 1967.

Before 1966, the line-of-rail production was sold in salisbury, Rhodesia while that from Eastern province was sold in Malawi. In 1966, Tobacco Board of Zambia (TBZ) opened an up-to-date auction floor with a sale capacity of 450,000 lbs per day. In the following year TBZ commissioned a tobacco processing, redrying, and packing plant in Lusaka with a capacity of 40 million lbs annually on one shift (TBZ, 1971).

Tobacco production was encouraged by establishing

(i) Mukonchi Training Scheme, an extension of the 1970 World Bank Project. The scheme was to train Zambians to manage 300 acre farms as Assisted Tenants under TBZ supervision;

(ii) Tenant Farming Scheme rented out farms of about 500 acres of arable land to experienced farmers for a period of five years with an option to renew;

(iii) Popota Training College was to train middle management and extension staff for TBZ; and

(iv) Family Farm Tobacco Schemes (TBZ, 1971).

Today tobacco producers in Zambia consist of

(i) large commercial growers(former Assisted Tenant tobacco farmers under TBZ farms).

(ii) Family Farming schemes at village level. Production by this group fell from 750,000 kgs (1981) to 145,000 kgs (1985) because of lack of management and finance. NATCO boosted their output in 1986 to 421,000 kgs (VTAZ, 1987).

(iii) Peasant farmers grow the crop as tenant farmers for big enterprises which provide them with the inputs required.

Tobacco production involves the following

(a) a continuous work-programme of over 15 months from basic land preparation to presentation of tobacco at sales;

(b) 3-month, labour intensive reaping/curing season, which requires 24-hour surveillance to ensure a good cure, and

(c) Considerable expertise and management skills are required for preparation of land, seed beds, planting, soil fumigation, weed control, reaping, curing, fertilizing, succouring and presentation. It is not easy to recruit personnel having these traits.

And the costs of setting up infrastructure (barns, machinery, etc) for a viable tobacco growing operation are very high, and considering that most inputs are imported there is a high foreign exchange bill.

Tobacco being a labour-intensive crop, provides a livelihood to some 28,000 workers and their dependents who earned some ZK 24 million in 1986 (VTAZ, 1987). Tobacco also provides large amounts of income-tax revenue to government. Tobacco farmers are large maize producers since maize benefits from being grown on land previously planted to tobacco.

6.2 Infrastructure

Tobacco Board of Zambia (TBZ) was established by an Act of Parliament passed in 1967. The Board of Directors are appointed by the minister responsible for Agriculture. The Board was responsible for all aspects of tobacco industry, including growing, packing and selling. In 1985, when NATCO was set up, the Board's functions were limited to:

-monitoring and enforcing provisions of the Tobacco Act and other legislation governing the industry,

-maintaining registers of growers as required by law, and

-managing the auction/classification floors.

National Tobacco Company (NATCO) was formed to revamp the declining tobacco production by peasant farmers in 1985. The main functions of the company were to:

-process and pack tobacco for the export market;

-ensure increased plantings through incentives, technical advice through extension service;

-administer credit scheme for the benefit of peasant farmers;

-provide inputs at right time, and

-secure export market for Zambian tobacco.

NATCO credit to small-scale farmers was in form of fertilizers, chemicals, seedlings, packing materials, tractor hire.

NATCO wanted to duplicate the success of the Lint Company of Zambia (LINTCO) which raised contribution of small-scale farmers in cotton production. Private enterprises are allowed to mobilise small-scale farmers on scheme basis. There is Burley Tobacco Development Company (BTDC) in Eastern province, Centaf in southern province, Fodya, Lupenga Farms, Marklands, Asgrow and Lukanga Investments, to name some of the major private enterprises in tobacco business in Zambia.

At the time of independence in 1964, the only credit programme for the mass of agricultural producers were the Peasant Farmer Scheme and growers of specialised crops. The Land Bank and commercial banks were exclusively geared to the needs of large scale commercial farmers. When Credit Organisation of Zambia took over the Land Bank, it injected credit into rural areas. In 1970, Agriculture Finance Company (AFC), a subsidiary of Rural Development Corporation, was created (TBZ, 1971).

Because of the smallness of tobacco industry in Zambia, it can not support a tobacco research programme. Any latest information is given by Kutsaga Research Station of Zimbabwe.

