THE PRODUCTION FUNCTIONS OF THE TEXTILES MANUFACTURING INDUSTRY IN NIGERIA: A CASE STUDY OF THE UNITED NIGERIAN TEXTILES LTD (U.N.T.L.)KADUNA.

BY

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D E C L A R A T I O N

I hereby declare that this Thesis is the outcome of my own research. It has not been accepted anywhere for the purpose of awarding a higher degree. All references have been acknowledged at the end of the Thesis.

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C E R T I F I C A T I O N

This thesis entitled "The Production Functions of The Textiles Manufacturing Industry In Nigeria: A Case Study of The United Nigerian Textiles Limited (U.N.T.L.) Kaduna" by Musa Muram Rabiu, meets the regulations governing the award of the degree of MASTER OF SCIENCE of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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I accept responsibility for all errors, either by omission or commission, in this Thesis.

January, 1988 MUSA MURAM RABIU.

D E D I C A T I O N.

This work is dedicated to the Struggling Masses of Nigeria in the Face of the Hardships of the Structural Adjustment Programme (S.A.P).

A B S T R A C T

This thesis has attempted an empirical analysis of the production functions in the textiles subsector of the manufacturing sector. In tackling the problem we have examined the production functions of the united Nigerian Textiles Limited (U.N.T.L.), Kaduna, with respect to scale parameter, factor-intensity, technical efficiency and factor substitution. We have sought, in this study, to expose the production functions of the U.N.T.L. and its manifold characteristics such as the productivity of the inputs and its relation to substitution technological process and the efficiency of production.

We advanced three hypothetical propositions with respect to the character of the firm's production functions. Firstly, we hypothesized that the U.N.T.L, operates a capital-intensive production functions, secondly, that the firm experiences increasing returns to its factors. And thirdly, that it enjoys technical efficiency (Hicks-neutral) in the process of production, in testing the validity of these hypotheses we examined four types of model specifications using an econometric approach. These are broadly categorized into "aggregated" and "disaggregated" models for Models I and II and Models III and IV respectively. All the models were estimated

for the Cobb-Douglas (CD) production function, while only Model I was estimated for the constant Elasticity of substitution (CES) production function for convenience in the technique of estimation.

Our findings indicate that the first hypothesis was generally rejected in Model II. This rejection in favour of the raw material input shows that the manufacturing production in Nigeria is highly sensitive to the use of raw materials. This sensitivity became acute in the 1980s when the supply (cotton) crisis adversely affected the capacity utilization in the textiles industry. We observed a divergence between the results obtained in Model III and Model IV with respect to the coefficients of capital taken individually and collectively. This, we explained, could be due to the use of machines of different vintages in production processes which we have, for convenience, singly harmonized in this study.

The study has also shown that the U.N.T.L. generally experiences increasing returns to scale. This finding theoretically implies that the firm's profit has not reached a global maximum. This is probably due to the imperfection in both the product and factor markets. The results obtained with respect to technical efficiency are generally positive. Technical changes (efficiency) contribute about 47 per cent to the growth of the firm's output per annum. We observed that these technical changes are both capital-deepening and raw material—

deepening implying that the productivity of each of the factors in question is enhanced overtime.

We also discovered that the U.N.T.L. exhibits elasticity of substitution less than unity. This finding confirms Maitha's (1973) conclusion that manufacturing industries in developing economies are characterized by capital-intensive production processes, we are, therefore, based on these results, making the conclusion that the expected benefits of the import-substitution industrialization strategy with respect to the unemployment problem, sectoral linkages, and transfer of technology have not been generally realized in Nigeria. The raw material crisis in the industry has exposed the dependency of the textiles industry on imported inputs as well as the increasing capital-intensity in the production processes vis-a-vis the worsening unemployment problem. This is an indication that the transnational corporations donot perform properly their expected roles in the industrialization process in Nigeria as in other dependent developing economies of the world.

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GLOSSARY OF TECHNICAL TERMS

ACTIVITY ANALYSIS - a method of calculating a firm's minimum unit costs of production on the assumption that it may combine various techniques, each characterized by fixing input-proportions, into different technologies. Also known as 'linear programming'.

ADJUSTED R^2 (also known as R bar squared) - The coefficient of determination adjusted for degrees of freedom. While it is not possible for the unadjusted R^2 to decline as more explanatory variables are added, if the latter do not significantly add to the explanatory power of the equation, then $\bar{R}^2$ will decrease.

AGGREGATE PRODUCTION FUNCTION - A functional relationship between the flow of output in the whole economy and the total labour and total capital inputs, actually engaged in production.

AGGREGATION PROBLEM - The problem of deriving predictable macroeconomic behaviour from the behaviour of the underlying microeconomic units.

ALLOCATIVE EFFICIENCY - The production of the 'best' or optimal combination of outputs by means of the most efficient combination of inputs.

APPROPRIATE TECHNOLOGY - The application of a technology which is appropriate for the factor endowments that exist.

A PRIORI - A term which describes a process of reasoning deductively from initial premises to conclusions.

ASSET - An entity possessing market or exchange value, and forming part of the wealth or property of the owner.

CAPACITY UTILIZATION - The ratio of actual to potential output of a firm, an industry or the economy which gives a measure of the amount of the total capacity that is being used.

CAPITAL - A word used to refer to capital goods in general; it is a factor of production.

CAPITAL DEEPENING - The process of accumulating capital at a faster rate than the growth of the labour force. Thus the capital/labour ratio is rising.

CAPITAL INTENSITY - Refers to the ratio of capital to labour employed in production.

CAPITAL-LABOUR SUBSTITUTION - The process of altering the factor proportions of capital and labour in a production technique.

CAPITAL-OUTPUT RATIO - The ratio of the amount of capital to the amount of output produced by that capital.

CAPITAL-REVERSING - The adoption of a technique of production when the value of the associated capital stock and the rate of profit have both risen. When only two techniques are being considered capital reversing implies double switching as the rising rate of profit means that a technique abandoned as the less profitable of the two will be readopted at a higher rate of profit implying a higher value of the capital stock associated with the abandoned technique.

CAPITAL STOCK - Refers to the aggregate capital goods in a firm, an industry or an economy.

CETERIS PARIBUS - A Latin expression meaning 'other things being equal'.

COEFFICIENT OF DETERMINATION (also known as R^2, Multiple Correlation Coefficient). It is the proportion of the variation in the dependent variable which is accounted for by the composite variation of the explanatory variables.

DEINDUSTRIALIZATION - A trend in a national economy towards a larger and larger share of the gross domestic product being taken up by services. For this to occur the rate of growth of the service sector must be greater than that of the manufacturing sector. It typifies advanced economies.

DISEMBODIED TECHNICAL PROGRESS - Technical progress which appears costless, completely independent of capital accumulation or any other variable in the economic system.

ECONOMETRIC MODEL - A formally specified mathematical Model of an economy, or part of an economy whose parameters are estimated by econometric techniques.

ECONOMETRICS - A branch of statistics concerned with the testing of economic hypotheses, and the estimation of economic parameters, mainly through the use of multiple regression techniques.

ECONOMIES OF SCALE - Reductions in the average cost of a production in the long run, resulting from an expanded level of output.

ELASTICITY OF INPUT SUBSTITUTION - A measure of the responsiveness of the optimal labour/capital combination to a change in the relative prices of the two inputs.

EMBODIED TECHNICAL PROGRESS - Technical progress which cannot take place unless it is embodied in new capital.

ESTIMATION - The quantitative determination of the parameters of economic models through statistical manipulation of sample information.

EX ANTE - The planned, desired or intended level of some activity.

Ex post is the realized or actual level of economic activity.

EXCESS CAPACITY - Rigorously defined, a firm is said to be producing with excess if its output level is below that at which average costs are at a minimum. The more common usage refers to firms operating plant at a rate of utilization below that considered normal.

FACTOR AUGMENTING TECHNICAL PROGRESS - Technical progress which raises the level of output even though the stock of capital and the labour force have not been changed.

FOOTLOOSE INDUSTRIES - Industries which are not bound to particular locations by specific locational requirements and thus can effectively locate anywhere.

GOODNESS OF FIT - A general term describing the extent to which an econometrically estimated equation fits the data.

HARROD NEUTRAL TECHNICAL PROGRESS - A classification of a disembodied technical progress which compares points in the growth process at which the capital to output ratio is constant.

HETEROSCEDASTICITY - An econometric problem in which the variance of the error term in a regression equation does not remain constant between observations.

HICKS NEUTRAL TECHNICAL PROGRESS - A classification of disembodied technical progress which compares points in the growth process at which the capital to labour ratio is constant.

INDUSTRY - An industry within the framework of a perfectly competitive market structure can be defined as a large number of firms competing with each other in the production of a homogeneous product.

INFANT INDUSTRY - An industry in its early stages of development whose share of its domestic market is currently small due to competition from overseas competitors.

INTERMEDIATE TECHNOLOGY - A set of techniques and technological processes which is half way between the highly capital-intensive technologies of the Western World and the 'primitive', indigenous techniques of underdeveloped countries.

ISO-PRODUCT CURVE (also known as producers' indifference curve, or isoquant). An iso-production curve traces out the combinations of any two or more inputs which give rise to the same level of output. These combinations must be the most efficient ones.

LABOUR INTENSIVE - A process or technique of production A is said to be more labour intensive than an equivalent process or technique B if the ratio of labour to capital used is greater than in A than in B.

LINEAR PROGRAMMING - A technique for the formalization and analysis of constrained optimization problems in which the objective function is a linear function, and is to be maximized or minimized subject to a number of linear inequality constraints.

MARGINAL RATE OF TECHNICAL SUBSTITUTION - The marginal rate of technical substitution of labour for capital is the difference in the amount of capital that needs to be substituted for a very small reduction in the amount of labour employed in order to maintain the level of output.

METHODOLOGY - A term often very loosely used in economics to describe the way in which economists proceed in their analysis of a problem.

MONOPOLY POWER - Monopoly power is the ability of a firm or group of firms to influence the market price of the commodity or service it sells.

MULTICOLLINEARITY - An econometric problem in which two or more of the explanatory variables in a regression analysis are highly correlated with each other.

MULTINATIONAL CORPORATION - A large enterprise having a home base in one country but operating wholly or partially-owned subsidiaries in other countries.

PERFECT COMPETITION - A market structure is perfectly competitive if there are a large number of firms each with an insubstantial share of the market producing a homogeneous product, using identical production processes possessing perfect information and normal profits.

PRODUCTION - The act of transforming the factors of production into the goods and services that are desired for consumption and investment.

PRODUCTION FUNCTION - The relationship between the output of a good and the inputs required to make that good.

RESEARCH AND DEVELOPMENT (R and D) - Activity devoted to increasing scientific or technical knowledge and applying that knowledge to the creation of new products and means of production as well as to the improvement of existing products and production processes.

RESWITCHING (also known as double switching) - In the capital controversy the notion that a technique of production abandoned when the rate of profit rises to much higher levels, with an alternative more profitable technique (or techniques) being used in the interim.

SERIAL CORRELATION (also known as autocorrelation) - An econometric problem in which the current value of the error term in an equation is correlated with its own past values, normally indicating that some systematic influence has been omitted from the equation.

STANDARD ERROR - A measure of the degree to which a calculated statistic is dispersed around its mean value. Whereas the term standard deviation is used to describe the dispersion of a variable, the term standard error is employed to describe the same quantity applied to a statistic.

SURROGATE PRODUCTION FUNCTION. In the debate surrounding the capital controvery a concept of the production function which implied some substitution between labour and capital in the long run was introduced with the aim of allowing the use of derived demand functions for factors of production in econometric work.

TECHNICAL PROGRESS - A central element in economic growth which enables more output to be produced for unchanged quantities of the inputs of labour and capital to the production process.

TECHNOLOGICAL DUALISM - The process of combining capital-intensive heavy industry with labour-intensive methods elsewhere to utilize the excess labour.

TOTAL COST - The total cost of producing any given level of output. In the short-run total costs can be divided into fixed and variable costs.

VALUE-ADDED - The value of the firm's output minus the value of the inputs it purchases from other firms.

WORK IN PROGRESS - Production that remains uncompleted at the end of the accounting period.

Mathematical Symbols

Greek	Meaning	English
α Alpha	Population regression Coefficient	a
β Beta	" "	b
γ Gamma	" "	g
δ Delta	" "	d
λ Lambda	Lagrange Multiplier	l
σ Sigma	Substitution Elasticity	s
ρ Rho	Population serial correlation of time series error	p
θ Tether	Population regression co-efficient.	-
μ Meu	Population mean	u

CHAPTER ONE

1.1 I N T R O D U C T I O N

1.1.1 Historical Development of The Textiles Industry

The developing countries have been obsessed with the development and growth of their economies since the termination of the second World War in 1945. This obsession with growth and development has led to the adoption of various strategies for the development of these countries' economies. Industrialization is one of such strategies. It is widely believed that industrialization is synonymous with development. The approach most developing countries have adopted for industrialization is the import-substitution industrialization. Nigeria adopted this strategy immediately after its political independence.

This strategy for industrialization encouraged the establishment of import substituting industries with particular emphasis on consumer-oriented production. The multinational corporations being the main agents of industrialization established local industries to produce goods which were hitherto imported. These local industries actually depend on their parent bodies in the metropoles for the supply of their industrial needs viz plants and equipments, spare parts and raw materials.

Arguments have been advanced for and against the establishment of such industries in Nigeria. The main conclusion from these arguments, given empirical evidences, is that the industries entrench dependency in the economy in terms of the imported inputs, and distort the structural growth of the Nigerian economy. Among the early industries established are the textiles, tobacco, confectionaries and leather industries.

The textile industry, particularly the cotton textile industry, has pioneered and dominated the industrialization process of almost every developing country during the twentieth century. In deed, it has been argued that the industry played a similar role in the initial phase of the industrialization process of some of the present-day developed countries (Ekuerhare, 1978). Rostow, for instance, identified the cotton textile industry as the "leading sector" in the British "take-off" into a "self-sustaining" economic growth process during the last two decades of the 18th century and the early decades of the 19th century (Rostow, 1960).

The textile industry as we have it today started in 1946 with the launching of the textile development scheme as part of the Ten-Year Plan. It has been stated that the scheme represented the largest single technical aid effort undertaken by the colonial government to foster the development of a Nigerian industry. It can

be argued, however, that the scheme was meant to further the economic interests of the colonial government. The initial project involved the establishment of eight textile centres.[1] In 1949, the textile development scheme was broadened to include power-looms. At the mid-point of the Ten-Year Plan, 1950/51, the hand-loom programme was reappraised and the findings indicated the existence of production problems, organization, purchasing and marketing difficulties. In 1954, the administration of the textile scheme was transfered to the regional governments.

The Ogunbiyi Textile Mills which was originally founded in the early 1940s was granted a loan of £1,500 in 1948, to purchase several power-looms and other equipments, by the Nigeria Local Development Board. In the north, Kano Citizens Trading Company which was established by a group of politically influential Kano traders was given a loan of £35,000 by the Northern Region Development Board in 1949.[2] This was Nigeria's first textile plant and came into operation in 1950. The Kaduna Textiles Ltd (K.T.L) commenced operations in January 1958 with the production of grey baft. Spinning operations began two months earlier using Nigerian cotton. Initial capital of £1 million was provided by the Regional Marketing Board and the Northern Nigerian Development Corporation. The technical partners were

David Whitehead and Sons of Lancashire, England. It has been stated that Kaduna Textiles Ltd was an unqualified success. It earned a profit from the first month of operation. The factory attained full capacity utilization in the second year of its existence. The success story of the Kaduna Textiles Ltd was due to the monopolistic situation in the textile industry, abundant cheap labour and the ban placed on imported textiles products at that time.

1.1.2 The Structure of The Textiles Industry

The textiles industry has about 90 established firms. Sixty-seven of these are members of the Nigerian Textiles Manufacturers Assocation (NTMA).[3] There are twenty nine spinning firms which are mostly very large and most of them are also weavers. The spinning firms account for nearly 80% of the weaving capacity in the industry. About 75% of them are located outside Lagos, three of the largest, including UNTL, are in Kaduna. A few of them are in Kano, and one each in Gusau, Funtua, Ilorin, Aba, Ado-Ekiti, Onitsha and Asaba. The firms which are combined weavers, knitters or embroiderers are 17 in number and located mainly in Lagos with a few in Kano. About eighteen of the non-spinners are single function firms and mostly weavers, usually small and found in Kano but most of them are in Lagos.

The capacity of the industry for cloth production is estimated by the Nigerian Textiles Manufacturers Association (NTMA) at 850 million metres per annum (Gunilla and Beckman, 1985). The total capacity of 560 metres has been suggested as the actually operable capacity in the industry which expresses the total demand for raw materials, since spinning products also feed into the stage of cloth production. The industry has 20,853 installed looms, 962 knitting machines and 231 embroidery machines. The Nigerian Textiles industry is estimated to be able to spin 106,000 tonnes of yarn per annum in addition to producing 5,500 tonnes of filament yarn. To achieve this target of yarn per annum there were 682,070 spindles installed and 4,885 rotor (or "opened" spindles) as at 1985.

1.1.3 The United Nigerian Textiles Limited (UNTL), Kaduna

The United Nigerian Textiles Ltd (U.N.T.L.) was established in July 1964 in Kaduna. Production started at the factory early 1965 with only the Printing and Dyeing department. The firm has substantial foreign interests viz Chinese, British, American, Singaporian and Canadian. In actual fact, these nationals are Chinese who have naturalized in countries they claim nationality. Ignoring this fact still, the Chinese have the largest share capital of about 60% and a Chinese has been the chairman of the company since its inception.

The U.N.T.L. as the largest textiles firm in the country has five subsidiaries. The subsidiaries are Supertex textiles Ltd (Kaduna), Unitex Ltd. (Kaduna), Zamfara textiles Ltd. (Gusau), Funtua textiles Ltd. (Funtua) and Nichemtex Ltd. (Lagos). Each of these subsidiaries has all the Departments to produce textile products. The U.N.T.L. and its subsidiaries control the largest proportion of the textiles market. The firm which started with a labour force between 350 and 400, with relatively few expatriates, attained its peak of employment in 1984 with a work force of 8,474.[4] This was the highest number of employees in the industry. The work force, however, declined to 7,690 in 1985 as the economic crisis which commenced in the early 1980s deepened. According to the management the decline was not occassioned by retrenchment of the workers but by a deliberate policy of not recruiting new workers and replacing those who left the firm.

The U.N.T.L. has thirteen main departments with actual production being undertaken in five departments namely Printing and Dyeing, Real Wax, Spinning, Weaving I and Weaving II. As a group (the U.N.T.L. and its subsidiaries), the production units of all the subsidiaries and those of the parent company make up its capacity. This capacity has been increasing as more looms, spindles and knitting machines are installed.

The figures for looms, spindles and knitting machines installed were not made available for this research.

The conventional inputs in the production process are labour and capital. Apart from these inputs the firm also uses raw materials in its production process. The main raw material is cotton (lint) which used to be abundantly available domestically up to 1977 (see Appendix B Table II). Also classified as raw materials by Nigerian manufacturers for the purpose of securing import licences prior to the Second-Tier Foreign Exchange Market (Now F.E.M.) are spare parts. The other inputs are chemicals, dyes, and other accessories.

The output of the U.N.T.L. can be classified into various categories of textile products. These products are Real Wax prints, Superb prints (African prints), Superb Roller prints, Dyed shirting, Dyed Drill, Dyed TC, Superb Dobby, Real Wax Dyed Crack, Superb Wax and Real Wax Cover style. We assumed for this study that the firm's products are homogeneous. Thus, U.N.T.L. is a single product firm. Some of these products actually require synthetic fibres in their production. The U.N.T.L. like many other textiles firms has been relying greatly on imported cotton (lint) and synthetic materials since the mid-1970s when domestic production began to decline.[5]

1.2 Statement of the problem

The production of manufactured goods which takes place in the industrial sector of the economy has been of fundamental concern to every society. However, for a developing country such as Nigeria, the growth of the industrial sector is crucial for the overall prospects of the economy. The manufacturing sector is expected to play an important role in the transmission of latest production techniques and efficiency to other sectors of the economy, given the utilization of modern methods of production, and the consequent relatively high labour productivity.

