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An analysis of efficiency in the trucking industry in Tanzania

September
1996

AN ANALYSIS OF EFFICIENCY IN THE TRUCKING INDUSTRY IN TANZANIA

SERVACIUS BEDA LIKWELILE

A Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy (Economics) of the University of Dar es Salaam

UNIVERSITY OF DAR ES SALAAM

September, 1996

CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the University of Dar es Salaam the thesis entitled: ***An Analysis of Efficiency in the Trucking Industry in Tanzania*** in fulfilment of the requirements for the degree of Doctor of Philosophy (Economics).

Ndulu

Professor Benno J. Ndulu

(SUPERVISOR)

Date 2nd August 1996

DECLARATION

I, SERVACIUS BEDA LIKWELILE, do hereby declare that this thesis is my own original work and it has not been presented and will not be presented to any other University for a similar or any other degree award.

SERVACIUS BEDA LIKWELILE

Date 25/09/1996

ABBREVIATIONS

AERC	African Economic Research Consortium
BoT	Bank of Tanzania
CIS	Commodity Import Support
CODESRIA	The Council for the Development of Social Science Research in Africa
Coop	Co-operative Union
CRDB	Co-operative and Rural Development Bank
DEA	Data Envelopment Analysis
DPF	Deterministic Parametric Frontier
EIU	Economist Intelligence Unit
ERP	Economic Recovery Programme
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
IMF	International Monetary Fund
MRC	Multisector Rehabilitation Credit
NCPI	National Consumer Price Index
NESP	National Economic Survival Programme
NIT	National Institute of Transport
NMC	National Milling Corporation
NPC	National Price Commission
NRHC	National Road Haulage Company
NTC	National Transport Corporation
OECD	Organisation of Economic Co-operation and Development
OF	Own Funded Imports
OGL	Open General License
OLS	Ordinary Least Squares
PE	Public Enterprise
PTA	Preferential Trade Area
RETCO	Regional Transport Company
RTCC	Regional Transport Co-ordination Committee
SCP	Structure-Conduct-Performance
SMC	State Motor Corporation
TAZARA	Tanzania Zambia Railway Authority
TIRIP	Trucking Industry Rehabilitation and Improvement Programme
TLA	Tanzania Licensing Authority

TRC	Tanzania Railway Corporation
URT	United Republic of Tanzania
WB	World Bank

ACKNOWLEDGEMENTS

I am grateful to, first and foremost, my supervisors Prof. Benno J. Ndulu, Executive Director, African Economic Research Consortium (AERC) in Nairobi and Dr Nils Bruzelius of the Department of Economics, University of Stockholm, Sweden for their guidance and unwavering encouragement and support throughout the thesis writing period; their busy schedules notwithstanding. Without them the completion of this work would not have been possible.

I am also thankful to the University of Dar es Salaam, my employer, for availing me with the opportunity to pursue Ph.D. studies. My thanks go also to Prof. Gasper Munishi, Dean Faculty of Arts and Social Sciences, who made sure my one year study leave was approved and guided me well through the *viva voce;* my Head of Department, Dr Ammon Mbelle and Prof. Joseph Semboja, Director Economic Research Bureau, who provided me with institutional support. The post *viva voce* supervision by Prof. J. Semboja and Dr W.E. Maro is also highly appreciated. I also thank all staff members in the two departments for their co-operation. I particularly thank Dr F.P. Mtatifikolo who keenly followed-up my progress.

I thank the Dar-Lund Co-operation which financed my three year (1987-90) course-work studies at the University of Lund. Special thanks are due to Ulla Olofsson, the programme administrator and co-ordinator, for her motherly care. I am also thankful to Prof. Göte Hansson, the academic co-ordinator of the programme, who had always followed up and shared the anxieties of our progress. The training in microeconomics and mathematical economics received from Prof. Lars-Gunnar Svensson will always be remembered.

Gratefully acknowledged is the financial support from AERC and CODESRIA which enabled me conduct research, and the Dar-Trondheim Research Co-operation who financed (under NUFU programme) my one year thesis writing at the University of Trondheim, Norway. My gratitude to Dr Knut Stenberg, the then Division Manager of SINTEF-Applied Economics, the current Manager Dr Kjetil Haugen, Dr Haakon Hellenes, and Dr Wilbald Maro, for their support during my stay in Norway. I am also thankful to institutions and trucking operators who provided me with the data.

I thank Marielle Christiansen, Dr Kåre Johanssen and Dr Jon Magnussen all of the Department of Economics University of Trondheim who supplied me with the necessary software and for their valuable comments on my draft chapters. I am also thankful to Morten W. Lund, Anders Stølan, Rut Dahl, and Nina Sindre who assisted me in a number of ways

One important source of inspiration has been friends and colleagues in the Dar-Lund programme. With them I shared what it meant to be a PhD student under the programme. We had, fruitfully in most cases, to turn into inspirational speakers for one another. I thank particularly L. Rutasitara, E. Luvanda, P. Mpango, O. Mashindano, T. Nyoni and H. Mwinyimvua.

I am greatly indebted to my wife Mary and our children Raymond-Babu, Doris-Ndewa and Liga-Beda for their support and endurance while they were away in Armidale, Australia. Their understanding has been crucial and invaluable in enabling me give my mind to the studies. This little achievement is for my family as a whole.

Some believe that writing a dissertation is character building. I surely revere and consider it to be a respectable institution in its own right. I would like to thank all those who have, in one way or the other, assisted me accomplish this work. All deficiencies still in this work remain solely my own responsibility.

Servacius Beda Likwelile

DEDICATION

To my children Liga-Beda, Doris-Ndewa and Raymond-Babu

ABSTRACT

The lacklustre performance of the distinctive trucking sector in Tanzania has concerned policy makers and analysts preoccupied with finding and instituting measures aimed at reinvigorating the economy, after years of suffering from the severe economic crisis. It is acknowledged that the revival of the economy is very much predicated on the proper functioning of the trucking sector; itself a victim of the crisis.

Of greatest concern has been the operating environment, dictated in large part by the regulatory framework (legislative and administrative) governing operations in the sector, which has imposed attenuating circumstances to operational efficiency, causing non-optimality in firm performance. The need to examine the structure of the trucking industry and its effect on productive efficiency, productivity growth and identification of the main determinants of performance, and to propose remedial measures had become apparent. This forms the gist of this study.

A performance analysis is carried out, much more deeply for the public subsector on account of data availability. The structure-conduct-performance (SCP) paradigm is used to show how the current structure has evolved; the effect of regulation on industry and firm performance is also examined. Cost and frontier production functions' estimations are conducted to identify determinants of performance, evaluate productive efficiency in relation to best practice technology and show its development overtime.

Findings confirm the existence of inefficiencies and lack of productivity in the industry. Substantial cost saving possibilities exist in terms of expansion, to economic advantage, of the scale of trucking operations, improvement of capacity utilisation and rationalisation of the use of resources in the production of trucking services. Competitiveness requires institutionalisation of these cost saving measures.

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CHAPTER I

INTRODUCTION

1.1 Background and Purpose

Since late seventies, Tanzania has been experiencing a severe economic crisis. The poor functioning of the transport sector, itself a victim of the general decline in economic performance in the country, is cited as one of the major causes.[1] Indeed problems in a sector such as transport, which impinges on much of the social and economic life of a country, requires special attention. In Tanzania, transport sector problems have manifested themselves in the form of continued deterioration of the infrastructure, inadequate fleet and poor performance, though in varying degrees, of transport operators such as railways, airlines, and road haulage firms. Several measures have consequently been proposed to redress the situation with emphasis that operations be liberalised (commercialised) so that the sector becomes more cost-efficient in the utilisation of resources (Maro et al., 1993; URT, WB and IMF, 1991).

Central in the discussion is the role played by the road and road transport industry that is distinctive in transportation and hauls about 70% of freight traffic in the country, the bulk of which being agricultural crops. However, the performance of this vital industry has been unsatisfactory. There has, as a result, been increased interest to undertake economic performance analysis as part of the process of identifying areas of improvement.

Important issues for policy reforms widely emphasised include the need to establish to what extent the available scarce resources are used as well as they should

[1] See economic strategies adopted since 1981, i.e., National Economic Survival Programme, (NESP, 1981), Structural Adjustment Programme (SAP, 1982), and Economic Recovery Programme (ERP I & II, 1986,1989).

operations in the sector. Also added inputs to successful reforms involves knowledge about the level and rate of productivity growth to help address the question how productive efficiency has developed overtime, and determine the scope for efficiency improvement in the industry. It is widely acknowledged that the pervasive role of the trucking industry makes efficient performance and strong productivity growth in the sector essential to the attainment of objectives in other sectors. Surely more efficient utilisation of existing transport facilities would be highly desirable.

Crucial and linked to the above is the necessity to improve management and operating practices. Managerial talent in the transport sector is described by Mwase (1993) to be at a low ebb. Evaluation of the performance of economic regulation (transport activities being highly regulated) and public institutions (as they hold a central position in freight operations in the country) underpin the reform measures now underway in the transport sector (URT, 1994a). This makes it necessary the examination of the structure of the industry under consideration and the regulatory framework as these have a bearing on industry and firm performance.

It is against this background and the importance attached to future policy formulation that a need has arisen to look at the efficiency and productivity performance of the trucking industry, and how different operators have performed over the years, with the aim to propose remedial measures. It is such critical assessment of the situation on the ground that will provide some of the needed policy inputs to smoothen operations in the industry. This is the task this study has set itself to accomplish.