6.3 Marketing

The Primary market serves the small-scale farmers. NATCO charges 30% service support to pay for transport, administration costs of extension services. The Main market serves all producers who operate without the NATCO assistance. TBZ runs this market with the Commercial farmers, Emergent farmers and NATCO.

Burley tobacco is financed by NATCO and Intabex. Intabex purchases tobacco by classification and exports it to Malawi. Centaf Tobacco Producers purchase all the tobacco produced west of the Luangwa river while Intabex purchases all Virginia tobacco produced east of the Luangwa river and all the Burley produced in Zambia. Both buyers purchase tobacco on three-year roll-over contract basis (VTAZ, 1987).

The auction system was replaced by classification in 1977 because the crop was too small to warrant an auction. With three merchants buying a small crop there was no competition, resulting into poor prices. Price negotiation team comprises of the Ministry of Agriculture, NATCO, VTAZ and TBZ.

Since 1980 flue-cured crop is tendered to Centaf Tobacco Producers, a subsidiary of Gerbruder Kullenkamp of West Germany. The tobacco that Centaf purchases is processed and packed in NATCO plant, where it is blended to the specification of Centaf client International Cigarette Manufacturers at an agreed price. The export price that Centaf receives is approximately double the floor price received by the Zambian growers (VTAZ, 1987).

The tobacco that Intabex purchases is exported unprocessed, but they pay a charge in foreign exchange in lieu of processing charges. The requirements of the domestic company, Central Cigarette Manufacturers (CCM), are easily met because they have a small market to carter for.

6.4 Foreign Exchange Policy

Because tobacco is mostly produced for the export market, exchange rate policy is very crucial in the tobacco farmers' operations. Exchange rate has a "...major impact on allocation of resources, incentive to save and invest, the decision to produce and consume, and the distribution of income and wealth" (EAZ Newsletter, Oct. 1993). It is a key determinant of balance of payments which affect a country's external indebtedness, and how much wealth individuals and firms hold in local financial assets.

For the most part of the Zambian economic history, exchange rate has always been fixed. There used to be surplus foreign exchange until after the 1973 "Oil Shock". The mid 1980's foreign exchange shortages forced the government to start devaluing the Zambian Kwacha (ZK). Devaluation continued with the new government that came into power in late 1991. The latest government action on the value of the exchange rate had been:

- January 1992 by 30% devaluation of the ZK;
- October 1992 a freely determined exchange rate and Bureau de Change were allowed to operate, and
- July 1993: BOZ intervenes in the foreign exchange market after ZK plummets in value rapidly by pouring in US $ 8 million every week, most of which was donated by the international donor community supportive of the on-going Structural Adjustment Programme which was being carried out under the auspices of the IMF and World Bank. Exchange rate gained value from ZK600 to ZK450 to a US dollar (EAZ Newsletter, Oct. '93).

Note that during the period when devaluation was going on, the exporters were enjoying the returns from their exports.

Another important aspect regarding foreign exchange is that non-Zambians farmers were allowed to retain 5% of their foreign exchange earnings in excess of 5,000 kgs in 1982. This went up to 15 % in Feb of 1987 and finally to 50 % when the foreign exchange shortage was very acute (VTAZ, 1987).

In 1980, TBZ was reorganised, and the responsibility of promoting tobacco was given to the Ministry of Agriculture. However, the tobacco sector continued to perform poorly because of lack of motivation on the part of extension workers, late payment for produce, low producer prices and lack of credit to farmers in general. In 1985, NATCO was formed to promote tobacco production by the small-scale farmers.

The change in administration of tobacco industry (NATCO taking up some of the TBZ functions in 1985) contributed to poor performance by the tobacco sub-sector such that by 1990 only 2.2 million kilograms of tobacco were produced. With 23 million hectares of class 1 and 2 arable land, adequate fuel supply and a potentially large labour force, Zambia can do much better than Malawi (16% the size of Zambia) or Zimbabwe (half the size of Zambia with semi-arid soils) which have enjoyed relatively greater success at the international tobacco market (TAZ, 1991).