It has been observed, however, that this expected role of the manufacturing industries in the Nigerian economy has not been satisfactorily performed due to certain factors. First, is the fact that the strategy of import-substitution industrialization which relied on the multinational corporations as agents of industrialization did not encourage the imported technology used in the industries to take root in the domestic economy. A case in point here is the use of capital-intensive technique of production by the manufacturers when the domestic economy suggests a labour-intensive method of production to take care of the problem of unemployment. Apart from the problem of unemployment the technique of production also precludes effective

sectoral linkages in the economy because of reliance on foreign economies for the necessary inputs. Secondly, the inputs used such as capital equipments, spare parts and raw materials are foreign exchange consuming and, therefore, have little or no linkage with productive activity in other sectors of the economy. More importantly, the will to enforce industrial regulations and implement policy statements by government functionaries is usually lacking.

The industrial sector is characterized by the structural dependence of the economy. It has been suggested that agro-allied industries in Nigeria are to over 90% dependent on imported raw materials. They are responsible for some of the heaviest import items, including wheat (flour mills), vegetable oils (oil mills and detergent factories), maize (feed mills), barley (breweries), milk powder (dairies, milk reconstitution factories), sugar (cubing plants), rubber (tyre manufacturers), cotton and other fibres for the textiles industry.[6]

The raw materials crisis in the textile industry began in mid-1974 when there was a gap of 410,000 tonnes in the expected allocations of import licences for cotton.[7] This figure is out of the requirements of about 560,000 tonnes, and after the Cotton Board has been able to supply only 150,000 tonnes from

domestic sources. When the import squeeze began in 1982 it was directed at the yarn imports, which were more than halved from 80,000 tonnes in 1981 to 33,000 tonnes. However, the spinning capacity was favoured by raw cotton imports which in 1985 increased to 25,000 tonnes. The supply crisis also affected such inputs as chemicals, dyes, machinery, spare parts and accessories. The near total import-dependence in the industry made these inputs contributed about 25% of the total import bill for the industry.

The shortage of raw materials has adversely affected capacity utilization of the textile mills in the industry. Low capacity utilization was reported for FIVE, a major lace and knitted goods producers in Lagos. This firm was running below 50% of its capacity of 100,000 metres per day, working 4 hours per day, and threatening to retrench 670 workers in 1984.[8] FIVE could only receive ₦3 million worth of import licences out of ₦18 million applied for. It was also reported that about 8,000 workers had been made redundant since the beginning of 1985. 6,000 workers were working only 4 days per week in various mills and many on compulsory leave due to the low import allocation which had forced the industry to operate at 40% of its installed capacity.[9]

From the foregoing analysis one can see that the economic crisis which began in the early 1980s has seriously affected productive activity in the manufacturing sector of the economy. The problem to tackle in this study is therefore an empirical analysis of production processes in the textile subsector of the manufacturing sector. In tackling this problem the paper will examine the production functions of the U.N.T.L. (the Group i.e., including the subsidiaries) and relate the empirical findings to theoretical postulations in production economics such as scale parameter, factor-intensity, and factor substitution. The study being an enquiry in production economics will shed more light on the production characteristics of the textiles industry with the U.N.T.L. as a case study.

The purpose of empirical studies in economics is to verify the validity or otherwise of economic models when confronted with data obtained from the economy. The ability of economists to do this has been greatly enhanced by the development of econometrics in the 1930s. The production functions can be estimated using econometric techniques. However, in doing that the fact must be acknowledged that the problem of the application of economic theories to policy decisions revolves around two central issues. The first is the difficulty of testing these theories the way they are being tested in the developed industrial economies

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where they were propounded. The second and more problematic is the fact that even if these theories work for the developed countries, they are not suitable in developing countries like Nigeria because of certain socio-cultural-cum-structural problems. The disenchantment and frustration with the neo-classical/ Keynesian economics in developing countries have been as a result of the issues raised in the preceding analysis.[11]

1.3 The Objectives of the Study

This study examines the production functions of the U.N.T.L. and their manifold characteristics such as productivity of the inputs, the potential trends in earnings and their relation to technological parameters, which include substitution, technological process and the efficiency of production. It has been stated that productivity and its division between capital and labour are some of the most important underlying factors in the determination of the size of the market, the scale of production, the size of employment, effective demand and technological change under perfect competition.

We shall test three basic hypotheses with respect to the characteristics of the production functions of the U.N.T.L. The first hypothesis is that the co-efficient of capital is greater than that of labour

i.e., that capital contributes more to the output of the firm in the production function than labour. This is based on the assumptions of capital intensity[12] and high capital productivity. Secondly, we hypothesise that the U.N.T.L. experiences increasing returns to scale. The third hypothesis states that there has been technical efficiency in the production process of the U.N.T.L. which has been occassioned by a positive technological change.

Two types of production functions are adopted for this empirical investigation. They are the Cobb-Douglas (CD) production function which is the most popular and convenient for empirical studies, and the Constant Elasticity of Substitution (CES) production function. The two functions will be used to test all the hypotheses stated. The findings of this work would enable an identification of the type of production function that explains the production process at the U.N.T.L. and indicate in quantitative terms the ease of factor substitution, factor productivity and scale of production.

This study assumes a long-run production function which applies to situations in which it is realistic to believe that enough time has elapsed for production managers to have implemented all changes in inputs.

In other words, all inputs are variable. It is noteworthy that empirical investigation into the technological aspects of the Nigerian industry and the textiles industry in this case rests on two basic assumptions, namely, perfect competition and decreasing marginal productivity. These are very crucial assumptions though not necessary for the estimation of a firm's production functions. However, many industries in Nigeria are overtly or covertly dominated by international monopolies (transnational corporations) which are big not only just for technical reasons but because of their monopoly power.

This study will examine four types of model specification. The first specifies output as a function of labour and capital. Here, we hope to bring out the relationship between the conventional inputs and output. The second model looks at the relationship between output and labour, capital, and raw materials. The third model examines the relationship between output and labour and the components of capital namely, land/leasehold properties, plant and equipments, and capital work-in-progress.[13] The fourth specification looks at the relationship between output and land/leasehold properties, plant and equipments, capital work-in-progress and raw materials. The last two types of model specification are known as "disaggregated" production functions though in this

work they are partially disaggregated that is, only with respect to capital.[14] The specification seeks to distinguish the influence of each component of capital on output. The first two models are the "aggregated" production functions which are the ones mostly used in empirical studies.

Finally, the estimated production functions of the U.N.T.L. would be used to explain the processes of production in the firm. The results of this study would be compared and contrasted with the findings of other researchers in this area.

1.4 The Justification of the Study.

This study is expected to yield valuable insights into the production functions of the textiles industry in Nigeria with particular reference to economies of scale, efficiency of production, and the technique of production whether capital-intensive or otherwise. The estimated coefficients might be useful for planning purpose by the firm with respect to factor inputs and output levels.

Most of the published works in this area (i.e. production functions) are usually based on the whole industry rather than the individual firms (textile mills) that make up the industry. This study therefore aims at contributing to the existing knowledge on the

production functions of industries by specifically examining a single firm - the U.N.T.L. - in the textiles industry which incidentally is the largest in the industry. This study is unique in the sense that it attempts a simultaneous investigation of both the "aggregated" and "disaggregated" production functions.[15] There is no known work in the literature which has attempted this. This study will actually test the strength of the two approaches in estimating production functions with respect to the textiles manufacturing industry.

Studies on Nigerian industries usually adopt either the Cobb-Douglas production function or the Constant Elasticity of Substitution production function. The CD and CES functions are chosen partly because they are the most popular in the literature, of the class of production functions, and partly for the sake of convenience of estimation.[16]

Finally, the study should serve as a take-off point for more elaborate empirical studies in production economics. It should therefore motivate those who hold the view that empirical testing of some of the established theories in economics is impossible in an economy with data paucity and, in most cases, lacunae.

1.5 The Outline of the Study

This research work is made up of five chapters. In the first chapter we have taken an historical excursion to look at the development of the textiles industry. The structure of the textiles industry and in particular that of the U.N.T.L. is discussed. The chapter also contains the statement of the research problem, the objectives of the study and justification of the study. Chapter two will review the relevant literature focussing particularly on empirical studies. In chapter three, we shall discuss the theoretical framework of the study and specify the models. The fourth chapter shall analyse the results of the estimated models with respect to the Cobb-Douglas and Constant Elasticity of Substitution production functions. The final chapter contains policy recommendations, summarises and finally concludes the work.

NOTES

1. Kilby, P., Industrialization In An Open Economy: Nigeria 1945-1966, Cambridge, Cambridge University Press, 1969, p. 311.

2. Ibid., p. 315.

3. Gunilla Andrae and Bjorn Beckman, "Industry Goes Farming: The Nigerian Raw Materials Crisis and The Case of Textiles and Cotton", A Paper presented at the Seminar on Nigerian Economy and Society Since Berlin Conference 1884-1985 A.B.U. Zaria, 11-15th November, 1985, p. 616.

4. Interview with Mal. Ali Joda, Senior Industrial Relations Officer, U.N.T.L., Kaduna.

5. Gunilla Andrae and Bjorn Beckman, Op.cit., p. 527.

6. Ibid., p. 615.

7. Ibid., p. 622.

8. See Guardian Newspaper of 1/7/84.

9. Mr. Adams Oshiomhole, The General Secretary of the National Union of Textile Garment and Tailoring Workers of Nigeria quoted in Gunilla and Beckman (1985).

10. See Business Times Weekly paper of 18/2/85.

11. Department of Economics (.A.B.U.), Economic Update: Nigerian Journal of Contemporary Public Policy Issues, Vol.1, No.1, January 1987, Zaria.

12. The factor intensity of any process is measured by the slope of the line through the origin representing the particular process (Thus the factor intensity is the capital-labour (K/L) ratio. In a Cobb-Douglas function intensity is measured by the ratio of the coefficients of capital and labour (α/β). The higher the ratio the more capital-intensive the technique of production. Similarly, the lower the ratio α/β the more labour-intensive is the technique (Kontsoyiannis, 1976).

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$$\text{Recall} \quad \alpha = \frac{\partial Q}{\partial K} \cdot \frac{K}{Q} \qquad \beta = \frac{\partial Q}{\partial L} \cdot \frac{L}{Q}$$

$$\therefore \alpha/\beta = \frac{\partial Q}{\partial K} \cdot \frac{K}{Q} \; \frac{\partial Q}{\partial L} \cdot \frac{L}{Q} = \frac{\partial Q}{\partial K} \cdot \frac{K}{Q} \cdot \frac{\partial L}{\partial Q} \cdot \frac{Q}{L}$$

$$= \frac{\partial Q}{\partial K} \cdot \frac{\partial L}{\partial Q} \cdot \frac{K}{L} = \frac{\partial Q}{\partial K} \Big/ \frac{\partial Q}{\partial L} \cdot \frac{K}{L}$$

$$= \text{MRTS} \cdot \frac{K}{L}$$

where $\frac{\partial Q}{\partial K}$ is the marginal product of capital, MP_K

$\frac{\partial Q}{\partial L}$ is the marginal product of labour, MP_L

The ratio of these gives the marginal rate of technical substitution (MRTS) which is constant at any point along the constant product curve for a particular process. Since MP_K/MP_L is constant then α/β becomes K/L which is the factor intensity.

13. This was the composition of capital employed as stated in the Annual Report and Statement of Accounts of the Company.

14. Eghosa Osagie and M.O. Odaro, "Production Functions In Selected Nigerian Manufacturing Industries", The Nigerian Journal of Economic and Social Studies, Vol.17, No.1, March, 1975.

15. It might be useful to distinguish the aggregate production function from the "aggregated" production function. The former is the macro-production function which in most cases looks at the production function of the economy of a country, region or sectors of such an economy. While the latter could be a macro - or micro-(firm) production function. The only difference is with respect to the type of capital and labour included in the function. An "aggregated" production function uses a single variable of either labour or capital whereas a "disaggregated" production function breaks down these variables into components - land, plant

and equipments and capital work-in-progress and production and non-production workers - and are included as separate variables of capital in the function.

16. Omosegbon, O.O., Production Functions: An Empirical Investigation of Nigerian Tobacco Company, Zaria, An Unpublished M.Sc. Thesis in Economics, A.B.U., Zaria, 1986.

CHAPTER TWO

2.0 LITERATURE REVIEW.

2.1 Empirical Studies

Paul Douglas was responsible for the first applied work in production economics. The model specification adopted by Douglas was the convenient and popular function, i.e. Cobb-Douglas production function, which he jointly developed with Charles Cobb in 1928.[1] The theoretical framework of this function is discussed in the next chapter. Douglas' empirical work was based on annual aggregate data for the manufacturing industry in the U.S.A. from 1899-1922.[2] He used the ordinary least squares estimation technique to estimate the single equation function. The estimated production function's coefficients for labour and capital are 0.25 (0.05) and 0.73 (0.12) respectively with standard errors in the brackets. The results obtained by Douglas confirmed the model specification of constant returns to scale since the sum of the estimated coefficients (0.25+0.73) is approximately equal to unity. In another similar study of the manufacturing industry in the U.S.A. Douglas arrived at estimates of the coefficients which approximate capital coefficient to 0.75. This production process exhibits capital-intensity and constant returns to scale.

Douglas' work received severe criticism from his colleagues. This criticism was based on three main premises. The first area of criticism was his specification of labour and capital as the main factor inputs that influenced production. This criticism is valid today and the inclusion of raw material as the third factor input is wrothwhile because of the role that the input plays in the production process of industries particularly in developing countries like Nigeria. Secondly, Douglas was criticised for a biased measurement of capital input in the production process. This was because he used capital stock. But which measure of capital should be used? Is it capital stock or the capital in use? He acknowledged these weaknesses and made the suggestion to other researchers that "certain errors in the capital formular should be modified to get some measurement of capital actually used rather than capital available".[3] A lot of empirical studies done have taken this suggestion into consideration. The suggestion is also noted in this study and is precisely the reason for the various model specifications in this study. Finally, Douglas was criticised for not giving serious consideration to the issues of technological change in the process of production. He, however, defended himself that the constant term (A) in the model absorbed the technical changes. Other critics of Douglas' pioneering empirical work pointed out

theoretical issues which bordered on economic theory and problems associated with applied econometric analysis. These problems, Douglas conceded, are inescapable in applied works.

At a conference in 1961 an alternative to the CD function was presented. This alternative which was called the Constant Elasticity of Substitution (CES) production function was jointly presented by Arrow, Chenery, Minhas and Solow (ACMS or SMAC). The main distinguishing feature of the C.E.S. function is the assumption of a constant but non-unitary elasticity of substitution. The C.E.S. production function has been extended to incorporate decreasing, constant, or increasing returns to scale by Dhyrmes and Kmenta.[4]

The original empirical study by Arrow, J.A. et al. was based on international cross-section data on output and labour input for manufacturing industries. Their findings and conclusions indicated that the elasticity of substitution is different from zero and secondly, that it is significantly below unity. The first conclusion holds for every industry group included in the original study. The second holds for only 10 of 24 industry groups.

Fuchs (1963) ran regressions for the same groups inserting dummy variable to allow for differences in

the level of development among the countries included in the sample. The results confirm the first conclusion of Arrow, J.A. et al. but not the second. It was for only two industry groups that the estimated elasticity of substitution is singificantly different from unity and in one of these it was significantly above unity. It has been conclusively argued, of the findings of Arrow et. al., therefore, that the elasticity of substitution less than unity could have resulted from a bias due to variations in labour quality or the price of inputs between developed and less developed countries.

Another empirical work using the C.E.S. production function was the one by Zarembka (1970). He estimated the elasticity of substutiton for two separate cross-sections of states for 1957 and 1958, taking into account possible serial correlation in the errors for the two periods. The estimates he got for (the textiles industry) the elasticity of substitution were 0.79 and 0.91 for 1957 and 1958 respectively. The results further show that the estimated elasticities for the two periods are not significantly different for 11 of the 13 industries at a singificance level of 0.025 (Zarembka, 1970, pp. 48-49). These elasticities are not significantly different from unity. These results are consistent with those of Bell, Dhyrmes and Minasian for cross-sections of states for a given year, with

those of Griliches for successive cross-sections, and with those of Solow for a cross-section of regions.[5] However, Zarembka's evidence is inconsistent with the "fixed coefficients" production function, that is, with constant capital-output and labour-input ratios. The empirical results support the conclusion of Arrow, J.A. et. al. that the elasticity of substitution is singificantly different from zero.

Using time series data, Ferguson (1965) presented estimates of the elasticity of substitution from data on labour input and output for industries within the U.S. manufacturing sector for the period 1949-1961 that are very similar to the cross-section results. Lucas (1969) and Mckinnon (1962) have reported estimates for these industries that are substantially lower than the cross-section estimates. Coch (1969) has given estimates of the elasticity of substitution for total manufacturing that are similar to those of Lucas and Mckinnon. A careful investigation of possible sources of bias in time series estimates has been carried out by Bernt (1974), using data on both labour and capital inputs.

A further examination of Zarembka's time-series studies shows that the results with respect to returns to scale indicate a consistency with the hypothesis of constant returns to scale at the plant level.[5] Zarembka's

estimates of the scale parameter for the textile industry in the U.S.A. is 0.91 with F-ratio of 1.04. For all but one industry group the scale parameter is slightly greater than unity invalidating the marginal conditions employed by Dhyrmes to estimate the scale parameter (Dhrymes, 1965). Equality between the marginal product of labour and the real wage is not a necessary condition for profit maximization with increasing returns.

Dhrymes' model has been employed by Eisner and Nadiri in estimating the scale and substitution parameters from investment functions. Eisner and Nadiri employed a distributed lag function with changes in the logarithms of capital as dependent variable and lagged values of these changes as independent variables. However, they did not test for serial correlation of the residuals; least squares estimates of the parameters of the distributed lag function corresponding to their model are inconsistent if the residuals are serially correlated.

Hildebrand and Liu (1965) carried out a study of production functions for two-digit U.S. industries based on data taken from three U.S.A. Bureau of Census publications. The study was aimed at estimating industry production functions without recourse to assumptions of perfect competition in both factor and product market; profit maximizing equilibrium, constant returns to scale, and neutral technical progress. They reviewed

the earlier research and especially that of Arrow et.al (1961). They made a number of criticisms as may be expected from their own aims. A fundamental criticism is that the empirical base on which Arrow et. al. built their C.E.S. function was very uncertain. Hildebrand and Liu claimed if one was attempting to explain movements in value added per man then capital per man should be included as an explanatory variable in addition to the average wage. The special features of the specification of their production function were the presence of two labour variables viz production and non-production workers and the allowances for improved quality of labour and technical progress in capital via the exponents of the input variables. Their work has influenced the specification of various components of capital as variables in some of the models in this study.

Maitha (1973) undertook an empirical study on capital-labour substitution in manufacturing industry using Kenya as a case. Maitha estimated the elasticity of substitution for the years 1963 to 1966 by fitting the C.E.S. function for three digit Kenya industries. His results actually high-light some of the problems of underdeveloped countries. The estimate of elasticity of substitution which is greater than unity suggests that given the differences in the relative prices of

inputs, a cost minimizing production unit would tend to substitute that factor which is relatively cheaper. The findings, however, indicate increasing capital intensity of the firms overtime inspite of the abundant labour supply with perfect supply elasticity in the Kenyan economy. The implication of this is that higher productivity is due to high capital-labour ratio which partly explains the slow growth of employment in the industrial sector of developing economies. Maitha's main conclusion is that the modern industries in developing economies tend to exhibit similar technological features compared to their counterparts in the developed economies. The conclusion is also relevant to the character of most of the industries in Nigeria. The findings of this study particularly with respect to the first hypothesis of capital-intensity would validate or invalidate his conclusion.

In Nigeria, the first systematic study ever done on empirical production functions was by Liedholm (1966). The study concentrated on the application of the Cobb-Douglas production function to five selected industries in the then Eastern Nigeria on the basis of 1962 and 1963 cross-section samples. The results of the study indicated that the production function for the entire region exhibited mild increasing returns to scale. Two industries namely Chemicals and Soft Drinks showed mild

decreasing returns to scale. The log linear CD model for the estimated coefficient of labour was twice larger than the coefficient obtained for capital. This evidence, which is in contrast with Maitha's is highly valuable for any developing economy in which labour is in abundant supply. Liedholm concluded that for individual firms the CD type of function concealed inter-industry differences in technology. This could have produced the results that he obtained. However, a major criticism of Liedholm's work is that, with the CD specification most of the features of production relation are predetermined and what remains to be done is the estimation of the relative shares of factors. The model (CD) specification assumes constant returns to scale if the sum of the two coefficients are (or the numerical value of the scale parameter is) assumed equal to 1.

Osagie and Odaro (1975) following Hildebrand and Liu (1965) came out with a "disaggregated" CD production function which has two labour variables and three capital variables. Labour was disaggregated into Nigerian labour and foreign labour while capital was disaggregated into non-residential building, machinery and equipment, and transport equipment. The results indicate generally larger output elasticities for labour than for capital which is consistent with the evidence provided by Liedholm.

