TECHNOLOGICAL PROGRESS IN THE NIGERIAN TOBACCO COMPANY, ZARIA

(A PRODUCTION FUNCTION APPROACH)

BY

ABDULSALAM SIKIRU ABIDEMI
B.SC (HONS) (ECON) A.B.U., 1991

A THESIS SUBMITTED TO THE
POSTGRADUATE SCHOOL
AHMADU BELLO UNIVERSITY, ZARIA

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR
THE AWARD OF MASTER OF SCIENCE DEGREE IN ECONOMICS
DEPARTMENT OF ECONOMICS
FACULTY OF ARTS AND SOCIAL SCIENCES
AHMADU BELLO UNIVERSITY
ZARIA, NIGERIA.

SEPTEMBER, 1996.

CERTIFICATION

This thesis titled, "TECHNOLOGICAL PROGRESS IN THE NIGERIAN TOBACCO COMPANY, ZARIA, A PRODUCTION FUNCTION APPROACH" by ABDULSALAM SIKIRU ABIDEMI, meets the regulations governing the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

Dr(Mrs) P.S. Aku
Chairperson, Supervisory Committee

22-9-97
Date

Omte Diachavbe
Omte Diachavbe
Member, Supervisory Committee

22-9-97
Date

Professor J.Olayemi
Dean of Postgraduate School

24/9/98
Date

External Examiner

Date

DECLARATION

I hereby declare that the whole of the work now submitted for the Master of Science Degree (Economics) of Ahmadu Bello University, Zaria is the result of my own research and has not been part of my presentation for my other certificate. References are made to published literatures and are duly acknowledged.

ABDULSALAM SIKIRU ABIDEMI

COPYRIGHT STATEMENT

All rights reserved. No part of this publication may be reproduced, stored in a retrievable system, or transmitted in any form or by any means without the prior written permission of the author.

DEDICATION

This work is dedicated to my late Mum (Mrs) Funke Abdulsalam, my sisters and brothers and my Fiancee, Mallama Nafisatu Abdulsalam.

ACKNOWLEDGEMENTS

I wish to express my gratitude to God for giving me the ability to begin and successfully complete the M.Sc degree programme in Economics.

I acknowledge the very honest guidance and understanding received from my major supervisors, Dr.(Mrs) P.S. Aku and Mr. Omte Diachavbe. They have both made possible the completion of this work in record time.

I extend my sincere gratitude to my brothers and sisters, Mallama Abiola, Mallama Oyebola Ajiboye, Mal. Surajudeen, Mal. Fatah, Mal. Abdulrasak, Mallama Mariam, Mal. Husseni and Mallama Ronti, for their moral and all support. May God reward them abundantly. I express same appreciation to all my friends who have shown goodwill to me.

Acknowledgements are also due to all my lecturers and colleagues in the department who have rendered assistance in the successful completion of the work. My special thanks goes to Mr. Titus Awogbemi for his encouragement and assistance during the course of this work.

I also acknowledge with appreciation the goodwil from all my colleagues in the Postgraduate class. I am also grateful for the understanding and affection shown by Mallama Nafisatu Abdulsalam.

My gratitude goes also to Miss Bola Olagunju for her tolerance and good humour in typing during her spare time.

Finally, I appreciate the assistance of the staff of the N.T.C. Zaria particularly Mr. Evans Uwah and Mr. K. Oyekunmi.

I accept responsibility for errors either by ommision or commission in this thesis.

ABDULSALAM SIKIRU ABIDEMI

SEPTEMBER, 1996

ABSTRACT

This thesis investigates the level of technological progress in the Nigerian Tobacco Company, Zaria. We adopt the production function approach in assessing productivity of inputs, factor substitution, technological process and efficiency in the firm.

Three hypotheses are proposed and verified. First, we hypothesize that the Nigerian Tobacco Company has over time experienced low rate of technological progress. Second, we postulate that output level in the firm depends on the import level of cigarette-making machinery . Third, we posit that the capacity of the firm to import machinery inputs and chemicals is dependent on the import capacity of the Nigerian economy. The econometric approach is applied to verify these hypotheses.

The results show that the Nigerian Tobacco Company, Zaria, witnessed virtually no technological progress during the period under review, a reflection partly of inadequate Research and Development (R & D) activities in the firm, and partly of the fledgling state of the capital-goods sector of the Nigerian economy. Furthermore, given that the Nigerian Tobacco Company is heavily dependent on the importation of machinery, chemicals and other inputs, its access to limited foreign exchange has been a determining factor in its technological progress.

TABLE OF CONTENTS

Title Page..... i

Certification..... ii

Declaration..... iii

Copyright Statement..... iv

Dedication..... v

Acknowledgement..... vi

Abstract..... vii

Table of Contents..... ix

List of Tables..... xii

Definition of Terms..... xiii

CHAPTER ONE

1.0 Introduction..... 1

1.1 Statement of Problem..... 3

1.2 Research Objectives..... 5

1.3 Research Hypothesis..... 5

1.4 Justification..... 6

1.5 Outline of Chapters..... 7

CHAPTER TWO

2.0 Literature Review..... 8

2.1 Theoretical Literature Review..... 8

2.1.1 Concept of Technology..... 8

2.1.2 Conditions for Appropriate Technology.... 11

2.1.3 Problems of Appropriate Technologies Less Developed Countries..... 14

2.1.4 Measurement of Technological Progress... 16

2.1.5 Microeconomic Theory of Technological Progress..... 18

2.1.6	Cobb-Douglas Production Function.....	19
2.1.7	Constant Elasticity of Substitution.....	22
2.1.8	Classification of Technological Progress.....	23
2.1.9	How Societies Progress Technologically...	24
2.2	Empirical Literature.....	27

CHAPTER THREE

3.0	Research Methodology.....	37
3.1	Brief History od NTC Zaria.....	39
3.2	Growth Performance.....	39
3.3	Contributions to the Economy.....	41
3.3.1	Agricultural Activities.....	41
3.3.2	Employment.....	41
3.3.3	Manpower Training and Development.....	42
3.3.4	Linkage Effects.....	42
3.3.5	Efforts to reduce foreign exchange outflow.....	43
3.4	Cigarette Production Processes.....	44
3.4.1	Green Leaf Threshing.....	45
3.4.2	Pregrading.....	45
3.4.3	Threshing Processing.....	46
3.4.4	Redrying.....	46
3.4.5	Prizing.....	46
3.5.6	Primary Manufacturing.....	47
3.5.7	Lamina Processes.....	47
3.5.8	Stem Processes.....	49
3.5.9	Final Handling.....	50
3.5.10	Secondary Manufacturing Processes....	50
3.5.11	Cigarette Making.....	50

3.5.12 Cigarette Packing..... 52
3.5 Methodology..... 53
3.5.1 The Models Specification..... 53
3.6 Sources of Data..... 56
3.7 Limitation of the Study..... 57

CHAPTER FOUR

4.0 Zaria Case Study..... 58
4.1 Test of Hypothesis..... 60
4.1.1 Model 1..... 60
4.1.2 Model 2..... 62
4.1.3 Model 3..... 63
4.1.4 Model 4..... 64
4.2 Estimated Model..... 65
4.3 Returns to Scale..... 70
4.4 Policy Implications of the Observed Technological Progress..... 71

CHAPTER FIVE

5.0 Summary of the Main Conclusions..... 76
Bibliography..... 81
Appendix I..... 88
Appendix II..... 89
Appendix III..... 90
Appendix IV..... 92
Appendix V..... 93

LIST OF TABLES

3.1 Analysis of Stock Holders of NTC..... 39

4.1 Labour and Capital Variables with their Regression Coefficients and t-ratios..... 60

4.2 Capital, Labour and Raw Materials variables with their regression coefficients and t-ratios..... 61

4.3 Variables Wage rate and Time Factor with their regression coefficients and t-ratios..... 62

4.4 Variable investment on import in the past with coefficient and t-ratio..... 63

4.5 Variable external reserve with regression coefficient and t-ratio..... 64

4.6 Regression Results for Cobb-Douglas Production Function..... 66

4.7 Regression Results for Constant Elasticity of Substitution Production Function..... 68

4.8 Regression Results for Import Dependency (Model III)..... 69

4.9 Regression Results for Import Dependency (Model IV)..... 70

4.10 Returns to Scale..... 71

DEFINITION OF TERMS

ADJUSTED R (also known as R bar squared) - The coefficient of determination adjusted for degrees of fredom. While it is not possible for the unadjusted R 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.

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

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

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

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

ASSET - An entity possessing market ot exchange value, and

forming part of the wealth or property of the owner.

BUTTS - Unburned end of a smoked cigarette.

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 taht 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 factor. 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 STOCK - Refers to the aggregate capital goods in a firm, an industry of 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.

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

ECONOMIC 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 hypothesis, 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 imputs.

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

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 utilisation below that considered normal.

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

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.

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.

HOPPER - Structure like an inverted cone or pyramid used to

feeding materials into a machine.

INDUSTRY - An industry withinthe 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 homogenous 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.

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 use is greater in A than in B.

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.

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 of there are a large number of firms each with an insubstantial share of the market producing a homogenous product, using identical production processes possessing perfect information and normal profits.

PLUG - Cake of pressed or twisted tobacco.

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 & 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 development of existing products and production processes.

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 ommited from the equation.

STANDARD ERROR - A measure of the degree to which an 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.

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 methos 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.

CHAPTER ONE

1.0 INTRODUCTION

It is generally acknowledged that technological progress influences development and that through it real income levels rise with concomitant positive effects on living standards. Technological changes are also believed to minimize the inflationary pressures which reduce industrial production costs. (Nwana, 1989). Technological progress is thus a most important aspect of industrialization and economic development. Indeed, a popular view in the literature (Todaro, 1977) holds that the differences between the developed and less developed countries are attributable to differences in their respective levels of technological development, and that the nature of the technology being used in the less-developed countries (LDCs) account largely for their underdevelopment.

The approach to technology development in Nigeria over the years has been that of application of foreign technology without any form of adaptation to local environment. The argument was that import substitution is typically a way of filling the gap between the domestically available supplies of foreign exchange, government revenue and skills to achieve developmental target. Secondly, that the strategy often brings along sophisticated technological knowledge about production processes while transferring modern machinery and equipment to poor third world

countries, such transfer are assumed to be both desirable and productive to the recipient nations.

Experience and analysis have taught key lessons about the nation's dependence on foreign technology. The first and perhaps most apparent (as evidenced by most transnational corporations) is that most investments by the transnational simply reallocate facilities without transferring the important element of technology required to make a project successful. This in fact are mostly transplanted in a package.

Secondly, the technology package is in such a form that call for mere robot-like activities and as a result, the human skills of the indigenous people are required merely for routine activities.

Thirdly, that the important technology especially in the industrial sector, imported for the purpose of industrial development, seems to be quite inappropriate. This import has been geared towards a particular simple consumer market without utilization or development of local resources.

Furthermore, there is a severe drain of the country's foreign exchange for the procurement of technologies which are often not suitable for our socio-economic environment and for good which could be alternatively produced with less expensive technologies. The foreign exchange drain arises from the payments of technological package themselves and for the importation of finished product which have been induced by acquired targets.

Therefore, the adoption of this strategy in Nigeria led to poor sectoral linkages in the economy. Moreso, the inputs used such as machinery, spare-parts and raw materials are foreign exchange consuming and thus, have little impact on other sectors of the economy.

The research work attempt to assess technological progress in the Nigerian Tobacco Company, Zaria, showing clearly the relevance or otherwise of technology to development.

1.1 STATEMENT OF PROBLEM

Theories designed to fit the special conditions of the western world often face difficulties when used in the study of less developed countries. This is due to a number of reasons. First, the practicability of the theories which usually is impossible in the less developed countries. Secondly, the models of such theories often seem to be complex and not easily amenable to simple estimation procedures. Thirdly, the time and finance required are usually not affordable by interested researchers. These explain why empirical efficiency has been limited in the less developed societies. In Nigeria, attempts in this direction are quite few and scanty and have been limited to aggregate level only. Little attempt exists for the examination of the technical efficiency of a firm.

Basically, most discussions on Nigeria's technological progress tend to ascribe an important role to private

foreign investment. The Nigerian Tobacco Company is a typical example of transnational corporation where the country depends not only on technology, but also on raw material inputs from the developed countries. These inputs include cigarettes, papers, cork tipping, aluminium foil, bounded paper, etc. (Annual Report, 1992). This trend has intensified overtime and has made the development of the Nigerian Tobacco Company almost reliant on the external sector. Reliance on the external sector for the development of the company implies neglect of whatever technological progress that has been achieved in the traditional economy. This situation as well as declining foreign exchange, crude oil price and a fall in oil demand, coupled with the country's heavy debt commitments, have over time reduced the already limited credit available for the import of essential raw materials for the firm.

These inabilities forced the company to grow below 50% of its capacity utilization and seriously affected the company's machinery modernization programmes.

These number of reasons have been said to be responsible for the escalation of market prices of cigarettes, closing down of the NTC, Ibadan branch and hence, the recent call to retrench a handful of the workers of the only surviving NTC, Zaria (Annual Report, 1994).

The questions then arise:

a. Has there been any meaningful technological progress in the company since its inception?

b. If yes, to what extent has it helped in the development of the company?

c. If no, does this have any negative impact on the development of the company?

These and other similar questions shall be verified using production function.

1.2 RESEARCH OBJECTIVE

The objective of this study is to evaluate the effect of technological progress in the Nigerian Tobacco Company, Zaria between 1980 and 1994.