Following the 1991/92 draught season, there was an overwhelming response from farmers to government calls to increase agricultural output. Despite the fact that many farmers in 1992/93 crop season had a bumper harvest, many farmers went bankrupt. "Many big farmers borrowed at between 50-60 % interest. Towards the end of the first quarter, this had soared to 140% and when compounded, this figure was in the region of 324% and could be more if penalties are included" (Productive Farming, Oct. 1993). Following from the inflation/devaluation process of the last five or so years the farmers have to contend with prohibitive input prices and very high interest rates. Unless there are other activities which could offer the same range of profitability as tobacco used to, we might experience disinvestment in the agricultural sector as a whole.

Diversification of the agricultural sector is going to be difficult if the economy continues to perform poorly. A lot of avenues into which farmers were to diversify are closing as the liberalization policies take their toll. There is little incentive to continue raising cash crops in general because farmers would also like to realize their revenue at a faster pace and utilize it as soon as it comes in before it is swallowed up by inflation.

Rural-urban migration can not be arrested given the poor performance of the agriculture sector which employs a significant portion of rural labour. Tobacco sub-sector is a big employer of the rural labour, such that when it performs poorly rural-urban migration is likely to go up. Government needs to look at how to retain or deploy the labour and other resources that are currently retained within the rural areas by offering more information and incentives on other ventures which can be equally or more rewarding.

In the wake of liberalized foreign exchange market, now farmers find it convenient to produce anything for export to have access to foreign exchange. Farmers can now retain 100 percent of their foreign exchange earnings and government is less strict on imports of agricultural inputs like machinery, chemicals, etc which are not available in Zambia. Individuals can have bank accounts in foreign currency denominations.

APPENDIX B: HYPOTHESES TEST RESULTS

Table B.1: Homogeneity and Symmetry Condition Tests,

---

1. Homogeneity condition:

Ho: $\sum_{i \neq 4}^{5} \beta_{ij} = 0$, $\sum a_{iy} = 0$ Observed $\chi^2_5 = 28.66$

Critical points:

$\chi^2_{0.01,5} = 15.08$

$\chi^2_{0.05,5} = 11.07$

2. Symmetry Condition:

Ho: $\beta_{ij} = \beta_{ji}$, $a_{iy} = a_{yi}$ Observed $\chi^2_{10} = 18.35$

$, i, j \neq 4$

Critical points:

$\chi_{0.01,10} = 23.209$

$\chi_{0.05,10} = 18.307$

$\chi_{0.1,10} = 15.987$

Table B.2: Auto-correlation Test, Ho: $\rho = 0$

Share Eqn	ρ	D-W Statistic	Comment
S1	0.2128	1.56	inconclusive
S2	0.3051	1.34	inconclusive
S3	0.3056	1.36	inconclusive
S5	0.1686	1.64	inconclusive
SY	-0.1901	2.35	no autocorrelation

$d = 2(1-\rho)$. Testing for positive autocorrelation; if $d \leq d_u$, reject Ho, if $d \geq d_u$, do not reject Ho, and if $d_L \leq d \leq d_u$, test is inconclusive.

CR	d_u	d_l
1%	0.821	1.836
2.5%	0.911	1.945
5%	0.991	2.041

The only sure way of solving autocorrelation problem, if at all it is significant, is by increasing the sample size to allow for more season variation. Though the estimates are unbiased, they are inefficient over time as the error is embedded in the estimated parameters, whose variances are underestimated if the OLS is applied.

Sources of autocorrelation

-Omission of important variables,

-Mis-specification of the mathematical form of the model

-Extrapolation/generation of data from the available for missing observations, or

-mis-specification of the true error term u.

Table B.3 Negative Semi-Definite Test Results

Main Diagonal Elements of the Hessian matrix

$$\frac{\partial^2 \log C}{\partial w_1 \partial w_1} = \frac{2\beta_{11}}{w_1^2}(1-\log w_1) = \frac{2(0.036)}{1678.4}(1-6.32) = -0.0002$$

$$\frac{\partial^2 \log C}{\partial w_2 \partial w_2} = \frac{2\beta_{22}}{w_2^2}(1-\log w_2) = \frac{2(0.053)}{2158.4}(1-9.70) = -0.0004$$

$$\frac{\partial^2 \log C}{\partial w_3 \partial w_3} = \frac{2\beta_{33}}{w_3^2}(1-\log w_3) = \frac{2(0.129)}{180.75}(1-5.04) = -0.0057$$

$$\frac{\partial^2 C}{\partial w_4 \partial w_4} = \frac{2\beta_{44}}{w_4^2}(1-\log w_4) = \frac{2(0.008)}{4034.6}(1-7.69) = -2.6x10^{-5}$$

$$\frac{\partial^2 \log C}{\partial w_5 \partial w_5} = \frac{2\beta_{55}}{w_5^2}(1-\log w_5) = \frac{2(0.169)}{4757.3}(1-8.25) = -0.0005$$

APPENDIX C: QUESTIONNAIRE AND DATA SET

(I). THE FARMER QUESTIONNAIRE

1. (a) Farm size......................................