A less contentious point is the conclusion that labour (and in particular that Nigerian labour was more efficient than foreign labour) was more productive in a situation where capital was fixed. The point to note here is the possibility of Nigerian labour being more productive with less constraints on capital associated with the inflow of foreign labour.[7]

Kazi and Odama (1981) investigated the issues of factor shares, technological progress and relative efficiency in selected Nigerian industries. The empirical results indicate that 37, 47 and 16 per cent of industries exhibit technologies which can be regarded as Marx-Leontief (ML) or Input-Output, Wicksell-Cobb-Douglas (WCD) and C.E.S. respectively. As far as substitution possibilities are concerned, the findings indicate that only 16 percent of industries showed high possibilities (with elasticity of substitution greater than 1), which invariably indicates that the organized sector in Nigeria lacks the opportunities for an existing, and for that matter ever widening, pool of unemployed labour. Also technological progress appears to be a negligible factor of the determinants of growth of output per annum. Eleven out of 29 industries show positive contribution to productivity with fixed factors. This, they argue, may be accounted for by such factors as scale, entrepreneurial ability,

trained manpower, including administrative personnel, and new equipments of production. According to Kazi and Odama one surprising inclusion on the list of efficient industries "is the textile industry, which is operated in countries such as India with outdated techniques and is considered to be inefficient. The possible explanation for the result we got would be that this industry in this country is relatively new and as such output is demand determined". Since this observation by Kazi and Odama is based on aggregated cross-section data for the whole industry, this study intends to validate or invalidate it at the level of the firm (U.N.T.L.) using time-series data.

In a similar enquiry Kazi and Odama (1982) sought to explain the rate of capital-labour substitution in time series production functions in the manufacturing industry in Nigeria. The study covered the period 1962-75. The main criticism of their work is the concentration on aggregate production function relying solely on data from secondary sources which do not reflect, however, approximate, the character of the industries' production functions. This study attempts to fill this gap from the angle of the textile industry.

The most recent known effort in empirical study of production economics investigated the production functions of the Nigerian Tobacco Company, Zaria (Omosegbon, 1986). The results of this study indicate the absence of a Hicks' neutral technical change which the author of the work explained away by the lack of new investments in the company for many years except for the replacement, repair and maintenance of existing plants. It was discovered using the conventional factor inputs that capital contributed 25% while labour accounted for 75% of the output of the firm. The main criticism of the work is the fact that the data used covered only two years while technical change occurs over a longer period of time.

Gunilla and Beckman (1985) have done a good expository work on the Nigerian raw material crisis with particular focus on the problems associated with the procurement, i.e. local supply, of cotton, the raw material in the textiles industry. Their work has shown that most of the large firms in the textiles industry like the U.N.T.L. and AFPRINT in Lagos have already initiated programmes aimed at backward integration in the industry.

Ekuerhare's (1978) work concerned the appraisal and the explanation of the pattern of resource allocation

and growth associated with Nigerian import-substitution industrialization in the context of the textile industry. The study investigated the general hypothesis that import substitution as a strategy of industrialization has resulted in inefficient allocation and utilization of resources. The approach of the study was the application of the methods of social-cost benefit analysis to firm level data of the textile industry. The results of the study indicated that the growth of the textile industry has been extremely inefficient, and that there have been wide differentials in relative inefficiency among firms and sectors in the industry. The study arrived at the following conclusions. The development of the Nigerian textile industry through import substitution has been extremely socially inefficient. Secondly, there was a very weak correlation between social profitability and private profitability in the industry. Finally, the shortages of managerial, technical and supervisory manpower and inadequate supplies of all conceivable infrastructural facilities partly explain the inefficiency in the industry. These findings would be useful in arriving at certain conclusions about the production functions of the U.N.T.L., Kaduna.

This study following the studies reviewed in the literature will expose mainly in quantitative terms the production characteristics of the textiles industry

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using the U.N.T.L. as a case study. Our study focuses on an individual firm rather than the whole industry as most studies in the literature have done. We have particularly adopted the 'disaggregated' model of Hildebrand and Liu and Osagie and Odaro to examine the production functions of the UNTL., Kaduna.

NOTES

1. Kazi, U.A. and Odama, J.S. (1981) have stated that the Cobb-Douglas production function was first proposed by K. Wicksell in his lectures on political economy and as such, they argue, should be called Wicksell-Cobb-Douglas (WCD) production function instead of the usual short form (CD) in the literature.

2. See Cramer, J.S. (1971), Empirical Econometric, California Wadsworth, pp. 234-236.

3. See Douglas, P., "Comments on the Cobb-Douglas Production Function" in Murray Brown (ed.) 1967, p. 20.

4. Jorgenson, Dale W., "Investment and Production: A Review" In Frontiers of Quantitative Economics, Vol. II, Kendrick, D.A. and Intriligator, M.D. (ed.), 1974, North-Holland/American Elseiner p. 344.

5. Ibid., p. 349.

6. Similar results are reported for cross-section data for industries within manufacturing by Zarembka and Chernicoff (1971) and for data on individual plants classified by industry within manufacturing by Klotz (1970).

7. See Kazi, U.A. and Odama, J.S., "Rate of Capital-Labour Substitution In Time Series Production Functions in The Nigerian Manufacturing Industry, 1962-75", Nigerian Journal of Economic and Social Studies, Vol.24, No.1, March, 1982.

CHAPTER THREE

3.0 THE THEORETICAL FRAMEWORK OF THE STUDY

3.1.1 Conceptualization of the Problem

The production functions are expected to expose key features of the firm's production process(es) such as returns to scale, allocation efficiency, returns to factors, factor substitution, and economic growth. For some prescriptions of Pigovian welfare economics it is necessary to know whether a firm or an industry enjoys increasing, constant or diminishing returns to scale. We may also like to look at efficiency in the allocation of resources by matching the marginal products of factor inputs with their prices in inter-firm comparisons. Related to the two preceding issues is the question of returns to a particular factor (or factor shares). It may be desirable to subsidize (or tax) the use of a particular input if returns to the factor are increasing (or diminishing) in a certain range. For example, local cotton (lint) may be subsidized if it has increasing returns. This is to ensure optimum utilization given that there is adequate supply.

A fundamental principle of economic behaviour is the tendency to substitute at the margin. Changes in the relative prices of inputs encourage corresponding substitution in the use of inputs by firms. The degree

of substitutability between inputs as measured by the elasticity of substitution is crucial to the distribution of total output between different inputs. We can examine the effects of exogenous changes in inputs prices, for example, minimum wage legislation or depreciation allowances and changes in the quantities of inputs supplied, for instance by immigration, on returns to factors and their shares in total output of an industry or a firm.

The notion of the production function has also been applied at the macroeconomic level, although controversially, to explain the distribution of national income between income classes, i.e. wages and profits.[1] Also, the notion of an aggregate production function has been used to provide empirical explanations of inter-country and inter-temporal differences in the economic growth of Gross National Product (GNP). In these studies, overall economic growth is apportioned as between different factors of production and often a residual remaining is labelled technical change i.e. the constant term of the CD function.

Whether we can observe all the preceding features of the firm or not depends on whether we can identify the production function, i.e. isolate the purely technological relationships from the economic, behavioural and other historical relationships. It is only if this can be done can the claim be made that the explanation

of the relative efficiency of firms or the relative growth experiences of countries is invariant with respect to parameters such as prices, the structure of industry, size, previous experience, etc. Much controversy exists regarding the identifiability of a microeconomic production function from observable data relating firms and conditions under which such production functions retain their identifiability when aggregated over firms and industries.

The neoclassical production function was formalised first by Wicksell.[2] Formally a production function expresses the output of a commodity as a function, sometimes a continuous and differentiable function, of all its inputs. A production function can therefore be defined as a mathematical function which relates the quantities of inputs and the quantities of outputs within a production unit, which may be variously defined as an activity or a process, a firm, an industry or a national economy. It is usually regarded as a technical relationship between the quantities of inputs and the maximum amount of output which can be produced with a given set of inputs.[3] Conventionally, it is useful to consider two factors of production, namely the labour input (L) and capital input (K) with the production function being

$$Q = f(L,K) \qquad (3.1)$$

where Q measures the amount of output

L measures the amount of labour input and

K measures the amount of capital input.

The classical theory of production assumes that the marginal products of capital and labour are positive but are diminishing so that the graph of output against capital or labour will have the general shape illustrated in figure 3.1. It is also assumed that equation (3.1) is a single valued continuous functions which is twice differentiable so that the assumption of diminishing marginal products of capital and labour requires

$$\frac{\partial Q}{\partial K} = Q_K = MP_K > 0, \quad \frac{\partial Q}{\partial L} = Q_L = MP_L > 0$$
$$\frac{\partial^2 Q}{\partial K^2} = Q_{KK} < 0 \quad , \quad \frac{\partial^2 Q}{\partial L^2} = Q_{KK} < 0 \qquad (3.2)$$

where Q_K and Q_L are the marginal products of capital and labour respectively.

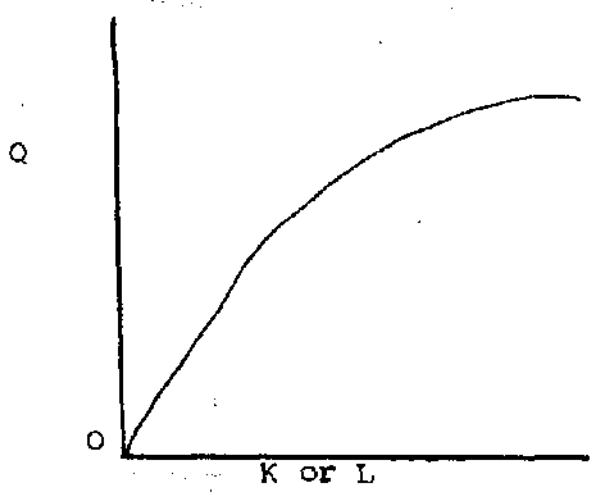


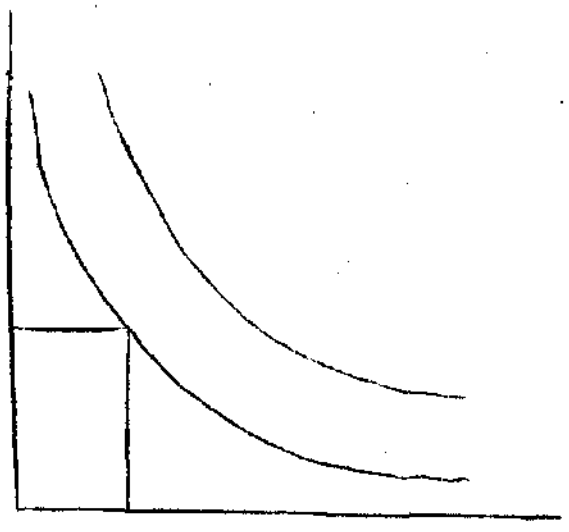
Figure 3.1

A given level of output can be produced by different combinations of capital and labour and so $f(K,L) = Q$. (constant) traces out the isoquants. Thus, variation along any isoquant, assuming two inputs at the same time

$$\frac{\partial f}{\partial K} dK + \frac{\partial f}{\partial L} dL = 0$$

that is, $Q_K \, dK + Q_L \, dL = 0$

and hence $\frac{-dK}{dL} = \frac{QL}{Q_K} = MRTS > 0 \qquad (3.3)$



Therefore, the isoquants have negative slopes and the absolute value of this is the marginal rate of technical substitution (MRTS). This measures the rate at which one input can be substituted for the other input. It is normally assumed that as the quantity of one of the inputs increases, the marginal

rate of technical substitution decreases so that the reductions in the level of one variable made possible by increases in the level of the other variable become progressively smaller, that is, by equation (3.3), dK/dL is increasing and so d^2K/d^2L is positive. Hence the isoquants are assumed to be convex to the origin as shown in figure 3.2. For a change from one point say (K^*, L^*) along the constant product curve, $d(K/L)$ measures the change in the use of K compared with L and MRTS represents corresponding change in the marginal rate of technical substitution (MRTS).

As stated earlier on, neo-classical production theory recognizes the possibility of substituting one factor of production for another. The existence of more than one point on an isoquant is equivalent to such an assertion. A measure of the rate of change of MRTS is given by the elasticity of substitution (σ) between factors K and L. The elasticity of substitution between factor inputs can be defined as the proportionate change in the ratio K/L expressed as a fraction of the proportionate change in MRTS:

$$\sigma = \frac{d[\ln(K/L)]}{d(\ln \text{MRTS})} = \frac{(L/K)d(K/L)}{d\text{MRTS}/\text{MRTS}} \qquad (3.4)$$

where variation is along the constant product curve. It can be shown that alternative expressions for σ are

$$\sigma = \frac{MRTS(LMRTS + K)}{KL\left[MRTS\frac{\partial MRTS}{\partial K} - \frac{\partial MRTS}{\partial L}\right]} = \frac{MRTS(LMRTS+K)}{KL\left[\frac{d^2K}{d^2L}\right]} \quad (3.5)$$

so that σ is inversely proportional to the curvature of the constant product curve (d^2K/dL^2) and measures the ease of substitution of L for K. If σ = 0 then substitution is impossible since d^2K/dL^2 is infinite. If σ = ∞ then the constant product curve is a straight line since d^2K/dL^2 is zero - (See figures 3.3 and 3.4 in Appendix A). Since MRTS, L.K and d^2K/dL^2 are all positive or zero, equation (3.5) shows that $\sigma \geq 0$.

3.1.2 The Cobb-Douglas Production Function

The theory of production function analysed in the preceding section will now be used to provide a priori expectations about unknown parameters with a view to testing whether the theory is appropriate or not.

The general form of the Cobb-Douglas production function for two factors is

$$Q = AK^{\alpha} L^{\beta} \quad (3.6)$$

where A, α and β are parameters. A measures the neutral technological change, α and β measure elasticities of output with respect to capital and labour respectively.[4] The sum of α and β measures the returns to scale. The value of A is determined partly by the units of measurement of Q, K and L and partly by the efficiency of the production process.

The relevance of the efficiency of the process can be seen by considering two Cobb-Douglas production functions which differ only in the value of A. For given levels of K and L, the function with the higher value of A will have the larger value of Q and so will be the more efficient process. The function (3.6) is single valued and assumed to be continuous (for positive K and L) and the marginal products of capital and labour are

$$\frac{\partial Q}{\partial K} = Q_K = A\alpha K^{\alpha-1} L^{\beta} = \frac{\alpha Q}{K}$$

$$\frac{\partial Q}{\partial L} = Q_L = A\beta K^{\alpha} L^{\beta-1} = \frac{\beta Q}{L}$$

By equation (3.2) these are positive so that assuming Q,L,K are positive, $\alpha > 0$ and $\beta > 0$. The second-order derivatives are

$$Q_{KK} = \frac{K\alpha Q_K - \alpha Q}{K^2} = \frac{\alpha(\alpha-1)Q}{K^2} \qquad (3.7)$$

$$Q_{LL} = \frac{L\beta Q_K - \beta Q}{L^2} = \frac{\beta(\beta-1)Q}{L^2} \qquad (3.8)$$

so that $Q_{KK} < 0$ and $Q_{LL} < 0$ if α and β are both less than one. Hence, $0 < \alpha < 1$, $0 < \beta < 1$. By equation (3.3) the marginal rate of substitution is

$$\text{MRTS} = \frac{Q_L}{Q_K} = \frac{\beta Q/L}{\alpha Q/K} = \frac{\beta K}{\alpha L}$$

and the elasticity of substitution is given by (3.4) with

$$\frac{\partial \text{MRTS}}{\partial K} = \frac{\beta}{\alpha L}, \quad \frac{\partial \text{MRTS}}{\partial L} = -\frac{\beta K}{\alpha L^2},$$

$$\text{MRTS}\,(L.\text{MRTS}+K) = \frac{\beta K}{\alpha L}\left[\frac{\beta K}{\alpha} + K\right] = \frac{\beta K^2(\alpha+\beta)}{\alpha^2 L},$$

$$KL\left[MRTS\ \frac{\partial MRTS}{\partial K} - \frac{\partial MRTS}{\partial L}\right] = KL\left[\frac{\beta^2 K}{\alpha^2 L^2} + \frac{\beta K}{\alpha L^2}\right] = \frac{\beta K^2(\alpha+\beta)}{\alpha^2 L}$$

$$\text{Hence, } \sigma = \frac{MRTS(L\ MRTS + K}{KL\left[MRTS\ \frac{\partial MRTS}{\partial K} - \frac{\partial MRTS}{\partial L}\right]} = 1.$$

That is, the elasticity of substutiton is equal to 1 (unity) at every point on the Cobb-Douglas production function.

To examine the behaviour of the function when the scale of operation is changed, let the level of inputs increase by a factor λ, so that the new level of output Q^1 is given by

$$Q^1 = A(\lambda K)^{\alpha} (\lambda L)^{\beta} = \lambda^{\alpha+\beta} Q$$

and the degree of homogeneity is $\alpha + \beta$. If $\alpha + \beta = 1$ there are constant returns to scale. If $\alpha + \beta > 1$ there are decreasing returns to scale and for + 1 there are increasing returns to scale. It should be noted that these are independent of the values of K and L and apply at any point on the production function.

3.1.3 The Constant Elasticity of Substitution Production Function (CES)

The specification of the Cobb-Douglas production function is rather restrictive because the elasticity of substitution is equal to unity at every point on the function. A logical generalization, following Arrow, K.J. et. al., is to allow the elasticity of substitution to be a constant which may be different

from 1 (unity).[5] The CD function is a special case of C.E.S. production function. For two factors of production the general form of the constant elasticity of substitution (C.E.S.) production function is[6] (3.9)

$$Q = A\left[(1-\delta)K^{-\rho} + \delta L^{-\rho}\right]^{-v/\rho}$$

where A, δ, ρ and v are parameters which represent respectively the netural technical change, the labour intensity, the ease of factor substitution and the returns to scale; and $\rho = 1/1 + \sigma$ is the elasticity of substitution. In order that the production function may be economically meaningful, it is necessary to impose certain a priori signs and magnitude restrictions on the parameters. These are:

$$0 < A < \infty \quad 0 \leq \sigma \leq \infty \quad (\text{i.e. } -1 \leq \rho \leq \infty)$$

$$0 < \delta < 1 \quad 0 \leq v \leq \infty$$

The value of the parameter A is dependent on the units of measurement (of Q,L,K) used and is, as stated earlier, a measure of the efficiency of the process. The production function is assumed to be single-valued and continuous, subject to some restrictions on the values of the parameters, for positive values of Q,K and L. The marginal products of capital and labour are

$$Q_K = \left[\frac{-v}{\rho}\right] A(1-\delta)(-\rho)K^{-\rho-1}\left[(1-\delta)K^{-\rho} + L^{-\rho}\right]^{-(v/\rho)-1}$$

$$= \frac{vA(1-\delta)}{K^{1+\rho}}\left[\frac{Q}{A}\right]^{1+\rho/v}$$

$$= \frac{(1-\delta)}{K^{1+\rho}} DQ^{1+\rho/v}$$

where $D = \frac{V}{A^{\rho/v}}$

$$Q_L = \left[\frac{-v}{\rho}\right] A(\delta)(-\rho)L^{-\rho-1}\left[(1-\delta)K^{-\rho} + \delta L^{-\rho}\right]^{-(v/\rho)-1}$$

$$= \frac{vA\delta}{L^{\rho+1}}\left[\frac{Q}{A}\right]^{1+\rho/v}$$

$$= \frac{\delta D Q^{1+\rho/v}}{L^{1+\rho}}$$

These marginal products will be positive if

$$(1-\delta)D > 0 \quad \text{and} \quad \delta D > 0 \qquad (3.10)$$

so that[7] $0 < \delta < 1$ and $D > 0$ (3.11)

The second-order derivatives of (3.10) are

$$Q_{KK} = (1-\delta)D\left[\frac{K^{1+\rho}(1+\rho/v)Q^{\rho/v}Q_K - Q^{1+\rho/v}(1+\rho)K}{K^{2+2\rho}}\right]$$

$$= \frac{Q^{1+\rho/v}(1-\delta)D}{K^{2+2\rho}}\left[(1+\rho/v)Q^{\rho/v}(1-\delta)D - (1+\rho)K^{\rho}\right]$$

$$Q_{LL} = \delta D\left[\frac{L^{1+\rho}(1+\rho/v)Q^{\rho/v}Q_L - Q^{1+\rho/v}(1+\rho)L^{\rho}}{L^{2+2\rho}}\right]$$

$$= \frac{Q^{1+\rho/v}\delta D}{L^{2+2\rho}}\left[(1+\rho/v)Q^{\rho/v}\delta D - (1+\rho)L^{\rho}\right]$$

These will be negative [given (3.11)] if

$$\frac{DQ^{\rho/v}(1-\delta)}{K^{\rho}} < \frac{1+\rho}{1+\rho/v} \quad \text{and} \quad \frac{DQ^{\rho/v}}{L^{\rho}} < \frac{1+\rho}{1+\rho/v} \qquad (3.12)$$

Since D, $(1-\delta)$, Q, L, K, δ are all positive then

$$0 < \frac{1+\rho}{1+\rho/v}$$

So that either $\rho > -1$ and $\rho/v > 0$ or $\rho < -1$ and $\rho/v < -1$.