In Tanzania both public and private, small and large operators offer trucking services. A few studies that have been carried out in the country suggest existence of differences in operational efficiency between public and private operators. Private operators are viewed to be efficient performers, the opposite is the case with their public counterparts. The latter have, however, been beneficiaries of preferential treatment made possible by the regulatory (legislative and administrative) environment which guide operations in the sector (Mwase, 1994). A comparative assessment of public and private operators would thus provide a complete picture of the operational environment surrounding the trucking sector and identify factors that determine individual firm operations.

Unfortunately, meaningful data for operational costs and output necessary for such a comparative study is only available for the regional transport companies (RETCOs) making it impossible to conduct direct comparison between the major players in the trucking market, hence the confinement of the deeper analysis to the public subsector. The RETCOs are a set of public firms which hold an outstanding position with regard to trucking operations in the country. They were established to specifically deal with transport oriented activities. They have operational autonomy in the sense that each is invested with own management team charged with making and effecting day to day decisions, are located in different regions but have one overseeing organ, the National Transport Corporation (NTC).

The fact that they are publicly owned adds to the analysis a very important dimension for policy, especially now when this kind of arrangement is evaluated the world over. Articles establishing them refers to the RETCOs as common carriers in the sense that they are obligated to carry for anybody, at government sanctioned charges, any goods which might be offered to them (Mtaki, 1988). They are therefore a microcosm of the regulated, publicly owned, trucking sector in Tanzania.

The general concern about trucking performance and effect of policy (trucking regulation and thus ownership in this case) does, therefore, directly touch this particular set of firms. According to TIRIP (World Bank, 1977) the RETCOs were, for efficient operation, to be guided by a predetermined set of performance indicators. An examination of the firms' operational data reveals that only a few firms have been able to meet some of the indicators and have done so in certain years only. There have thus been differences in operational performance between them.

The differing locational features, for instance, in terms of road condition, availability and type of goods for shipment, etc., must have important implications on input/output mix, scale of operation and generally on individual firm performance. Variations in efficiency may as well be attributable to poor management and organisation particularly in co-ordinating haulage operations and general control over costs. Individual RETCO performance would therefore be best evaluated if compared to an observed standard in the group. This is important in terms of policy in that it will provide knowledge as to how firms use available and known trucking technology (all assumed to have access to), and also how to improve operations of the RETCOs, and more specifically, of the relatively inefficient ones.

A few studies that have studied trucking operations in Tanzania have used, among others, ratio analysis (Mrema, 1979; Bagachwa, 1981), qualitative assessment (Mwase, 1985) and econometric techniques on scale economies (Likwelile, 1987) and partial productivity analysis (Haule, 1987). This study is a new attempt therefore at using the suggested set of approaches (see section 1.3) to analyse the operational performance of the RETCOs with the possibility of generalisation of the results to the whole trucking sector in the country. If not, findings here should provide motivation for the study of another set of firms, if not the industry as a whole, data permitting.

However, as Hooper (1987) and Odeck (1993) point out, generally literature on the efficiency of the road sector using the suggested methodology is still severely limited. This deficiency, together with the type and quality of data available, has to some extent affected some constructions and results in this study. Nevertheless, the findings provide one with the best reflection of the operational features of the (regulated) trucking industry in the context of Tanzania.

1.2 Objectives of the Study

This study addresses the issue of productive efficiency of the trucking industry in Tanzania. It is an attempt to show how the trucking firms, particularly the RETCOs which are prominent in the business and for which data is available, perform in the production of their services. The aim is to examine the relative (in)efficiency between these trucking firms that otherwise have similar objectives. It is also of interest to know sources of inefficiency and how to rectify the situation. Attention is thus directed at the cost structure, technical efficiency and how this has developed overtime, i.e., productivity performance, for the whole set and for individual firms. Policy affecting their operations is also discussed in the understanding that this has a bearing on industry structure, which does eventually, impact upon firm performance.

The main hypothesis of the study centres around the inefficient operations of the firms being studied. Specifically the following hypotheses will be tested:

(i) there has been lack of productivity growth in the trucking industry in Tanzania; this is attributed to the fact that the policy environment does not seem to foster productivity enhancement and be conducive to efficient operations generally,

(ii) firms have been operating at inappropriate (sub-optimal) scales and this has contributed to poor performance,

(iii) the poor performance in the operations can also be attributed to inefficient utilisation of factors (capacity), and

(iv) improved operations may require paying attention to operating characteristics which somehow reflect regulatory restrictions.

The study covers the period 1980-1992. The indepth analysis is based on operations of RETCOs. Reference, mostly qualitative with some reliance on past studies, is also made to private operators and co-operative unions for comparison purposes. Selected (partial) operating indicators are used for the purpose. Full incorporation of these operators in the quantitative analysis carried out in this study has been inhibited by lack of operational data on their part.

Both primary and secondary data are used. These have been obtained from National Transport Corporation (NTC), RETCOs, Bureau of Statistics, Central Transport Licensing authority (TLA), Central Motor Vehicle registration department, private operators and co-operative unions.

The problem of availability of good quality data is prevalent in developing countries. This is more so in the road transport sector where record keeping is not widely exercised. Surely this has a severe impact on the analysis and, consequently, on the derived policy prescriptions. Most of our definitions for the variables may be less than ideal. Their construction follows the dictates of data. Appropriate adjustments have been made and the best possible estimates have been used. The aim has been to minimise possible biases emanating from differences in operating environment, technology, or composition of output.

Our reliance on RETCO data for the analysis has helped address some of these concerns. At the end of the year, each RETCO sends to NTC a summarised report that has to reflect previous monthly reports. This helps check on inconsistencies. It does not, however, guarantee congruity with the situation on the ground, i.e., if the records depict exactly what transpired in haulage operations. RETCOs' autonomy in operations and locational differences should provide us with a satisfactory indication of how the (regulated) trucking industry operates in Tanzania. The next section provides the road map to the study.

1.3 Organisation of the Study

As pointed out above, the analysis of the economic performance of the trucking industry in Tanzania has to address the following aspects if meaningful issues for future policy formulation are to be derived: structure of the industry, regulatory policy, productive efficiency and productivity growth. Accordingly the study takes the following structure. Chapter two discusses the trucking industry in Tanzania. The structure of the industry (ownership pattern, size of firms and their locational distribution), its contribution to the economy, (agricultural) transportation institutions, regulatory policy and how it has evolved over time and effects thereof, are some of the issues discussed. The chapter enables understanding and highlights operational features of the industry.

Also important is the knowledge about the players in the trucking business in the country. Chapter three discusses the road freight carriers in the Tanzanian trucking industry. Operators' fleet sizes, their performance overtime (through evaluation of selected performance indicators), and determination of the relative importance of each operator in the industry are among the issues examined. The discussion is done in the context of the economic crisis that beset the economy and policy reforms now being implemented in the country.

The theoretical framework to the evaluation of performance is provided in chapter four. The chapter gives the basis for the indepth analysis done in the subsequent chapters in that it discusses various approaches usually employed in the evaluation of firm or industry performance and reviews literature on efficiency/performance of the trucking industry and related sectors elsewhere and for Tanzania.

Chapter five examines the determinants of performance through estimation of the cost function. This is aimed at identifying factors that characterise the industry's cost structure and which are therefore important in the subsequent evaluation of efficiency. The relative importance of the cost items and operating characteristics in trucking operations, scale economies and productivity growth are among the issues that are addressed here.

Productive efficiency is evaluated in chapter six. Frontier production function approach is employed. Deterministic parametric frontier (DPF) and data envelopment analysis (DEA) approaches are used to provide a comparative assessment of the relative efficiency of firms and thus check on the robustness of the results while acknowledging the purpose, ability and weakness of each method. Aspects of technical, scale and structural efficiencies and capacity utilisation are addressed for identification of ways to save on costs and eradicate inefficiency.

The question how productive efficiency has developed overtime is addressed in chapter seven through an indepth analysis of productivity growth in the trucking industry in Tanzania. This is an attempt at performance analysis directed at an evaluation of cost efficiency in the industry. Two approaches are used, the index number approach and the parametric frontier approach. Trends in total factor productivity and firm attempts at utilising known technology in the production of trucking services are evaluated.

Policy implications as derived from the empirical analysis and policy implications are presented in chapter eight. A recapitulation on the way the hypotheses have been tested, industry and cost structure, productivity and efficiency measurement results and their implications for policy are discussed. A guide for future policy aimed at improving operations in the trucking sector is proffered. Chapter nine provides the summary of the study by revisiting the main findings and points to limitations and what remains to be done.

CHAPTER II

THE TRUCKING INDUSTRY IN TANZANIA: ROLE, STRUCTURE AND REGULATION

2.1 Introduction

This chapter looks at the trucking industry in Tanzania. It covers issues related to its contribution to the economy and the industry's structure where aspects of ownership, firm size, capacity and regional distribution of vehicles are discussed. The supply and demand status in the industry are also examined. It discusses also policies (regulatory framework) affecting trucking performance covering the history, scope and effect of regulation on various aspects of the industry. This is done via the structure-conduct-performance paradigm. It also looks at policy changes now underway and points at the reasons that have precipitated them. Finally, the chapter highlights the operational features of the trucking industry and identifies operational indicators important for the subsequent performance (efficiency) evaluation of the public subsector.