   (b) For long have you been farming?................

   (c) what crops do you grow.........................

   ....

   ....

2. (a) What determines how much tobacco you cultivate?

   ....

   ....

   (b) How much tobacco is usually produced?..........

   " " " " " sold?.............

   (c) To whom do you sell the tobacco?...............

   ....

3. PRODUCTION AND SALES OF TOBACCO

Year	Area(Ha)	Output (kg)	Selling Price
1990/91			
1991/92			
1992/93			

INPUTS

(i) FERTILIZERS

YEAR	TYPE	QUANTITY	UNIT PRICE
1990/91			
1991/92			
1992/93			

(ii) TOBACCO SEED

YEAR	QUANTITY	UNIT PRICE	TOTAL EXPENDITURE
1990/91			
1991/92			
1992/93			

(iii) **HERBICIDES/PESTICIDES**

YEAR	Quantity	UNIT PRICE	TOTAL EXPENDITURE
1990/91			
1991/92			
1992/93			

(iv) **MACHINERY/TRACTOR HIRE**

YEAR	AMOUNT	RENTAL FEE	TOTAL EXPENDITURE
1990/91			
1991/92			
1992/93			

(v) LABOUR

YEAR	No. of WORKERS	WAGE RATE	TOTAL BILL
1990/91			
1991/92			
1992/93			

(v) OTHER INPUTS (specify)

YEAR	QUANTITY	UNIT PRICE	TOTAL EXPENDITURE
1990/91			
1991/92			
1992/93			

5. (a) How do you determine how much of the other crops to grow?......................................

....

(b) What is the future like for tobacco?...

....

....

....

(c) MAIZE OUTPUT

YEAR	AREA	OUTPUT
1990/91		
1991/92		
1992/93		

'Thank you very much for your time and the invaluable information. The information will be treated as strictly confidential.

(II). THE POOLED CROSS-SECTION/TIME-SERIES DATA FROM ZAMBIAN TOBACCO FARMERS FOR THE 1990/91-93 CROP SEASONS

Table C.1: **Tobacco Output**

Farmer	Season	Price(ZK)	Output(kg)	Size of Farm(Ha)
1.	1	190.8	68,000	2,500
	2	357.2	63,000	2,500
2.	2	156	8,000	1,500
	3	799	3,400	1,500
3.	2	142	4,000	104
	3	164.5	6,500	104
4.	2	385	7,000	80
	3	526.4	6,000	80
5.	3	120	6,200	7,000
6.	2	300	7,000	300
7.	3	250	8,000	57
8.	3	90	5,000	1,200
9.	2	430	14,000	1,300
	3	900	39,000	1,300
10.	2	320	1,000	250
11.	2	720	6,000	917
12.	3	250	218,000	273
13.	2	100	1,500	987
	3	300	30,500	987
14.	2	400	12,900	20
	3	350	11,000	20
15.	2	240	4,500	341
	3	343.1	3,500	341
16.	2	250	12,013	1,600
	3	500	24,000	1,600
17.	2	500	5,000	450
	3	350	14,500	450
18.	3	352.5	28,000	1,322
19.	3	441.8	75,000	3,000
20.	2	500	4,000	271
	3	400	7,400	271
21*.	1	400	2,000	209
	2	350	5,000	209
	3	300	5,000	209
	4	200	6,000	209
22.	2	140	3,580	218

*: Data includes that of the 1989/90 season as well.