The marginal rate of technical substitution is given by

$$MRTS = \frac{Q_L}{Q_K}$$

$$= \left[\frac{\delta}{1-\delta}\right]\left[\frac{K}{L}\right]^{1+\rho} \qquad (3.13)$$

and so depends upon δ and ρ as well as K and L. By partial differentiation of MRTS,

$$\frac{\partial MRTS}{\partial K} = \left[\frac{\delta}{1-\delta}\right]\left[\frac{(1+\rho)K^{\rho}}{L^{1+\rho}}\right]$$

$$= \frac{(1+\rho)MRTS}{K}$$

$$\frac{\partial MRTS}{\partial L} = \left[\frac{\delta}{1-\delta}\right]\left[\frac{(-1-\rho)K^{1+\rho}}{L^{2+\rho}}\right]$$

$$= \frac{-(1+\rho)\,MRTS}{L}$$

and the elasticity of substitution, from (3.5) is

$$\sigma = \frac{MRTS(LMRTS + K)}{KL\left[MRTS\ \frac{\partial MRTS}{\partial K} - \frac{\partial MRTS}{\partial L}\right]}$$

$$= \frac{MRTS\ (MRTS + K)}{KL\left[\frac{MRTS^2}{K}(1+\rho) + \frac{(1+\rho)\ MRTS}{L}\right]}$$

$$= \frac{LMRTS + K}{(1+\rho)\ (LMRTS + K)} = \frac{1}{1+\rho}. \qquad (3.14)$$

The parameter ρ is therefore related to the elasticity of substitution and so σ is a constant over the range of values of Q, K and L. This then explains the name of the constant elasticity of substitution production

function. Since $\sigma > 0$, ρ must be greater than -1, and from (3.13), $\rho/v > 0$.

The returns to scale behaviour of (3.10) can be examined by increasing the inputs K and L by a factor λ. The new level of output is

$$Q' = A\left[(1-\delta)\lambda^{-\rho}K^{-\rho} + \delta\lambda^{-\rho}L^{-\rho}\right]^{-v/\rho} = \lambda^{v}Q$$

and so if V = 1 there are constant returns to scale,

V > 1 there are increasing returns to scale,

V < 1 there are decreasing returns to scale.

Thus V is the return to scale parameter. As with the Cobb-Douglas production function, for given values of the parameters, the same returns to scale behaviour occurs at all combinations of K and L.

The a priori restrictions on the parameters of the C.E.S. function can be summarized as follows

$$\rho/v > 0,\ 0 < \delta < 1,\ \rho > -1,\ A > 0. \qquad (3.15)$$

The last of these arises because in (3.10) A will have the same positive sign as Q.

3.2 Statistical and Econometric Methodology

The approach of this study is the use of econometric techniques to estimate the Cobb-Douglas and Constant Elasticity of Substitution production functions given the industry data of the United Nigerian Textiles Limited (U.N.T.L.), Kaduna. We have adopted for the estimation of the specified models, after a linear transformation,

the ordinary least squares (O.L.S.) method whose regression parameter estimates are best, linear, and unbiased (B.L.U.E.).

3.2.1 The Model

The Cobb-Douglas function has been generally specified as follows for the estimation of the production function of the U.N.T.L., Kaduna:

$$Q_t = AK_t^{\alpha} L_t^{\beta} e^{U_t} \qquad (3.16)$$

where A is constant and its value depends on the unit of measurement of Q, K and L as well as the efficiency of the production process, α and β are positive parameters of the model and measure the elasticities of the factor inputs. Q_t is a measure of the output in period t, K_t and L_t are capital and labour inputs at time t respectively. U_t is the stochastic term which represents all factors affecting the production process but not explicitly specified in the model.

The CD specification (3.17) is not in a convenient form for direct estimation by least squares methods and it is usually transformed into a logarithmic form

$$\log Q_t = \log A + \alpha \log K_t + \beta \log L_t + U_t \qquad (3.17)$$

The a priori values of α and β satisfy the following restrictions: $0 < \alpha < 1$ and $0 < \beta < 1$, and if constant returns to scale are present then $\alpha + \beta = 1$. The stochastic term (U_t) is assumed to have the following properties:

(a) $E(U_t) = 0$ for all t; t=1,2,.... n

(b) $E(U_t, U_{t+1}) = \begin{cases} 0 \text{ for } t \neq t+1; 2, \ldots, n \\ \sigma U_t^2 \text{ for } t = t+1; 2, \ldots, n \end{cases}$

The first (a) property implies that on the average the residual (e_t) value is zero, and the first part of the second property rules out the existence of autocorrelation of the error (e_t) terms while the second part assumes a constant and finite variance of the stochastic term for the model.

We can also impose constant returns to scale if we want to eliminate the problem of multicollinearity by putting $\beta = 1 - \alpha$ so that

$$Q_t = AK_t^{\alpha} L_t^{1-\alpha} e^{U_t}$$

$$= A\left[\frac{K_t}{L_t}\right]^{\alpha} L_t e^{U_t}$$

or $$\frac{Q_t}{L_t} = A\left[\frac{K_t}{L_t}\right]^{\alpha} e^{U_t}$$

and taking logarithms of both sides,

$$\log (Q_t/L_t) = \log A + \alpha \log (K_t/L_t) + U_t. \quad (3.18)$$

This second form (3.19) avoids multicollinearity between log K and log L and also reduces heteroscedasticity if the variance of U_t is correlated with L_t.[8]

The C.E.S. production function can similarly be specified as follows for the U.N.T.L., Kaduna.

$$Q_t = A\left[(1-\delta)K^{-\rho} + \delta L^{-\rho}\right]^{-v/\rho} e^{U_t} \quad (3.20)$$

Where Q_t is the level of output at time t. L_t and K_t are labour and capital inputs at time t. A, $(1-\delta)$, and δ are parameters of the model. The same restrictions on the parameters of the CD model apply to the C.E.S. model. The stochastic term has the same properties as in the CD model.

The C.E.S. function (3.20) is difficult to estimate directly and it is not even possible to make a simple transformation to an estimable form. Estimation of the C.E.S. function has therefore generally be limited to either examining whether the conditions for profit maximization, are satisfied or making some approximation to the function.

The procedure adopted in this study to estimate the C.E.S. function follows Kmenta (1967) who suggested an approximation to the C.E.S. which would allow the parameters to be estimated.[9] Now, writing (3.10) as

$$\frac{Q}{L} = e^{U} A L^{v-1} \left[\delta + (1-\delta) \left[\frac{K}{L} \right]^{-\rho} \right]^{-v/\rho}$$

and taking logarithms gives

$$\log \left[\frac{Q}{L} \right] = \log A + (v-1) \log L - (v/\rho) f(\rho) + U$$

where $f(\rho) = \left[\log + (1-\delta) \left[\frac{K}{L} \right]^{-\rho} \right]$.

The expression $f(\rho)$ can be approximated by the use of Taylor's expansion

$$f(\rho) = f(0) + f'(0) + \frac{\rho^2}{2} f''(0) + \ldots$$

Since $f(0) = 0$,

$$f'(\rho) = \frac{\left[(1-\delta)(K/L)^{-\rho}(-\log(K/L))\right]}{\delta + (1-\delta)(K/L)^{-\rho}}$$

and $$f'(0) = -(1-\delta)\log(K/L)$$

$$f''(\rho) = \frac{\delta(1-\delta)\left[\log(K/L)\right]^2}{\delta + (1-\delta)(K/L)^{-\rho}}$$

and $$f''(0) = \delta(1-\delta)\left[\log(K/L)\right]^2$$

then, approximately

$$f(\rho) = -\rho(1-\delta)\log(K/L) + \frac{\rho^2}{2}\delta(1-\delta)\left[\log(K/L)\right]^2$$

and hence,

$$\log\left[\frac{Q}{L}\right] = \log A + (v-1)\log L + v(1-\delta)\log\left[\frac{K}{L}\right] - 0.5v\,\delta(1-\delta)\left[\log(K/L)\right]^2 + U \quad (3.20)$$

The equivalent equation for the Cobb-Douglas function is found by re-writing (3.17) as

$$\log\left[\frac{Q}{L}\right] = \log A + (\beta - 1 + \alpha)\log L + \alpha\log\left[\frac{K}{L}\right] + U. \quad (3.21)$$

Thus the only difference between these approximations is the extra term which occurs in the C.E.S form. The approximation used is closer when σ is close to 1, and if $\sigma = 1$ then $\rho = 0$ and (3.21) and (3.22) are the same. The estimated coefficient of $\log (K/L)^2$ therefore provides a test for a Cobb-Douglas or C.E.S. form. If the function is Cobb-Douglas then the estimated coefficient of $\log (K/L)^2$ should not be significantly different from zero. If this coefficient is significantly different from zero the Cobb-Douglas form is rejected

but since the approximation to the C.E.S. required to be close to zero the approximation is invalid. Therefore a rejection of the Cobb-Douglas form does not imply the function is C.E.S. An additional problem is that the coefficient of $\log (K/L)^2$ depends on ρ, v and δ. Since $0 < \delta < 1$ and ρ is likely to be small, the product $\rho v \delta (1-\ )$ will also be small, and therefore a large sample is required to estimate the coefficient with precision.

3.2.2 Model Specification.

There are four sets of model specification with each set having four versions. Each version of the first two models estimated for the Cobb-Douglas function has four specifications while the last two models have two specifications in each version. The first specification is the most commonly used in the literature. The second introduces 'disembodied' capital into the first specification. While the third and fourth specifications posit a capital-labour ratio approach without and with 'disembodied' capital respectively to eliminate the possible problem of multicollinearity among the variables.

The first two sets of models are for the "aggregated" production functions while the last two sets are for the "disaggregated" production functions. The specified models are estimated first for the Cobb-Douglas (CD) production function to determine which best explains

(or fits) the production process of the U.N.T.L. The criteria for selecting the 'best' are the values of the coefficient of determination (R^2), the F-significance, the t-ratios (or standard errors) of the coefficients and the Durbin-Watson statistic. For the Constant Elasticity of Substitution (C.E.S.) production function only model I (particularly version A of the model) has been estimated. We find this approach much more convenient and discreet than estimating all the models because of the complicated estimation procedure and the non-availability of the estimation techniques at the University Computing Centre.

3.2.3 'Aggregated' Production Function

MODEL I

Version A

$Q_t = AK_t^{\alpha} L_t^{\beta} e^{U}t$ CD production function (3.23a).

$Q_t = A e^{\theta t} K_t^{\alpha} L_t^{\beta} e^{U}t$ CD function with 'disembodied' capital (3.23b)

$Q_t/L_t = A(K/L_t)^{\alpha} e^{U}t$ CD function with capital-labour ratio specification (3.23c)

$Q_t/L_t = A e^{\theta} t (K_t/L_t)^{\alpha} e^{U}t$ CD function with capital-labour ratio and 'disembodied' capital specification (3.23d)

where Q_t = Turnover/Total Sales in period t

L_t = Wages and Salaries in period t

K_t = Capital Employed in period t

t = period/time i.e. t=1,2,...., 16

A, θ , α , β are parameters and U_t is the stochastic term in period t.

Version B

Same as Version A but where L_t = number of employees in period t.

Version C

Same as Version A but where Q_t = value-added in period t.[10]

Version D

Same as Version B but where Q_t = value-added in period t.

Model II

Version A

$$Q_t = AK_t^{\alpha} L_t^{\beta} R_t^{\delta} e^{U_t}$$ CD production function (3.24a)

$$Q_t = Ae^{\theta t} K_t^{\alpha} L_t^{\beta} R_t^{\delta} e^{U_t}$$ CD function with 'disembodied' capital (3.24b)

$$Q_t/L_t = A(K/L_t)^{\alpha} e^{U_t}$$ CD function with capital-labour ratio specification (3.24c)

$$Q_t/L_t = Ae^{\theta t}(K_t/L_t)^{\alpha} e^{U_t}$$ CD function with capital-labour ratio and 'disembodied' capital specification (3.24d)

where Q_t = Turnover/Gross Sales in period t

L_t = Wages and Salaries in period t

K_t = Capital Employed in period t

R_t = Raw Materials used in period t

t = period/time i.e. t=1,2,...., 16

A, θ, α, β, δ are parameters and U_t is the stochastic term.

Version B

Same as Version A but where L_t = number of employees in period t.

Version C

Same as Version A but where Q_t = value-added in period t

Version D

Same as Version B but where Q_t = value-added in period t.

3.2.4 'Disaggregated' Production Function

Model III

Version A

$$Q_t = AL_t^{\beta} (FP)_t^{\alpha_1} (PE)_t^{\alpha 2} C_t^{\alpha 3} e^{U_t}$$ CD function (3.25a)

$$Q_t = Ae^{\theta t} L_t^{\beta} (FP)_t^{\alpha_1} (PE)_t^{\alpha 2} C_t^{\alpha 3} e^{U_t}$$ CD function with 'disembodied' capital (3.25b)

where Q_t = Turnover/Gross Sales in period t

L_t = Wages and Salaries in period t

$(FP)_t$ = Freehold Land and Leasehold Properties in period t.

$(PE)_t$ = Furniture fittings, Plant, Machinery, Equipments and Vehicles in period t.[14]

C = Capital Work-in-progress in period t

t = period/time i.e. t=1,2,...., 16

$A, \beta, \theta, \alpha_1, \alpha_2, \alpha_3$ are parameters and U_t is the stochastic term in period t.

Version B

Same as Version A but where L_t = number of employees in period t.

Version C

Same as Version A but where Q_t = value-added in period t.

Model IV

Version A

$$Q_t = AL_t^{\beta} (FP)_t^{\alpha_1} (PE)_t^{\alpha 2} C_t^{\alpha 3} R_t^{\delta} e^{U_t} \quad \text{CD funtion} \qquad (3.26a)$$

$$Q_t = Ae^{\theta t} L_t^{\beta} (FP)_t^{\alpha_1} (PE)_t^{\alpha 2} C_t^{\alpha 3} R_t^{\delta} e^{U_t} \quad \text{CD function with 'disembodied' capital} \qquad (3.26b)$$

where Q_t = Turnover/Gross Sales in period t

L_t = Wages and Salaries in period t

$(FP)_t$ = Freehold land and Leasehold Properties

$(PE)_t$ = Furniture fittings, plant, machinery, Equipments and Vehicles in period t

C_t = Capital Work-in-progress in period t

R_t = Raw Materials in period t

t = time/period, t=1,1,...., 16

$A, \theta, \beta, \delta, \alpha_1, \alpha_2, \alpha_3$ are parameters and U_t is stochastic term in period t.

Version B

Same as Version A but where L_t = number of employees in period t.

Version C

Same as Version A but where Q_t = value-added in period t

Version D

Same as Version B but where Q_t = value-added in period t.

3.3 Sources of Data

The estimation of the models is based on the data obtained from the United Nigerian Textiles Limited (U.N.T.L.), Kaduna. These sets of data are mainly available in the Annual Reports and Accounts of the Company spanning sixteen years i.e. from 1971 to 1986. Other relevant data for comparative analytical purposes are obtained from other published sources like the Abstract of Statistics, a publication of the Federal Office of Statistics (Lagos), Newspapers, Journals, Magazines and publications by the Central Bank of Nigeria (Lagos). Finally, data and relevant information are obtained through interviews conducted with some key officers of the U.N.T.L. These officers include the Senior Industrial Relations Officer and the Production Managers.

The main problem with data collection in Nigeria especially from industrialists is the authenticity of the figures supplied. It is, therefore, doubtful if these figures actually reflect the production figures. It is alleged in some circles that companies, especially the multinational corporations, prepare

different versions of their annual reports and statements of accounts. There are three versions of the report. The first goes to the expatriate owners and the second goes to the top management of the company including a few Nigerians. The third version is the one that goes to the public and is presented to the shareholders of the company. The actual and authentic report is the one kept by the expatriates who own majority shares in the company. The U.N.T.L. is not in any way immuned to this practice given its ownership structure. The limitation that the authenticity of the data poses does not actually affect the outcome of the study significantly since the published figures (i.e. contained in the third version) are those used by the government for taxation and other policy measures.

3.4 Limitations of the Study

Most empirical works have certain limitations. This study is not an exception. The theoretical framework of this study assumes perfect competition in both the product and the factor inputs markets. This assumption is not realistic in the Nigerian setting but the specification of the Cobb-Douglas and Constant Elasticity of Substitution production functions assumes it. Similarly, the mathematical specification of the models cannot be the exact one thus misrepresenting true production function of the U.N.T.L.

It is noteworthy that, at first sight, it would appear that the CD and C.E.S. production functions can be observed given their properties and the availability of industry data. But the fact is that single observation of values of output (Q), capital (K), labour (L) and raw material (R) would not allow the parameters or form of a production function to be determined. More importantly there would be no guarantee that the particular value of Q observed is the maximum level of output for the given values of K, L and R. That is, the observed point may not be on the production frontier (isoquant). We doubt if the efficiency measure can capture this. It has also been assumed that the firm has the desired usage of K, L and R which are the profit maximizing values. If this assumption does not obtain then the observed values relate to a disequilibrium position. Related to this is the argument that firms like the U.N.T.L. have several production processes with varying scale parameters. Therefore aggregating all the processes into a single process is a serious limitation of the study.

This study has made use of time-series data on the U.N.T.L. Time-series data have their problems too in empirical investigation. Relative prices change over-time and hence the optimal combinations of the factor inputs also change. Observations are therefore much

more likely to refer to disequilibrium positions because of lags in the adjustment process. The quality of entrepreneurial skill also change with longer experience and staff changes so that there may be a movement from sub-optimal to optimal utilization of given factor inputs. However, the major problem with time-series data is technical progress. That is, as knowledge increases processes which are technologically more efficient become available and the skill and quality of the labour improves. The result is that factor input rates, substitutability between factors, efficiency parameters and the economies of scale behaviour can all change. Thus the parameters, and e even the mathematical form, of the production function change over-time.[12]

NOTES

1. Infact, the pioneering econometric estimation of production function by Cobb and Douglas was undertaken precisely for this purpose. The starting point was the observed income shares of wages and profits in the total income leading to a search for a production function in terms of output and inputs which would explain these observed shares. However, in recent years, there has been some doubt about the validity of an aggregate production function and the meaningfulness of empirical estimates using such a production function.

2. Desai, Meghnad (1976), Applied Econometrics, North-Holland Publishing Company, Amsterdam, London.

3. The approach adopted, in this study, to the theory of production follows Walters (1963) section 2, Allen (1967) Chapter 3, and Wynn and Holden (1974).

4. The concept of neutral technical change was devised to separate out (1) movements of the isoquant (2) movements along the isoquant and (3) changes in the shape of the isoquant as a result of shift. Two definitions of neutral technical change have been the mainstay of the discussion in this area. They are known after their authors as Hicks neutral and Harrod neutral. These are both of the disembodied type although they relate to changing efficiency (marginal products) of the inputs.

Hicks neutral: The marginal rate of technical substitution (ratio of marginal physical products) remains unchanged before and after the shift as long as the ratio of inputs remains constant (see Appendix A figure 3); or

$$\left.\frac{\partial (f_i/f_j)}{\partial t}\right|_{x_i/x_j} = 0$$

A general way of characterising the Hicks neutral technical change is to write the production function specified by

$Q = f(K,L,t)$-(where Q,K,L are observed values of output, capital and labour at time t and t is a shift variable) - as

$$Q = f[a_1(t)K,\ a_2(t)L] \qquad (\quad)$$

$a_1(t)$ and $a_2(t)$ are efficiency factors. Inputs are measured not just by their physical measures K and L but by their effieicny as inputs. If they remain unchanged in efficiency over time then $a_1(t)$ and $a_2(t)$ are constants. Any improvement in these inputs is otherwise caught by these factors. The Hicks neutral technical change is then defined as a situation where $a_1(t)/a_2(t)$ is a constant.