2.2 Trucking and the Economy of Tanzania

2.2.1 Overview

In an agricultural country like Tanzania where people and economic activities are sparsely distributed, the role of transport becomes even the more crucial. Of specific importance is the road transport sector (freight and passenger) and, in particular, the road freight industry which handles about 70 percent of total traffic (measured in ton-kms) in the country[2]. So central is the transport (trucking) sector in the economy that the Economic Recovery Programme (ERP) adopted by the

[2] In the case of Sub-Saharan Africa, roads are reported to carry 80-90 percent of the region's passenger and freight traffic (Heggie, 1995).

government in 1986 had, as one of its key elements, the rehabilitation of the main roads and the trucking sector (URT, ERP 1986-89). The importance of the trucking sector cannot therefore be overemphasised.

However, because of the way data is presently kept, it is difficult to separate the contribution of the trucking industry to the economy from that of the whole (road) transport sector. Except for freight traffic, all other indicators we use here encompass the whole road sector and sometimes economic infrastructure and services. Other aspects looked at are contribution to gross domestic product (GDP), employment, share in gross fixed capital formation (GFCF) and credit and foreign exchange (forex) allocations.

2.2.1.1 Contribution to Gross Domestic Product (GDP)

Table 2.1 shows transport sector's contribution to gross domestic product (GDP) for the years 1982-90. On average the transport sector (road, rail, air, and water) contributed 6.4 percent to GDP annually during the period. The highest contribution was 9 percent recorded in 1990, the lowest being 5 percent recorded in 1988. The average growth rate of transport GDP stands at 2.7, and that for the overall GDP is about 2 percent. Transport sector's performance seems to follow that of the whole economy. An economic downturn meant a poor showing on the part of the transport sector and that the sector did well when there was a general economic improvement. The average growth rate for transport GDP for the period 1980-83 stands at -13 percent, while that of total GDP was -7 percent.

The general positive trend recorded by the economy as a whole in the economic reform era beginning 1984[3] (the background to reforms and the policy changes coming out of the economic crisis are discussed later in the chapter) is also

[3]This is the year during which the first major exchange rate adjustment (with a 20 percent currency devaluation) was effected, fiscal and external balance reforms made and import liberalisation via legalisation of "Own Funds" imports instituted (Bhaduri et al., 1993).

reflected in the case of transport GDP. In all these years, transport GDP has been on the rise, except for a small fall of 0.3 percent in 1986, when the total GDP also fell by 4.7 percent. The highest growth was in 1987 (about 5.6 percent), while the lowest was recorded in the initial reform year itself (about 0.6 percent). Ndulu (1994) reports that the combined growth rate of transport and other economic services, averaged 0.4 percent for 1981-85 period and 4.2 percent for 1986-92 period[4]. Transport sector's contribution to the national economy has therefore been increasing.

Table 2.1: Transport Sector Contribution to GDP (1976 Prices)

	1982	1983	1984	1985	1986	1987	1988	1989	1990
Total GDP (TGDP)(mshs)	23439	22886	23656	24278	25070	26345	27460	28378	29396
GDP Real Growth rate		-7.0[a]	2.7	-3.9	-4.7	4.2	5.4	5.1	4.4
Transport GDP (TG)(mshs)	1694	1473	1482	1509	1504	1588	1643	1663	1736
TG as % of TGDP	6.5	5.7	6.3	7.1	6.5	5.8	5.0	7.2	9.0
Land Transport GDP (LG)*	1237	1071	1086	1112	1106	1172	1198	1216	1253
LG as % of TGDP	5.3	4.7	4.6	4.6	4.4	4.4	4.4	4.3	4.3
LG as % of TG	73.0	72.7	73.3	73.7	73.6	73.8	72.9	73.1	72.2
TG Growth rate		-13.0[a]	0.6	1.8	-0.3	5.6	3.5	1.2	4.4
LG Growth rate		-13.1[a]	1.4	2.4	-0.5	6.0	8.2	1.5	5.6
Total Employment (TE)**	165132	168320	175953	137141	160232	173236	176178	182626	
Transport Employ. (TRE)**	40828	41903	42130	41821	40116	39931	43890	45872	
TRE as % of TE	24.7	24.9	23.9	30.5	20.0	23.1	24.9	25.1	

Note:(a)1980-83, '*' Land transport (rail and road), '**' Public sector (PEs) only
Source: Bureau of Statistics, National Accounts 1976-1992; PEs Accounts 1989, Mbelle (1994), Appendix 6.1.

Also important is transport sector's contribution to employment. Employment figures for the public sector, the only sector with updated data, are

[4]The rates of growth of transport GDP in the OECD countries for comparable periods are reported at 0.82% and 3.64%; rates for economic (GDP) growth have been 1.6 and 3.1 respectively (Nijkamp, 1994).

used. Figures in table 2.1 show that public sector transport activities contributed about 25.3 percent to public sector employment. Employment data for the economy as a whole, ending in 1982, indicate that the transport sector employed an average of 9.7 percent of the total work force in the country (Likwelile, 1987). Bhaduri et al. (1993) report that, for 1991, transport and communications contributed about 10.1 percent of formal sector employment and 3.3 percent of employment in the informal sector.

Land transport (road and rail) comprises about 4.6 percent of total GDP. Its contribution was highest in 1982, about 5.3 percent, it dropped to 4.3 percent in 1990. With regard to the whole transport sector, land transport contributed an average of 73.2 percent of transport GDP. Its contribution in this case appears to have been stable over the period under discussion; it has all along been in the region of 70 percent. It performed poorly before 1984 with an average fall of 13.1 percent for 1980-83 period; just as the whole transport sector was performing badly, with a 7 percent decline. Land transport GDP has grown almost steadily after the economic reforms. It registered an average growth of 3.8 percent per year; the highest growth having been recorded in 1988 (about 8.2 percent). It experienced a small fall of 0.5 percent in 1986, slightly above that of the whole transport sector (-0.3).

It can be observed that, all along, the growth of land transport GDP has been higher than that of the transport sector as a whole. This evidences the dominance and indispensability of land transportation in the country. There are encouraging signs with regard to the performance of the sector during the economic reform era, especially in terms of the recorded positive growth rates, averaging 5.3 percent during 1987-90 period. This could be attributed to the combined efforts, aimed at liberalising operations in the industry, and the emphasis put in reconstruction and rehabilitation of major transport infrastructures under the Integrated Roads Programme (IRP) (URT, 1994a) (see discussion in a later section).

2.2.1.2 Contribution to Capital Formation

Overall investment, i.e., gross fixed capital formation's (GFCF) share of GDP stood at 22.1 percent in 1970-78, 22.3 percent in 1979-85, 26.3 percent in 1986-92 and 27.5 percent in 1990-92 (SASDA, 1994). The share of economic infrastructure (transport, storage, water and electricity) to GFCF has averaged 31.7 percent for 1981-85 period and 27.7 percent for 1986-92 period (Ndulu, 1994). From table 2.2 one observes that transport equipment (vehicles, road works equipment) has on average made up 36.5 percent of GFCF per year. It rose from 13.7 percent in 1982-83 to 49 percent during 1984-87, falling to 17.9 percent in 1988-89, before rising to 48.6 percent in 1990-91.

Transport equipment's average annual share of total equipment is 59.6 percent. One notices an upward surge in the share of transport equipment from 23.1 percent in 1983 to 68.7 percent during 1984-1987. The share dropped in the next two years (1988, 31.3 percent and 1989, 23 percent) before it rose again to 68.7 percent in 1990[5]. One notices, therefore, a boom in the investment in equipment during the economic reform period, with transport equipment playing a dominant role. The effect of import liberalisation measures, i.e., the introduction of various forex schemes which eased the availability of foreign exchange (its allocation is discussed in the next section) used for importation of, among others, transport equipment[6] and exchange rate adjustments, becomes evident here.

[5]In the case of Zimbabwe, transport sector's share in GFCF is reported at 19.6% in 1990 with transport GDP making up for 8% of total GDP. Importation of machinery and transport equipment comprised 37.4, 40.7 and 36.3 percent of total imports in 1990, 1991 and 1992 respectively (EIU Country Report on Zimbabwe, 1994).

[6]For details on how these schemes operate see, among others, Skarstein et al. (1988).

Table 2.2: Transport Sector Contribution to GFCF (1976 Prices)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
GFCF (m.shs)	6052	4042	5891	7221	7007	8964	8823	8055	6946	8428
Agg.Eco-ICOR	-32.5	44.4	19.1	7.8	7.5	7.3	7.5	8.7	9.5	
Total Equip. (TGQ) (m.shs)	3369	2496	4102	5517	4993	6092	5403	5808	4248	6762
TGQ as % of GFCF	55.7	61.8	69.6	76.4	71.3	68.0	61.2	72.1	61.2	80.2
TransportEquip.(TRQ) m.shs)	794	577	2817	3789	3429	4184	1692	1334	2918	4644
TRQ as % of GFCF	13.1	14.3	47.8	52.5	48.9	46.7	19.2	16.6	42.0	55.1
TRQ as % of TGQ	23.6	23.1	68.7	68.7	68.7	68.7	31.3	23.0	68.7	68.7
Transport-ICOR	-10.9	-20.8	-19.3	139.2	47.0	53.9	54.8	90.9	108.0	
Road(RD), m.sh	1339	673	741	635	849	1922	2510	1466	3098	2350
RD as % of TRQ	20.4	14.4	11.7	8.3	11.5	20.5	27.2	16.3	36.7	20.6

Note: Road includes water, Incremental capital output ratio (ICOR) figures adopted from Bhaduri et al. (1993), Table 4.1.
Source: Statistical Abstract: 1992; Tanzania Economic Trend, Vol. 6 (1), 1993

One such scheme is the Export Retention scheme, originally introduced in 1982 and expanded in 1986, which authorises exporters to retain a certain share of the export proceeds, which can then be used for the importation of goods. Another is the Own Funded Imports (OF) scheme initiated in 1983/84. The OF facility concerns individual funds obtained through a variety of activities, and through which, goods can be imported independent of government decisions, i.e., the utilisation of such funds does not require the approval of the Treasury or the Bank of Tanzania (BOT); it does not require access to official foreign exchange resources (DeRosa, 1993).