Table C.2: **Tobacco Seed**

Farmer	Season	Price/gramme	Quantity Bought(gms)
1.	1	400	200
	2	600	300
2.	2	80	100
	3	138.4	30
3.	2	64	5,000
	3	140	10,000
4.	2	40	175
	3	120	175
5.	3	112	100
6.	2	100	20
7.	3	500	20
8.	3	400	40
9.	2	500	15
	3	500	43
10.	2	4,166	108
11.	2	3,333	36
12.	3	500	600
13.	2	450	10
	3	1,200	10
14.	2	200	50
	3	1,400	50
15.	2	280	20
	3	670	20
16.	2	750	100
	3	870	100
17.	2	140	300
	3	200	300
18.	3	2,500	10
19.	3	1,000	800
20.	2	250	30
	3	2,500	30
21.	1	2,500	24
	2	4,160	36
	3	10,000	36
	4	18,330	36
22.	2	1,330	18

Table C.3: **Machinery (or Tractor hire)**

Farmer	Season	Rate/Ha	Number of Hectares
1.	1	16,000	50
	2	22,000	40
2.	2	33,000	5
	3	50,000	3
3.	2	1,360	4
	3	5,150	8
4.	2	3,000	7
	3	5,000	7
5.	3	40,000	1
6.	2	18,000	10
7.	3	18,000	14
8.	3	50,000	4
9.	2	19,000	15
	3	35,000	40
10.	2	10,000	2
11.	2	10,000	6
12.	3	20,000	273
13.	2	10,000	2
	3	20,000	4
14.	2	25,000	8
	3	50,000	10
15.	2	30,000	4
	3	50,000	4
16.	2	7,500	15
	3	12,000	28
17.	2	12,500	3
	3	20,000	12
18.	3	20,000	20
19.	3	28,000	32
20.	2	20,000	5
	3	50,000	6
21.	1	5,000	4
	2	10,000	6
	3	15,000	6
	4	25,000	6
22.	2	11,500	3

Table C.4: **Labour**

Farmer	Season	Rate/day*	Number of Workers
1.	1	130	34
	2	285	29
2.	2	125	16
	3	178	12
3.	2	107	10
	3	160	10
4.	2	90	25
	3	178	25
5.	3	27	40
6.	2	200	15
7.	3	200	11
8.	3	250	20
9.	2	196	70
	3	268	135
10.	2	45	12
11.	2	150	13
12.	3	141	284
13.	2	107	10
	3	285	10
14.	2	65	25
	3	145	25
15.	2	120	18
	3	160	18
16.	2	250	20
	3	300	20
17.	2	150	45
	3	280	45
18.	3	450	80
19.	3	280	50
20.	2	80	20
	3	180	20
21.	1	30	12
	2	150	15
	3	300	15
	4	300	15
22.	2	145	12

* There are twenty-six working days in a month on average. Although the typical agricultural calendar is about eight months, tobacco farmers' calender is twelve months long.

Table C.5: **Chemicals**

Farmer	Season	Price/litre	Number of litres
1.	1	3,055	21
	2	7,639	39
2.	2	7,000	1
	3	9,000	1
3.	2	147	4
	3	431	4
4.	2	2,000	7
	3	4,000	7
5.	3	1,768	30
6.	2	250	20
7.	3	400	20
8.	3	3,000	80
9.	2	1,058	20
	3	4,064	80
10.	2	1,220	20
11.	2	440	20
12.	3	1,500	20
13.	2	1,580	1,316
	3	3,160	3,000
14.	2	1,000	144
	3	2,300	96
15.	2	3,000	2
	3	1,500	2
16.	2	1,145	840
	3	8,825	40
17.	2	660	108
	3	972	180
18.	3	1,600	420
19.	3	6,600	30
20.	2	3,333	12
	3	2,000	6
21.	1	9,500	10
	2	9,500	10
	3	20,000	10
	4	20,000	10
22.	2	1,600	2

Table C.6: **Fertilizers**

Farmer	Season	Price/50kg Bag	Number of Bags
1.	1	4,500	550
	2	8,000	450
2.	2	3,900	60
	3	5,800	36
3.	2	5,870	52
	3	5,870	132
4.	2	5,000	126
	3	10,000	126
5.	3	4,200	14
6.	2	5,000	150
7.	3	8,000	210
8.	3	5,000	80
9.	2	3,800	2,500
	3	7,040	3,000
10.	2	800	32
11.	2	800	102
12.	3	8,282	3,276
13.	2	800	32
	3	4,500	64
14.	2	3,500	200
	3	7,000	200
15.	2	3,000	68
	3	4,000	68
16.	2	800	255
	3	4,700	476
17.	2	4,000	48
	3	7,500	192
18.	3	5,200	350
19.	3	3,000	780
20.	2	4,000	196
	3	7,000	120
21.	1	800	54
	2	3,800	66
	3	5,000	67
	4	10,000	56
22.	2	800	42