Harrod neutral. The Harrod neutral technical change is defined as the rate of increase in efficiency of labour occuring when the marginal product of capital remains constant if the average product of capital (inverse of the capital output ratio) remains unchanged. For Harrod, $a_1(t)$ in equation (3.) above is constant and $a_2(t)$ is the rate of technical change. Since this has the effect of increasing the efficiency of labour (equivalent to an expansion in the physical quantity of labour), it is called the rate of labour augmentation. In a general notation, the rate of technical progress (R) can be defined as

$$R = \frac{\partial \ln f}{\partial t} \qquad (\quad)$$

$$= \eta_k \frac{\partial a_1(t)}{a_1(t)} + \eta_L \frac{\partial a_2(t)}{a_2(t)} \qquad (\quad)$$

where η_k is the output elasticity of capital which is equal to capital's share under neo-classical assumptions and η_L is similarly defined. In Solow's case (see note 6 below), by his assumption of Hicks neutrality, the two rates of change are equal and

$$R = (\eta_k + \eta_L)\ \frac{\delta a(t)}{a(t)} \qquad (\quad)$$

$$= \delta a(t)/a(t) \text{ (since income shares sum to one)} \qquad (\quad)$$

Now, if we assume the production function to be Cobb-Douglas, then it is impossible to distinguish between Hicks and Harrod neutrality since the parameters of the Cobb-Douglas production function give constant output elasticities of inputs. For

Harrod neutrality, the ratio of marginal product to the average product of capital is constant but this is also the output elasticity of capital which is a parametric constant. Since the share of labour is also a constant, the Hicks neutrality condition is also satisfied simultaneously.

5. Arrow, K.J., Chenery, H.B., Minhas, B.S., and Solow, R.M. (1961), "Capital-Labour Substitution and Economic Efficiency", Review of Economics and Statistics, Vol.43, pp.

6. The constant elasticity of substitution (C.E.S.) production function was first mentioned by H.D. Dickinson but it was estimated in 1961 by Arrow, Chenery, Minhas and Solow (ACMS or SMAC).

7. These can easily be shown as follows. If $D > 0$ then (3.11) are satisfied if $(1-\delta) > 0$ and $\delta > 0$ so that $0 < \delta < 1$. If, on the other hand, $D < 0$, then (3.11) are satisfied if $(1-\delta) < 0$ and $\delta < 0$, that is, $1 < \delta$ and $\delta < 0$ which is contradictory. Hence $D > 0 \quad 0 < \delta < 1$.

8. Holden, K. and Wynn, R.F. (1974), op.cit., Chapter 1, Section 1.3.

9. An alternative approach is the use of the iteration estimation procedure. . . . The procedure is as follows.

$$\log Q_t = \log A + V \log F + U_t$$

$$\text{where } F = \left[(1-\delta)K^{-\rho} + \delta L^{-\rho} \right]^{-1/\rho}$$

If the values of the parameters $[\delta, (1-\delta)$ and $\rho]$ are known then F can be evaluated and hence A and V can be estimated by the OLS method. We proceed by choosing values of δ and $(1-\delta)$ such that their sum is either equal to or less than one in each particular iteration and these are combined with values of ρ from 0.1 to 1.5 in steps of 0.2 to give values of F. The best pair of A and ρ values is selected as being the pair that minimizes the residual sum of squares.

Since the residual is multiplicative then the minimand is given by

$$\sum_{i=1}^{n} \left[\log Q_t - (\log A + V \log F)^2 \right].$$

In this way, the estimators of δ, $(1-\delta)$, ρ, v and A are obtained. These are to some extent dependent on the size of the steps used in the iterative process over δ, $(1-\delta)$ and ρ.

10. Value-added is defined as the difference between Gross Sales (Turnover) and production (i.e. raw materials) costs.

11. It has not been possible to disaggregate the data of this variable into their components so as to look at the effect of plants and equipments on output. The variables (FP and PE) have been aggregated for most of the years as contained in the Annual Report And Accounts of the U.N.T.L.

12. Two approaches (methods) have been adopted in the literature to eliminate or minimize the problems of time-series data in technical progress. The first method assumes that technical progress can be measured by adding a time trend, t, to the production function to give

$$Q_t = f(t, K_t, L_t)$$

and for example (for the specification of the CD function)

$$Q_t = Ae^{\theta t} K_t^{\alpha} L_t^{\beta} e^{U_t}$$

or $$\ln Q_t = \ln A + \theta t + \alpha \ln K_t + \beta \ln L_t + U_t.$$

Here $e^{\theta t}$ is the exponential rate of technical progress, and implies that output rises at a rate of θ per cent per annum independently of changes in the factor inputs, and in particular, independently of new investment. This type of technical progress is not associated with the measures of capital or labour and is known as 'disembodied' technical progress. Further, it is Hicks-neutral since the marginal rate of technical substitution of capital for labour is unchanged by technical progress. This formulation is, to some extent, unrealistic in that intuitively old machines are unchanged by new discoveries and technological progress will only have an effect on output (Q) through investment (K).

The second method to technical progress assumes that new investment embodies technical advances and that only after investment occurs can technical progress have any effect. This is known as 'embodied' technical progress and gives

rise to a vintage model because a different production function applies for each vintage(age) of capital. For example:

$$Q_t(v) = f\left[V, L_t(v), K_t(v) \right]$$

where $Q_t(v)$ = output at time t from machines of vintage v

$L_t(v)$ = labour used at time t on machines of vintage v

$K_t(v)$ = capital of vintage v is used at time t.

The term v in the production function measures technical progress and, for example, with the Cobb-Douglas function

$$Q_t(v) = Ae^{\theta v} K_t(v)^{\alpha} \; L_t(v)^{\beta}$$

The production function at time t is

$$Q_t = f(L_t, K_t) \text{ with } Q_t = \int_{-\infty}^{t} Q_t(v)dv$$

$$L_t = \int_{-\infty}^{t} L_t(v)dv$$

$$K_t = \int_{-\infty}^{t} K_t(v)dv$$

being the measures of total output, labour input at time t.

CHAPTER FOUR

4.0 ANALYSIS OF THE RESULTS OF THE ESTIMATED MODELS

The results of the estimated models specified in the preceding chapter are presented and analysed in this chapter. The next section discusses the estimated models for the Cobb-Douglas (CD) production function. Each of the four versions of Models I and II has four specifications namely, the conventional CD specification, specification with 'disembodied' capital, output-labour ratio specification and output-labour ratio with 'disembodied' capital specification. Models III and IV have two specifications each in all the versions. The section (4.1) embodies the main empirical results of the study.

The style of presentation and analysis of the results is simply listing the regression equations model by model at the end of which a brief discussion of the statistical, econometric and economic implications of the results are made in relation to the three main hypotheses advanced in chapter one. A detailed discussion of the results with economic justifications comes at the end of the section. In providing such justifications, we have related the results to the production characteristics of the U.N.T.L. such as productivity of the inputs and their relation to technological process and efficiency of production.

The same analysis is done in section 4.2 with respect to the constant elasticity of substitution (C.E.S) production function. As stated in chapter three only Model I, particularly, Version A specifications one and two has been estimated for the C.E.S. function.

The Models were estimated using the Vogelback Computing Center software version 6.50 of April 1, 1976. The technique of estimation has been with the aid of the Statistical Package for the Social Sciences (SPSS). We have used the conventional criteria relating to the R^2 (Coefficient of determination), Adjusted R^2, t-ratios (or standard errors), F-ratio, and the Durbin-Watson statistic in determining the goodness of fit of the regression equations and the statistical significance of the coefficients. Therefore the 'best' model or version of a model has been selected based on the above criteria.

4.1 The Cobb-Douglas Production Function

4.1.1 MODEL I

Version A

Specification 1

$$\text{Log } Q = -2.59 + 0.93 \log K + 0.28 \log L \qquad (4.1.1a)$$

T-Ratios (-1.94)(8.72) (2.16)

$R^2 = 0.96$ F-ratio = 155.12

$\bar{R}^2 = 0.95$ [1]Durbin-Watson = 1.73

Specification 2

$$\text{Log } Q = -0.32 + 0.11t + 0.76 \log K + 0.32 \log L \qquad (4.1.1b)$$

T-Ratios (-0.12)(1.02)(3.77) (2.34)

$R^2 = 0.96$ F-Ratio = 104.14

$\bar{R}^2 = 0.95$ Durbin-Watson = 1.89

Specification 3

$$\text{Log}\left(\frac{Q}{L}\right) = 0.33 + 1.08 \log \left(\frac{K}{L}\right) \qquad (4.1.1c)$$

T-Ratios (0.40)(11.38)

$R^2 = 0.90$ F-Ratio = 129.45

$\bar{R}^2 = 0.89$ Durbin-Watson = 1.52

Specification 4

$$\text{Log}\left(\frac{Q}{L}\right) = 1.38 + 0.10t + 0.94 \log \left(\frac{K}{L}\right) \qquad (4.1.1d)$$

T-Ratios (1.21)(1.28) (6.42)

$R^2 = 0.91$ F-Ratio = 68.51

$\bar{R}^2 = 0.90$ Durbin-Watson = 1.62

The results of Model I (Version A) have indicated that generally the conventional criteria are satisfactory. For instance, the high goodness of fit of the model implies that at least 90 per cent of variation in the rate of output (gross sales) is explained by the use of the factor inputs (labour and capital). The Durbin-Watson(statistic) test for the existence of serial-correlation of the stochastic term with reference to the first order scheme indicates that the null hypothesis

($H_o: \rho = 0$) is not rejected at both the 1 and 5 per cent levels of significance in specifications 1 and 2 while in the remaining specifications (3 and 4) the null hypothesis is not rejected at the 1 per cent level but test is inconclusive at the 5 per cent level. Therefore, there is no problem of autocorrelation neither do the results indicate the problem of multicollinearity. All the coefficients of the estimated model are statistically significant except those of the constant term and the time variable. In fact, these results can be adduced to explain the wrong signs of the constant term in the first two specifications which is against a priori expectation. Based on the conventional criteria the first specification is the best in this version of the model.

Relating these results to the hypotheses of capital-intensity, increasing returns to scale and technical change it is observed that all the hypotheses are accepted with respect to specifications 1 and 2. The hypothesis on technical change is not strongly accepted because the coefficient of t is not significantly different from zero even though it is positive. The acceptance of the hypotheses implies that the U.N.T.L. operates a capital-intensive production process and experiences increasing returns to scale plus technical change which tend to reinforce each other. This finding lends support to casual empiricism on the operations of large

foreign-dominated firms such as the U.N.T.L. which make use of capital-intensive method of production thus employing less workers and without really 'transfering' the knowledge of the imported technologies to the indigenous staff.

Version B

Specification 1

$$\text{Log } Q = -1.44 + 1.08 \log K + 0.12 \log L \qquad (4.1.2a)$$

T-Ratios (-0.95) (11.71) (0.57)

$R^2 = 0.95$ F-Ratio = 115.48

$\bar{R}^2 = 0.94$ Durbin-Watson = 1.58

Specification 2

$$\text{Log } Q = -0.56 + 0.04t + 1.04 \log K + 0.10 \log L \qquad (4.1.2b)$$

T-Ratios (-0.16) (0.28) (5.43) (0.46)

$R^2 = 0.95$ F-Ratio = 71.57

$\bar{R}^2 = 0.93$ Durbin-Watson = 1.59

Specification 3

$$\text{Log} \left(\frac{Q}{L} \right) = 1.55 + 0.92 \log \left(\frac{K}{L} \right) \qquad (4.1.2c)$$

T-Ratios (1.68) (7.20)

$R^2 = 0.79$ F-Ratio = 51.83

$\bar{R}^2 = 0.77$ Durbin-Watson = 1.20

Specification 4

$$\text{Log}\left(\frac{Q}{L}\right) = 2.96 + 0.15t + 0.69\log\left(\frac{K}{L}\right) \quad (4.1.2d)$$

T-Ratios (3.36)(2.96) (5.31)

R^2 = 0.87 F-Ratio = 44.61

$\bar{R}^2$ = 0.85 Durbin-Watson = 1.89

The general specification of this version is the same as that of Version A except that labour (L) is measured in unit of the number of workers (employees) with the firm per annum. The aim here is to contrast the influence of employment of labour, specified separately as wages and salaries and number of employees, on the output of the firm. The statistical and econometric criteria are very satisfactory particularly for the first two specifications. The drop in the value of the R^2 for the last two specifications indicates that the use of the output-labour ratio approach in estimating the model, given that labour is measured in the number of workers, does not capture clearly the technical relationship between inputs and the output of the firm. The very low t-ratio of the labour variable supports this assertion. The wrong sign of the coefficient of the constant term in the first two specifications can be ignored since the t-ratios indicate that the coefficients are not significantly different from zero. However, the a priori expectation of the sign of the constant term and t variable is satisfied in the other two specifications.

All the estimated specifications do not have the problem of autocorrelation as indicated by the D-W values.

In terms of the hypotheses, specifications 1 and 2 support the hypotheses that the production process of the U.N.T.L. is capital-intensive and that it experiences increasing returns to scale. In specifications 1 and 2 the hypothesis on technical efficiency with respect to the constant term is rejected but it is accepted with respect to the Hicks-neutral technical change (with 'disembodied' capital) in specification 2 though the coefficient of t is not significantly different from zero. The results obtained in (4.1.2d) are the best in this version because of the statistical significance and correct sign of the coefficients. The specification shows that technical change contributes about 15 per cent per annum to the growth of the firm's output. This result supports the hypothesis on technical efficiency in the production process.

Version C.

Specification 1

$$\text{Log } Q = 0.25 + 0.12 \log K + 0.89 \log L \qquad (4.1.3a)$$

T-Ratios (0.20) (1.18) (7.23)

$R^2 = 0.94$ F-Ratio = 94.16

$\bar{R}^2 = 0.93$ Durbin-Watson = 0.73

Specification 2

$$\text{Log } Q = 1.63 + 0.03t + 0.08\log K + 0.85\log L \qquad (4.1.3b)$$

T-Ratios (0.50) (0.25) (0.28) (4.54)

$R^2 = 0.89$ F-Ratio = 32.9

$\bar{R}^2 = 0.86$ Durbin-Watson = 1.51

Specification 3

$$\text{Log}\left(\frac{Q}{L}\right) = 2.99 + 0.67\log\left(\frac{K}{L}\right) \qquad (4.1.3c)$$

T-Ratios (2.15) (4.13)

$R^2 = 0.55$ F-Ratio = 17.05

$\bar{R}^3 = 0.52$ Durbin-Watson = 0.68

Specification 4

$$\text{Log}\left(\frac{Q}{L}\right) = 1.17 - 0.17t + 0.92\left(\frac{K}{L}\right) \qquad (4.1.3d)$$

T-Ratios (0.60) (-1.31) (3.70)

$R^2 = 0.60$ F-Ratio = 9.81

$\bar{R}^2 = 0.54$ Durbin-Watson = 0.88

We have measured output in this version, in terms of value-added of the firm but other variables remain as in Version A. The results have shown that the first two specifications have a high goodness of fit. However, specifications 1 and 3 suffer from the problem of serial correlation. The consequences of this problem are that the O.L.S. estimators no longer have the property of having a sampling distribution which has the smallest variance among the class of linear unbiased estimators, and that the standard errors are underestimated (over-

estimation of the t-ratios). It is observed that the explanatory power of the regression line declined in the last two specifications. A plausible explanation for this could be that the output-labour ratio approach is not very appropriate in estimating the production function of the firm using value-added (Q) as the dependent variable. Specification 2 gives the best results in this version.

The first hypothesis is rejected in specifications 1 and 2 implying that the U.N.T.L. operates a labour-intensive production technique. This contradicts our earlier results in Versions A and B. The explanation for this is the fact that value-added which is the dependent variable (Q) in this version and is comprised of payments due to employees, providers of funds, government (taxation), and for maintenance of assets is mainly made up of salaries and wages to workers. So that the influence of labour on it is greater than that of capital. We have also observed a mild increasing returns to scale in the first specification but not in the second. Technical change is observed in specifications 2 and 4. Specification 4 has a wrong sign. The coefficients are however not statistically significant.

Version D

Specification 1

$$\text{Log } Q = 5.5 + 0.71 \log K - 0.04 \log L \qquad (4.1.4a)$$

T-Ratios (1.99) (4.2) (-0.10)

R^2 = 0.69 F-Ratio = 8.87

$\bar{R}^2$ = 0.61 Durbin-Watson = 0.72

Specification 3

$$\text{Log}\left(\frac{Q}{L}\right) = 6.46 + 0.12\log\left(\frac{K}{L}\right) \qquad (4.1.4c)$$

T-Ratios (9.31) (1.23)

R^2 = 0.10 F-Ratio = 1.5

$\bar{R}^2$ = 0.03 Durbin-Watson = 0.72

Specification 4

$$\text{Log}\left(\frac{Q}{L}\right) = 14.27 - 0.77t - 0.84\log\left(\frac{K}{L}\right) \qquad (4.1.4d)$$

T-Ratios (13.52) (-7.31) (-7.17)

R^2 = 0.89 F-Ratio = 36.77

$\bar{R}^2$ = 0.87 Durbin-Watson = 0.78

This version has the same variables as Version B where value-added is the dependent variable. The explanatory power of the regression equations has generally declined in contrast with the same specifications of the preceding versions. In fact, the third specification has no good fit at all. The specifications all, have the problem of autocorrelation. A possible explanation for these poor results could be that there is not much technical relationship between value-added (as the output) and the capital and the number of workers employed as the factor inputs of the firm. The fourth specification passes as the best in this version.

The hypothesis on capital-intensity is accepted but the one on returns to scale is rejected. The third is not rejected with respect to the Hicks-neutral technological change ('disembodied' capital) in the second specification. This acceptance is weakened by the fact that the coefficient has a wrong (or negative) sign and a very low t-ratio. The fourth specification is an improvement on the second but still with wrong signs of the coefficients. The results might be due to the overestimation of the t-ratios because of the presence of autocorrelation.

4.1.2 MODEL II

Version A

Specification 1

$$\text{Log } Q = \log -3.48 + 0.84\log + 0.14\log L + 0.27\log R \quad (4.2.1a)$$

T-Ratios (-2.27) (6.26) (0.79) (1.15)

$R^2 = 0.96$ F-Ratio = 106.37

$\bar{R}^2 = 0.95$ Durbin-Watson = 1.51

Specification 2

$$\text{Log } Q = -0.39 + 0.16t + 0.52\log K + 0.12\log L + 0.40\log R \quad (4.2.1b)$$

T-Ratios (-0.16)(1.60)(2.2) (0.73) (1.69)

$R^2 = 0.97$ F-Ratio = 90.80

$\bar{R}^2 = 0.96$ Durbin-Watson = 1.75

Specification 3

$$\underset{\text{T-Ratios}}{\text{Log}\left(\frac{Q}{L}\right)} = \underset{(-0.39)}{-0.41} + \underset{(5.78)}{0.93\log\left(\frac{K}{L}\right)} + \underset{(1.14)}{0.22\log\left(\frac{R}{L}\right)} \quad (4.2.1c)$$

$R^2 = 0.91$ F-Ratio = 66.75

$R^{-2} = 0.90$ Durbin-Watson = 1.38

Specification 4

$$\text{Log}\left(\frac{Q}{L}\right) = 0.93 + 0.23t + 0.35\log\left(\frac{K}{L}\right) + 0.56\log\left(\frac{R}{L}\right) \quad (4.2.1d)$$

T-Ratios (1.03)(3.15)(1.58) (3.10)

R^2 = 0.95 F-Ratio = 78.39

$\bar{R}^2$ = 0.94 Durbin-Watson = 1.75

The results indicate that the firm operates a capital-intensive technique of production. It has also been observed that it experiences increasing returns to scale for the first and second specifications. The hypothesis on technical efficiency is accepted since it accounts for at least 16 per cent of the growth of the firm's output per annum. The second specification is the best in this version with respect to the conventional statistical-cum-econometric criteria.

Version B

Specification 1

$$\text{Log } Q = -4.71 + 0.74\log K + 0.22\log L + 0.45\log R \quad (4.2.2a)$$

T-Ratios (-2.69)(5.0) (1.30) (2.67)

R^2 = 0.97 F-Ratio = 115.64

$\bar{R}^2$ = 0.96 Durbin-Watson = 1.50

Specification 2

$$\text{Log } Q = -1.65 + 0.15t + 0.48\log + 0.18\log + 0.55\log R \quad (4.2.2b)$$

T-Ratios (-0.62)(1.47) (2.08) (1.06) (3.14)

R^2 = 0.97 F-Ratio = 95.64

$\bar{R}^2$ = 0.96 Durbin-Watson = 1.77

The hypothesis on capital-intensity is accepted for all specifications except the second specification

where the coefficients indicate that the production process is raw material-intensive (i.e. raw material contributes more to the output of the firm). The second hypothesis is also accepted for the first two specifications. The results also show that there has been technical change (positive) in the production process of the firm during the period under study. Specification 2 gives the best results for this version of the model.