Other schemes include the Open General License (OGL) system for imports established in 1988 (this succeeded the Multisector Rehabilitation Credit, MRC, introduced in 1986/87 which allowed co-operative unions and private institutions to import and distribute agricultural inputs) whose functioning resembles that of the Commodity Import Support (CIS) scheme. CIS and OGL require a forex recipient firm or institution to pay in local currency at the going exchange rate into a counter value fund held by the Ministry of Finance (Skarstein et al., 1988).

In all these schemes, the transport sector is cited as one of the priority sectors, and this has facilitated the observed increased financing of transport equipment. In addition to the sectoral financing, transport equipment is also acquired through programmes falling under other sectors, especially the industrial and agricultural sectors (if viewed through type of goods imported rather than utilising sectors). On average, transport related equipment accounts for between 28 and 38 percent of amounts spent on import under these various schemes (Skarstein et al., 1988). During the early phase of import liberalisation, beginning with the implementation of OF scheme, transport equipment was favoured over the other categories of equipment. This explains the surge noticeable during the 1984-87 period. With the introduction of OGL and CIS, the emphasis shifted relatively to industrial spares and machinery aimed at boosting capacity utilisation, hence the drop experienced in 1988-1989.

The introduction of bonded warehousing beginning 1990, liberalised further vehicle importation, enabling restoration in 1990-91, of transport equipment importation to the 1984-87 share. The presence and utilisation of the forex schemes, together with the general removal of administrative restrictions (permits) on importation of vehicles and spare parts, enabling vehicle importers to place their orders directly with overseas agents, have considerably eased vehicle importation (URT, WB and IMF, 1991).

Road transport's share of transport equipment is at an average of 18.8 percent. Investment in vehicles has thus comprised nearly one fifth of total investments in transport equipment. The road's share stood at 13.7 percent in 1982-85, increased to 19.7 percent in 1986-88, experienced a small drop to 16.3 percent in 1985, before increasing to 28.7 percent in 1990-91. Investment in road transport equipment has thus averaged 25 percent in the period 1987-91. On the whole, this signifies the importance of the transport sector, especially road transport, to the economy of Tanzania.

An examination of the incremental capital output ratio (ICOR) (its inverse defines investment productivity) shows that for the period 1982-84, investments in the transport sector were associated with declining output, hence the negative ICORs. The economic reforms turned this around, with the year 1985 having an uncharacteristically high ICOR of 139.2, in tandem with the surge in the investment in transport equipment described earlier. In all the subsequent years, transport sector ICORs have been exceptionally high compared to those of the aggregate economy, and have been increasing. The large investments in the transport sector combined with the relatively modest contribution to GDP (table 2.1), tend to suggest that imported transport equipment is being poorly utilised, i.e., there has been low investment productivity in the sector. The poor road network could be the factor; but equally important are the poor operational practices (inefficient facility utilisation) by transport firms.

2.2.1.3 Trucking, Foreign Exchange and Credit Allocations

With regard to forex allocations, distributions based on the amounts made available through the various forex schemes (discussed above) are used here. Table 2.3 provides information on the forex allocations as made available through the forex schemes for certain periods in the years 1987, 1990 and 1992.

In terms of total funds allocated, the transport sector[7] received about 23 percent during the first half of 1987 and 16.3 percent in the July-December period (Skarstein et al., 1988).

Table 2.3: Foreign Exchange Allocations (percentages)

Forex Scheme	Jan-June 1987	July-Dec. 1987	Jan-March 1990	Jan-Oct. 1992
Free resources	24	10.8	-	-
CIS	24	8.6	-	-
Export retention	-	18.9	-	-
Grants/loans	40.9	40.9	-	-
OGL*	-	-	7.7	21.7

Note: * refers to percentage distribution of Letters of Credit (LCs) established
Source: Skarstein et al. (1988) and Bhaduri et al. (1993).

The main sources and percentages that went to transport operations, for the first and second half (in brackets) of 1987 were as follows: Free transport resources as percentage of total "Free" resources (i.e., receipts from exports and net transfers after honouring amounts for tied imports, e.g., oil syndication and other commitments) allocated 24 percent (10.8), Transport CIS as percentage of total CIS 24 (8.6), Transport Retention as percentage of total Retention 18.9 (for July-December only), and Transport Grants as percentage of total Grants/Loans allocated 40.9 (40.9). The table shows that the transport sector increased its share in total OGL funding considerably from January-March (7.7 percent) to 21.7 percent in 1992. It should be noted here that, since the second half of 1993, OGL has been replaced by a system of weekly forex auction (Doriye et al., 1994).

[7]Transport sector activities receiving forex allocations include: Air Tanzania Corporation (ATC), Ferry Rehabilitation, Government Transport Agency, State Motor Corporation (SMC), Trunk Road Maintenance, National Transport Corporation (NTC), Treasury-Crude oil, Tacoshili, Tanzania Harbours Authority (THA), and Transport and Communications. These fall under what Skarstein et al. classify as "propèr transport". There are also a multitude of other transport related activities that receive forex allocations, e.g., body building, General Tyre, etc.

Skarstein et al. (1988) note, however, that generally the amount that went to transport proper (referring to agents that actually deliver transport services, instead of say, dealing with vehicle manufacturing, spare parts selling, etc.) was less than would have been desirable. This could explain some of the problems (infrastructural deterioration, etc.) discussed later in the chapter.

Table 2.4: Commercial Banks Domestic Lending by Sector (m. Tshs)

Sector	1986	1987	1988	1989	1990	1991	Av %
Agricultural Production	1362.3	4039.4	6020.2	6612.4	13224.7	20074.2	8.6
Mining & manufacturing	1451.3	6262.8	14429.8	22429.6	35562.7	43855.3	20.8
Transportation (TR)	414.2	1096.9	1539.0	2223.9	3837.7	4632.9	
TR as % of total	2.1	2.0	2.1	2.1	2.7	2.3	2.2
Agric. marketing	5149.6	35220.7	37324.1	48360.5	49220.4	76530.5	42.2
Other	11097.6	8452.5	14145.1	27040.9	42284.3	53388.0	26.2
Total	19475.0	55072.3	73458.2	106667.3	144129.8	198480.9	100.0
CRDB Loans-total	1235.8	2010.6	2203.1	3046.0	5363.6		
CRDB-rural transport	76.6	528.2	191.6	423.8	2330.7		
CRDB-rural transport %	6.2	26.3	8.7	13.9	43.5		19.7

Source: Bureau of Statistics, Statistical Abstract:1992; Agricultural Statistics, 1989

Another area worth looking at is with respect to commercial lending by banks. Information on bank credit is contained in table 2.4. It may be noticed that out of total domestic lending to various sectors in the country, transportation's share has averaged 2.2 percent for the period 1986-1991, the highest being in 1990, i.e., 2.7 percent. It may be observed, however, that the share going to transportation (in terms of types of goods imported) may be higher than this, in view of the fact that amounts going to the agricultural sector, an important transport utilising sector, has a substantial amount spent on acquiring transport equipment (vehicles) to facilitate crop marketing and input distribution. The agricultural sector's share is not small, a combined figure of 63 percent (20.8 for production and 42.2 for marketing).

Also noticeable is the amount of credit from the Co-operative and Rural Development Bank (CRDB). It may be noticed that transportation is one of the leading sectors in the priority list of loans from CRDB. Over the 1980-90 period, transport's (rural) share stood at 25 percent per annum. The economic reform era saw a substantial increase in CRDB's credit to rural transport; it went up to about 26 percent in 1987, the highest being 43.5 percent in 1990, with an annual average of 19.7 percent for the period 1986-90. It may be noted here that rural transport is comprised mainly of purchase of goods carrying vehicles. So even in terms of domestic bank lending, the trucking industry occupies an indisputably important place.

2.2.1.4 Share of Road Transport in Freight Traffic

Skarstein et al. (1988) report shares of transport volume (in ton-km) handled by various operators in Tanzania for 1985/86 as follows: Tanzania-Zambia Railways (TAZARA) 25 percent, Tanzania Railway Corporation (TRC) 20 percent, truck domestic 44 percent and truck transit 11 percent. Thus, the road freight industry handled a total 55 percent of the traffic. For the subsequent years, the relative contribution of the trucking sector is shown by using international cargo shipped by rail and road for which data are easy to come by. Figures are presented in table 2.5.

It is shown that road transport (trucking) handles slightly more than half of what is transported to neighbouring countries. For a six year period (1987-92), the trucking sector handled, on average, about 56 percent per annum, of transit cargo. The highest shares were 65 percent in 1989 and 61 percent in 1991 and 1992. There is thus an increased use of road transport compared to 1987 (41 percent). A drop in rail cargo could be reflecting reductions in the use of TAZARA in the case of Zambian cargo which, following political changes in Southern Africa which have facilitated removal of sanctions and boycott of Republic of South Africa transport routes, together with rehabilitation of Mozambique and Angolan routes, has diverted some of its traffic to harbours other than Dar Es Salaam (Mwase, 1993). The cited figures show the trucking sector to hold an important place, in the case of transit cargo, for the Tanzanian and neighbouring countries' economies.