(III). TIME-SERIES DATA

Table C.7 **Production and Price data for Virginia and Burley Tobacco**

YEAR	Weight(kgs)	Price/kg	Weight(kgs)	Price/kg
1955	3,457,000	0.62		
1956	4,589,000	0.57		
1958	4,208,000	0.70		
1959	3,078,000	0.64		
1960	5,670,000	0.62		
1961	5,745,000	0.61		
1962	7,340,000	0.64		
1963	7,041,000	0.75		
1964	10,985,000	0.51		
1965	6,614,000	0.61		
1966	6,580,000	0.67		
1967	4,999,000	0.97		
1968	6,292,000	0.67		
1969	5,033,000	0.78		
1970	4,805,000	0.65	255,000	0.56
1971	6,248,000	0.69	389,000	0.56
1972	5,544,000	0.75	385,000	0.57
1973	6,236,000	0.88	471,000	0.61
1974	6,214,000	0.90	430,000	0.88
1975	6,480,000	0.81	502,000	0.97
1976	6,236,000	1.00	312,000	
1977	5,588,000	0.98	264,000	
1978	3,703,000	1.29	259,000	
1979	4,590,000	1.51	380,000	
1980	4,126,000	1.57	554,000	
1981	2,350,000	3.58	664,000	
1982	1,868,000	2.40	703,000	
1983	2,337,000	2.67	536,000	
1984	2,620,000	2.80	500,959	
1985	2,194,000	3.45	565,830	1.65
1986	2,978,000	11.00	615,504	5.00
1987	2,955,000	19.90	650,976	8.78
1988	3,738,000	25.72	610,208	12.46
1989	3,249,000	28.50	1,016,407	17.44
1990	2,927,000	84.49	1,553,099	71.00
1991	3,525,000	194.49	1,798,678	161.00
1992	3,006,000	342.00	337,068	380.00(West of Luangwa)

Source: NATCO

Table C.8 **Producer Prices For Tobacco (1970-1990)**

YEAR	Virginia	Burley
1970	0.81	0.56
1971	0.81	0.56
1972	0.88	0.57
1973	0.88	0.62
1974	0.96	0.88
1975	0.84	0.97
1976	0.97	1.01
1977	1.10	1.06
1978	1.45	1.10
1979	1.51	1.11
1980	1.57	1.25
1981	1.65	1.26
1982	2.40	1.56
1983	2.70	1.65
1984	2.80	1.80
1985	3.45	2.30
1986	5.12	3.50
1987	6.25	5.10
1988	14.00	9.00
1989	14.40	12.00
1990	60.00	48.00

Source: Ministry of Agriculture

Table C.9: **Virginnia Tobacco: Price, Area, Output, and Sales (1950-1970)**

YEAR	Price/lb	Acres	'000 lbs	K'000	US $ '000
1950		14,574	6,171		
1951		2,835	10,698		
1952		23,535	9,779		
1953		21,779	10,779		
1954		14,610	7,885		
1955		13,550	7,606		
1956		14,870	10,096		
1957		12,100	9,257		
1958		12,860	6,773		
1959		13,870	12,628		
1960	0.28	14,830	12,470	3,492	4,990
1961	0.28	16,950	14,840	4,155	5,940
1962	0.29	16,870	16,150	4,684	6,6990
1963	0.34	20,390	15,490	5,267	7,520
1964	0.23	25,110	24,170	5,559	7,940
1965	0.27	16,250	14,550	3,928	5,612
1966	0.31	16,970	14,570	4,517	6,453
1967	0.44	11,340	10,720	4,717	6,759
1968	0.31	14,640	13,850	4,294	6,130
1969	0.35	14,200	11,070	3,904	5,465
1970	0.28	13,500	10,600	3,000	4,200

Source: Family Farming Tobacco Project: Zambian Government (Tobacco Board Of Zambia, July 1971).

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