Version C

Specification 1

$$\text{Log } Q = -0.41+0.05\log K+0.78\log L+0.20\log R \quad (4.2.3a)$$

T-Ratios (-1.46)(0.38) (4.56) (0.89)

R^2 = 0.94 F-Ratio = 62.04

$\bar{R}^2$ = 0.92 Durbin-Watson = 0.79

Specification 2

$$\text{Log } Q \quad -1.31+0.007t-0.04\log K+0.41\log L+0.69\log R \quad (4.2.3b)$$

T-Ratios (-0.57)(0.072)(-0.20) (2.42)

R^2 = 0.96 F-Ratio = 58.55

$\bar{R}^2$ = 0.94 Durbin-Watson = 2.33

Specification 3

$$\text{Log}\left(\frac{Q}{L}\right) = -0.04+0.06\log\left(\frac{K}{L}\right)+0.89\log\left(\frac{R}{L}\right) \quad (4.2.3c)$$

T-Ratios (-0.03)(0.29) (3.79)

R^2 = 0.79 F-Ratio = 23.83

$\bar{R}^2$ = 0.75 Durbin-Watson = 1.38

Specification 4

$$\text{Log}\left(\frac{Q}{L}\right) = 0.37+0.07t-0.12\log\left(\frac{K}{L}\right)+0.99\log\left(\frac{R}{L}\right) \quad (4.2.3d)$$

T-Ratios (0.25)(0.58)(-0.33) (3.31)

R^2 = 0.79 F-Ratio = 15.19

$\bar{R}^2$ = 0.74 Durbin-Watson = 1.42

For all the relevant specifications the first hypothesis is rejected. The results indicate that labour and raw materials contribute more to the level of output than capital. All the relevant specifications indicate increasing returns to scale. The hypothesis on Hicks-neutral technical change is accepted with very low t-ratios. The results obtained from the second specification meet most satisfactorily the conventional criteria.

Version D

Specification 1

$$\text{Log } Q = -1.45+0.02\log K+0.19\log L+0.97\log R \quad (4.2.4a)$$

T-Ratios (-0.51)(-0.06) (0.68) (3.51)

R^2 = 0.84 F-Ratio = 21.07

$\bar{R}^2$ = 0.80 Durbin-Watson = 1.43

Specification 2

$$\text{Log } Q = -0.44+0.05t+0.10\log K+-0.18\log L+1.01\log R \quad (4.2.4b)$$

T-Ratios (-0.09)(0.28)(-0.26) (0.59) (3.25)

R^2 = 0.84 F-Ratio = 14.60

$\bar{R}^2$ = 0.78 Durbin-Watson = 1.46

Specification 3

$$\text{Log}\left(\frac{Q}{L}\right) = 5.57 + 0.06 \log\left(\frac{K}{L}\right) + 0.16 \log\left(\frac{R}{L}\right) \quad (4.2.4c)$$

T-Ratios (4.25)(0.50) (0.81)

$R^2 = 0.14$ F-Ratio = 1.06

$\bar{R}^2 = 0.008$ Durbin-Watson = 0.75

Specification 4

$$\text{Log}\left(\frac{Q}{L}\right) = 5.51 + 0.03t - 0.01 \log\left(\frac{K}{L}\right) + 0.23 \log\left(\frac{R}{L}\right) \quad (4.24d)$$

T-Ratios (4.08)(0.57) (-0.07) (0.97)

$R^2 = 0.16$ F-Ratio = 0.78

$\bar{R}^2 = -0.05$ Durbin-Watson = 0.82

The above results have depicted poor goodness of fit for the last two specifications. This might be due to the output-labour ratio approach adopted where output is value-added and labour is the number of employees. A possible conclusion from these results is that the two variables used, given the approach, donot bring out the technical relationship in the production process. Thus the output-labour ratio specification does not fit well the relationship of variables in the production process of the U.N.T.L. The first hypothesis is rejected for all specifications. The coefficient indicates that raw materials has the largest output elasticity. This result actually confirms the assertion that production in the manufacturing sector is sensitive to the use of raw materials. The second hypothesis is rejected in the last two

specifications probably due to 'no good fit' of the regression line. The firm has experienced positive technical (Hicks-neutral) change. But the low t-ratios make the acceptance of the third hypothesis unreliable. The first specification gives the best results for the estimated model in this version.

4.1.3 MODEL III

Version A

Specification 1

$$\text{Log } Q = -14.83 + 1.72 \log L - 2.35 \log FP + 2.39 \log PE + 0.11 \log C$$

T-Ratios (-3.77) (5.71) (-3.63) (3.63) (1.26)

(4.3.1a)

$R^2 = 0.90$ F-Ratio = 24.36

$\bar{R}^2 = 0.86$ Durbin-Watson = 2.04

Specification 2

$$\text{Log } Q = 10.73 + 0.47t + 0.38 \log L + 0.68 \log FP - 0.45 \log PE - 0.02 \log C$$

T-Ratios (3.53) (4.55) (0.98) (1.01) (-0.57) (-0.20)

(4.3.1b)

$R^2 = 0.91$ F-Ratio = 19.44

$\bar{R}^2 = 0.86$ Durbin-Watson = 1.81

In this model, and the next, we have restricted ourselves to only two specifications since we are examining the relationship between output, labour, the components of capital and raw material. The output-labour ratio approach is not known to have been applied in the literature by using the 'disaggregated' model.

Specification one has a better fit of the regression line. The coefficients are all statistically significant and the D-W statistic indicates no serial-correlation of the stochastic term. In the first specification the a priori sign of the FP variable is wrong [illegible], however, the low t-ratios give the impression that the coefficients are not significant at the 5 per cent level. The first hypothesis is accepted in both specifications. The second is accepted only in the first specification while the hypothesis on technical change is also accepted. Thus, implying that the firm experiences technical efficiency though the capital variable (K) has been disaggregated to allow for the observation of the role of each component of capital in the production process. Specification one gives better results for this version.

Version B

Specification 1

$$\text{Log } Q = 0.20 + 1.21 \log L + 0.86 \log FP - 0.39 \log PE - 0.004 C \quad (4.3.2a)$$

T-Ratios (0.05) (2.10) (0.76) (-0.30) (-0.03)

$R^2 = 0.71$ F-Ratio = 6.84

$\bar{R}^2 = 0.61$ Durbin-Watson = 1.21

Specification 2

$$\text{Log } Q = 10.73 + 0.47 + 0.38 \log L + 0.68 \log FP - 0.45 \log PE - 0.02 \log C \quad (4.3.2b)$$

T-Ratios (3.14) (4.56) (0.98) (1.01) (-0.57) (-0.20)

R^2 = 0.91 F-Ratio = 19.44

$\bar{R}^2$ = 0.86 Durbin-Watson = 1.81

Test for autocorrelation is inconclusive at both levels of significance in the first specification which suggests that the t-ratios are overestimated. The second specification has no such problem. The first hypothesis is rejected in all the specifications while the second is accepted only in the first spefification. The third hypothesis of technical change is also accepted. We have better results from the second specification.

Version C

Specification 1

Log Q = -0.97+0.93logL+0.08logFP-0.004logPE+0.09logC

T-Ratios(-0.49)(6.13) (0.26) (-0.01) (1.96)

(4.3.3a)

R^2 = 0.95 F-Ratio = 55.74

$\bar{R}^2$ = 0.94 Durbin-Watson = 1.79

Specification 2

Log Q =1.07+0.05t+0.81logL+0.28logFP-0.20logPE+0.01logC

T-Ratios(0.28)(0.65)(3.45) (0.62) (-0.43) (1.63)

(4.3.3b)

R^2 = 0.95 F-Ratio = 42.33

$\bar{R}^2$ = 0.93 Durbin-Watson = 1.70

The firm, given these specifications, is not capital-intensive but rather labour-intensive. This

result is not surprising since the dependent variable is the value-added of the firm which is composed of wages and salaries, profits, taxes, etc. Increasing returns to scale is observed with the first specification only. Technical change is observed but the t-ratio is low. In terms of the conventional criteria, the first specification is better.

Version D

Specification 1

$$\text{Log } Q = 6.40 + 0.97 \log L + 2.17 \log FP - 1.96 \log PE + 0.02 \log C \quad (4.3.4a)$$

T-ratios (4.13) (4.59) (5.21) (-3.99) (0.29)

$R^2 = 0.93$ F-Ratio = 35.92

$\bar{R}^2 = 0.90$ Durbin-Watson = 1.77

Specification 2

$$\text{Log } Q = 9.55 + 014t + 0.73 \log L + 2.12 \log FP - 1.98 \log PE + 0.01 \log C \quad (4.3.4b)$$

T-Ratios (5.80) (2.83) (3.88) (6.49) (-5.16) (0.28)

$R^2 = 0.96$ F-Ratio = 48.66

$\bar{R}^2 = 0.94$ Durbin-Watson = 2.16

The first hypothesis is rejected for both specifications. The second is rejected for the second hypothesis while the third is accepted with high t-ratio. These results have generally indicated that the elasticity of output with respect to labour is larger than the elasticities with respect to the components of capital when taken collectively. Individually, the

elasticity of output with respect to free/lease-hold properties is greater than the others. Specification 2 has better results in this version.

4.1.4 MODEL IV

Version A

Specification 1

$$\text{Log } Q = -14.58 + 1.06\log L - 1.96\log FP + 1.95\log PE + 0.06\log C$$

T-Ratios $(-4.29)\ (2.65)\ \ (-3.33)\ \ (3.22)\ \ (0.74)$

$$+0.72\log R \qquad (4.4.1a)$$

(2.18)

$R^2 = 0.93$ F-Ratio = 27.07

$\bar{R}^2 = 0.90$ Durbin-Watson = 1.52

Specification 2

$$\text{Log } Q = -2.72 + 0.27t + 0.46\log L - 0.85\log FP + 0.88\log PE$$

T-Ratios $(-0.59)\ (3.05)\ (1.31)\ (-1.50)\ \ (1.54)$

$$+0.01\log C + 0.63\log R \qquad (4.4.1b)$$

$(0.20)\ \ (2.59)$

$R^2 = 0.97$ F-Ratio = 42.77

$\bar{R}^2 = 0.94$ Durbin-Watson = 1.90

The FP variable has a wrong sign in all the specifications. The labour input contributes more to output than the components of capital in the first specification when taken individually. While raw material is greater than the rest variables in the second specification. A plausible explanation for this apparently unrealistic results can be found by examining the changes in the values of the components of capital

in Appendix B Table 2. It can be observed that though in nominal terms the values have been increasing over the years but in actual fact their netbook values (i.e. accounting for depreciation allowance) have declined for certain years when the output level of the firm was increasing. The firm, according to the two specifications, experiences increasing returns to scale by the factors. We have also observed the presence of Hicks-neutral technical change in the second specification. We have better results in the first specification than in the second.

Version B

Specification 1

$$\text{Log } Q = -9.49 + 0.52 \log L - 0.46 \log FP + 0.53 \log PE$$

$$\text{T-Ratios } (-2.77)(1.34) \quad (-0.61) \quad (0.62)$$

$$= 0.02 \log C + 1.22 \log R \qquad (4.4.2a)$$

$$(-0.22) \quad (4.35)$$

$R^2 = 0.90$ F-Ratio = 18.15

$\bar{R}^2 = 0.85$ Durbin-Watson = 0.92

Specification 2

$$\text{Log } Q = 0.98 + 0.31t + 0.22 \log L - 0.11 \log FP + 0.16 \log PE$$

$$\text{T-Ratios } (0.28)(3.85)(0.82) \quad (-0.21) \quad (0.29)$$

$$= 0.02 \log C + 0.79 \log R \qquad (4.4.2b)$$

$$(-0.39) \quad (3.66)$$

$R^2 = 0.96$ F-Ratio = 38.50

$\bar{R}^2 = 0.94$ Durbin-Watson = 1.73

The first hypothesis is rejected and the results indicate that production at the U.N.T.L. is raw

material-intensive. The second hypothesis is accepted. The third is also accepted with respect to the Hicks-neutral technical change. Specification 2 gives better statistical and econometric results.

Version C

Specification 1

$$\text{Log } Q = -0.92 + 0.80\log L + 0.16\log FP - 0.09\log PE$$

$$\text{T-Ratios}(-0.45)\ (3.37)\qquad (0.45)\qquad (-0.24)$$

$$+ 0.08\log C + 0.14\log R \qquad (4.4.3a)$$

$$(1.62)\qquad (0.70)$$

$R^2 = 0.96$ F-Ratio = 42.60

$\bar{R}^2 = 0.93$ Durbin-Watson = 1.81

Specification 2

$$\text{Log } Q = 0.89 + 0.04t + 0.71\log L + 0.33\log FP - 0.25\log PE$$

$$\text{T-Ratios } (0.23)\ (0.56)\ (2.40)\qquad (0.69)\qquad (-0.53)$$

$$+ 0.07\log C + 0.12\log R \qquad (4.4.3b)$$

$$(1.37)\qquad (0.61)$$

$R^2 = 0.96$ F-Ratio = 33.10

$\bar{R}^3 = 0.93$ Durbin-Watson = 1.75

The specifications indicate that production is more labour- sensitive than the hypothesized capital-intensity taking the coefficients both individually and collectively. The second hypothesis is rejected for the second specification which indicates decreasing returns to scale. Technical efficiency is observed in the second specification. However, the generally low t-ratios of the coefficients make the results unreliable..

Despite this the first specification has the better results in this version.

Version D

Specification 1

Log Q = 3.06 + 0.74logL + 1.71logFP - 1.64logPE +0.01logC

T-Ratios(2.18) (4.62) (5.49) (-4.71) (0.28)

+ 0.42log R
(3.64) (4.4.4a)

R^2 = 0.97 F-Ratio = 63.45

$\bar{R}^2$ = 0.95 Durbin-Watson = 2.60

Specification 2

Log Q = 5.69 + 0.08t + 0.66logL + 1.80logFP - 1.73logPE

T-Ratios(2.77) (1.65) (4.27) (6.14) (-5.31)

+ 0.01logC + 0.31logR (4.4.4b)

(0.28) (2.48)

R^2 = 0.98 F-Ratio = 62.37

$\bar{R}^2$ = 0.96 Durbin-Watson = 2.93

This version shows that the production process is more labour-sensitive than capital-sensitive. The second hypothesis is rejected for the second specification but the firm experiences Hicks-neutral technical change. Specification 1 gives the better results in this version and generally for all the versions in the model.

The three hypotheses on the elasticity of output with respect to factor inputs, the returns to scale of

the factors and the technical change in the production process of the U.N.T.L. were tested against the results obtained for the models. We have observed that out of 8 specifications in Model I 6 support the hypothesis on capital-intensity. The other two specifications which reject the hypothesis have very low t-ratios for the capital coefficients. The version(s) of the model in which these specifications appear has value-added as the dependent variable and wages and salaries as one of the independent variables; and since the value-added is made up of wages and salaries one would expect the elasticity of output (value-added) with respect to labour (wages and salaries) to be greater than that with respect to capital. The fact that most of the specifications support the hypothesis of capital-intensity makes the finding important since it confirms the results obtained by Maitha (1973) which indicate increasing capital-intensity of the manufacturing firms overtime in Kenya despite the abundant labour supply in the economy. Maitha argues that the higher capital productivity observed is due to high capital-labour ratio, and that it partly explains the slow growth of employment in the modern sector of most developing economies. This argument could be applied to the manufacturing sector in Nigeria since empirical results support it.

Models III and IV which are the 'disaggregated' production functions have exposed the contributions of the various components of capital, labour and raw material to output collectively and individually. In Model III, collectively, the results indicate that the production process is labour-intensive in all the 8 specifications. While, individually, land and lease-hold property (FP) variable contributes most to output in 4 out of 8 specifications. Labour (L) input's contribution to output is greater in 3 out of 8 specifications. The first part of the results that indicates labour-intensity is contrary to expectation (i.e. first hypothesis). Therefore, the hypothesis on capital-intensity is rejected in all the specifications in Model III. In Model IV, collectively, capital-intensity is observed in only 2 specifications out of 8. Raw material and labour intensities are observed equally in the remaining six specifications. The divergence between the collective and the individual factor elasticities is accounted for by the wrong (negative) sign attached to 7 of the 8 coefficients of land and Equipments (PE) and 3 of the 8 coefficients of capital-work in progress. As suggested earlier, with reference to Appendix B Table 2, the explanation for the divergence is because the netbook values of the capital inputs decline in some years while the output of the firm increases. This decline is due to

the variation in the rates of depreciating components of capital. For instance, in 1973 the leasehold buildings were depreciated at the rate of 5% of the total cost at the year-end while other fixed assets were depreciated at rates ranging from 5% to 50% of their total cost at the year-end. In 1986, leasehold land was amortised over the period of the lease while buildings were written off over a period of 20 years. The depreciation rates used for other assets range from 10% for Plant and Machinery to 100% for Motor Vehicles. The manipulation of the depreciation rates seems to be aimed at lessening the tax burden on the company.

The generally high elasticity of output with respect to capital observed in some of the models (especially Models I and II) may be due to a variety of factors such as scale of operation, entrepreneurial ability, trained manpower (including administrative personnel), new equipments of production, etc. The value of capital employed by the firm was ₦16.2 million in 1971. This figure rose to ₦66.2 million in 1986. The results obtained from Models III and IV generally confirm the findings by Osagie and Odaro (1975) which characterize the Nigerian manufacturing industries as labour-intensive. It is interesting to note that Osagie and Odaro estimated 'disaggregated' production functions as we have done in Models III and IV.

In Model I, the hypothesis on the returns to scale is rejected in 3 out of 8 specifications. Nine specifications out of 16 have indicated increasing returns to scale in Model II while 4 out of 8 specifications indicate increasing returns in Model III. Model IV validates strongly this hypothesis since only one out of eight specifications rejects it. However, 4 specifications show that the U.N.T.L. experiences mild increasing returns to scale.[2] It should be noted that the use of value-added as the dependent variable in versions C and D in all the models assumes implicitly that raw materials are used in fixed proportion to output, and that there are no economies of scale in the use of raw materials (Liedholm, 1966). We have observed from the results that there are increasing returns to scale in 1 out of 4 specifications (Model I), 4 out of 8 specifications (Model III), and 2 out of 4 specifications (Model IV) for all versions C and D. Though the implicit assumption behind the use of value-added as the dependent variable in versions C and D is unrealistic the findings of this study generally seem to prove that there are no increasing returns to scale rather than economies of scale in the use of raw materials.

Technical change (or efficiency) has been observed in 5 out of 8 specifications in Model I. Only one of

these results is reliable since the t-ratios of the remaining four are very low. Thus, the result indicates that 15% of the growth in output per annum is accounted for by technical efficiency. This efficiency is probably due to 'disembodied' capital in the production function of the U.N.T.L. All the 8 specifications in Model II indicate positive Hicks-neutral technical change but only 2 of these have coefficients which are statistically significant at 5 per cent level. The percentages of technical efficiency are 19 and 23 for these specifications. In Model III, the results accept the hypothesis on technical change but 1 out of the 4 coefficients is not significantly different from zero. The other 3 specifications indicate technical efficiency of 14% (version D) and 47% (versions A and B). In Model IV 2 of the 4 technical coefficients are statistically not significant. The others indicate efficiency of 27% and 31% per annum. It can be safely stated given these results that the U.N.T.L. experiences technical efficiency in its production process which ranges from 14% to 47% per annum.

Technical changes are usually classified as factor-augmenting and non-factor-augmenting. The former arise from increases in education and training, improved health, and research and development (R and D); whereas the latter arise from managerial and organiza-

tional improvements. Factor-augmenting technical changes with respect to this study could either be capital-deepening, labour-deepening or raw-material deepening. The results have shown that technical changes are capital-deepening in 6 out of 8 specifications in Model I.[3] In Model II 4 out of 16 specifications indicate capital-deepening while 7 out of 16 show raw-material-deepening technical changes. The technical changes in Model III are observed to be generally capital-deepening (with respect to the Free/Leasehold Property Component of capital). However, in Model IV the capital-deepening is with respect to the Plant and Equipments component of capital. The general conclusion to be made with respect to factor-augmenting technical changes is that our results have indicated increasing productivity (or augmentation) of capital in the production process of the U.N.T.L. This finding reinforces the assertion that the production process is capital-intensive.