It is in this light that the study seeks:

1. To establish the production functions of the Nigerian Tobacco Company with a view of measuring the technical efficiency of the firm.

2. To examine the production functions of NTC with its associated characteristics such as the productivity of inputs, the growth performance and the structural bias of the company and the implications of such bias for the future development of the industry.

1.3 RESEARCH HYPOTHESES

In this study, we verified three hypotheses. First, we hypothesize whether or not the Nigerian Tobacco Company over the years experienced technological progress during

the study period. Underlying this hypothesis is the conviction that technological progress is essential to development. Second, we postulate whether or not output level in the Nigerian Tobacco Company is dependent on the importation of cigarettes-making machinery, spare parts and chemicals. Third, we posit whether or not the acquisition of cigarette-making machinery, spare parts and chemicals bear any relation to the capacity of the economy to import. We need to verify this because Nigeria is a net importer of these inputs as it still lacks the capacity to internally produce these required machinery, equipment, spare parts and chemicals to support domestic industries, such as NTC, Zaria. This further underscores the view that foreign exchange availability is important for technological progress.

1.4 JUSTIFICATION

The vital role of industrialisation in development is well-known. It is also generally acknowledged taht through its use of modern methods and linkage effects, industrialisation induces forward technological movement in the rest of the economy. Thus the policy of industrialisation embarked upon by less-developed countries (LDCs), whether based on import substitution or export promotion, is a prerequisite for their technological progress. In turn, technological progress affects the rate of further development. It is the inter-relationship between industrialisation, development and technological

progress, that has inspired this modest effort to enquire into the level of technological progress of NTC, Zaria, as a case study.

1.5 OUTLINE OF CHAPTERS

This dissertation contains five chapters. Chapter one is on introduction, statement of problems, objectives of the study, research hypotheses, justification, and the outline of chapters.

Chapter two reviews the relevant literature both theoretical and empirical. In chapter three, we discuss historical development of the Nigerian Tobacco Company, Zaria, its growth performances, constributions to the economy, cigarettes production processes, methodology, sources of data and limitations. Chapter four presents and analyses the data, interpretes the results and discusses the policy implications.

Chapter five contains summary of the main conclusions.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1.1 Concept of Technology

Technology has been variously defined in the literature. Three definitions stand out. First, technology is defined in terms of human knowledge applied to production. Among the protagonists of this school of thought is Rosseger (1980) who conceptualizes technology as the knowledge of how to convert inputs into outputs. Caprile (1979) views technology in terms of combination of types of knowledge indispensable for the operation of transforming factors of production into products. Schon (1967) et al define technology as any tool or technique any product or process, any physical equipment or method for doing or making, by which human capacity is enhanced. This approach, in short, sees technology as a process of application of scientific knowledge to the production of goods and services in contrast to pure science which is devoid of pragmatic application.

Second, technology is visualized as extending to all skills, knowledge and procedures for making, using and doing useful things. Stewart (1972), for instance, sees technology in terms of methods used in non-marketed as well as marketed activities, the nature and specification of what is produced, managerial and non-managerial techniques as well as techniques directly involved in production, services (such as administration, education, banking and

law), and in terms of manufacturing and agriculture, organisation of production units (of scale and ownership). Norman (1975) conceives technology as the sum total of knowledge, skill and methods related to the production, distribution and consumption of goods and services including the organisation thereof. Sharing the same view, Kenz (1984) sees technology as comprising all elements of knowledge and know-how or management, business administration and marketing. UNCTAD (1977) defines technology not merely as the systematic application of a scientific or other organised knowledge to practical tasks, but also as the social and economic atmosphere within which such application has to take place, and postulates that technology has a great impact on the structure of the economy, as well as values and attitudes. The upshot of these definitions so far is three-fold: (i) technology does not concern itself merely with the knowledge of making hardware only, but extends to administration, law, finance and marketing, (ii) technology influences the socio-economics of the environment in which it operates and (iii) the technology itself influences that environment.

Thirdly, Farrel (1979) identifies technology as knowledge which enables the possessor to efficiently perform certain routine production assignments. This conception has been categorized as static. A good example is Green Leaf Reception staff (GLR department) of NTC, the skills possessed by this category of workers are limited to routine performance of receiving tobacco leaf and does not

confer on them the understanding of the scientific principles upon which their skills are based. Yet to others, technology is dynamic, it confers on the processor not only the capacity to perform certain routine function, but also the knowledge to identify the scientific principles governing his actions to suit changing conditions and circumstance. (Farrel, 1979). Of typical example is the job of a leaf blender in primary manufacturing department of NTC who is always faced with the task of utilizing his scientific knowledge to determine receipts of various tobacco leaf and chemicals that desire the taste and quality of a cigarette smoker. It is against this situation that Bell (1970) conceives technology as skills to carry out technical function, a stock of technical knowledge that is accessible to skilled people to draw upon in carrying out their functions, instruments of production including tools and deploying the stock of skilled people, technical knowledge and instruments of production.

The implication of the foregoing concepts of technology to our understanding of the meaning of technology is threefold. The first is that technological capability can exist at the level of the plant, firm, the industry and the national economy. Second, is that technology is capacity fully reflected in the ability to affect certain functional activities such as planning, production, facilities, distribution and marketing of finished goods as well as the ability to identify problems

and finally find solutions to them. Further, technology is a source of absolute advantage and "structural competitiveness" for which a nation has an opportunity for changing the pattern of a country's comparative advantage and as a way of replacing particular inputs used in production.

2.1.2 Conditions for Appropriate Technology

In our previous discussion of technology, it has been said that technology is heavily influenced by the socio-economic environment for which it is produced. For instance, it has been said that the difference between the developed countries and less developed countries (LDCs) arise from the difference in the socio-economic and the level of technology being used in the less developed countries. (Bell 1970). It is within this context that Stewart (1972) argue that inappropriate nature of developed country's techniques for underdeveloped countries arises from the differences in the economic and institutional environment between developed and underdeveloped countries. Using the technological relationship between the advanced and less advanced countries to illustrate the concept of appropriate and inappropriate technology, Steward (1972) identifies four main areas in which technology may be inappropriate if used in an environment other than that for which it is designed.

Stewart argues that the developed country technologies

is inappropriate to the conditions of LDC economies because of the skill acquisition disparity. Production activities in the developed countries are generally skill intensive and the technologies in these countries are designed to reflect this condition. Therefore since the general situation in the LDCs is that skills are lacking, if such technologies are imported into an LDC, such skills will either be provided locally or imported. Higgins (1959) however argues that developed countries techniques can only be introduced in the LDCs if top management and technicians are brought from abroad. This was the case when the bulk of the Nigerian Tobacco Company was incorporated in 1960. At that time, there were no Nigerian tobacco technologists. Uptill today, the top management staff are still expatriates.

The implication of this, according to Onyemelukwe (1974) is that even where the local labour acquired such skill, it tends to perpetuate the use of developed country's technologies in line with its training. Therefore, Schanmachers (1973) argues that since the LDCs are not particularly endowed with highly skilled manpower, the condition of appropriate technology requires that technologies being introduced in these areas should be less skill-intensive, simple to operate, to make, repair and maintain.

Secondly, Stewart (1978) argues that employment generation potentials disparity between the developed and the less developed countries is another factor for

inappropriateness of the technologies. She emphasizes that while developed countries have abundant capital and skilled labour force, the LDCs have an abundance of unskilled labour. Therefore, Onyemelukwe (1974) stresses that technologies transplanted to the LDC economies from the advanced countries without modification have adverse employment effect. It is therefore obvious that the advanced country technologies cannot solve the unemployment problem in LDCs. Along this trend of views has been expressed, Stewart and Streeten (1973) argues that the use of labour intensive technologies in the LDCs does not increase output but rather generates increase in payment of labour and thus, discourages domestic investment since much of the money paid to labour goes into current consumption instead of investment. But Sen (1968) opposing this, argues that in most industries, labour intensive method saves capital per unit of output. This situation is very relevant in explaining the present retrenchment exercise going on in the Nigerian Tobacco Company, Zaria.

Furthermore, Stewart stresses that another inappropriateness identified is the organisational scale of unit of production. She argues that the organisation scale of unit of production in developed country is large, while it is generally small in LDCs because the entrepreneurs in most LDCs cannot afford the cost of large scale plant.

Stewart also argues for disparity in income level. According to her, the transfer of techniques designed for a particular society with a higher income level to one with

lower income level distorts the recipient economy.

Onyemelukwe (1974) views the inappropriateness from the use of domestic nature resources as the fifth area. He argues that if an imported technology does not make use of domestic natural resources, but emphasizes the use of those imported, then that given technology may be inappropriate. However, the application of foreign technology without any form of adoption to local environment in the less developed economy has restricted the fuller and better use of local resources. This is the case with most Nigerian industries.

The Nigerian Tobacco Company is one of the typical examples of transnational corporation where the country depends not only on imported technology, but also on imported raw material inputs. As a result, the company operates at less than 50% capacity utilization. (Akinola, 1989).

2.1.3 Problem of Achieving Appropriate Technologies in the Less Developed Countries

Having discussed clearly in preceding sections that technology is environmental inclined and having examined the conditions of appropriate technology, we now examine the factor militating against appropriate technologies in the LDCs.

First problem identified by Sagastic (1979) is that the research and development carried out in the LDCs are mainly devoted to projects that have less or no technological relevance to the need of the domestic economy. Expressing same view in more broader form, Diwan

and Livingston (1969) also argue that an attempt by scientists and researchers in the LDCs to internationalized Research and Development (R & D) undermined the technological capacity of the LDCs. Thus, they emphasized that the only available technology in underdeveloped countries today are those developed in the advanced countries and few currently searching for appropriate technology.

Second, Bruton (1970) argues that the unwillingness to adopt alternative technology where available because of the fear of untried production technologies is another factor militating against the achievement of appropriate technologies in LDCs.

Ekuerkhane (1978), Oyejide (1975), Egbon (1970) argue also that economic policies pursued by these countries (LDCs) which emphasize importation of developed countries' technologies and discourage production and adoption of technologies which suit the socio-economic conditions of LDCs is another problem militating against the achievement of appropriate technology in LDCs.

Felix (1966) further argues that the development strategies adopted in most LDC which emphasize industrialization orientation toward large-scale production, high income product that serve the needs of high-income consumers, and the production of goods that will satisfy the quality taste of international consumers militate against the achievement of appropriate technologies. The argument here is that transnational

corporations carry out their production within the framework of import substitution, which implies production in the host countries, using imported technology and since their motive is to make profit, they would want to continue their production activities with those techniques which will enhance profit to them. Therefore, this will discourage the development of alternative technology which could be economically viable to host countries but jeopardize the interest of the parent organizations.

Thus, the use of the advanced country technologies in the LDCs continue to be unabated, thus making it more difficult to obtain and develop indigenous alternative.

2.1.4 Measurement of Technological Progress

Devine (1979) argues that technological progress can be measured in two summarized forms namely; input and output measure.

Input method measures the cost of product input in its money physical unit; output on the other hand measures project which complete the progress of technological progress and emerge successful.

From the input side, the assumption is that the larger volume of R and D expenditure, the more will be the activities in innovation, particularly at the stage of basic research leading to some invention.

Therefore in this method, the statistics of expenditure on research and development is taken in either absolute terms or as a proportion of total annual budget of

the firm, as a measure of technological progress.

Kamien and Schwarz (1982) on the other hand argue that the research and development spending is treated as a flow cost rather than investment, thereby ignoring the accumulation of knowledge and know-how which in actual fact constitutes an asset. This thus is a major limitation. Despite this, R and D expenditure is widely used index of technological progress.

Secondly, the measure of technological progress through the number of scientists and engineers engaged in R and D is another input type of measurement. Here it is assumed the greater the number of personnel, the more will be R and D activities of the firm or research organisation. The limitation of this method, though similar to the initial one, is that it emphasizes individuals doing research work independently, that is who do not belong to either a firm of research organisation are likely to be left out by this index.

From the output side, is the use of patent issued or sale of new product, Comanor and Schever (1969) argue that since all inventions may not be patentable equally, the use of patent as method of measurement for technological progress is a set back. However, taking the number of potents as a measure of R and D activities is a partial index and thus popular for empirical studies.

A further output measure of technological progress is export. The argument here is that since trade restriction are so important in the LDCs, it is only exports that meet

international efficiency criteria. This method has been criticized on the ground that export may be the result of factor differences or successful technological progress. Thus, exports will be an inadequate indicator of technological progress.

However, following the argument so far, there is no unique method of measuring technological progress, the decision is left to the researchers.

2.1.5 Microeconomic Theory of Technological Progress

A convenient starting point for our study of the theory of technological progress is the discussion of the neo-classical production function. This is because the microeconomic analysis of the theory of technological progress is based on the neoclassical production function.

A production function can therefore be defined as a mathematical function which relates to the quantities of inputs and quantities of output within a prevailing institutional circumstance and by the existing state of technical knowledge. Ekuerkare (1973) also defines production function in terms of the available techniques of production from which the firm must choose, given factor prices.

The underlying assumptions of the neoclassical production function are as follows:

1. The assumption of only two factors - labour and capital.
2. That factors are substitutable and almost infinitely.

3. That there are no fixed proportions.
4. That labour and capital are homogenous.
5. That production and distribution are inseparable.