Table 2.5: International Freight Traffic by Rail and Road

	1987	1988	1989	1990	1991	1992	Av.
Freight Traffic (FT) (000 tons)	545	651	360	373	389	381	450
Traffic by Road (TR) (000 tons)	223	380	233	206	238	233	252
TR as % FT	41	58	65	55	61	61	56

Source: Maro et al. (1993)

2.2.2 Levels of Freight Traffic Movement

Three levels of traffic movement can be distinguished. These are intra-regional, inter-regional and international (transit) traffic. We base the discussion on the first two, by looking at agricultural transportation which constitutes the lion's share.

Intra-regional transportation is short-distance in nature. With regard to agriculture this level of transportation is mainly concerned with the collection of agricultural produce from various buying posts (primary societies) and channelling it to major godowns in the respective regions. The level of economic development, amount of produce moved within a region and the degree of connectivity between various centres in a region are factors that determine the intensity of intra-regional agricultural transportation. This level of operation is described as being unattractive to profit seeking private operators, due to regulated and uneconomic rates (Maro, et al., 1993). Its short haul nature and the fact that most of the traffic is carried on poor road infrastructure, and thus subjecting operators to high (unrecoverable) operational costs, adds to the unattractiveness (URT, 1994a).

Inter-regional transportation on the other hand, refers to the movement of cargo from one region to another within the country. Movements of crops from the regional godowns to consuming/processing centres and export points, and movement of agricultural inputs to the producers, constitute inter-regional agricultural transportation. Factors that affect this level of transportation include location of marketed agricultural output, location of processing and milling facilities, peakedness of agricultural transport demand, origin of agricultural inputs, condition of roads and possibilities of modal combination/substitution (Msambichaka et al., 1983).

2.2.3 Supply and Demand in the Trucking Industry

In this section an attempt is made to examine the factors that determine the supply (importation) of trucks and determinants of demand for freight services in Tanzania.

2.2.3.1 Supply of Trucking Capacity

The functioning of the trucking sector is dependent on the availability of trucking capacity. Trucks have to be imported. However, the supply (importation) of trucking capacity in Tanzania, has been very much influenced by government policy stance over the years. In the post-Arusha (1967) period, up to beginning of the economic reform era in the early eighties, vehicle importation was restricted and controlled by State Motor Corporation (SMC); mainly due to foreign exchange (forex) constraints (Mwase, 1983). During this time, the position of official forex reserves was a critical factor in the importation of vehicles. The situation changed with economic reforms, especially the introduction of various forex schemes and, most specifically, the legalisation of own funded imports, which have tremendously facilitated vehicle importation (as discussed above). These schemes have eased the availability of forex (Mwase, 1994; URT, 1994a).

This section attempts to establish the determinants of truck importation (*TIMP*) in Tanzania. Both prior reform and post reform periods are considered. The differential role of official reserves and private transfers should become obvious; the former being prominent during the economic restriction era, while the latter in the liberalisation period. The factors considered are gross domestic product (*GDP*) in constant prices and net private transfers, *NPT*, which correspond more closely to financing of own funded imports, and thus reflecting on the measures accompanying the economic reform era.

A dummy variable (*DUM*) for liberalisation (1 after 1984 and 0 otherwise) is included. The expectation is that liberalisation measures have eased the importation of trucks. The country's net foreign reserves (*NFR*), which is an indicator of the country's forex capacity, is also tried for comparative purposes to the situation observed by Mwase (1983). Also included is the truck import price (*IMP*) per average unit. This has been obtained by dividing the value of imported trucks and lorries (at constant prices) by the number of imported units.

GDP and *NPT* (or *NFR*) are expected to be positively related to truck importation, so also for the liberalisation dummy variable. *IMP* is inversely related to the amount of trucks imported. The correlation coefficients presented in table 2.6, indicate that among the independent variables, only *IMP* and *GDP* and *IMP* and

NFR (not important for our models 1 and 2) have high coefficients of 0.83 and 0.85 respectively.

Table 2.6: Correlation Coefficients of Truck Importation Variables

	TIMP	*GDP*	*NFR*	*IMP*	*NPT*
TIMP	1.0000				
GDP	0.7515	1.0000			
NFR	0.6228	0.6725	1.0000		
IMP	0.6716	0.8282	0.8493	1.0000	
NPT	0.7358	0.7053	0.3126	0.5490	1.0000

Source: Own Computations

Both *GDP* and *IMP* are important factors and cannot be dropped to avoid omitted variables bias. Their correlation coefficients with *TIMP* are, respectively, 0.75 and 0.67. Also with high correlation (0.74) with the dependent variable is *NPT*.

The period covered is 1980-1990. This entails too few degrees of freedom (d.f.) to the truck importation function. An extension of the period backwards, to cover 1975-1990 (as data had permitted), did not yield satisfactory results[8]. This may probably be due to the fact that prior to 1984, i.e., a good part of the period 1975-83 was dominated by government restrictive measures and only government resources mattered (see footnote eight). *NPT* funding increased with the reform measures. It may be noted that net private transfers, which averaged Tshs. 20.389m during the period 1975-83, increased to Tshs. 63m in 1984, before jumping to the highest Tshs. 260m in 1986 (IMF, International Financial Statistics, 1993).

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[8]The following results were obtained (with 11 d.f):

$$\ln TIMP = \underset{(0.5794)}{27.243} - \underset{(-0.7608)}{1.6235}\ln GDP + \underset{(0.3904)}{0.1261}\ln IMP + \underset{(2.5704)}{1.0139}\ln NPT - \underset{(-1.0539)}{0.8934}DUM, Adj.R^2 = 0.61.$$

Only *NPT* is significant at 5 percent significance level and bears the expected sign. *GDP* and *IMP* bear incorrect signs. The liberalisation dummy, *DUM*, seems to suggest reform measures have a drawback effect on truck importation.

The Cochrane-Orcutt procedure (by use of a least squares grid search, LSGS) is used in the estimations to circumvent the problem of autocorrelation that is likely to be present because of the time-series nature of the data, and likely effects of omitted variables. This procedure improves the efficiency of the estimators in the sense that, it chooses the optimal value of the serial-correlation coefficient, ρ, with the minimum sum of squared errors, while maintaining the unbiasedness of the estimators.

The truck importation function in the general form is given as:

$$TIMP=f(GDP,\ NPT,\ IMP,\ DUM) \tag{2.1}$$

A log-linear form was estimated[9] and the obtained results are presented in table 2.7. The results are presented in terms of models 1 to 3. Models 1 and 2 use net private transfers (*NPT*), whereas model 3 uses net official transfers (*NFR*). All variables, except *NFR* and the liberalisation dummy, are significant at the three conventional levels and bear expected signs. Variables in model 1 explain about 93 percent of the variations in truck importation. *GDP* and unit import price are the most significant, followed by net private transfers. The liberalisation dummy (*DUM*) is insignificant, bears an unexpected sign and appears, therefore, not to really capture the reform measures.

In model 2, the dummy was dropped. The explanatory power has increased to 94 percent. All variables have substantially gained in significance, and in the case of *GDP* and *IMP*, also the magnitude of the coefficients, with that of *NPT* decreasing slightly. These are the variables that help therefore explain truck importation in the country in the post-reform era. So as the economy grows, one would expect

[9]The non-transformed function was also estimated and the results (not reported to avoid superfluity) were equally good. The log transformed is preffered for easy reference to elasticities.

increased truck importation and that prices play an important role in importers decision making. An increase in vehicle unit import price leads to a decline in the quantity of trucks imported. These results suggest that features of a competitive market economy are beginning to show in the Tanzanian economy.

Model 3 uses *NFR* and, as can be noticed, this variable is insignificant and bears an unexpected sign. This may be explained by the fact that liberalisation measures have made vehicle importation, to a greater extent, independent of the official forex reserves. A contrast can be made with results obtained by Mwase (1983)[10]. As expected, *GDP* and *IMP* bear expected signs and are significant, the model explaining about 75 percent of the variations in truck imports.

Table 2.7: Truck Importation Regression Results

Model	1		2		3	
Variable	**Coefficient**	**t-ratio**	**Coefficient**	**t-ratio**	**Coefficient**	**t-ratio**
Constant	-258.49	-4.7652	-259.32	-5.6106	-344.71	-2.6712
lnGDP	11.27	4.8235*	11.345	5.5775*	15.258	2.6801**
lnNPT	0.3605	2.0747***	0.3184	7.2273*	-	-
lnNFR	-	-	-	-	-0.0378	-0.2322
lnIMP	-0.7879	-4.3504*	-0.8066	-4.9077*	-0.9360	-1.9369***
DUM	-0.1082	-0.2383	-	-	-	-
$Adj.R^2$	0.93		0.94		0.75	
d.f.		6		7		6

Note: * significant at 1 percent level, ** significant at 5 percent level, and *** significant at 10 percent level.

[10]Mwase (1983), using the official reserves, *FEL*, obtained the following results:

$$LIMP = \underset{(2.34)}{1449.5} - \underset{(-2.06)}{0.066}GDP + \underset{(1.71)}{0.741}FEL - \underset{(0.41)}{0.0018}PIMP, \quad R^2 = 0.69.$$

The estimation covered the period 1968-1977. *LIMP* is the number of lorries and trucks imported, *GDP* is gross domestic product, *FEL* is net foreign exchange reserves and *PIMP* import price variable for a 7-ton Isuzu truck. It may be noticed that *FEL* is a significant determinant of truck importation at 10 percent level of significance, *GDP* though significant at 5 percent, has an inverse relationship with vehicle imports. Import price variable is insignificant. This suggests absence of a competitive environment were factors other than prices are decisive determinants, a situation contradicted by the current results.