The U.N.T.L. has been able to install and operate efficiently relatively advanced technology viz plants, machines and equipments through a consistent manpower development programme over the years. Since the early 1970's the firm embarked on training programmes for its Nigerian staff. In 1973, about 500 employees received training, both basic and higher technical

training at recognized educational institutes. In 1975, the company recruited 16 graduates in specialized fields and sponsored 144 employees for training courses both in Nigeria and overseas. By 1979, training designed to up-grade employees by improving their knowledge in their specific fields of responsibility and working techniques was intensified and a substantial fund to finance training programmes was made available. In 1987 the company spent ₦152,570 directly on training and education of its workers in addition, to its contribution to the Industrial Training Fund of ₦284,505. These figures increased in 1982 to ₦249,000 and ₦237,862 respectively. In 1983 more than 400 members of staff, both junior and senior, benefitted from various inplant and outside courses at a cost of ₦181,772.00.

It has been stated by the management that the training benefitted the company in raising efficiency and enhancing profitability, and that it was a systematic and smooth means of transfering operational techniques to Nigerian staff. The company continued to give serious recognition to manpower development and in 1984 Managers, sub-Managers and above 70% of supervisors underwent intensive training in the field of technical, maintenance, financial and industrial management. Likewise, some 350 of the company's

operatives benefitted from training given by Kaduna Polytechnic. While, the sum of ₦304,024 was spent between 1985 and 1986 on both in-plant and external courses, organized by various training institutions, and a total of 760 staff of junior, senior and managerial levels benefitted from the training programme. The foregoing analysis of the firm's training programmes apparently indicates that whatever technical changes observed in the production process of the firm would be labour-deepening. This is contrary to our finding that technical changes are generally capital-deepening. A plausible explanation is that only few Nigerian staff are actually exposed to the acquisition of skilled knowledge in the production departments. Most of the firm's training programmes are usually not aimed at the real production (factory) workers but for staff in managerial capacities. It is also doubtful if the training programmes have really systematically and smoothly transfered operational techniques to Nigerian staff as claimed by the management. Even if this is true repairs and maintenance are usually done by expatriate staff who are employed as engineers and technicians in the firm.

4.2 The Constant Elasticity of Substitution Production Function.

Specification 1

$$\text{Log}\left(\frac{Q}{L}\right) = \log A+(v-1)\log L+v(1-\delta)\log\left(\frac{K}{L}\right)-0.5v\delta\rho(1-\delta)\left[\log\left(\frac{K}{L}\right)\right]^2 + U$$

$$\text{Log}\left(\frac{Q}{L}\right) = -9.01+1.21\log L + 0.93\log\left(\frac{K}{L}\right) - 0.93$$

T-Ratios (-5.81)(15.47) (8.73) (8.73)

$$\left[\log\left(\frac{K}{L}\right)\right]^2 \quad (4.2a)$$

$R^2 = 0.96$ F-Ratio = 155.28

$\bar{R}^2 = 0.95$ Durbin-Watson = 1.73

$v-1 = 1.21$ $v(1-\delta) = 0.93$ $0.5v\delta\rho(1-\delta) = 0.93$

$v = 1.21+1.0$ $2.21(1-\delta)=0.93$ $0.5(2.21)(0.58)(1-0.58)\rho = 0.93$

$v = 2.21$ $2.21-2-21\delta = 0.93$ $0.5(2.21)(0.58)(0.42)\rho = 0.93$

$2.21\delta = 2.21-0.93$

$2.21\delta = 1.28$ $0.27\rho = 0.93$

$\delta = \frac{1.23}{2.21}$ $\rho = \frac{0.93}{0.27}$

$\delta = 0.58$ $\rho = 3.44$

$$\sigma = \frac{1}{1+\rho} = \frac{1}{1+3.44}$$

$$\sigma = \frac{1}{4.44} = 0.23$$

$\sigma = 0.23$

Specification 2.

$$\text{Log}\left(\frac{Q}{L}\right) = \log A+\theta t+(v-1)\log L+v(1-\delta)\log\left(\frac{K}{L}\right) - 0.5v\delta\rho(1-\delta)\left[\log\left(\frac{K}{L}\right)\right]^2 + U$$

$$\text{Log}\left(\frac{Q}{L}\right) = -5.55+0.11t+1.07\log L+0.76\log\left(\frac{K}{L}\right) - 0.76$$

T-Ratios (-1.49)(1.02)(6.72) (3.77) (3.77)

$$\left[\log\left(\frac{K}{L}\right)\right]^2 \quad (4.2b)$$

$R^2 = 0.96$ F-Ratio = 104.22

$\bar{R}^2 = 0.95$ Durbin-Watson = 1.89

$v-1 = 1.07$ $\quad v(1-\delta) = 0.76$ $\quad 0.5v\delta\rho(1-\delta) = 0.76$

$v=1.07+1.0$ $\quad 2.07(1-\delta) = 0.76$ $\quad 0.5(5.07)(0.63)(1-\delta)\rho=0.76$

$v=2.07$ $\quad 2.07-2.07\delta = 0.76$ $\quad 0.5(2.07)(0.63)(0.37)\rho=0.76$

$2.07\delta = 2.07-0.76$ $\quad 0.24\rho = 0.76$

$\delta = \frac{1.31}{2.07}$ $\quad \rho = \frac{0.76}{0.24}$

$\delta = 0.63$ $\quad \rho = 3.17$

$$\sigma = \frac{1}{1+\rho}$$

$$\sigma = \frac{1}{1+3.17}$$

$$\sigma = \frac{1}{4.17}$$

$$\sigma = 0.24$$

The estimated model (i, Version A) has only two specifications. The results in the first specification indicate a high goodness of fit of the regression equation. All the parameter estimates are statistically significant at the 5 per cent level. Our hypothesis on capital-intensity is rejected since the coefficient of labour ($\delta = 0.58$) is greater than the coefficient of capital ($1-\delta = 0.42$). The results also indicate that the firm experiences increasing returns to scale ($v = 2.21 > 1.0$). The third hypothesis is similarly accepted with respect to specification 2 but with caution due to the low t-ratio. The elasticity of substitution ($\sigma = 0.23$) is low thus implying that factor substitution is also low. This finding actually agrees with those of Kazi and Odama (1982. They found that only 16 per cent

of the industries in Nigeria exhibit a high level of substitution of capital and labour. Our finding implies that the textiles industry given its production technique cannot possibly solve the problem of unemployment in Nigeria since with its development capital cannot be substituted for labour. This result further strengthens the main conclusions by Ekuerhare (1978) that the development of the Nigerian textiles industry through import substitution has been extremely socially inefficient, and that there was a very weak correlation between social profitability and private profitability in the industry. We observe that while private profitability encourages the use of capital-intensive method of production social profitability suggests labour-intensive technique of production.

NOTES

1. $0 \leq d < 0.77$ Null hypothesis (H_o) rejected at both the 1 and 5 per cent levels of significance.

   $0.77 < d < 1.00$ H_o rejected at 5 per cent level; test inconclusive at 1 per cent level.

   $1.00 < d < 1.41$ Test inconclusive at both levels.

   $1.41 < d < 1.68$ H_o not rejected at 1 per cent level; test inconclusive at 5 per cent level.

   $1.68 < d \leq 2.00$ H_o not rejected at both levels.

2. See Appendix B Table 8.

3. See Appendix B Tables 9 and 10.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS.

This thesis has examined the issue of the production process of the textiles manufacturing industry with the U.N.T.L. as a case study. We have attempted in this study to provide insights into the production processes of the textiles industry in Nigeria. In doing this, three basic hypotheses were stated and tested using the empirical results of the estimated models. Firstly, we hypothesized that the U.N.T.L. operates a capital-intensive production process. Secondly, that the firm experiences increasing returns to its factors. And thirdly, we hypothesized that the firm enjoys technical efficiency (Hicks-neutral) in its production process. The last hypothesis is aimed at detecting the presence of 'disembodied' capital in the production function of the firm. We have sought, with these hypotheses, to expose among others the production features of the ease of factor substitution (using the C.E.S. function), the scale (parameter) of production and factor-augmentation.

In testing the validity of these hypotheses we have examined four types of model specifications using an econometric approach. These are broadly categorized into "aggregated" and "disaggregated" production functions. The latter specifies output as a function of labour and the components of capital, and raw

material. While the former relates output to labour, a single variable of capital and raw material. Each model has four versions and each version has four and two specifications for the "aggregated" and "disaggregated" production functions respectively. The various categorization and specifications of the models are aimed at exposing their efficacy in examining the production functions of the U.N.T.L.

The first model examined the relationship between output and the conventional inputs - labour and capital. Model II has the same relationship as Model I but raw material is included as the third factor input. The third model examined the technological relationship between output and labour, the components of capital namely, land/leasehold properties, plant and equipments, and capital work-in-progress. Model IV is the same as Model III but raw material is included as the fifth factor input. The "aggregated" production functions are Models I and II while the "disaggregated" production functions are Models III and IV.

We have run fifty regressions in all. Thirty-three of these have R^2 value of 90 per cent and above. Fourteen have $\bar{R}^2$ value of between 54 and 89 per cent. The remaining regressions have R^2 value of 20 per cent and below. These results generally indicate that the estimated models have high goodness of fit. Twenty

three of the regressions have Durbin-Watson statistic which indicates no serial correlation at both the 1 and 5 per cent levels of significance. Thus, in general, the estimated models donot violate the econometric assumption of non-autocorrelation of the stochastic term. Based on these statistical and econometric results Model I particularly Version A has the best fit for the production function of the U.N.T.L. using the Cobb-Douglas function.

From the analysis of the results in chapter four we have observed that the first hypothesis is generally accepted in Model I but rejected in Model II. This rejection in favour of the raw material input is an indication that the manufacturing production in Nigeria particularly in the textiles industry is highly sensitive to the use of raw material. This empirical finding tacitly supports the arguments by Gunilla and Beckman (1985) that the production process in the textiles industry is highly susceptible to fluctuations in the supply of raw material. As stated in chapter one the utilization of industrial capacity i.e. both machines and labour, was adversely affected by the shortages of raw material (cotton lint, chemicals, etc). This neatly ties up with the dependency syndrome in the economy which is more pervasive in the manufacturing sector.

There is a divergence between the results obtained in Model III and Model IV with respect to the coefficients

of capital taken individually and collectively. One startling finding in Model III is that the coefficient of Plant and Equipment variable has a negative sign which is against a priori expectation. The implication is that increases in the level of Plant and Equipments of the firm is translated into decreases in the level of output. A rationalization of this result for proper economic meaning may require the suggestion that the U.N.T.L. has been employing additional Plant and Equipments which are of the old vintage. Old vintage machines may require the use of more labour thus reducing the productivity of the workers. It can also be argued that the existence side by side in the factory of new and old vintage machines where the productivity of the former is higher than the latter is responsible for this result. The results in Model IV are generally an improvement on Model III. The inclusion of raw material as an explanatory variable in the Model could have brought about the improvement.

The results we got from testing the second hypothesis are generally positive. Thus, we can safely conclude that the U.N.T.L. experiences increasing returns to scale. Analysing this result within the context of the study's theoretical background the conclusion that could be made is that the firm's profit has not reached a global maximum. A global maximum

profit is reached only when additional output leads to diminishing returns of the factor inputs. One possible explanation for this result is the absence of perfect competition in the product and factor markets. This situation allows profit to be increased, ceteris paribus, by increasing the level of production. However, the economic crisis situation adversely affects the firm's production level. Increasing returns to scale observed in the production function of the U.N.T.L. could also be due to the presence of technical efficiency which was reported in the preceding chapter.

The results obtained with respect to technical efficiency are generally positive. The results imply that technical efficiency contributes about 47 per cent, at most, to the growth of the firm's output per annum. We have also found that the technical changes (with 'disembodied' capital) are both capital-deepening and raw material-deepening. Capital-deepening is observed in Models I and II where raw material was not included as a variable. The latter is observed in Models III and IV. The implication of these findings is that the productivity of each of the factor input is enhanced overtime.

The estimates of the C.E.S. production function indicate that the firm experiences increasing labour-intensity. Though this result rejects our hypothesis

it validates Liedholm's (1966) finding with respect to some selected industries in Eastern Nigeria. The second hypothesis is accepted. Technical efficiency is not high in this function since it contributes only about 11 per cent per annum to output. This is supported by Kazi and Odama's (1981) findings which indicate that technological progress contributed about 2.46 per cent to the growth of output per annum in selected Nigerian industries.

We have also discovered that the U.N.T.L. exhibits elasticity of substitution less than unity which indicates that the textiles industry lacks the opportunities for the ever widening pool of unemployed labour. This result confirms Maitha's conclusion that the modern industries in developing economies tend to exhibit similar technological features compared to their counterparts in the developed economies. The situation in the textiles industry with respect to factor substitution has worsen since the commencement of the economic crisis at the beginning of this decade. From the interviews with some management staff it was discovered that the U.N.T.L. has been gradually laying-off its production (factory) workers and relying more on the utilization of machine capacity. Our conclusion, therefore, is that the firm has been experiencing increasing capital-intensity since the raw material crisis began early this decade.

Our findings are corroborated by the fact that some factories in the textiles industry have used the economic crisis situation to concentrate work on the remaining work force (Gunilla and Beckman 1987). It has been observed that in one company the number of workers per loom in the weaving section has gone from one operator to 8 machines in 1968 to one to 24 machines in 1985, and further stepped up to one in 36 machines in 1986. The workers have claimed that the output of cloth in the factory has not gone down inspite of a reduction of the work force by over 400 from 1985 to 1986. It has also been reported that, in one of the companies in Kaduna, one overlooker and one assistant on 16 looms plus one weaver and spare weaver on 12 looms in 1982 have been replaced by one overlooker and no assistant on 30-34 looms plus one weaver on 10-12 looms, with no spare weaver in 1987. In another multinational textiles firm in Kaduna, where there was one weaver to 20 looms in early 1987, the company secretary has been reported to say that 40 looms to a worker would be quite possible, if only there was raw materials enough to keep up production at that level. Data on the U.N.T.L. were not made available for this study.

Our findings have generally indicated the acceptance of all the hypotheses. And we conclude that despite

the increasing returns to scale in the face of the raw material crisis the U.N.T.L. has been experiencing increasing capital-intensity. The expected benefits of the import-substitution industrialization strategy with respect to the unemployment problem, sectoral linkages, and transfer of technology have generally not been substantially realized. The raw materials crisis has exposed the dependency of the textiles industry on imported inputs. The crisis has also exposed the increasing capital-intensity in the production process and the worsening of the unemployment problem. The level of technical efficiency (47 per cent) observed with the U.N.T.L. is not high enough for a multinational corporation of its type. This is an indication that most of the multinational corporations which are supposed to be the agents of industrialization do not fulfil their expected role.

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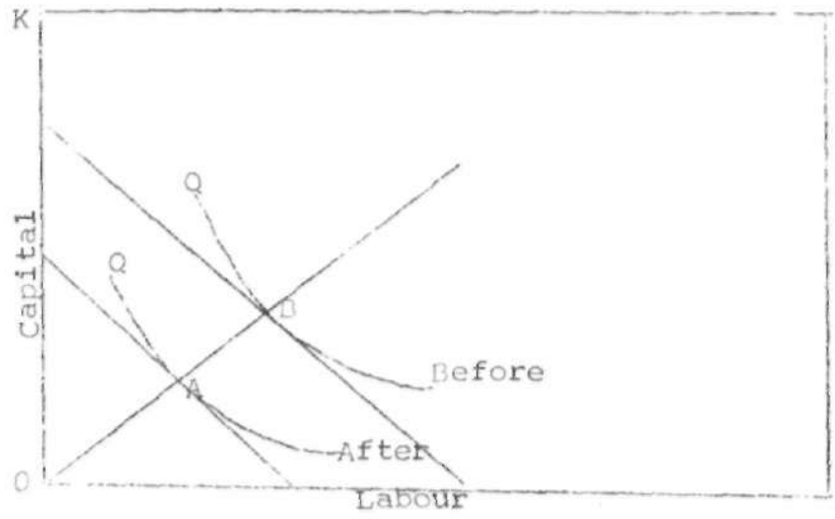
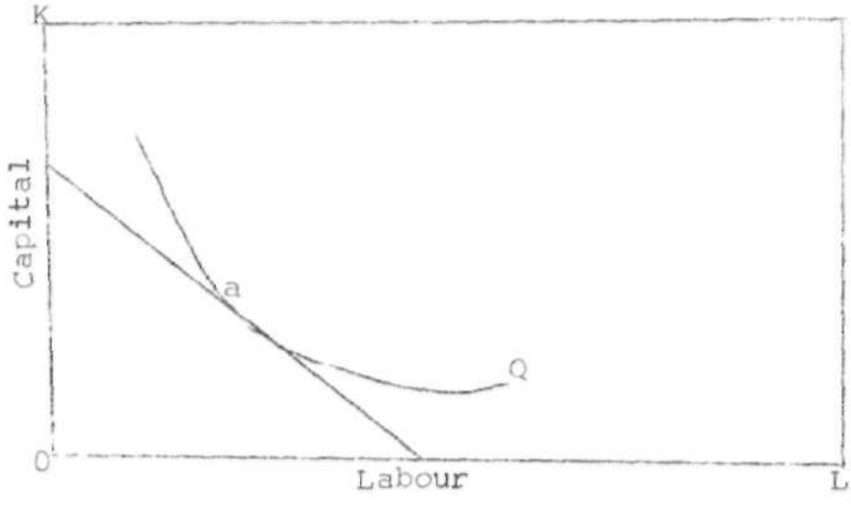


Figure 3: Graphical Illustration of Technical Change



4(i)

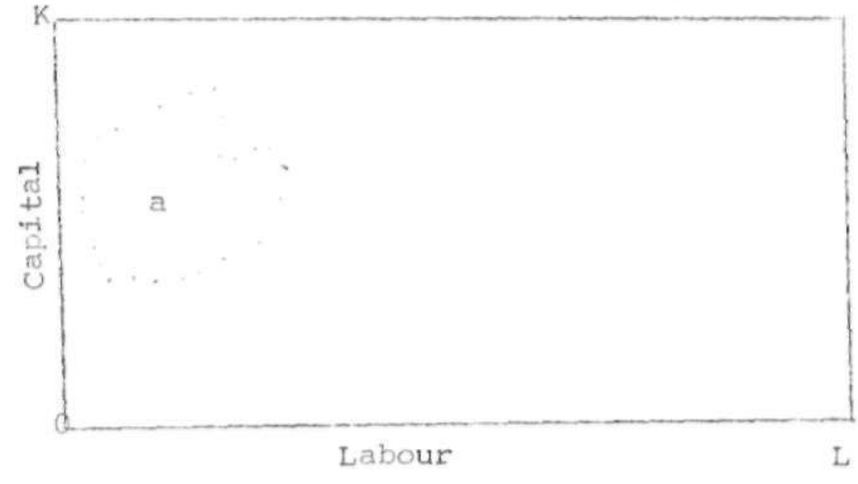


Figure 4(ii) Under-identification

APPENDIX B TABLE 1

The Output and Input Variables of the U.N.T.L. (The Group) Measured In Naira Except for L*

Year	Turnover/Gross Output (Q) ₦'000	Wages & Salaries (L) ₦'000	Capital Employed (K) ₦'000	Raw Materials & Services (R) ₦'000	Number of Employees (L*)	Value-Added (Q) ₦'000
1971	44,956	18,225	16,201	48,682*	4817*	26,648*
1972	35,385	18,225*	16,958	48,682*	4817*	26,648*
1973	41,153	18,225*	16,889	48,682*	4666	26,648*
1974	49,595	18,225*	16,923	48,682*	4775	26,648*
1975	67,301	18,225*	21,399	48,682*	5474	26,648*
1976	70,363	18,225*	26,185	48,682*	5734	26,648*
1977	67,166	12,236	28,534	48,519	6000	18,647
1978	68,231	16,142	33,560	41,898	7282	26,333
1979	108,087	23,267	35,598	69,383	8074	38,704
1980	136,222	33,996	43,687	92,359	7522	43,863
1981	139,813	27,788	51,606	101,391	6562	38,422
1982	153,743	39,428	58,617	102,273	4817*	51,470
1983	138,582	39,775	47,991	85,094	4817*	53,488
1984	142,912	40,276	46,905	81,333	8474	61,579
1985	175,193	40,464	54,664	107,977	7690	67,216
1986	211,517	37,968	66,240	137,286	7621	77,925

Source: Annual Report And Statement of The U.N.T.L., Kaduna for various years.