The theory of production can be and has been developed using many approaches and following different methodologies. We have attempted in this work an approach inclined towards empirical econometrics. The approach is akin to the Lead given by Allen (1938) and similarly amplified by Wynn and Holden (1980). However, for the pure theory of production see any standard test on micro-economics.

In order to examine the above concepts with specific form of production function, we shall now apply the theory to two specific, but well known production functions; viz the Cobb-Douglas and Constant elasticity of substitution (CES) functions.

2.1.6 Cobb-Douglas Production Function

The Cobb-Douglas production function is the most popular method of analysis in applied research because of its simplicity. The function assumes the following:

1. perfect competition
2. homogeneity of labour and capital
3. the same level of wage and profit.

The Cobb-Douglas function has the following features:

1. It exhibits constant return to scale, if capital and labour are increased in the same proportion.
2. The production function reveals diminishing returns to

the factors of production. Thus, if one factor increases and the other remains constant, output will increase, but at a diminishing rate.

3. Both inputs are necessary to the production process if either input is zero, output is zero.
4. There is no symptotic level or (ceiling) output beyond which output grow but the rate of increase decreases at high levels of input.

The general form of the Cobb-Douglas production function for two factor inputs is:

$$Y = e_0 K^{e1} L^{e2} \qquad (1)$$

where e_0, K, and L are parameters, e_0 measures the efficiency (Neutral technological changes) K and L measure elasticities of output with respect to capital and labour respectively. The sum of e_1 and e_2 measures the returns to scale. The parameter e_0 is determined partly by the units of measurement of Y, K and L partly by the efficiency of the production process. The parameter e_0 can better be assessed by comparing two Cobb-Douglas production functions. It is assumed that the higher the value of e_0 in a function, the higher will be the value of Y .

The Cobb-Douglas production function is single varied and continuous (for K > 0, L > 0). The marginal products of capital and labour are:

$$dy/dk = e_0 e_1 k^{e1-1} L^{e2} \qquad (2)$$

$$dY/dL = e_0 e_2 K^{e_1} L^{e_2-1} \qquad (3)$$

By (2) and (3) assuming Y, K and L are positive K > 0, and L > 0, so that $e_1 > 0$ and $e_2 > 0$, then the second order derivatives are:

$$dY^2/d^2K = \frac{K_{e_1}Y - e_1 Y}{K^2} = \frac{e_1(e_1-1Y)}{K^2} \qquad (4)$$

$$d^2Y/\partial^2 L = \frac{L_{e_2}Y - e_2 Y}{L^2} = \frac{e_2(e_2-1)Y}{L^2} \qquad (5)$$

and the marginal rate of technical substitution of K for L is

$$MRTS_{L,K} = -dk/dL = dY/dL + dY/dK = MPL/MPK \qquad (6)$$

Hence the elasticity of substitution of the function is

$$\alpha = \frac{d(K/L)/(K/L)}{d(MRTS)/(MRTS)} = 1 \qquad (7)$$

Inverting and multiplying confirms that the elasticity of substitution is indeed unity at every point on the Cobb-Douglas production function.

Testing for the homogeneity of the function, let the level of inputs increase by a factor μ, so that the new level of output Y is given by:

$$Y = e_0(\mu K)^{e_1} (\mu L)^{e_2} = \mu^{e_1+e_2} \qquad (8)$$

and the degrees of homogeneity is e_1+e_2. If $e_1+e_2=1$, there is constant returns to scale. If $e_1+e_2<1$, there is decreasing returns to scale and for $e_1+e_2>1$, there is one increasing returns to scale.

2.1.7 Constant Elasticity of Substitution

For years, the Cobb-Douglas Production Function or one of its variants was used almost exclusively in statistical studies of production functions and in theoretical analysis of a wide variety of problems. Presumably, the mathematical simplicity of the function overcome objectives of its crucial limitation (i.e. the units of elasticity of substitution). In 1961, however, Arrows, Chevery, Minhas and Solow, popularized a new class of production function that is mathematically simple often statistically practicable and characterized by a constant elasticity of substitution. Since that time, the function has been dominant in literature.

The CES function contains three parameters, two introduced as constraints of integration and one attributed to the assumption that the elasticity of substitution is constant. In Appendix VII for instance, the parameters are e_0, b and e (e_0 = efficiency; b = input intensity; e = substitution). The role of e_0 in the CES is identical to the role of e_0 in the Cobb-Douglas production function. CES function is implicit in the derivation of the Cobb-Douglas function. In particular when b=1, the CES function reduces to Cobb-Douglas function. The technological

progress used in this work was derived from CES function (Chen, 1981).

2.1.8 Classification of Technological Progress

The classification of technological progress may be approached from two stand points which depend upon the time period under analysis (Fergerson, 1976). That is, one may chiefly be concerned with the effect of technological progress during a period in which input supplies are relatively fixed. This is the Hick (1932) approach. On the other hand, one may focus on the longrun effects of technological progress when input supplies are allowed to adjust to economic condition. This is the approach of Harrod (1948).

The Hick (1932) classification of technological progress employs the concept of marginal rate of technical substitution (MRTS). In a given capital-labour ratio, technological progress is either capital using, neutral or labour using according as the marginal rate of technical substitution of capital to labour decreases, remains unchanged or increases. The essence of Hick (1932) definition is as follow:

"At any given time there is a prevailing input- price, given an economic operation, the input-price ratio tends to an equilibrium capital-labour ratio at the point where an isoquant is tangential to isocost curve". At this point the marginal rate of technical substitution equals the input- price ratio. Technological progress is then

represented graphically by the shift of isoquant toward the origin (Appendix V). Therefore, holding constant the ratio of labour to capital, technological progress is said to be capital- saving (labour-using) if it raises the marginal product of labour in greater proportion than the marginal product of capital. And it is labour-saving (capital-using) if it raises the marginal of capital in greater proportion than the marginal product of labour. And it is neutral if it leaves unchanged the ratio of capital-labour.

Harrod (1948) classification of technological progress employs the concept of capital-output ratio. To him, technological progress is capital-using, neutral or labour using, according as the capital-output ratio increases, remain unchanged or diminishes. More succinctly, given the rate of profit technological progress is said to be capital saving (labour using) if it lowers the capital-output ratio; neutral if it leaves the capital-output ratio unchanged and labour-saving (capital-using)if it raises the capital-output ratio.

2.1.9 How Societies Progress Technologically

The study of the way in which societies progress technologically and the speed of progress is not only the preserve of the economist. Economists can identify the main strings of progress, but their pervasiveness and acceptance in societies is not a purely economic matter. The spread of new knowledge for example depends on its rate of adoption and diffusion and this raises questions of

motivation, the willingness to assimilate new ideas and to break with custom and tradition which impinge heavily on territory occupied by development sociologists (Arrow, 1962). The relative importance of different factors contributing to progress,and the speed of progress itself, will vary from country to country according to its stage of development and a whole complex of social and economic forces. Therefore for simplification, we shall confine to four main sources of progress which are significant to any society.

Firstly, "invention or innovative activity of the entire native population". All societies are endowed, to some degree, with potential supply of inventors, innovators and risk takers even in the absence of imported technology and personnel (Arrow, 1962). It is the emergence of classes of persons that technological progress will primarily depend on the early stages of development. Economic backwardness in many countries may quite legitimately be traced back to a relative shortage of inventors,innovators and risk- takers. It is fairly well established that some cultures and some environments are more amenable than others and in the past have provided a greater supply of entrepreneurs. The growth during Britain's Industrial Revolution was primarily attributed to abundant supply of investors, innovators entrepreneur and risk-takers, with the accumulation of capital playing an essentially second role. Technical assistance programmes in developing countries are designed to foster innovation, particularly

the adoption of new goods which may be a powerful factor in economic development by acting as an incentive to producers and workers to increase their surplus for exchange.

Secondly, the process of commercial intercourse and the exchange of information through trade which is often referred to as the "cultural diffusion process".

Thirdly, through "learning by doing" which refers to the accumulation of experience by workers, managers and owners of capital in the course of production which enables production efficiency to be improved on in the future. For instance "at any point in time, new capital goods incorporate all the knowledge available based on accumulated experience,but once built, their productive efficiency cannot be altered by subsequent learning" (Schumpeter, 1934).

Finally, through education or what is commonly called investment in human capital. Investment of this nature takes many different forms, including expenditure on health facilities, on the job institutional training and re-training, formally organised education etc. Investment in human capital can overcome many of the characteristics of the labour force that act as impediments to greater productivity, such as poor health, illiteracy, un-receptiveness to new knowledge, fear of changes, lack of incentive and immobility. Improvement in the health, education and skill of labour can increase considerably the productivity and earnings of labour and may be pre-conditions for the introduction of more sophisticated,

advanced technology applied to production .the capacity to absorb physical capital may be limited among other things by investment in human capital.

We may sum up the discussion so far by saying that the sources of economic progress can be traced to variety of factors. but by and large, investment which improve the quality of existing physical and human resources increases the quality of these same productive resources and raises the productivity of all or specific resources through invention, innovation and technological progress have been and will continue to be primary factors in stimulating economic growth in any society.

2.2 EMPIRICAL LITERATURE

The pioneering work of evaluating a frequently used production was jointly developed by Paul Douglas with chance Cobb in 1929.

Douglas collected annual aggregate data for manufacturing sector in U.S.A. from 1899 to 1929. The result obtained by Douglas confirmed the model specification of constant return to scale and hence unity. In other similar studies of the manufacturing industries in the U. S. A. Douglas carried out estimates of the coefficient which approximately, capital coefficient exhibit increase and constant return to scale.

Douglas work received criticisms based on the following premises. The specification of labour and capital as the only factor inputs, since the inclusion of raw

material is worth-while. Second his biased measurement for capital input in the production process and finally for not giving a serious consideration to the issues of technological progress.

At a conference in 1961 an option to Cobb and Douglas production function called constant elasticity of substitution (CES) was jointly presented by Arrow et al. They assumed a constant and non-unitary elasticity of substitution which makes it different from Cobb Douglas production function. Arrow el at (1961) used the cross section data to study the output and labour inputs for manufacturing industries. Their findings and conclusions indicated that the elasticity of substitution was different from zero and unity.

Hilderbrand and Liu (1965) carried out a study of production function for two digit U.S. industries. Assuming competition in both factor and product market, profit maximizing equilibrium, constant returns to scale and the neutral technical progress they aimed at estimating industry production functions. To build a trend of analysis, they criticized Arrow el at (19961) that their assumptions were quite unrealistic and that if one was attempting to explain movements in value-added per man, other capital per-man should be included as an average wage. The special features of this production function were the presence of two labour variables viz productive and non-productive workers and the allowances for improved quality of labour and technical progress in capital viz the

exponents of the input variables.

Yu Hsing (1993) worked on the choice of production functions of the United States manufacturing industries. A new CES production function that has Cobb Douglas and Leotief function as special cases were considered for non-durable goods and durable goods sectors in United States manufacturing. Translog and CES function cannot be estimated properly due to muilticollinearity, whereas the Cobb Douglas and new CES functions yield coefficients that are significant. He thus concluded that Cobb Douglas function cannot be rejected, but that new CES function has the maximized value of the likelihood function and the advantage that the variable output elasticity with respect to inputs can be tested.

Yauri Wu (1993) estimated the scale factor intensity and efficiency in the Chinese coal industry. Using the Chinese industrial survey data in 1985 and a stochastic frontier model empirical analysis was made. He found that labour intensive enterprises were on the average, more efficient than capital intensive ones. Second that there were no gains from economies of scale in the sample and third that the existence of a two-tier price system greatly influenced the performance of the Chinese enterprises. He also observed that mines like the country and the prefectual level ones were able to overcome disadvantages associated with small scale and to benefit from other sources of efficiency. In all, he revealed highest efficiency rating.

Investigating the technological progress in under-developed economies. Hill, H and Kalirajan (1993) examine technical efficiency in the indian garment industry, based on the country's 1986 census of small industry. Drawing on a sample of 2250 firms their analysis suggested that inter-firm variation in efficiency are very considerable. The study then investigated the correlates of this variation findings; in particular, the positive correlation between technical efficiency and each of export orientation, financial integration and female participation in work force. He thus, concluded that a significant level of labour-capital substitution exist in the industry.

JHA, R, M.N Munty, Satya, Paul and Bhoskara Rad (1993) examined the biases of technical changes, factors substitution and economics of scale in four major manufacturing industries (viz cement, electricity and gas, cotton textile and iron and steel) in India. They estimated the translog cost function. Using the annual time series data covering the period 1960-61 to 1982-83, the study reveals that technical change has been biased towards the use of labour and materials and against the use of capital and energy in electricity and gas industries. In cotton textiles, the technological changes have shown the opposite biases. Significant economies of scale exist in the production of electricity and gas. Enough evidence or substitution possibilities among factors of production in all the industries was also found.

Rajeevan Sinhas (1993) attempted to ascertain the

relationship between various forms of participation (FP) and technical efficiency of the firms in Indian industries. The exercise covers 164 large manufacturing companies distributed evenly across four industry group. The distinction between forms of FP was made. The firm level analysis clearly brings out a positive and significant influence of foreign equity participation on technical efficiency. He thus established that the impacts of the form of foreign participation varies from industry to industry. Greater technical efficiency however, does not implies greater volume of exports, and that technical efficiency has no relationship with export in three industry group and a significant negative relationship in one industry group. He therefore concluded that equity participation by international business seems to consistently lead to higher efficiency in all industry groups. Other forms of foreign participation could be equally (if not more) significant on a case by case basis.