2.2.3.2 Demand for Trucking Services

The demand for trucking services (in ton-km, *TKM*) is examined. In Tanzania greater freight demand possibilities are in the agricultural compared to the industrial sector (manufacturing having an average growth rate of -0.9 percent for the period 1983-90). The agricultural sector appears therefore to continue to hold promise to the freight industry as its absolute output, contribution to GDP and growth rate have been on the increase since the institution of economic reforms (post-1984 period) (see table 2.8).

Table 2.8: GDP-Agricultural and Industrial Contribution (Tshs m., 1976 prices)

Sector/Year	1983	1984	1985	1986	1987	1988	1989	1990
Total GDP	22882	23656	24278	25070	26345	27460	28378	29396
Total agric. output	9914	10312	10931	11557	12066	12606	13183	13567
as % of total GDP	43.3	43.6	45.0	46.1	46.3	46.5	46.5	46.6
Growth rate of agric. GDP	2.9	4.0	6.0	5.7	4.4	4.5	4.6	6.6
Crop&animal husbandry	9048	9413	9928	10396	11027	11315	11831	12127
as % of agric. output	91.3	91.3	91.8	90.0	91.4	89.8	89.7	89.4
Forestry	236	236	254	278	261	280	292	305
as % of agric. output	2.4	2.3	2.3	2.4	2.2	2.2	2.2	2.2
Industry	3239	3444	3311	3394	3866	4117	3904	4201
as % of total GDP	14.2	14.6	13.6	13.5	13.6	13.6	13.6	13.5
Growth rate manufacturing	-3.3	-8.2	2.6	-3.9	-6.7	7.1	7.7	-2.5

Note: Other components in agricultural output are fishing and hunting products which use specialised vehicles for transport.
Source: URT (1992), Agriculture Statistics 1989, Bureau of Statistics.

The share of agricultural output to GDP stands at an annual average of 45.5 percent, having risen from 43.3 percent in 1983 to 46.6 percent in 1990. The annual growth rates rose from 2.9 percent in 1983 to 6.6 percent in 1990, with an annual average rate of 4.8 percent over the sample period. The increase in tonnage should ordinarily translate into more traffic for hauliers.

The problem of availability of freight demand data for meaningful analysis is, however, acute. Data as reported in Maro et al.(1993) is employed. These figures represent only part of the market, mostly official. The set of variables used, key as they may be, may provide only a partial explanation to traffic generation/attraction in the country. The results should therefore be taken to be indicative of the situation. They indicate all the same the freight traffic generation aspect in the country. Pooled regional and time-series data for 1987-1991 period, covering 18 regions (making up 90 observations), are used (Dar Es Salaam and Coast have been left out for lack of data on *TKM*). What is left out is, in fact, a substantial part of the market.

The demand for trucking services is examined through a simple demand model. Trucking services are postulated to be explained by the level of four factors. Regional GDP (*RGDP*) and regional population (*POP*) as factors that attract the flow of trucking services to the regions; and rank weighted road condition index (*WRD*) and regional freight rate (*RFR*)[11] which are expected to relate inversely (resistant factors) to the flow of trucking services to the regions.

The road network in Tanzania is poor and vulnerable to heavy rain[12]. This makes the type of roads of vital importance for accessibility of a region. *WRD* (adopted from Amani et al., 1987), is thus intended to take into account the aspect of poor road in that it corresponds roughly to the relationship between vehicle operating costs (VOC) on different types of roads. The higher the *WRD* (the poorer the road condition), the more difficult the accessibility to a region and the less the

[11]As it will be seen in section 2.4.3.2, freight rates have been set by government. These have in effect, however, been basic or threshold rates. Each region has been given the mandate, through their respective Regional Transport Co-ordination Committees (RTCC), to set own rates while taking into consideration regional conditions; hence the use of *RFR* as an explanatory variable.

[12]See section on recent developments where the impact of the Integrated Roads Programme is also shown.

attraction/flow of trucking services to and from a region. For *RFR*, which may also reflect the quality and density of road infrastructure in the regions, figures from the regional transport companies (RETCOs) have been used. For regions without a RETCO, rates from contiguous regions with RETCO have been taken to be close estimates of the actual rates in those regions[13].

Again, the Cochrane-Orcutt procedure, with LSGS, is applied. The estimated function, in general form, may be presented as follows:

$$TKM = g(RGDP,\ POP,\ WRD,\ RFR) \tag{2.2}$$

The following results were obtained from an estimated log-linear specification:

$$\begin{aligned}\ln TKM = & \underset{(-3.8776)}{-14.018} + \underset{(3.1541)}{0.3129}\ln RGDP + \underset{(8.6631)}{1.9157}\ln POP - \underset{(-1.9388)}{0.222}\ln WRD \\ & - \underset{(-3.3106)}{0.5116}\ln RFR,\quad Adj.R^2 = 0.77\end{aligned} \tag{2.3}$$

All variables bear expected signs and, as shown in table 2.9, multicollinearity appears not to be a problem. All correlation coefficients are quite small in size. The variables explain about 77 percent of the variations in freight traffic movement in the country. Regional GDP (representing the level of productive economic activity in the regions), population (which shows a significant part of the output generating resources in the regions, confirmed by the correlation coefficient of 0.61 with *TKM*) and regional freight rate, are significant at 1 percent significance level. Index for road density is significant at 5 percent significance level.

[13]The Regional Transport Co-ordination Committees (RTCC) use NTC cost estimates as a basis for rate setting in their respective regions. These are normally the rates used by the RETCOs. They thus give a best estimation of the operating rates in the regions, at least the minimum of (as, usually, private operators charge more).

Table 2.9: Correlation Coefficients for Freight Generations Variables

	TKM	*RGDP*	*POP*	*WRD*	*RFR*
TKM	1.0000				
RGDP	0.1926	1.0000			
POP	0.6122	0.0764	1.0000		
WRD	-0.3999	-0.1728	-0.2262	1.0000	
RFR	-0.1054	-0.0056	0.1041	0.0983	1.0000

Source: Own Computations

The significance of *RGDP* and *POP*, which together represent the level of economic activity, traffic generating capability and the size of trucking market in the regions, is indicative of the fact that the development or growth of trucking operations in the country is very much tied to the performance of the economy as a whole. The most developed areas, with high resource endowments, should be the areas generating and attracting more freight traffic. This does also have a bearing on the location of trucking operators, for whom nearness to the source and destination of cargo is crucial for cost effectiveness. So, left unhindered by restrictive policies, the configuration of trucking operations (spread and intensity) will be predicated on the level of economic development in the various regions in the country.

The significance of *WRD* and *RFR* explains the effect poor road condition has on traffic movements in the country. The fact that virtually the whole road network in Tanzania is poor, must be raising a very important aspect for policy. It makes the poor road related costs, i.e., vehicle damage, increased fuel use, etc., to be of considerable importance in determining the price-output configuration in the trucking market.

It may also be a pointer to the fact that areas with the poorest road networks are the ones suffering a lot, in terms of increased freight charges, i.e., if they are to attract any trucking services at all. Else chances are that they might be missing trucking services completely. Goods have nevertheless to be hauled to and from regions. As such, operators offer services and cover the high operating costs through increased rates (the two variables may be reflecting the quality and density of the regional road infrastructures), to the detriment of the welfare of shippers who have to pay dearly for such trucking services.

2.3 Structure of the Industry

2.3.1 The Concept of Structure

According to Scherer (1980), industry structure is determined by four factors: economies of scale, mergers and concentration, the impact of government policy and stochastic determinants. This is in the spirit of the *Structure-Conduct-Performance* (SCP) paradigm pioneered by Bain, Mason and others; also referred to as the Harvard tradition (Tirole, 1988)[14]. According to this paradigm, market structure contains two sets of variables, intrinsic and derived. Intrinsic variables (also known as basic conditions) are determined by the nature of the product and the available technologies for production and marketing. Derived elements may reflect government policy, business strategies, or accidents of history, as well as relevant intrinsic variables, i.e., those specifically related to the nature of the product. Included in structure are: number of sellers in the market, their degree of product differentiation, the cost structure, the degree of vertical integration, buyer concentration and conditions of entry.

[14]The SCP model in the Harvard tradition is empirical oriented. There is another brand to the SCP which emphasises both rigorous theoretical analysis and empirical examination/identification of competing theories. This is known as the Chicago tradition (pioneered by Aaron Director and George Stigler) (Tirole, 1988). The meaning of structure as per SCP-model is within the context of the traditional industrial organisation theory. Baumol, Panzar and Willig in their theory of Contestable Markets, on the other hand, use the ideas of the Chicago school (in a multiproduct context) to propose an approach to the study of industry structure by examining the effectiveness of potential entry; this they argue, disciplines monopoly (Brock, 1983). Another approach to the study of industry structure is the Putty-Clay which addresses the dynamic aspect of production where structure is related to some degree of inertia in the capital structure of an industry (Forsund and Hjalmarsson, 1987).