L* - number of workers in the firm during the year.

* - The mean value for the whole period (observations) substituted for missing observations.

APPENDIX B TABLE 2

The Fixed Assets of the U.N.T.L. (The Group) And The Netbook Values

	Freehold Land & Leasehold Properties (FP), Cost (C1) in ₦	Furniture & Fittings, Plants, Machinery, Equipment & Vehicles (PE) Cost (2) in ₦	Capital Work-in-Progress C, Cost (C2) in (₦'000)	Netbook Value (V2) ₦	Netbook Value (V2) ₦	Netbook Value (V3) ₦	Total Cost C1+C2+C3	Total Book Value V1+V2+V3
1971	17,329,505*	32,091,153*	1,517*	13,325,779*	1,496,956*	1,531,123*	50,937,457*	31,669,791*
1072	17,329,505*	32,091,153*	1,517*	5,895,574	7,075,000	2,148, 38	50,937,457*	13,185,412
1973	7,259,610	13,236,914	1,517*	5,608,921	6,590,303	1,531,123*	20,496,524	12,199,224
1974	17,329,505*	32,091,153	1,517*	5,316,010	5,887,735	1,531,123*	50,937,457*	11,203,745
1975	7,324,902	14,562,016	1,517*	4,957,862	5,236,929	1,531,123*	21,886,918	10,194,791
1976	7,818,055	17,193,362	1,517*	5,085,319	6,892,377	1,531,123*	25,011,417	11,977,696
1977	8,077,000	19,808,000	9,400	4,952,000	7,968,000	9,400,000	37,285,000	22,320,000
1978	14,455,000	34,445,000	1,707	10,944,000	20,207,000	1,707,000	50,607,000	32,858,000
1979	17,335,000	34,248,000	1,517	13,024,000	17,770,000	1,531,123*	51,583,000	30,794,000
1980	19,557,000	39,785,000	1,191	14,351,000	20,860,000	1,191,000	60,533,000	36,402,000
1981	24,330,000	50,169,000	1,018	18,212,000	28,511,000	1,018,000	75,517,000	47,741,000
1982	37,447,000	60,336,000	516	29,696,000	35,570,000	516,000	98,299,000	65,782,000
1983	39,690,000	62,737,000	1,763	29,825,000	32,825,000	1,763,000	104,190,000	64,547,000
1984	37,625,000	65,062,000	1,228	26,247,000	29,150,000	1,228,000	103,915,000	56,625,000
1985	39,024,000	69,785,000	5,929	25,638,000	27,650,000	5,929,000	114,738,000	59,217,000
1986	43,895,000	75,141,000	3,081	28,293,000	26,572,000	3,081,000	122,117,000	57,946,000

Source: The AnnualReport and Accounts of the U.N.T.L., Kaduna for various years.

* - The mean value for the whole period (observations) substituted for missing observations.

APPENDIX B TABLE 3

Statement of Value-Added of the U.R.T.L., Kaduna

	Gross Sales of Products + other Income Rec. (o) (₦'000) 1	Purchases & Services i.e. Raw Materials (R) (₦'000) 2	Salaries, Wages, ensions & Soc. Benefits i.e. Cost of Labour (L) (₦'000) 3	Total Cost (TC) (2+3) (₦'000)	Income Tax Payable (₦'000)	Profit After Taxation (1-4-5) (₦'000)	Value-Added (1-2) (₦'000)	Capital Employed (₦'000)
1971	44,956	48,682*	18,225*	66,907*	1,899*	2,409*	26,648*	16,201
1972	35,385	48,682*	18,225*	66,907*	1,899*	2,409*	26,648*	16,958
1973	41,153	48,682*	18,225*	66,907*	1,899*	2,409*	26,648*	16,889
1974	49,595	48,682*	18,225*	66,907*	1,899*	2,409*	26,648*	16,923
1975	67,301	48,682*	18,225*	66,907*	1,899*	2,409*	26,648*	16,399
1976	70,363	48,682*	18,225*	66,907*	1,899*	2,409*	26,648*	21,399
1977	67,166	48,519	12,236	60,755	2,250	1,305	18,647	28,534
1978	68,231	41,898	16,142	58,040	1,290	5,168	26,333	33,560
1979	108,087	69,383	23,267	92,650	4,158	5,934	38,704	35,598
1980	136,222	92,359	33,996	126,355	1,641	2,680	43,863	43,687
1981	139,813	101,391	27,788	129,179	2,299	2,441	38,422	51,606
1982	153,743	102,273	39,428	141,701	3,127	1,006	51,470	58,617
1983	138,582	85,094	39,775	124,869	2,203	175	53,488	47,991
1984	142,912	81,333	40,276	121,609	3,441	6,627	61,579	46,905
1985	175,193	107,977	40,464	148,441	7,375	10,797	67,216	54,664
1986	211,317	137,280	37,968	175,254	11,018	19,279	77,925	66,240

Source: Annual Report and Accounts of the U.N.T.L., Kaduna for various years.

* - The mean value for the whole period (observations) substituted for missing observations.

APPENDIX B TABLE 4

Output-Labour Ratio, Capital-Labour Ratio And Raw Material-Labour Ratio

Year	Q/L**	Q/L	K/L**	K/L	R/L**	R/L	V/L**	V/L
1971	1,333*	2,467*	3,363*	889*	10,106*	2,671*	5,532*	1,462*
1972	7,346*	1,942*	3,520*	930*	10,106*	2,671*	5,532*	1,462*
1973	8,820	2,258*	3,620	927*	10,433*	2,671*	5,711*	1,462*
1974	10,386	2,721*	3,544	929*	10,195*	2,671*	5,581*	1,462*
1975	12,295	3,693*	3,909	1,174*	8,893*	2,671*	4,868*	1,462*
1976	12,271	3,861*	4,567	1,437*	8,490*	2,671*	4,647*	1,462*
1977	11,194	5,489	4,756	2,332	8,086	3,965	3,108	1,524
1978	9,370	4,227	2,609	2,079	5,754	2,596	3,616	1,631
1979	13,387	4,645	4,409	1,530	8,593	2,982	4,794	1,663
1980	18,110	4,007	5,808	1,285	12,278	2,717	5,831	1,290
1981	21,306	5,031	7,864	1,857	15,451*	3,649	5,855	1,383
1982	31,917*	3,899	12,169*	1,487	21,232*	2,594	10,685*	1,305
1983	28,769*	3,481	9,963*	1,207	17,665*	2,139	11,104*	1,345
1984	16,805	3,548	5,535	1,164	9,598	2,019	7,267	1,529
1985	22,782	4,330	7,108	1,351	14,041	2,668	8,741	1,661
1986	27,728	5,566	8,692	1,745	18,014	3,616	10,225	2,052

Source: Computedfrom Appendix B Table 1
* - Computed using the mean value for the missing observation
** - The number of employees in the firm
Q - The gross output (or turnover) of the firm
V - Is the value-added of the firm

APPENDIX B TABLE 5

Time Series Estimates of Cobb-Douglas Production Functions the U.N.T.L.Case*

Model	Version	Specification	A	α	β	t	$\alpha+\beta$	R^2	$\bar{R}^2$	D-W
I	A	1	-2.59	0.93	0.28	-	1.21	0.96	0.95	1.73
			(-1.94)	(8.72)	(2.16)					
		2	-0.32	0.76	0.32	0.11	1,08	0.96	0.95	1.89
			(-0.12)	(3.77)	(2.34)	(2.34)	(1.02)			
		3	0.33	1.08	-	-	-	0.90	0.89	1.52
			(0.40)	(11.38)						
		4	1.38	0.94	-	0.10	-	0.91	0.90	1.62
			(1.21)	(6.42)		(1.28)				
I	B	1	-1.44	1.08	0.12	-	1.20	0.95	0.94	1.58
			(-0.95)	(11.71)	(0.57)					
		2	-0.56	1.04	0.10	0.04	1.14	0.95	0.93	1.59
			(-0.16)	(5.43)	(0.46)	(0.28)				
		3	1.55	0.92	-	-	-	0.79	0.77	1.20
			(1.68)	(7.2)						
		4	2.96	0.69	-	0.15	-	0.87	0.85	0.89
			(3.36)	(5.31)		(2.96)				
	C	1	0.25	0.12	0.89	-	1.01	0.94	0.93	0.73
			(0.20)	(1.18)	(7.23)					
		2	1.63	0.08	0.85	0.03	0.93	0.89	0.86	1.51
			(0.50)	(0.28)	(4.54)	(0.25)				
		3	2.99	0.67	-	-	-	0.55	0.52	0.68
			(2.15)	(4.13)						
		4	1.17	0.92	-	-0.17	-	0.60	0.54	0.88
			(0.60)	(3.70)		(-1.31)				

APPENDIX B TABLE 5 CONTINUED

Model	Version	Specification	A	α	β	t	$\alpha+\beta$	R^2	$\bar{R}^2$	D-W
	D	1	5.5 (1.99)	0.71 (4.20)	-0.04 (-0.10)	-	0.67	0.68	0.63	0.65
		2	1.56 (0.25)	0.92 (2.68)	0.3 (0.09)	-0.16 (-0.71)	0.95	0.69	0.61	0.72
		3	6.46 (9.31)	0.12 (1.23)	-	-	-	0.10	-0.03	0.72
		4	14.27 (13.52)	-0.84 (-7.17)	- -	-0.77 (-7.31)	- -	0.89	0.87	0.78

Source: Compiled from the Computer Print-Out of the Estimated Models.

* - T-rations are in parentheses.

APPENDIX B TABLE 6

Time Series Estimates of Cobb-Douglas Production Functions: The U.N.T.L. Case*

Model	Version	Specification	A	α	β	δ	t	$\alpha+\beta+\delta$	R^2	$\bar{R}^2$	D-W
II	A	1	-3.48	0.84	0.14	0.27	-	1.25	0.96	0.95	1.51
			(-2.27)	(6.26)	(0.79)	(1.15)					
		2	-0.39	0.52	0.12	0.40	0.16	1.04	0.97	0.96	1.75
			(-0.16)	(2.2)	(0.73)	(1.69)	(1.60)				
		3	-0.41	0.93	-	0.22	-	1.15	0.91	0.90	1.38
			(-0.39)	(5.78)		(1.14)					
		4	0.93	0.35	-	0.56	0.23	0.91	0.95	0.94	1.75
			(1.03)	(1.58)	-	(3.10)	(3.15)				
	B	1	-4.71	0.74	0.22	0.45	-	1.41	0.97	0.96	1.50
			(-2.69)	(5.0)	(1.30)	(2.67)					
		2	-1.65	0.48	0.18	0.55	0.15	1.21	0.97	0.96	1.77
			(-0.62)	(2.08)	(1.06)	(3.14)	(1.47)				
		3	1.56	0.92	-	-0.002	-	0.92	0.79	0.76	1.20
			(0.87)	(5.62		(-0.007)					
		4	1.19	0.47	-	0.41	0.19	0.88	0.90	0.87	1.77
			(0.93)	(2.79)		(1.79)	(3.66)	1.03	0.94	0.92	0.79
	C	1	-0.41	0.05	0.78	0.20	-				
			(-1.46)	(0.38)	(4.56)	(0.89)					
		2	-1.31	-0.04	0.41	0.69	0.007	1.06	0.96	0.94	2.33
			(-0.57)	(-0.20)	(2.42)	(3.95)	(0.07)				
		3	-0.04	0.06	-	0.89	-	0.95	0.79	0.75	1.38
			(-0.05)	(0.29)		(3.79)					
		4	0.37	-0.12	-	0.99	0.07	0.87	0.79	0.74	1.42
			(0.25)	(-0.33)		(3.31	(0.58)				

APPENDIX B TABLE 6 CONTINUED

Model	Version	Specification	A	α	β	δ	$t_{\alpha\beta\delta}$	R^2	$\bar{R}^{-2}$	D-W
II	D	1	-1.45 (-0.51)	-0.02 (-0.06)	0.19 (0.68)	0.97 (3.51)	- 1.14	0.84	0.80	1.43
		2	-0.44 (-0.09)	-0.10 (-0.26)	0.18 (0.59)	1.0 (3.25)	0.05 (0.28) 1.08	0.84	0.78	1.46
		3	5.57 (4.25	0.06 (0.50)	-	0.16 (0.81)	- 0.22	0.14	0.008	0.75
		4	5.51 (4.08)	-0.01 (-0.07)	-	0.23 (0.97)	0.23 (0.57) 0.22	0.16	-0.05	0.82

Source: Occupiled from the Computer Print-out of the Estimated Models.

* - T-ratios are in parentheses.

APPENDIX TABLE 7

Time Series Estimates of Cobb-Douglas Production Functions: The U.N.T.L. Case*

Model	Version	Specification		β	α_1	α_2	α_3		$\beta\ \alpha_1\ \alpha_2\ \alpha_3$	R^2	$\bar{R}^2$	D-W
III	A	1	-14.83 (-3.77)	1.72 (5.71)	-2.35 (-3.63)	2.39 (3.63)	0.11 (1.26)	-	1.87	0.90	0.86	2.04
		2	10.72 (3.13)	0.38 (0.98)	0.68 (1.01)	-0.45 (-0.57)	-0.02 (-0.20)	0.47 (4.55)	0.59	0.91	0.86	1.81
	B	1	0.20 (0.05)	1.21 (2.10)	0.86 (0.76)	-0.39 (-0.30)	-0.004 (-0.03)	-	1.68	0.71	0.61	1.21
		2	10.73 (3.14)	0.38 (0.98)	0.68 (1.01)	-0.45 (-0.57)	-0.02 (-0.2)	0.47 (4.56)	0.59	0.91	0.86	1.81
	C	1	-0.97 (-0.49)	0.93 (6.13)	0.08 (0.26)	-0.004 (-0.01)	0.09 (1.96)	-	1.06	0.95	0.94	1.79
		2	1.07 (0.28)	0.81 (3.45)	0.28 (0.62)	-0.20 (-0.43)	0.01 (1.63)	0.05 (0.65)	0.90	0.95	0.93	1.70
	D	1	6.40 (4.13)	0.97 (4.59)	2.17 (5.21)	-1.96 (-3.99)	0.02 (0.29)	-	1.20	0.93	0.90	1.77
		2	9.55 (5.80)	0.73 (3.88)	2.12 (6.49)	-1.98 (-5.16)	0.01 (0.28)	0.14 (2.83)	0.88	0.96	0.94	2.16

Source: Compiled from Computer Print-Out of the Estimated Models.

* - T-ratios are in parentheses.

APPENDIX B TABLE 8

Time Series Estimates of Cobb-Douglas Production Functions: The UNTL Case*

Model	Version	Specification	A	β	α_1	α_2	α_3	δ	t $B_{x_1 x_2}$	R^2	R^{-2}	D-W
IV	A	1	-14.58 (-4.29)	1.06 (2.65)	-1.96 (-3.33)	1.95 (3.22)	0.06 (0.74)	0.72 (2.18)	-	1.83	0.93	0.90	1.52
		2	-2.72 (-0.59)	0.46 (1.31)	-0.85 (1.50)	0.88 (1.54)	0.01 (0.20)	0.63 (2.59)	0.27 (3.05)	1.13	0.97	0.94	1.90
	B	1	-9.49 (-2.77)	0.52 (1.34)	-0.46 (-0.61)	0.53 (0.62)	-0.02 (-0.22)	1.22 (4.35)	-	1.79	0.90	0.85	0.92
		2	0.98 (0.28)	0.22 (0.82)	-0.11 (-0.21)	0.16 (0.29)	-0.02 (-0.39)	0.79 (3.66	0.31 (3.85)	1.04	0.96	0.94	1.73
	C	1	-0.92 (-0.45)	0.80 (3.37)	0.16 (0.45)	-0.09 (-0.24)	0.08 (1.62)	0.14 (0.70)	-	1.09	0.96	0.93	1.81
		2	0.89 (0.23)	0.71 (2.40)	0.33 (0.69)	-0.25 (-0.53)	0.07 (1.37)	0.12 (0.61)	0.04 (0.56)	0.98	0.96	0.93	1.75
	D	1	3.06 (2.18)	0.74 (4.62)	1.71 (5.49)	-1.64 (-4.71)	0.01 (0.28)	0.42 (3.64)	-	1.24	0.97	0.95	2.60
		2	5.69 (2.77)	0.66 (4.27)	1.80 (6.14)	-1.73 (-5.31)	0.01 (0.28)	0.31 (2.48)	0.08 (1.65)	1.05	0.98	0.96	2.93

Source: Compiled from the Computer Print-Out of the Estimated Models

* - T-ratios are in parentheses.

APPENDIX B TABLE 9

*Estimates of Factor-Intensity and Scale Parameter for Models I and II

Model	Version	Specification	α/δ	α/β	δ/β	α	β	δ
I	A	1	3.32			1.21	-	-
		2	2.38	-		1.08	-	-
	B	1	9.0	-		1.20	-	-
		2	10.4	-		1.4	-	-
	C	1	0.13	-		1.01	-	-
		2	0.09	-		0.93	-	-
	D	1	17.75	-		0.67	-	-
		2	3.07	-		0.95	-	-
II	A	1		6.0	1.93	-	1.25	-
		2		4.33	3.3	-	1.04	-
		3	4.23	-	-	-	1.15	-
		4	0.63	-	-	-	0.91	-
	B	1	-	3.36	2.0	-	1.41	-
		2	-	2.67	3.10	-	1.21	-
		3	4.60	-	-	-	0.92	-
		4	1.45	-	-	-	0.88	-
	C	1	-	0.06	0.26	-	1.03	-
		2	-	0.10	1.68	-	1.06	-
		3	0.07	-	-	-	0.95	-
		4	0.12	-	-	-	0.87	-
	D	1	-	0.11	5.11	-	1.14	-
		2	-	0.56	5.56	-	1.08	-
		3	0.4	-	-	-	0.22	-
		4	0.04	-	-	-	0.22	-

*Computed from Appendix B Tables 5 and 6

APPENDIX B TABLE 10

*Estimates of Factor-Intensity and Scale Parameters for Models III and IV

Model	Version	Specification	α_1/β	α_2/β	α_3/β	δ/β	α_1	α_2	α_3	β	δ
III	A	1	1.37	1.39	0.06	-	1.87				
		2	1.79	-1.18	0.05	-	0.59				
	B	1	0.71	0.32	-0.003	-	1.68				
		2	1.79	-1.18	0.05	-	0.59				
	C	1	0.09	-0.004	0.10	-	1.06				
		2	0.35	0.25	0.01	-	0.90				
	D	1	2.24	-0.02	0.02	-	1.20				
		2	2.90	-2.71	0.014	-	0.88				
IV	A	1	-1.85	1.84	0.06	0.68	1.83				
		2	-1.85	1.91	0.02	1.37	1.13				
	B	1	-0.88	1.02	-0.04	2.35	1.79				
		2	-0.5	0.72	-0.10	3.59	1.04				
	C	1	0.2	-0.11	0.10	0.18	1.09				
		2	0.46	-0.35	0.10	0.17	0.98				
	D	1	2.31	-2.22	0.01	0.57	1.24				
		2	2.73	2.62	0.02	0.47	1.05				

*Computed from Appendix B Tables 7 and 8.

APPENDIX B TABLE 11

Raw Material Supply for Textile Industry: Fibres and Yarns 1972/73 to 1981/82 (Tonnes).

	Cotton Lint			Man-made Fibre	Yarns Imported		
Year	Domestic Production	Exported	Imported	Imported	Cotton	Man-made	Total Yarns
1973	48500	5500	300	1800	2200	16400	20200
1974	31000	15000	8190	10600	1200	16400	19400
1975	5120	-	20000	6300	4400	32100	39300
1976	58400		3640	n.a	6900	34100	47300
1977	80400	19700	-	n.a	300	41200	53700
1978	37100	18200	-	n.a6	23000	66900	98000
1979	36300	-	200	2500	20100	58900	83300
1980	28500	n.a	n.a	n.a	n.a	n.a	n.a
1981	26400	-	15700	1800	19400	55400	79900
1982	20700	-	23000	4700	10100	18300	32700
1983	19200	-	25800	5200	n.q	n.a	n.a

Source: Andrae, G. and Bechman, B. (1985), Industry Goes Farming: The Nigerian Raw Materials Crisis and the Case of Textiles and Cotton', A Paper Presented At the Seminar on Nigerian Economy and Society Since The Berlin Conference: 1884-1985,A.B.U.,Zaria,11th to 15th November, 1985.

n.a Not Available .