Malta's (1973) used Kenya three digital industries to estimate the elasticity of substitution for the years 1963-1966. In her findings, she establishes that elasticity of substitution was greater than unity and this suggested that given the differences in the relative prices of output, cost of minimizing production, firms would tend to substitute that factor which is relatively cheaper. This further indicate increasing intensity of the firm over time despite the abundant labour supply with perfect supply elasticity in the Kenyan economy. To this therefore she

concluded that modern industries in the developing economies tends to exhibit similar technological feature as compared to their counterpart in the developed countries.

In Nigeria, Liedheld (1966) estimated a Cobb Douglas production function for eastern Nigerian industries. Although he established that the industries were experiencing an increasing return to scale, his fundamental criticism was that his result failed to represent the entire country and perhaps also he employed value-added instead of output as dependent variable because as he argued, there are no economies of scale in the use of raw material. Hakam (1966) estimated a Cobb Douglas production function for the Nigeria economy.He therefore established a constant slightly increasing returns. He was criticized for his inability to disaggregate so as to demonstrate differences in production relationship between industries.

Osagie and Odaro (1975) carried out a "disaggregate" Cobb Douglas production function which have 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, equipment and transport equipment.

The model produced reasonable good fits though the disaggregated components of capital in the models are not significant. The results show high output elasticities for labour than for capital. This then indicates a likely relatively labour- intensive technique employed in the Nigerian industrial sector. This shows consistency with

the evidence provided by Hiedhelm (1966).

Kazi and Odama (1981) studied the issue of factor shares technological progress and relative efficiency in selected Nigerian industries. The empirical result showed that 67 percent of industries exhibited technology progress. For C.E.S. they indicated that 16 percent of the industries showed elasticity of substitution greater than one. These indicated that the organised sector in Nigeria lack the opportunities of an existing pool of unemployed labour. Also, technological progress appears to be a negligible factor of the determinants of growth of output per annum. 11 of the 29 industries showed positive contribution to production with fixed factors. This they argued may be accounted for by such factors as entrepreneurial ability to train manpower including administrative personnel and equipment of production.

At a similar enquiry Kazi and Odama (1981) sought to explain the rate of capital-labour substitution on time series production function in the manufacturing industries in Nigeria. Their work faced a number of criticisms, that they relied solely on aggregated data from secondary sources which does not reflect the character of the individual industry production function.

Omosegbon (1986) estimated the production function of the Nigerian Tobacco Company Zaria (NTC). He postulated the Cobb Douglas and constant elasticity of substitution (CES). He found that technological changes of NTC was factor augumenting and in particular, labour deepening. He further

estimated that innovations were not present in the operation of the industry. His major criticism was that he used a cross section analysis which was quite too few to obtain a reasonable result and analyse clearly the technical position of the company.

Following the method of Omosegbon, Musa, M. R (1988) adopted an empirical analysis of the production function of the textile sub sector of manufacturing sector. To establish his findings, he advanced three hypothetical preposition with respect to the character of the firm's. Production function. First that the united textile limited (UNTL) operated a capital intensive production function. Second,that the firm experience increasing returns to its efficiency in the process of production. He therefore, established that manufacturing in Nigeria was highly sensitive to the use of raw materials and that UNTL generally experienced increasing return to scale. This finding theoretically, implies that the firm has not reached a global maximum. This he attributed to imperfection in production techniques and factor substitution in terms of technological changes, he established that it contributed about 47% of the firm's output per annum. He further observed that those technological changes were both capital deepening and raw material intensive and that the firm exhibited elasticity of substitution less than unity.

On the whole, he followed Maltas's conclusion that the import substitution industrialization strategy with respect

to the unemployment problem, sectoral linkage and transfer may not be generally in Nigeria.

Ihuoma (1992) appraised the technological progress in Nigerian Leather industry.He tested three hypotheses. First, that the Nigeria Leather Tanning industry had overtime experienced low rate of technical progress. The second, that output level in Nigerian Leather industry depended on the import level of the industry. Third, he hypothesized that the acquisition of tanning machinery, spare parts of tanning machinery and chemical depended on import capacity of the economy. He thus contended that leather industry was characterized by low rate of technological progress which is a reflection of the absence of research and development activities and engineering facilities in the industry. This in turn reflects the weak presence of the capital goods sector of the Nigerian economy. The short coming of the work include its inability to compare period to period of the technological progress through the efficiency parameter overtime.

While there have been several studies on production function and technological progress in manufacturing industries as reviewed above, they suffer from three principal weaknesses. First, almost all are based on production technology of the Cobb douglas or CES (with the exception of Jha, R. et al (1993), Yu Hsing (1993)), Second the time period covered by these studies rarely extended beyond 1980's. Thirdly and perhaps most significantly, all such studies, with the sole exception of Omosegbon (1986)

and Rabiu (1988), considered capital and labour to be the only inputs into production. Since other inputs like material inputs are very significant constituents of cost of production. It is possible that their exclusion in an analysis of production functions would significantly alter the estimates of elasticities of substitution and technological progress.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.0 THE NIGERIAN TOBACCO COMPANY: A SURVEY

This chapter places the Nigerian Tobacco Company in perspective. It surveys its historical growth and development as well as it's contribution to the economy and technology of cigarette production.

3.1 BRIEF HISTORY OF NTC, ZARIA

The Nigerian Tobacco Company was first established in 1904 as an import trading where all tobacco products were imported and marketed by various trading companies. By 1933 the British-American Tobacco Company Limited (BAT) established a pilot factory in Oshogbo. This factory was manufacturing cigarette from imported leaf. In 1937, the first full scale factory was opened at Ibadan and in March 1957, NTC was incorporated as the successor of British-American Tobacco.

NTC stock holding reveals that in May 1960, BAT offered for sale to the public in Nigeria, some of the ordinary stock of the company more shares were sold in 1964. By December 1980, the number of NTC stock stood at fifty thousand. The company authorised share capital increased to N50 million as at 1987. British-American Tobacco Company Limited held 119,700,664 stock unit 59.80% of the issued share capital of the company as at 21st December 1994. (Annual Report 1994). See Table 4.

The company currently has one factory left out of 3, at Zaria established in 1959. It's first factory at Ibadan established 1957 was about down in mid 1994 and much of the machinery recommissioned to Zaria. This was in order to generate substantial saving from freight and administration costs and to sharpen the focus of product quality. The second factory at Port-Harcourt established in 1952 was earlier closed down in 1982 due to high degree of smuggling which adversely affected the sales of locally manufactured cigarettes (Annual report 1989).

The company manufactures and market cigarettes. Included in its portfolio are such well known brands as Bicycle, Excel, High Society, John Player, Gold Leaf, Sweet-Methol, Three Rings, Trend and Will Mars.

3.2 ANALYSIS OF STOCK HOLDERS.

The company has share capital of N200,000,000 as at 1994 held by stock holders as followers.

NIGERIAN	NUMBER OF HOLDERS	STOCK-HOLDING N000	STOCK-HOLDING %
1 - 500	2,489	273	0.19
501 - 1,000	9,281	2,705	1.35
1,001 - 5,000	30,717	29,344	14.67
5,001 - 10,000	4,098	12,530	6.27
10,000 - 15,000	2,477	14,112	7.06
15,000 - 20,000	257	2,249	1.12
20,001 - 25,000	84	947	0.47
25,001 - 50,000	161	2,758	1.38
50,001 - 100,000	76	2,608	1.30
100,001 - ABOVE	64	12,374	6.19
SUB-TOTAL	49,694	80,000	40.00
NON-NIGERIANS			
BAT CO. LTD.	1	119,723	59.86
OTHERS.	57	277	0.14
	49,746	200,000	100.00

Source: Annual Report and Account (1994).

3.2 GROWTH PERFORMANCE

In assessing the growth performance, we shall be concerned with growth performance indicators as defined in the Federal Office of Statistics industrial survey. These measures include gross output, value-added industrial cost and so on.

The growth performance of the company is to give a brief overview of the Nigerian Tobacco company Zaria.

Looking at (Table II) for instance, it is easy to observe the phenomenal expansion in the company between 1982 and 1994. The value-added in real term was over N100,000 in 1982, it rose to over N65 million in 1984 and over N107 million in 1986. This trend continued until 1994 when it hit the ceiling of over 1322 million (Annual Report, 1994).

The same goes with the gross profit. It's value was 434 million as at 1982. It rose to over 1563 million as at 1993 and increased by less than 10% by 1994. The same pattern of growth is replicated in nearly the rest of the indicators (see Appendix II). The short fall of 1994 was attributed to frequent interruption in supplies to the market due to irregular availability of foreign exchange to finance the import of the small but essential proportion of the company's inputs. As a consequence, the company suffered about 25% reduction in sales volume in 1994 (Annual Report 1994).

Taking the period 1984 to 1985 the growth rates seem poor (see Apppendix IV). Between 1986 and early 1990s, the company experienced the peak due to the export boost of tobacco leaf which aasisted the company in tackling the cost of foreign exchange as initiated by the Structural Adjustment Programme. The general decline in growth rate of the company between 1993 and 1994, was attributed further to inability of the company to look inward for sources of raw material input especially spare parts and machinery. It was also observed that within this period, there was the increasing use of capital intensive technology much of

which were imported. (NTC at a glance 1991).

3.3 CONTRIBUTION TO THE ECONOMY

3.3.1 Agricultural Activities

Nigerian tobacco company operates one of the most efficient agricultural extension services in the country. NTC, extension work, among its 17,000 farmers has important benefit of teaching the farmer current practice of mechanization, crop rotation, use of fertilizers etc which they apply not only to tobacco growing but also to the cultivation of food and other crops.

NTC also provides to the farmers free seed and other agricultural inputs such as tractors, ploughing machines and fertilizers on credit. Through these tobacco farmers, NTC inject about N15 million annually into the rural economy. This has contributed significantly to food crop production and also helped to halt the drift from rural to urban areas.

3.3.2. Employment

The cigarettes factory owned and operated by NTC at Zaria gives full employment for 2,100 persons, and casual and seasonal employment for another 1000 (NTC at a glance 1991).

The company also provides contributions to employee's pension schemes. The funds generated by these contributions are in turn integral parts of the Nigerian economy.

NTC has distributors all over Nigeria whose annual

turnover exceed N116.00 million. They give direct employment to about 660 persons while thousands of retailers earn at least a part of their living from selling NTC brands of cigarettes (NTC at a glance 1991).

3.3.3 Manpower Training and Development

About 2100 person are directly employed by NTC. Of its 186 management staff, 175 are Nigerians (NTC at a glance 1994).

In such a highly mechanized company as NTC the development of supervisory and teaching skill is very important. Thus staff training and development is a major aspect of the company's policy.

NTC has a training centre at Ibadan where most grades of staff are trained. For most advanced and specialized training, NTC managers are sometimes sent overseas.

The result of this programme of training and development can be seen in the high calibre of manpower in the company, and in the improvement in the efficiency and performance of its employees. The programme has also provided high level manpower for the public and private sectors of the Nigerian economy.

3.3.4 Linkage Effects

Nigerian Tobacco Company has for a long time played a leading role in the development of the economy. Twenty-one years ago, NTC in partnership with Times Press Limited established Niger Park Limited to produce packaging

materials for NTC and other manufactures. More so, NTC has contributed to the development and extension of other such companies in the country by providing them with necessary incentives.

Tobacco farming has also created a demand for certain goods and services leading to the establishment of small-scale businesses in the rural areas. These include mechanized land preparation by NBC sponsored or NTC financed tractor contractors, and the manufacturer of simple farm implements. These small businessmen and 17000 farmers with about 68,000 rely mainly on NTC's prosperity. NTC contributes to social development in the various communities in which it operates. Those contributions range from sports promotion and participation in community affairs to the award of scholarship for studies in schools and universities (see Appendix I).

3.3.5 Efforts to reduce Foreign Exchange Outflow

Local sourcing of raw materials is not a recent idea in Nigerian Tobacco company. For years, NTC has consistently worked on ways of reducing its dependence on imported raw materials. Unfortunately some of the essential components in cigarette manufacturing, such as cigarettes papers, cellulose acetate, filter fow, cork tipping and aluminum foil bounded to paper are product of highly capital intensive industries located only in very few countries of the world. Such components and some machine spare-parts must be imported before cigarettes can be

produced in Nigeria except a further and detailed research is undertaken, such capital-intensive goods cannot be obtained for now. As further steps toward self sufficiency, NTC has, in the recent past, taken the following steps:

a) Use of local rather than imported starch and adhesive.
b) Fabrication of some machine spare-parts in the company's own workshops and local purchase from the Federal Institute of Industrial Research, Oshodi.
c) Elimination of certain imported items from the company's packaging.
d) Use of locally produced "karte" paper instead of over printed imported wrappers.

NTC also provides credits to small-time businessmen who produce some of the implements the company would have imported.

3.4 CIGARETTE PRODUCTION PROCESS

Cigarette production process in NTC encompasses the following departments Green leaf reception, Green leaf threshing, primary manufacturing department (PMD) and secondary manufacturing department comprising of cigarette making department and cigarette packing department. All these departments are interwoven.

Green leaf reception is the department highly involved in the receiving raw tobacco from buying centers and adequately arranging in form of grades for further

processing in green leaf threshing.

3.4.1 Green Leaf Threshing

Leaf threshing can be simply put as the separation of stem from lamina in a tobacco leaf. The green leaf threshing is a section of production process and it performs the following functions:

3.4.2 Pregrading

In this department, raw tobacco leaf is received in grade as laid down at marshalling area from Green Leaf Reception (GLR) and check weighted. This is then carried to the pre-blending tables with 20 feeding boxes. This allow for primary grading to take place as leaves are fed from the feeding boxes on to the tables in accordance with the blend receipt advised by the leaf blender.