Market conduct is concerned with the behavioural rules followed by buyers, sellers, and potential entrants to choose the variables under their control. Conduct is determined by market structure. Important issues here are price, research and development, investment, advertising, etc. Market performance then deals with the assessment part, by comparing the results of market conduct to first-best ideals such as perfect competition, or feasible alternatives. The issues addressed are efficiency, ratio of price to marginal cost, product variety, innovation rate, profits, and distribution.

It is important to note that market structure is, in the long-run, affected by market conduct through, among others, mergers and investments, marketing strategies, and invention and innovation. These may affect seller concentration, product differentiation, attractiveness to entry and availability of technology (Schmalensee, 1989). The kind of structure that evolves in a country does also depend on size and the degree of economic development. Indeed, just like in most other countries, the evolution of the structure of the trucking industry in Tanzania has been very much influenced by these factors, but mostly, by the regulatory policies adopted by the government (Hofmeir, 1973; Mwase, 1980).

In essence, the derived elements in the SCP-model, most specifically government policy, have had a considerable influence in shaping the structure of the industry. Indeed one of the most important aspects of public policy concerns its impact on industrial structure and pricing. In Tanzania, the industry's operations have been so much guided by the overall policy environment (following Arusha Declaration) that it is difficult to characterise the evolvement of its structure on the basis of factors intrinsic to it. This is not to rule out the limited role of some relevant intrinsic features in shaping the structure of the industry as evidenced by the persistence of small private operators despite government policy in their disfavour.

The World Bank (1974) gives testimony to this when it notes that the industry is considered as one of the best starting points (easy to enter and exit) for an independent business career in developing countries.

2.3.2 Structure of the Trucking Industry in Tanzania

This section looks at the structure of the trucking industry in Tanzania as it has evolved over the years. The main determinant has been government policy, an SCP-model derived element, which has institutionalised conditions for entry and general rules of operation. It is the regulatory framework (discussed in section 2.4) that has shaped the ownership pattern, firm size, firm distribution and the institutional set-up and policy which have governed operations in the industry (Hofmeir, 1973; Mwase, 1980). These are the issues that are addressed below.

2.3.2.1 Ownership Pattern

Ownership rights have a bearing on firm performance in that they influence economic behaviour of employees through the incentive system (reward-cost schedule) that is in place. A theoretical discussion on ownership-efficiency relationship is provided in chapter four.

This section traces the ownership pattern in the trucking industry in Tanzania as it has developed over the years. The contention being that it is government policy that has been instrumental in shaping the pattern. The ownership aspect came with the Arusha Declaration in 1967. The declaration stressed the desire to encourage public ownership and participation in economic activities including provision of transport services; referred to here to include co-operatives and parastatal organisations. The trucking industry was thus also affected. One of the stated reasons is the strategic position the industry holds in the country. The industry is central in providing goods haulage services to the general public.

Private operators operate on profit-maximisation criterion. They would therefore avoid loss-making operations, e.g., unprofitable routes, where it would be difficult, for instance, to secure return loads, or where rates charged (government set) are low. A public firm would be easily called upon to fill in supply gaps, ensure lower charges, and be subsidised for the losses incurred. If any profits are realised from operations, public ownership can ensure such profits accrue to the state. This helps ensure a stable supply of transport capacity. Hence the need to establish subsidy dependent transport parastatals (Mwase, 1988)[15].

In the 1970s State Motor Corporation (SMC) was established to help regulate road transport in conjunction with the Transport Licensing Authority (TLA, more on it in section 2.4.2 and 2.4.3) with the aim to develop public owned transport operations through preferential allocation of goods carrying licenses and vehicles. SMC was to be concerned with importation and allocation of vehicles, in which case, transport parastatals and agricultural parastatals with transport wings were to be favoured (Mwase, 1980; 1983; 1984).

Despite the policy stance which had favoured transport parastatals as well as other parastatals (especially agricultural) with transport wings and co-operative unions (some purely transport oriented), private operators have always taken part (Mwase, 1980). There has therefore been a co-existence between public and private operators. The share of the market enjoyed by each, their respective fleet sizes, modes of operation, etc. have, however, been different (see chapter three).

[15]It has, however, been observed that the share of public enterprises (PEs) in each sector in an economy is normally more important when market failures are numerous, that is, in cases with costly or absent information, a shortage of entrepreneurs, externalities, increasing returns to scale, etc. It is also noted that (see chapter four) the higher the share of PEs, the lower the growth rate of GDP. In Tanzania, where PEs grew from 42 in 1967 to 425 in 1984 (Moshi, 1994), the ratio of PE value-added to GDP for the period 1970-1985 is reported (in brackets for neighbouring Kenya) at 12.3 (8.7); average annual GDP growth rate during 1970-81 and 1970-85 are, respectively, 3.0 (6.2) and 2.2 (5.2) (Plane, 1992).

Historically, transport co-operatives had been encouraged to increase possibilities for the participation of Africans in the road transport industry (Hofmeir, 1973). The scope of operation of these co-operatives was limited to their respective regions. Their formation was voluntary, out of loose co-operation of several individual transporters who helped each other to, *inter alia*, obtain freight. The founding of Tanganyika National Co-operative Ltd. (TNT) in 1965 by decree of the Registrar of Co-operatives changed this arrangement. In this case political pressure was applied. This does perhaps explain its disintegration only a year later, in December 1966 (Hofmeir, 1973).

Following the failure of TNT, there had been demands to have a new arrangement. The intention has been to establish a public national transport company which would be commercially oriented (Mwase, 1985). This arose from the fact that the road transport sector was so important that it could not be left solely in the hands of private operators. The National Transport Corporation (NTC) was subsequently founded in 1969.

With regard to goods haulage, NTC formed the National Road Haulage Co. (NRHC) in 1971 as its subsidiary (also known as UMITA). Its national and centralised character, among other reasons, made it difficult for NRHC to survive (Mwase, 1985). A decentralised system was consequently chosen. The regionally based Regional Transport Companies (RETCOs) were subsequently established as subsidiary companies of NTC (more in section 2.4.4 and chapter three).

In addition to these, several crop authorities and Marketing Boards were encouraged to establish transport wings. So also were the non-transport oriented co-operative unions and parastatals like National Milling Corporation (NMC) and Tanzania Breweries Co. Ltd (TBL). The performance of most of these wings has, however, been unsatisfactory (Maro et al, 1993).

The extent of public and private sector participation in the industry can be observed from registration and licensing statistics (see Table 2.10). In the table, total fleet refers to the estimated number of trucks available in the country in a particular year while registration and license figures are for annual recordings. It can be observed that the annual registration of vehicles of public operators accounts for, on average, about 25 percent.

Table 2.10: Motor Vehicles and Licensed Operators by Ownership

Year	Total fleet[1]	Parastatal Registered Vehicle[2]	Parastatal Licensed Operators	Co-operative Registered Vehicles	Co-operative Licensed Operators	Private Registered Vehicles	Private Licensed Operators
1982	16,688	1014	56	n.a.	48	638	1687
1983	15,444	532	50	n.a.	41	385	1488
1984	14,370	981	65	n.a.	41	693	1565
1985	14,425	440	82	n.a.	82	2,833	1798
1986	14,609	539	66	n.a.	64	4,827	1903
1987	14,118	191	70	n.a.	63	2,827	1663
1988	13,422	522	69	n.a.	62	3,599	1762
1989	12,601	87	80	n.a.	49	3,442	1602
1990	11,908	201	66	n.a.	25	3,190	1148
1991	11,287	482	55	n.a.	22	2,503	1245
1992	10,688	564	66	n.a.	50	1,347	1586
%		24.9	3.9	n.a	2.9	75.1	93.2

Note: 1. (no. of trucks) Present arrangements preclude the possibility of obtaining an accurate estimate of the stock of vehicle fleet in the country. These figures, based on estimates by, among others, Ndulu (1988) are taken to be close estimates (see Maro et al, 1993).
2. Includes vehicles owned by Co-operative Unions.
3. Percentages are extracted from Maro et al. (1993).

Source: Tanzania Licensing Authority (TLA) and Maro et al (1993)

Registration figures also show that public operators made up about 61 percent of the vehicle registrations in 1982. For 1983 and 1984 public sector registrations accounted for 58 percent of those years' registrations. Percentages for public sector registrations dwindled beginning 1985, a year after the inception of liberalisation measures, in favour of private operators. In terms of licenses, about 3.9 percent are held by parastatals and 2.9 percent by co-operative unions. The public sector commands therefore about 6.8 percent of the licences[16].

As noted earlier on, government policy stance did not deter private operators from offering transport services. Table 2.10 shows that private operators' annual registrations account, on average, for about 75 percent of the trucking capacity. Their dominance has been reinforced by the liberalisation measures. In the period 1985-1992 registrations by private operators ranged between 70 to 97 percent of annual truck registrations. License figures show transport commercial activities to be the domain of private operators. About 93 percent of the licenses are private. In this case, the domination was there even before policy changes; they accounted for about 94 percent in 1982.

2.3.2.2 Size of Firm

A theoretical discussion on the determinants of firm size, size distribution of firms and effect thereof on efficiency is provided in chapter four. The presentation here is confined to an attempt to throw some light on the size structure of trucking firms in Tanzania by use of licensing figures. Firm sizes are defined in this case in terms of the number of trucks owned by an operator. The use of transport output generated by an operator to characterise firm size for the whole freight industry has not been possible for lack of consistent and reliable data across operators.