The tobacco is transported to the tipping and tie leaf cutters where the butts are untied and the tips are cut. The butts are conditioned at first conditioning cylinder to 17 - 18% moisture content before being passed through the first sand reel where fines and sand/silica are removed. The tobacco is further passed through the proportioning units on to the packing tables. At the packing tables, foreign matters are removed and clean tobacco sent to second conditioning cylinder where it is conditioned at 20 - 21% moisture content. At this moisture content level, tobacco is made pliable ready for handling at threshing line.

3.4.3 Threshing Processes

The conditioned tobacco leaf is fed through the feeder/refuser assembly onto the first thresher. Here, by the action of thresher teeth and basket, the lamina particles are torn off the tobacco leaving the stem, some of which may be flaggy. By the action of air flow through classifier and separators, the light particles, usually lamina, are air-lifted to a separate conveying line while the heavy particles usually stem are further passed for further cleaning exercise. These actions are repeated through other three threshers and sets of classifiers in order to obtain clean stem and stem free lamina at acceptable particle size distribution. All recovered lamina are passed into the silo ready for redrying while stem is conveyed directly through the stem spraying machine.

3.4.4 Redrying

This comprises of processes of cooling, drying and reordering of lamina and stem through their respective redrying machines to an acceptable storage moisture content. This is achieved by the action of cooling tons, hesters and steam.

Stem is dried down to a moisture content of 11.5 - 12.5% while lamina is dried down to 13 - 13.5%.

3.4.5 Prising

At this zone, clean stem is bagged through the stem discharge unit. The bagged weight of 20 kgs is

automatically achieved through the mechanical/electrical arrangements on the conveyor called the weigh belt. The lamina is passed through the press where they are automatically weighted and packed into cartons at 200kg. Both bagged stem and cartons of strapped lamina are passed to leaf warehouse for storage and subsequent use at the primary manufacturing department (PMD). Other supplementary services that enhances leaf threshing are obtained from quality information bisection and record office.

3.4.6 Primary Manufacturing Process

The basic inputs of the PMD is the separated lamina, stem and even fines kept in the leaf warehouse.

Every cigarette contains several graders of tobacco which could be 20 or more. Each grade has its own contribution to the smoke desired or the physical properties of the cigarettes e.g flavour, aroma, taste, nicotine and sugar level, filling power etc. Those are carefully worked out by the blender who produces a recipe that will give the smoker of that brand the type of smoke he enjoy's.

Each brand has its own coded blend number assigned to it. There are laid down procedures for issuing lamina bale, stem bags and fines for PMD for processing.

3.4.7 Lamina Process

Full operation size at PMD is 6000kg consisting of about 4500kg of lamina (fines inclusive) and about 1500kg

of stem. The lamina composition of 4500kg comprises of various types of crop and grade. These crops and grades have their various rates of retention of steam and water. Therefore they are processed one after the other.

The redried tobacco bales, through expected at 12.5%, moisture content sometimes come to PMD as low as 7 or 8%. The first conditioning cylinder called direct conditioning cylinder jacks the moisture up to between (19% - 20%).

The conditioned lamina is then passed through an arrangement of gravity feed pipe (GFP) and a metering band for uniform feed rate, and then over a set of siere to remove fines and dust particles sizes of about 6mm go into the casing cylinder while particle size of less than 6mm are sieved and added as ex-lamina cutter.

The lamina containers on its journey through the casing cylinder to the blending bin where all grades in the operation are spread evenly in layers and leaf for sufficient time for the moisture to even out. When the processing continues, the discharge end of the bin is done with the aid of doffers filled at the discharge end of the bin. The rotation helps in blending the lamina properly.

Lamina now goes into the milli cutters and cut at 30 cuts per inch. The cut lamina joins the GLT fines, small particles seieved pre-casing cylinder, and these sieved pre-cuttings in a hopper from which all are fed through a metering band to the super conditioning cylinder. There in super conditioning cylinder, moisture and temperature are raised to 28%-30% and 60oC respectively.

The super conditioning cylinder does that function to blow up the lamina property. The drier then dries up the lamina properly. The drier then dries down to 16% - 17% moisture content. Thus the filling power is improved upon. The dried cut lamina which is at 65°C - 70°C is passed to the cooler for temperature reduction. If flavouring is required, it is applied in the cooler. It is at this junction that cut stem mixes with lamina and both are conveyed into the product bin. The discharge end of the product bin is filled with doffers (Just as the blending bin) to assist the mixing cut-tobacco exit product bin are at 13 - 15% moisture content.

3.4.8 Stem Process

Here we discuss the position of the stem before it is ready to mix with lamina. Redried stem supplied are received in a very dry condition. They are therefore conditioned at between 35 to 40% temperature of 65oC the stem cylinder. The conditioned stem is passed to a baling bin to allow it pick up moisture evenly winnowing, which are added to the conditioned stem to enable them pick up moisture.

Baked stem and the aforementioned add back are passed into millicutters which cut them at 180 cut per inch. The cut stem is then passed through an arrangement of metering bands into supper conditioning cylinder where the moisture and temperature are raised for 48% - 50% and 93% respectively. This action is aimed at blowing up the stem

to increase the filling power (i.e the volume occupied per weight of the cut stem) the stem is then dried down to 16% - 17% in a drier and air-lifted through a classifier. The particles serve as point of add back pre-cutters. Cut stem silo are conveyed to meet up with the out-lamina exploder as explained above.

3.4.9 Final Handling

Cut tobacco/cut rag (or the mixture of cut-stem and cut lamina) are then weighted into cartons for Ibadan bound tobacco (before the closure) or boxes for Zaria bound ones. They are then put in cut-tobacco store under controlled atmosphere. Here also the boxes are usually lined with polythene bags to pressure the moisture.

3.4.10 Secondary Manufacturing Process

Activities, here will be discussed under two main headings, cigarettes making and cigarette packing.

3.4.11 Cigarette Making

Three main raw materials form the input of cigarettes making.

i. Cut-tobacco

ii. Filter rods - for filter cigarettes

iii. Wrapping materials i.e. cigarettes paper, cork tipping material ink and adhesive.

Cut-rag is fed into the hopper pneumatically in Zaria but manually in Ibadan factory (before the closure)

according to blend. An endless belt elevator craving rows of sharp pins, lifts the tobacco carpet. A magnet located at the top of the rise of the conveyor removes metal objects from cut-rag. Tobacco then drops behind the elevator to a lower section of the machine housing two carded drums. The tobacco is removed from the drums by a picker roller and transferred to the winnower section. A section at the chimney pulls tobacco underside of an endless, perforated thin metal band which conveys the tobacco to the garniture. The shape and size of cigarettes is formed at the graniture. Excess tobacco gets trimmed off by the aerateur and conveyed back to the hopper feed unit. Cigarettes paper receives the required print passes through series of drums and is guided to the garniture where the stream of tobacco is delivered unto it. The print on the paper indicates the brand being manufactured. The tobacco steam and paper pass through guide tubes where one inside edge of the papers is applied to completely seal the cap thus forming a continuous cigarette rod. The cigarettes rod is cut into required length by a cutting unit. A high speed wheel accelerates the cut length onto a fluted catcher drum rotating at right angles to the rod maker. At this point plain cigarettes are completed. Filter cigarettes pass on to the plug assembler.

At the plug assembler, a train of suction drums control the passage and formation of filter tipped cigarettes. At the point, the filter rods are cut into 2 or 3 sections as the case may be for king size or long size

cigarettes. Each cut section is first of all joined with double cigarettes and are wrapped with a piece of pasted tipping paper before parting them off to make 2 identical cigarettes. All cigarettes made now pass to the catcher band where they are caught and put in trays.

3.4.12 Cigarette Packing

Cigarettes brought in cigarette parking department are packed in sizeable qualities for case presentation to consumers and for good preservation.

To ensure a long "shelf life" cigarettes must be at current moisture content. Therefore packed cigarettes are wrapped with non-permeable material called polypropytene. The cigarette packing machine has a hopper into which trays of cigarettes are loaded.Cigarettes fed into the hopper are forced into hopper crips in three rows of 7-6-7 for 205 packs and two rows of 5-5 for 10 packs. Sensor probe that defect absence of cigarettes and affect the ejection of incomplete packets are available.

Formed bundles pass through guides before being wrapped in foil (Aluminium or paper foils). This is then wrapped with pre-printed cup packet labels (For soft cups) or hinged lid carton (For hinged lid cigarettes).

The side and the ends of the cup packet labels and hinged lid carton are progressively filled gummed and sealed until the packets is formed, strup with NTC logo is used to seal up the top end of soft cup packs.

A tear-off strip is gummed to the reel of polyprop as

it unwinds to wrap the packed. The polyprop wrap is leaf sealed after final folding.

A final collation unit group the finished packs into 20 of 10s cigarette packs to form bundles of 200 sticks:. Depending on the brands, a display of outer paper and polyprop over wrapper or both are used for final handling and wrapper up. These are then loaded into pre-printed cases before final despatch to packed stock room.

3.5 METHODOLOGY

In carrying out our analysis of the technological characteristics of the Nigerian Tobacco Company, Zaria, we adopted regression analytical technique using econometrics models. This technique enabled us to establish clear relationships between the variables and draw useful conclusions.

A t-statistical was used to show the significance of the stated hypothesis in chapter one.

3.5.1 The Models Specification

The theoretical models applied for this study are the Cobb-Douglas production function and constant elasticity of substitution. To corroborate these models, we also postulate that import dependency of the firm affects technological progress in the firm. These postulates are very verified in models III and IV.

Model 1.

In seeking insight into the technological efficiency of NTC Zaria, the Cobb-Douglas production function was selected because it gives a better fit. Also, it is convinient in the interpretation of elesticities and returns to scale. The Cobb-Douglas production function is stated as follows:

$$Y = e_o K^{e_1} L^{e_2} U_o \qquad (9)$$

The non-linear form was linearised by converting it into a logarithmic function shown below:

$$Log\ Y = Log\ e_o + e_1 LogK + E_2 LogL + Log\ u_o \qquad (10)$$

Where

Y = Total output (Naira)

K = Capital employed (Naira)

L = Labour employed (wages and salaries)

e_0 = Constant term

U_0 = Error term

The e's are the regression coefficients for the equation. In equation (10), they are also the elasticities of production for the regression equation and represent the percentage increase in the output of y for each 1 percent increase in the output of respective resources. The greater the value of e_0 the more advance is the technology.

We introduced also the third variable into the specification (raw material). This was attempted because

materials input were assumed to be a significant constituent of cost of production.

Model II

Estimating of technological progress using the Constant Elasticity of Substitution production function (C.E.S.) is difficult (Chen, 1981). However, Chen 1981 has derived a simpler version for estimating technological progress. We used this derived form in this research (See Appendix 8).

$$\log Y/L1 = e_0 + e_1 \log w + e\log t + \log u_0 \qquad (11)$$

from the equation (11) the extent of technological progress for NTC, Zaria will be measured as follows:

$$r = \frac{e_2}{1-e^1} \qquad (12)$$

where

Y/L1	=	Output per person
w	=	Wage rate
e_1	=	elasticity of substitution
r	=	technological progress

Model III

This model was used to test that output of the NTC Zaria depends on the investment on import of machinery, spare parts and chemicals.

$$\log y_t = \log e_o\ e_1\ \log 1m_{t-1} + \log u_o \qquad (13)$$

where

y_t = current output level

$1m_{t-1}$ = investment in the past period.

Model IV

$$Log\ 1m = \log_{e_o} + e_1\ \log ER + \log U_o$$

where

1m = Import (Machinery, Spare parts and chemicals)

ER = External Reserves

Here we tested that the import capacity of the firm to acquire machinery, spare parts, and chemicals depends on the external reserves of the economy.

3.6 SOURCES OF DATA

Data for this study are mostly secondary. They are derived from published materials such as the Annual Report of the Nigerian Tobacco Company, Annual Abstracts of Statistics of the Federal Office of Statistics. Journals, and Publications of the Central Bank. These secondary sources were supplemented by field survey to bridge any lacunae.

3.7 LIMITATIONS OF THE STUDY

Like most human effort, this study cannot be described as perfect. The assumption of perfect competition in both factor inputs and products markets is one obvious limitation. The mathematical formulation of the model itself is not exact, being stochastic. Furthermore, the inadequacy or complete dearth in some cases, of the required data, constituted a serious bottleneck. Nevertheless, results obtained in the study though indicative but are to be interpreted against the backdrop of the aforementioned limitations.

CHAPTER FOUR

4.0 ZARIA CASE STUDY

This chapter investigates empirically the extent of technological progress in the Nigerian Tobacco Company, Zaria. Specifically, it verifies three hypotheses namely:

i. The Nigerian Tobacco Company has over the years experienced low rate of technological progress.

ii. Output in the Nigerian Tobacco Company is a function of import levels of cigarette related machinery, spare parts and chemicals.

iii. Acquisition of machinery, spare parts and chemical in the company depends on the import capacity of the economy as a whole.

In choosing the method of testing the hypothesis we were mindful of Farrel's firm-level approach to the measurement and evaluation of technological characteristics at the micro-level. (Farrel 1979).

He advocated the following criteria:

a) The existence of persons with foundation and training the basic aspects of knowledge relevant to the particular line of activity.

b) The above persons must prossess some minimum operational experience.

c) The existence of an organisation in which the skills are available and can be ungraded tapped and deployed in pursuit of the stated objectives of the firm.

d) The existence of a problem - sensing and problem - solving capacity within the firm.

e) Some machine of valves and attributes which are vital to cohesion within the firm and realization of set goals.

By these criteria according to Farrel, the above technological features can be said to posseses a high degree of technological capability. Farrels criteria of assessing technological progress of a firm is difficult to quantify. How, for example, do you quantify "problem, sensing and problem - solving capability or values and attitudes of a firm? Given these shortcomings of the Farrel approach and similar ones (Ada 1987), we adopt the regression analytical techniques. The approach is premised on the concept of the neoclassical production function espoused in chapter two.

The student t-statistics was used for testing our hypothesis. The concern here is with the null hypothesis (Ho) as against alternative (Ha). Therefore, the null hypothesis is symbolical thus:

$$Ho \; ; \; B1 = o$$

against the alternative hypothesis

$$Ha \; : \; B1 > O \text{ or } B < O$$

In the student t-statistics, the thoeretical values of t are the critical values which define the critical region of the test. The calculated t-value was then compared with the critical value at n-k degree of freedom. If the

calculated t-value lied outside the critical region the test was considered significant, if not it was not significant.

Using this method, our hypothesis could be accepted or rejected accordingly.

In this analysis, we present and discuss four regression models each of which constitutes a production function, from which we infer the extent of technological progress in the firm. The goodness of fit of the models is verified using the coefficient of determination (R2), the adjusted R^{-2}, the t-ratio, and the below Dubbin-Watson statistic. The t-ratios are in parenthesis below the relevant estimated coefficients.

4.1 TEST FOR HYPOTHESIS

4.1.1 Model 1

Table 4.1

Labour and capital (L & K) variables with their regression coefficient and t-ratios.

Variable	K	L
e-coeffients	0.341	1.73
t-ratio	(2.29)	(3.75)

Sources: Extracted from Table 4.6

The null hypothesis tested in this section states that Nigerian Tobacco Company over the years does not experience

poor technological progress.

As can be seen from the table above, the calculated t for variable K is 2.29 with ó = 0.05, the rejection for the null hypothesis with 12 degree of freedom (dF) given in the t-distribution table comes to be 1.782 or t < -1.782. The observed t-value falls behind the rejection region.

The variable L also has the value 3.75 as the t-ratio for its coefficient, in table 4.1. The tabulated -t value at 12 degree of freedom (df) and with ó = 0.05 is 1.782. The t-calculated also falls inside the rejection region.

Similar test was carried out when we introduced the third variable (raw material employed) table (4.2) below shows the t values and variable used.

Table 4.2:

Capital, labour and raw material variables with their regression coefficients and t-ratio.

Variable	K	L	K_1
e-coefficient	0.332	1.62	0.047
t-ratio	(2.02)	(2.06)	(2.17)

Source: Extracted from regression equation in table 4.6.

The calculated t values for capital is 2.02, labour is 2.06 and raw materials is 2.17. The rejection region for the null hypothesis with 11 degree of freedom (DF) is t > 1.796 or t < -1.796 for ó = 0,05.

In table 4.1 and 4.2 above, it was found that the

calculated t-values was greater than the t-tabulated one of 1.782 and 1.796 respectively, which falls within the rejection region. So we rejected the null hypothesis and accepted the alternative with the conclusion that NTC over the years experienced poor technological progress.

4.1.2 Model II

To confirm the hypothesis of poor technological progress in the Nigerian Tobacco Company we follow the derived version of CES production function (Chen, 1981).

Table 4.3

Variable, wage rate and time factor with their regression coefficient and t-ratios.

Variable	w	t
e-coefficient	-0.583	-0.231
t-ratio	(-1.34)	(-6.23)

Source: Extracted from regression equation in table 4.7.

The principles of the test remain the same as the preceeding. Using the hypothesis test ó = 0.05, the calculated t is -6.23 for variable wage rate (L/L1) at 12 degree of freedom with t-tabulated of 1.782. The rejection region of the hypothesis is t > 1.782 or t < -1.782. Since t-calculated was greater than t-tabulated, we rejected the null hypothesis and accepted the alternative with respect to the variable wage rate (L/L1).

We also tested the Null hypothesis with respect to variable time period (t). At ó = 0.05, the calculated student 't' was found to be -1.34, the critical t-value with 12 degree of freedom (df) was 1.782. We accepted the Null hypothesis and concluded that NTC over the year does not experience poor technological progress.

4.1.3 Model III

In our third model we hypothesized that the output level of Nigerian Tobacco Company depends on the imported level of the cigarettes making machinery, spare parts and chemicals. In investigating this hypothesis, it was theoretically assumed that the output in current period depends on the investment level of the past year. As a result of the lag the imported items would have effect on output in the next period befre they arrived and are utilised for production.

Table 4.4

Investment in the past period with its regression coefficients and t-ratio.

Variable	1mt-1
e-coefficient	0.915
t-ratio	9.60

Source: Extracted from regression equation in table 4.8.

The calculated t value of 9.60 was found to be greater than the tabulated of 1.771. At ó = 0.05 with 13 degree of

freedom (DF). The regression region was fixed at t > 1.771 or t < 1.771 since the t-calculated falls on the rejection region. The null hypothesis was rejected and the alternative accepted and concluded that output of NTC depends on the import levels of the cigarette making machinery, spare parts and chemicals.

4.1.4 Model IV

In our fourth model, we hypothesized that the acquisition of machinery, spare parts of cigarette making machines and chemicals depends on the import capacity of Nigerian economy. The capacity of the Nigerian economy to import is a function of the level of external reserves. Table 4.5 below shows the values used to test the Null hypothesis.

Table 4.5

Variable external reserve ER, with regression coefficient and t ratio.

Variable	1mt-1
e-coefficient	0.915
t-ratio	9.60

Source: Extracted from regression equation in table 4.9.

The calculated t value of 5.25 was found to be greater than the tabulated one of 1.771. The rejection region was set at t > 1.771 or t < -1.771. Since the t-calculated of 5.25 falls on the rejection region at ó = 0.05 and 13

degree of freedom, the Null hypothesis is rejected and the alternative accepted and concluded that the acquisition of machinery, spare parts and chemicals depends on the import capacity of the Nigerian economy.

From the results obtained in the investigation of our three hypotheses, we concluded that the Nigerian Tobacco Company was characterised by poor technological progress and is import-determined dependent for the period under review.

4.2 ESTIMATED MODELS

Model 1

In computing the Cobb-Douglas production function for NTC, Zaria, it was hypothesized that the total output for NTC Zaria would be influenced by two variables.

K = capital employed

L = labour employed (wages and salaries).

Total output which is the dependent variable was regressed against the two explanatory variables listed above.

From the results of the regression analysis shown in table 4.6, it could be seen that the coefficient of determination (R^2) shows a good fit of 0.94. This indicated that 94 percent of the observed variation in total output was jointly explained by thw two variables indicated in the model.

The coefficients in the Cobb-Douglas production function represent the elasticities of output with respect

to inputs. From the results of regression analysis in table 4.6, the coefficients are:
Capital (0.341), labour (1.73). This indicated that 1 percent increase in the amount of labour and capital employed led to 0.341 percent and 1.73 percent increase respectively in the amount of output. The efficiency parameter of -8.8 shpws negative technical efficiency of the firm. The value implies that productivity in the firm fell during the survey period.

TABLE 4.6

Regression Results for Cobb-Douglas production function in the study period.

Constant term	Capital Input (K)	Labour Input (L)	Raw Material Input (K1)	R^2	R^{-2}	DW	Number of Observation
-8.80 (-2.44)	0.341 (2.29)	1.73 (3.75)	-	0.94	0.935	1.69	15
-8.11 (-1.48)	0.332 (2.02)	1.62 (2.06)	0.047 (2.17)	0.944	0.929	1.69	15

Figure in parathesis represent the t-values.

Since one of the interest in this study is to determine the significant efefct of each explanatory variable, the calculated t-values of each variables was compared with the critical t-values. The results indicated that capital and labour have a significant effect on productivity of the firm.

From table 4.6 results, the difference between the

roles input played in the amount of output realised are shown. Labour for instance are more responsive to the level of output than other input.

We next introduced the third variable (raw material). Here, it was hypothesized that the total output of NTC Zaria would be influenced by the three variables.

K = Capital employed

L = Labour employed (wages and salaries)

K1 = Raw materials employed

R^2 shows a good fit of 0.94 the coefficient of the variables labour, capital and raw material are significant because the t-calculated is greater than the t-tabulated (that 2.02 > 1.796, 2.06 > 1.796 and 2.171 > 1.796 respectively. The high coefficient determination indicates that the production function fits the data well and thus the inclusion of material input is worthwhile.

Further, the model does not have the problem of antocorrelation as indicated by DW value.

Model II

In computing the C.E.S. production function for technological progress a derived version was used (see Chem, 1981). It was hypothesized that productivity per person of the NTC Zaria would be influenced by two variables, that is wage rate and time factor.

From the results of the regression analysis shown in table 4.7, it could be seen that the coefficient of determination (R^2) was 0.89. This indicated that 89

percent variation in output (productivity per person) was explained by the use of factor input in the model. This thus shows that the estimation fits the data well. Furthermore, the coefficient time and wage rate has a negative sign, signifying that within the study period, productivity per person falls as factor inputs changes.

The extent of technological progress obtained from equation (12) was 15 percent (see Appendix IV). This thus confirm to our hypothesis that poor technological progress has been experienced in the Nigerian Tobacco Company over the years.

TABLE 4.7

Constant elasticity of production function regression results.

Constant Term	Wage rate (w)	Time factor (t)	R^2	R^{-2}	DW	N
3.83 (3.36)	-0.583 (-1.34)	-0.231 (-6.23)	0.89	0.87	2.09	15

Figure in parentheses represent the t-ratio

Further, the model II does not have the problem of auto correlation as indicated by DW value.

Model III

The results was presented in table 4.8, from this table, it could be seen that the $R^2 = 0.88$ which means that 88 percent of variation in dependent variable was explained

by explanatory variables. A high R^2 value indicated a good fit. We further observed that 100 percent changes in the level of past investment on imported machinery will bring about 91 percent changes in the level of current output of cigarettes in the same direction.

This therefore confirms to our hypothesis that output level of Nigerian Tobacco Company Zaria, depends on the import levels of cigarettes making machinery, spare parts and chemicals. We further observed that the coefficient of investment in the past period is significantly different from zero at 5 percent level of significance.

The coefficient in the regression model was positive signifying positive contribution to total output. This is consistent with the hypothesis of a direct relationship between the dependent and explanatory variables.

TABLE 4.8

Import Dependency Regression Results Model III

Constant Term	Investment in Past period IM_{t-1}	R^2	$\bar{R}^2$	DW	N
3.74 (4.18)	0.915 (9.60)	0.88	0.87	1.20	15

Figure in parenthesis represent the t-ratio

Model IV

The results are presented in table 4.9. The table shows that the imports of machinery, spare parts, and chemicals in NTC Zaria are postively correlated with import

capacity of the economy. The coefficient of determination of 68 percent signifies that the data fit the function.

The elasticity of coefficient in the estimated regression model indicated that 100 percent change in the level of the foreign imported machinery, spare parts, cigarette making machines and chamicals. These findings tends to support our casual empiricism on the fact that import of machinery, spare parts and chemicals are positively correlated to the external reserves of the economy. Further, the coefficient of external reserves was significantly different from zero since the calculated t falls outside critical region.

Table 4.9

Import Dependency Regression Results Model IV

Constant	External reserves (ER) period IM_{t-1}	R^2	R^{-2}	DW	N
2.74	0.744	0.68	0.66	1.60	15
(2.17)	(5.25)				

Figure in parenthesis represent the t-ratio

4.3 RETURNS TO SCALE

Estimating the returns to scale for the Nigerian Tobacco Company, Zaria, we observed that the company in Model I experienced increasing returns to scale in the study period. This was because the coefficients sum up to over 1 (that is 2.07 and 2.00) see table 4.1. A situation of increasing returns to scale implies that output is increasing at an increasing rate. This as we observed in

our findings, the company replaced non specialised equipment with specialised ones. (see Annual report, 1994). This observation however should be treated with caution. This is because acquisition of skills required for the specialised equipment have not been extended to Nigerian staff on the production department. Even if this is true, maintenance and repairs are usually done by expatriate staff who are employed as engineers and technical staff in the firm.

Table 4.10

Returns to Scale

Model	Sums of regression coefficients	Returns to Scale
1	2.07	Increasing
	2.00	Increasing

Source: Computed from Table 4.1 and 4.2.

4.4 POLICY IMPLICATIONS OF OBSERVED TECHNOLOGICAL PROGRESS

Going through the computation from equations 9 to 14, we observed that though we measured our variables in different ways, most indicate good fits. Equation 12 indicate that the rate of technological progress in the Nigerian Tobacco company is rather poor (15 percent). These quantitative results agree with our empirical observation that poor technological progress has been experienced in the NTC Zaria. This according to our observation was due to inadequate research and development (R and D). This R and D is necessary here because it will encourage the use of

domestic resources in the company. Therefore the introduction of modern techniques based on the application of foreign inputs has considerably put the use of domestic inputs into total neglects.

This conclusion is very important because it conforms with the conclusion of Ihuoma (1992) and reflects the position of most industries in Nigeria. It is therefore the use of locally obtained inputs that should be the focus of the company. This includes, for instance, the use of local rather than imported starch and adhesive, fabrication of some machine spare parts in the company's own workshop and local purchase from the Federal Institute of Industrial Research, Oshodi, elimination of certain items from the company's packaging, changes in packet designs and packing specification, use of locally designed knives and drums for separating tobacco leaves and lamina and for conditioning the tobacco mixture content, equipments needs to be up graded using simple technological application and traditional chemicals needs to be refined and considerable research carried out into the new ones.

We therefore observed that the technological innovation of these types need well developed capital goods sectors which is so far lacking. The few emerging ones are weak and have not made desirable impact on the economy. Thus the absence of strong capital goods sector in the Nigerian economy is a missing gap in the quest for rapid and self-reliant industrialization and development.

Poor technical efficiency has been observed in all the

2 versions of model 1. Therefore, the result indicates that an average of 8% fall in output per annum is accounted for by technical efficiency. It can then be safely stated, given these results, that the NTC experiences falling technical efficiency in its production process during the study period.

Technical changes are usually classified as factor augumenting and non factor-augumenting. The former arise from increase in education and training, improved health and research and development (R and D) whereas the latter arises from managerial and organisation improvement. Factor-augumenting technical changes with respect to this study could either be capital-deepening, labour deepening or raw material deepening. The results in table 4.1 and 4.2 have shown that technical changes was labour deepening. The general conclusion to be drawn with respect to factor-augmenting technical changes is that our results have indicated increasing productivity of labour in the production process of the NTC.

The elasticity of substitution (0.58) as obtained in model II is low which implies that factor substitution is also low. This finding actually agrees with those of Kazi and Odama (1982). They established that only 16 percent of the industries in Nigeria exhibited a high level of substitution of capital and labour. Our finding however implies that NTC Zaria, given its production techniques, cannot possibly assist in solving the problem of unemployment in Nigeria. This result strengthens the main

conclusions by Ekuerhare (1978) that the Nigerian industry through import substitution has been extremely socially inefficient and that there was a very high correlation between social profitability and private profitability in the Nigerian industries.

On technological progress, it can be inferred from the results that the Nigerian Tobacco Company experienced virtually no technological progress in its operation during the study period.

Model III establishes that the output of Nigerian Tobacco Company depend on the import levels of the cigarette making machinery, spare parts and chemicals.

Model IV further showed that the Nigerian Tobacco Company was highly dependent on external inputs of machinery, spare parts and chemicals. This conforms to Ihuoma (1992). He agrees that the shortage of foreign exchange limits the production capacity of the manufacturing industries in Nigeria. For instance, in model IV 100 percent change in external reserves brought about 74 percent change in import. We therefore observe that the reliance of the Nigerian Tobacco Company on imported inputs, particularly capital goods means that any significant changes in the external sector will seriously and directly affect the development of the company.

The general conclusion here is that with technological changes our results indicate increasing productivity of capital in the production process of NTC which is imported and so highly foreign exchange consuming. This finding

reenforces the assertion that production process of Nigerian Tobacco is not backward linking (Omosegbon, 1986).

The policy implication of the above development and conclusion is that government should concern itself primarily with economic policy that emphasizes expansion of economic activities to regenerate greater utilization of domestic resources, removing these foreign exchange constraints on intermediate raw material inputs and technical personnel which limit the rate of utilisation of capacity.

CHAPTER FIVE

5.0 SUMMARY OF THE MAIN CONCLUSIONS

This study has examined technological progress in the Nigeria Tobacco Company Zaria, we have attempted to show clearly the importance of technology to development. In doing this we advanced and tested three hypothesis. Firstly, we hypothesized that the Nigerian Tobacco Company over the years has experienced poor technological progress. Second, that the output of the company depends on import level of cigarettes manufacturing machinery, spare parts and chemicals. Third, that the acquisition of spare parts and chemicals depends on the import capacity of the economy.

In verifying the validity of these hypotheses we have examined four (4) models. The first model examined the impact of labour, capital and raw material on the output performance. The second model looked at the technological evaluation. The third examined that output of NTC depend on the investment on import in the past period, while the fourth model examined that the import capacity of the NTC Zaria depend on the import capacity of the economy.

In our discussion of concept of technology, it was concluded that technology does not only concern itself with the knowledge of making technological hardware but also it is influenced by the environment. It has an impact on the society in which it operates, this, infact may be positively or negatively. It is positive when it responds to the need of its host society and when it utilizes

domestic resources in its operation. Technology can also be negative when it is inappropriate to its host society.

Factors which inhibit the achievement of appropriate technologies were identified. These factors include the type of research and development in LDCs, the unwillingness of entrepreneurs to use technologies developed in LDCs. Also the economic policy being used in LDCs favour more of importation of foreign technology. We also identified methods of measuring technological progress. These measures have been summarized as input and output methods.

In our discussion of microeconomic theory of technology, the concept of neo-classical production function was reviewed. The classification of technological progress was established on the basis of Hicks/Harrods classification. We established that technological progress according to Hicks/Harrod can be classified as labour-saving, capital-saving and neutral. Our discussions on the theory of technological progress continued with examination of determinant of technological progress.

The empirical literature of technological progress studies was examined. One of the main conclusions reached is that the import substitution industrialization strategy with respect to unemployment problems, sectoral linkages and transfer may not be generally realized in underdeveloped countries. On the contending views of technological progress in manufacturing industries in Nigeria, it was observed that Nigerian manufacturing

industries exhibited virtually no technological progress during the period under review which reflected the absence of research and development activities and engineering facilities. As a background to the study attempt was made to show the Nigerian Tobacco Company as distinct economic activities. To do this, we examined a survey of Nigerian Tobacco Company. Here we took an historical excursion of the development of the company. We broadly assessed the growth performance and established the increasing use of capital intensive techniques, much of which were imported. We examined also the contributions of the company to the Nigerian economy. We revealed its contribution in agricultural activities, manufacturing, manpower training, linkage effect, the effort of the company to conserve foreign exchange, and the production process of cigarette manufacturing. In our investigation, we ran 5 regressions in all, many of which have the coefficient of determination (R2) values of about 90%. We also established that reasonable numbers of the regressions have Dubin-Watson statistics which indicated no serial correlation at 5 percent level of significance. Thus, in general, the estimated models did not violate the econometric assumptions of non-autocorrelation of the stochastic term.

From the analysis in chapter four, we have observed that model 1 and model 2 showed that technological progress of NTC Zaria is generally poor (that is -15%) during the period under review. This empirical findings support the conclusion of Ihuoma (1992) that the production process and

technological progress of manufacturing industries in Nigeria is poor. It also goes in line with Omosegbon (1986) who said that technical efficiency of the NTC is rather poor. Model 2 further suggests that in the utilization of industrial capacity in both labour and capital, raw material is worth-while. The model also reveals that technical efficiency contribute about 8.8% almost to the falling of the firms output per annum (see table 4.6). For model 3 we have found that output level of NTC is dependent on the import levels of cigarettes making machinery, spare parts and chemicals. In model 4, we have established that the development of indigenous technology was far below expectation. Two conclusions which emerged from these were that Nigerian manufacturing industries are highly dependent on external inputs such as machinery, spare parts and chemicals and that the shortage of foreign exchange can effectively limit the productive capacity of the economy. This has revealed the position of the R and D and the import intensity of the Nigerian manufacturing sector.

Our findings have generally indicated the acceptance of all the hypotheses. And we concluded that despite the increasing return to scale in the face of foreign exchange crisis, the Nigerian Tobacco Company has been experiencing increasing capital using. This increasing capital intensity exposed the problem of R and D activities and worsened the unemployment problem. The poor level of technological progress of -15% is rather too poor for a firm like NTC.

This is an indication that most of the multi-national corporations which were supposed to be the organ of industrialization and economic development do not fulfill their expected roles and therefore, there should be a reprieve towards technological development policy that will address the problem.

The policy implication of the foregoing analysis is that there is the need to facilitate R and D activities not only for the Nigerian Tobacco Company but for the whole economy. This R and D activities should be the type that will encourage the use of modern technology based on the use of domestic input.

Further that the poor state of capital sector in the Nigerian economy, has a serious implication on the industrial sectors. It is therefore pertinent for policy formulation in Nigeria to concern itself primarily with the economic policies that emphasized expansion on economic activity to regenerate greater efficiency and also creates a conducive atmosphere for growth in the capital sector.

It is also important for policy to encourage a comprehensive and broad industrialisation strategy directed at self-reliance and efficiency by encouraging inward looking of domestic industrial production in terms of resources use. By the same token, local management can minimise the adverse effects of foreign exchange availability.

BIBLIOGRAPHY

Aybair, I.J.: Growth and Development of Industries in Nigeria". The Nigerian Trade Journal Volume 38, No. 3, 1963.

Allinola, A.O. and Zeas Plum Chom: "A Long term System Dynamic Model". The Nigerian Economy Policy Analysis Department, Federal Ministry of Industries. 1989.

Arrow, K.: "The Economic Implication of Learning by Doing". Review of Economic Studies. 1962.

Arrow et al: "Capital-Labour Substitution and Economic Efficiency". Review of Economics and Statistic. 42, 1961.

Aiguel, D.J., Lovel, G.A. and Schmdit, P." "Formation and Estimation of Stochastic Frontier Production Timetable Models". Journal of Econometric 6, 1977.

Amano Akihiro: "Based Technique Progress and a Neoclassical Theory of Economic Growth". Quarterly Journal Econometric, 1964 pg 129-38.

Allen, R.G.: Mathematics Economics (2nd Ed.) ELBS, 1959.

Allen, R.G.: Macroeconomics Theory: A Mathematics Treatment. London ELBS and Macmillan (1967).

Bhaskera Rao et al: "An Analysis of Technological Change Factor Substitution and Economics of Scale in Manufacturing Industry in India". Journal of Applied Economics. Chapman and Hall 25, 1993.

Binswagger, H.P.: "The measurement of technological change bases with many factors of production". American Economic Review" 64, pg 964-76, 1974.

Blonstron, M.: "Foreign investment and productive efficiency" Journal, Industrial Economics, 35, pg. 77-164, 1986.

Box, G.E. et al: "An Analysis of transformation" Journal of Royal Statistics Society Series B 26, p. 211-43, 1964.

Blige, J.M.: "Technique efficiency and Economic Performance some evidence of Ghana" Oxford Economic Paper 32, p. 319-339, 1980.

Bagi, F.S. et al: "Estimating production technique efficiency for individual farm in Tennessee" Canadian Journal of Agricultural Economics, 1992.

Batlen, G.E. and Colti, T.J.: "Production of farm level technique efficiency with a generalized frontier production function and panel data" Journal of Econometric, 28, p. 387-99.

Bruton, H.J.: The Import Substitution Strategy of Economic Development, A survey, Pakistan Development Review, Vol. 10, No. 2, 1970.

Chen, E.: "The role of multinational corporation in the production and transfer of technology in Host Countries" Development and Change, 12, 1981.

Clark, W. et al: "Science based industrialization in a developing country. The case of India Scientific Instrument Industry 1947-1968". Modern Asian Studies, 16, (1982).

Crane, D.: "Technological innovation in developing countries". A Review of the Literature Research Policy, 6, pg. 374-95, 1972.

Caprices, R.S.: "Technological transfer and the industrialists integrated technology transfer" on Jacques Richard Ed., 1979.

Comanor, et al: "Patent statistics as measure of technology" Change Journal of Political Economy, 177, (1969).

Cooper, C.: Science, Technology and Production in Underdeveloped Countries, London (1973).

Capriles, R.S.: Technological Transfer and the Industrialists Integrated Technology Transfer in Jacques Richardson Ed.

Delong, J.B. and Semmer, L.H.: "Equipment investment and economic growth" Quarterly Journal of Economics, 106, (1991).

Dosi, G. et al: Technical change and Economics theory, London Hempstew (1973).

David, P.J. et al: An Introduction to Industrial Economics, London George Allen and Unwin.

Diwan, R.K.; Livingstone, D.: Alternative Development Strategies and Appropriate Technology: Science Policy for an equitable world order. New York, Pergamon Press (1986).

Daine, P.J. et al: An introduction to Industrial Economics, London, George Allen and Unwin (1979).

Douglas, Paul: "Comments on the Cobb-Douglas Production Function". In Murray Brown (Ed) 1967.

Egbon, P.C.: The State of Capital Goods Sector in Nigeria. The case of Bendel State, Capital Goods and Technological Development in Nigeria. Proceeding of the Nigerian Economic Sohiti Conference, Minna, May (1990).

Ekukhano, B.: The Economic Appriasal of Import Substitution Industrialisation with Special Reference to the Nigerian Textile Industry. A Ph.D thesis submitted to the University of Manchester in Economic and Social Science Faculty (1978).

Felix, D.: Beyond Substitution. A Latic American Dileman Minegraph.

Farrel, T.M.: A Tale of Issues: Nationalization, the transfer of technology and petroleum multinational in Trinidad - Tobago, Social and Economic Studies, Vol. 28 (1979).

Feyeson, C.E.: The neo-classical Theory of Production and Distribution, Cambridge Press, 1959.

Griliches and Jorges, D.W.: "The explanation of productivity change" Review of Economics Studies, 34, pg. 249-83.

Hicks, J.: The Theory of Wages, London Mcmillan, 1932.

Higgin, B.: Economic Development, New York Western, 1959.

Harrod, R.: Towards a dynamic Economics, London Macmillan, 1948.

Hendason and Quadt (3rd Ed) Microeconomic Theory: A Mathematical Approach Tokyo, McGraw Hill (1980).

Hsing Y.: On the Choice of Production Functions: The case of U.S. Manufacturing Industries. Journal of Applied Economics, Chapman and Hall, Vol. 25, No. 3, pp 321 - 24 (1993).

Hill, H. and Kapirujan, P.: Small Enterprise and Firm Level Technical efficiency in the Indonesian Garment Industry. Journal of Applied Economics, Chapman and Hill, Vol. 25, No. 9, pp 1137 - 44 (1993).

Ihuoma, A.O.: An appraisal of technological progress in the Nigerian Leather Industry. An unpublished Ph.D Thesis (1992).

Kadjo, A.L.: "The problem of environment neutrality of technology and its policy implications" Nigerian Journal of Development, 1 (1970).

Kaliran, K.P. and Tse, Y.K.: "Technical Efficiency measures for Malaysian Food Manufacturing Industry" Developing Economics, 27, pg. 179-84 (1989).

Kabi, M.A. and Odama, J.S.: "Factor schemes technological progress and factories efficiency in selected industries in Nigeria 1962-1975" Nigerian Journal of Economic and Social Studies, 23 (1981).

Kalijan, K.P. and Oblong, M.B.: "A measurement of firm and input-specific technical and allocative efficiency" Applied Economic, 26, 1994.

Koutsoyomis, A.: Theory of Econometrics, Macmillan, London, 1978.

Koutsoyomis, A.: Modern Macroeconomics, Macmillan, London, 1973.

Katz, J.: Domestic Technology Innovations and Dynamic Comparative Advantages: Further Reflections on a Comparative Case, 1984

Kamine, M. and Schwartx, N.: Market Structure and Innovation. Cambridge University Press (1982).

Lieldholm, C.E.: Production Function for Eastern Nigerian Industry. Nigerian Journal of Economics and Social Studies, Vol. 8, No. 3 (1966), pp 427 - 36.

Livingston, I.M.: Economic Development. Theory, Policy and International Relations, New York, Basic Book.

Meansen, W. and Vanden Broech G.: "Efficiency estimation from Cobb-Douglas Production Function with composed error" International Economic Review, 18, pg. 135-44.

Needhaw, D.: "Market structure and firm R and D Behaviour" The Journal of Industrial Economic Vol. 23, (1979).

Nnanna, O.J.: "Managing SAP: An economy in Transition" CBN Publication 18, (1990).

Nigerian Tobacco Company Annual Report and Accounts. Various Edition, Lagos Academy Press.

Nigerian Tobacco Company Limited at "a glance - A Brochure". (1984).

Nigerian Tobacco Industry Publication (Facts and Figures about NTC, 1985).

Oyemekwe, C.E.: Economic Development : An Inside View, London, Longman.

Oyejide, T.A.: Tarriff Policy and Industrialization in Nigeria, Ibadan. Ibadan University Press, 1955.

Omosegbon, O.O.: The Production Function. A case study of Nigerian Tobacco Company, Zaria. Unpublished M.Sc thesis.

Odama, J.S. and Kazi, U.A.: "Factor Shares, Technological Progress and Relative Efficiency in Selected Industries in Nigeria 1962 - 1975". In Njess, Vol. 23, No. 3, pp 441 - 45 (1981).

Odama, J.S. and Kazi, U.A.: "Rate of Capital - Labour Substitution in Time Series Production Function in NIgerian Manufacturing Industry, 1962 - 1975". In Njess, Vol. 24, No. 1, pp 37 - 53 (1982).

Osagie, E. and Odaro, M.O.: "Production Function in Selected Nigerian Manufacturing Industries". Vol. 17, No. 1, pp 151 - 57 (1982).

Rossenger, G.: The Economics of Production and Innovation" An Industry perspective. Oxford Pergamon Press (1980).

Rabic, M.A.: The Production Function of the Textile Manufacturing Industry in Nigeria. A case study of the United Nigerian Textile Limited. An unpublished M.Sc thesis.

Steronal, F.: "Choice of Techniques in developing countries" Journal of Development Vol. 9, No. 1 (1972).

Schumpeter, J.: Capitalism and Democracy, London Allen and Lumin, 1943.

Schumpeter, J.: The Theory of Economic Development. Harvard University Press, 1934.

Solon, D.A.: Technology and Change, London, Oxford Pergamon Press, 1967.

Steward, F. (1978): Technological and Underdevelopment, London, Macmillan.

Sapastic, L.: Understanding Technology, Baltimore, John Hopkin University Press (1973).

Sen, A.K.: Choice pf Techniques: An aspect of the theory of Planned Economic Development, Oxford Basic, Blackwell.

Schummachen, E.: Small is Beautiful. A Study of Economics as If People Mattered. Blond and Priggs (1973).

Sinha, R.: Foreign Participation and Technical Efficiency in Indian Industry. Journal of Applied Economics. Cahpan and Hall, Vo. 25, No. 5, pp 583 - 87 (1993).

Stewart, F. : Choice of Techniques in Developing Countries. Journal of Development Studies, Vol. 9, No. 1 (1970).

Stewart, F. and Streeten, P.P.: Conflict between Output and Employmnt Objectives in Jolly, R. et al (Ed). Third World Employment Problems and Strategy, Harmodsworth Penguin Books (1973).

Sagastic, F.R.: Technology, Planning and Self-Reliant Development - A Latin American View, New York, Praeger Publishers (1979).

Transman, C.: "Research and development in Electronic Capital Goods" National Institution for Economic Reviews, Vol. 34 (pg)65).

Todaro, M.: Economic for Developing World, Longman (1977).

UNITAD: Major Issues Arising from the Transfer of Technology to Developing Countries, TD/B/AC 11/10, 1977.

Wynn, R.F. and Holden: An Introduction to Applied Econometric Analysis, London, Macmillan (1974).

Wu, Y.: Scale factor intensity and efficiency: An empirical study of Chinese Local Industry. Journal of Applied Economics, Chapman and Hall, Vol. 25, No. 3, pp 335 - 42 (1993).

Zarembka, P.: On the Empirical Reference of the C.E.S. Production Functions. Review of Economics and Statistics, Vol. 52, pp 47 - 53 (1960).

APPENDIX I

NTC DONATIONS AND GIFTS (measured in Naira) 1994

	N : K
Kaduna Polo Club	189,250.00
Saminaka Flood Disaster	100,000.00
Sokoto State Government Relief Fund	100,000.00
Nigerian Youth Trust	66,600.00
Nigerian Union of Journalist, Oyo State	48,000.00
Farm Management Association of Nigeria	29,000.00
Ala Farmer Cooperative Society	29,950.00
The Nigerian Stock Exchange, Ibadan	15,000.00
Zaria Local Government	15,000.00
Nigerian Farmers Council	10,000.00
Nigerian Conservative Foundation	10,000.00
American Women's Club of Lagos	10,000.00
Kaduna State Endowment Fund	10,000.00
Nigerian Army Officers Wives Ass.	10,000.00
Rotary Club of Zaria	8,000.00
Nigerian Union of Journalists Ondo State	7,000.00
Actuarial and Investment Students Ass. (Univ. of Lagos)	5,000.00
Others (below N5,000)	42,270.00

SOURCE: Annual Report and Statement of the NTC, 1991.

APPENDIX II

THE OUTPUT AND INPUT VARIABLES OF NTC
Measured in Naira

Year	Gross Sales (Y) (000)	Capital employed (K) (000)	Labour employed (L1)**	Raw material (K1) (000)	Wage salaries (L) (000)	Import (IM) (000)	External reserve (ER)* (000)
1980	29187	2079	976	11074	16020	2568	5445.6
1981	30176	2136	1045	12041	18454	2968	3424.8
1982	43414	2247	1086	12027	19072	3074	1026.5
1983	64546	2342	1097	13037	20756	3178	781.7
1984	70985	2647	1176	14147	21099	3212	1143.8
1985	116053	2984	1268	17953	23172	3574	1641.1
1986	13966	3374	1294	22041	25609	3838	3587.4
1987	173566	3838	1362	89031	27758	5404	4643.3
1988	247395	5404	1551	136826	36938	18750	3272.7
1989	407981	18750	1637	153632	43742	18075	13457.1
1990	505586	15307	1742	218383	30726	15307	34953.1
1991	694302	27586	1832	210370	57445	27586	44249.6
1992	868720	132866	1738	330165	46336	132866	13992.5
1993	1563072	91373	1398	384996	56499	91373	67245.6
1994	1718220	82445	1334	563036	79989	82445	76688.4

SOURCE: The Annual Report and Account of NTC for Various Years.
* SOURCES: CBN Publication (1994): Statistical Bulletin.
** Measured in physical quantity.

APPENDIX III

In obtaining the value of the technological progress of NTC, the CES production function can similarly be specified as follows for NTC, Zaria:

$$Y = e_o(bk^{-n} + (1-b)L^{n-1})^{1/n} \quad 15$$

Y	=	value added
e_0	=	productivity index
k	=	capital employed
1-b	=	labour input intensity
e	=	the substitution factor
L	=	labour employed
b	=	capital output intensity.

Rearranging the equation as done by Chen (1981), assuming profit maximization under perfect competition in both the product and factor markets (see Ihuoma, 1992), we obtain:

$$\log Y/L = \alpha \log [eo^{(n)}(1-b)^{-1}] + \alpha \log w \quad 16$$

where

Y/L_1	=	productivity per person
W	=	wage rate
σ	=	elasticity of substitution.

In its unrestricted form, equation 16 becomes:

$$Log Y/L_1 = e_0 + e_1 \log w + u_0 \quad 17$$

where

e_0	=	constant term
e_1	=	elasticity of substitution
u_0	=	error term.

To introduce technological changes, we assume:

$$A = A\,0e^{rt} \quad 18$$

where

e = the exponential rate of technical progress.

The equation 17 becomes:

$$\log Y/L = \log e_0 + e_1 \log w + e_2 \log t + U_o \quad 19$$

where

t = time trend

e_2 = coefficient of time trend

where

$$e_2 = r(1-\alpha) \quad 20$$

r = *rate of technological progress* $r = e_2/1-e_1$

from equation 20

$$r = e_2/1-\alpha \quad 21$$

According to Hicksen technological progress as defined in equation (19) is neutral, exogenous and disembodied since to (Chen, 1981). It is the disembodiment assumption that gives rise to statistically significant estimates. For this we adopt the conventional method of estimating the rate of technological progress as represent by:

$$r = e_2/1-e_1 \quad 22$$

Thus in the estimated form, 22 becomes:

$$r = e_2/1-e_1 \quad 23$$

It is therefore easy to estimate the value of rate of technological progress in any industry.

APPENDIX IV

From Model II:

$$LogY/L1 = 5.83 - 0.583L/L1 - 0.231T$$

where

$e_1 = -0.583$

$e_2 = 0.231$

Thus:

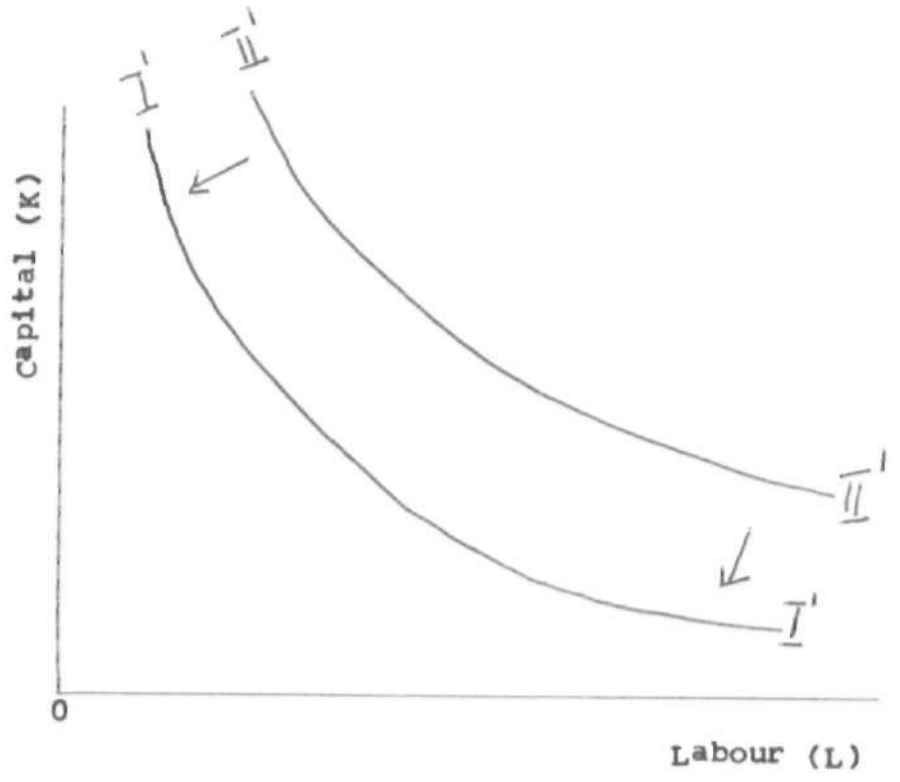
$$r = \frac{e_2}{1-e_1} = \frac{-0.231}{1-(-0.583)}$$

$$= \frac{0.231}{-1.583}$$

$$= 0.145$$

$$\approx 15\%$$

APPENDIX V



Technological progress