As can be seen from table 2.11, 85.5 percent of license holders own one to two trucks. Those in the middle range, i.e., 3-5 trucks constitute 9 percent of license

[16]It should be noted that licenses are renewed after every two years, as such a year's number of licenses shows license renewals made in that particular year and does not stand for the total number of operating licenses in a year.

holders with the remaining 5.5 percent owning six or more vehicles. This naturally defines three groups of firms, i.e., *small* (1-2 trucks), *medium* (3-5 trucks) and *large* (six plus trucks). Small operators thus dominate the trucking industry. In the nine year period, small operators have, on average, grown at 1.1 percent while large operators declined by 2.8 percent.

This may be explaining the easiness of entry into the industry by small and sometimes owner-operators. This may be reflected further by the ranges of the annual percentage shares of license distributions for each group: small firms 81-88 percent, medium firms 7-12 percent and large firms 5-7 percent. The small firms group has a spread of 7 percentage points in between, 5 for the medium firms group and 2 for the large firms group. This may also be suggestive of the fact that competitive pressures are stronger for smaller firms.

Table 2.11: Size Distribution of the Trucking Industry (license holders)

Veh. No.	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Av.	%
1	1321	1154	1170	1476	1563	1360	1424	1259	871	868	1247	73.3
2	225 (86)	205 (85)	219 (83)	244 (88)	206 (87)	216 (88)	191 (85)	218 (85)	158 (83)	201 (81)	207 (85)	12.2
3-5	158 (9)	146 (9)	193 (12)	145 (7)	162 (8)	133 (7)	154 (8)	146 (8)	130 (11)	167 (12)	153 (9)	9.0
6+	87 (5)	92 (6)	89(5)	97(5)	102 (5)	87 (5)	124 (7)	108 (7)	80 (6)	86 (7)	95 (6)	5.5
Total	1791	1597	1671	1962	2033	1796	1893	1731	1239	1322	1702	100

Note: In brackets are percentages; those in row for 2 vehicles are totals for the small group, with vehicles 1-2.
Source: Compiled on the basis of data from TLA files

It should be noted here that most of these small operators own no terminal facilities. In fact to some of them, these may not be important. To them one of the cost savings are associated with non-ownership of such facilities. This creates enough room for flexibility in their operations, unless otherwise restricted by license stipulations. It is also natural that small size operators will principally operate in the truck-load (TL) sector of the trucking industry, compared to the less-than-truckload (LTL) segment (see section on trucking features for a distinction). Difficulties involved in maintaining big fleets (financial problems in the face of rising prices of spares, etc.) could be another problem. Most big operators must have dropped in size (fleet reduction), hence the negative growth.

2.3.2.3 Other Features

There are other important aspects that concern the trucking industry (structure related) which need to be mentioned. Among these are: proportion of own account vis-à-vis for hire operators, capacity distribution and regional distribution of vehicles.

(a) Own Account vs For-Hire Operators

Table 2.12 presents information on these two categories of operators. Own account operators are operators who provide transportation services by operating their own fleets for haulage of their own goods. For-Hire operators are those who own trucks and provide transportation services for others. They operate commercially and are therefore specialised freight transport operators (holders of Public Carrier, category B, licenses, see section 2.4).

However, this does not preclude the possibility of an operator assuming both status. On average 90 percent of operators engage in for-hire services. Own account operators thus account for, on average only 10 percent. These are relatively few and are mostly public firms with transport wings meant to service their primary undertakings.

Table 2.12: Operator Composition (number of licences)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Av.	%
Own Account	144	141	147	206	190	206	245	212	142	130	176	10.1
For-Hire	1647	1456	1524	1756	1843	1590	1648	1519	1180	1572	1574	89.9
Total	1791	1597	1671	1962	2033	1796	1893	1731	1322	1702	1750	100

Source: Compiled from TLA files

(b) Capacity Distribution

A number of factors are responsible in determining the sizes of trucks operators prefer. The condition of roads and road configuration, size of the market served whether intra-regional, inter-regional, international or a combination of any of these (scale economies argument) and financial capabilities are some of these factors. In Tanzania most of the trucking capacity is used to serve the agricultural sector wherein the haulage of crops and inputs dominates (Maro et al., 1993).

The road network in Tanzania is in poor condition. This, together with the dominance of agricultural cargo, obtained mostly from areas not served with good roads, may be rationalising the use of not very heavy vehicles. Table 2.13 reflects this picture. Concentration is in vehicles with capacities in the range 0-10 tons. These constitute 81.7 percent. The 7-tonners are the most ubiquitous in the group. The middle range, 11-30 tons, comprises 17.5 percent, while the range 31-41+ makes-up about 0.8 percent.

It has been observed by Maro et al. (1993) that vehicles of capacities 7-20 tons are mainly used for inter-regional traffic. They observe that for transit cargo, vehicles of capacities above 40 tons are the most commonly used. The statistics show that of the goods carrying vehicles, pick-ups dominate, constituting 48 percent followed by trucks 28.2 percent, tractors 12 percent, trailers 10.8 percent and tankers 1 percent. Trucking capacity is therefore composed of mainly small trucks[17].

However, truck carrying capacity has a bearing on operating costs. Alokan (1995) observes that operating costs decrease with the payload capacity of the vehicle used. This he demonstrates in the case of Nigeria where, for instance, the operating costs per ton-km for five, ten and thirty tonners were, respectively, 8.23, 4.82 and 2.9 Kobo (1 Kobo=1 U.S. Cent, 1980 prices). He observes that the profit margin is thus expected to be higher for larger lorries compared to smaller ones.

Table 2.13: Distribution of Trucking Capacity (Cap) (tons)

Cap	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Av.	%
0-5	1252	1312	1292	1660	1594	1455	1720	1681	1048	1296	1431	40.7
6-10	1655	1539	1596	1570	1459	1287	1679	1474	1062	1094	1442	41.0
11-15	260	269	285	277	316	375	363	425	284	290	314	8.9
16-20	155	187	160	197	185	175	171	216	103	139	160	4.8
21-25	69	87	59	111	75	106	73	108	66	69	82	2.3
26-30	26	25	34	73	64	81	67	67	46	55	54	1.5
31-35	8	16	2	8	9	18	13	20	8	10	11	0.3
36-40	1	8	4	6	15	20	6	10	6	16	9	0.3
41+	6	3	7	14	6	4	5	2	10	6	6	0.2
Total	3432	3446	3439	3916	3723	3521	4097	4003	2633	2975	3518	100

Source: Compiled from TLA files

Also important though, for realisation of this advantage, is the intensity in the utilisation of such capacity. One needs also to take into consideration such factors as the nature of the network on which operations are carried out, the spread and intensity of economic activities utilising transportation services, which will then

[17]For other parts of Africa, the CFA Franc Zone for instance, the structure of the vehicles is such that trucks of 25 tons design capacity are used for long-distance transport and those with 12 ton capacity for shorter regional journeys (Rizet and Hine,1993).

determine the frequency of pick-up and delivery services, and the type of goods handled, i.e., whether agricultural or industrial, perishable or otherwise, etc. These factors are important in making judgement as to the suitability of any one vehicle type and size.

Table 2.14 presents the cost-vehicle size relationship in the case of Tanzania. Unfortunately, only two vehicle sizes are considered. As observed above, these happen to be common sizes in the trucking business in Tanzania. It can be seen that the per ton-km costs are lower for a 10 tonner compared to a 7 tonner. As noted earlier, the cost advantages do not strictly favour anyone size, and this information does not suggest the abandonment of anyone size from utilisation. Rather, it calls for caution in decision making. It expresses the need to consider, among others, the cost-size related factors, while observing the environment in which operations are to be undertaken.

Table 2.14: Cost Structure of 7 and 10 Tonner Trucks (Tshs), 1988

	Seven Tonner		**Ten Tonner**	
	Per kilometre	Per tkm	Per kilometre	Per tkm
Direct variable costs	42.33	10.08	43.08	7.18
Direct fixed costs	48.92	11.64	55.87	9.31
Adm. and overhead costs	13.89	3.31	13.39	2.32
Total	105.14	25.03	112.84	18.81

Note: Exchange rate 1988, USD 1 = Tshs 99.3 (i.e., 1 Tsh = 0.01 USD)
Source: National Transport Corporation (NTC) as reported in Wangwe et al. (1989)

(c) Regional Distribution

Tanzania is a vast country with its population, business and economic activities widely dispersed. Economic potentials and the actual levels of economic development also differ from region to region (Ndulu, 1982). Some are major suppliers of agricultural produce while others are centres of industries and business. Vehicle concentration in any one region would have to reflect such differences.

Surely the locational bias of operators and vehicles is dictated by such factors reflecting the level of economic activity.

Naturally freight operators need to have their operational bases near the source of freight, this is more so when agricultural haulage is a dominant undertaking (Alokan, 1995). We know also that infrastructure and the type and quality of transport services provided have a close correlation (Carapetis et al, 1984). Other things remaining equal, the development of transport infrastructure has significant implications for the spread of economic activities. Table 2.15 gives us the picture of vehicle distribution in the regions in Tanzania.

Table 2.15: Regional Distribution of Vehicles for Category B Licenses

Region	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Av.
DSM	1420	1336	1373	1150	1063	1113	1208	1249	575	1048	1154
Arusha	234	309	263	363	371	444	493	247	254	299	328
Coast[1]	-	-	-	-	-	-	-	-	-	-	-
Dodoma	245	241	188	430	346	365	373	232	284	229	293
Iringa	285	293	312	433	379	318	321	391	262	358	335
Kagera[2]	26	11	19	72	69	27	67	48	48	19	41
Kigoma[2]	16	11	8	26	31	14	7	13	18	11	16
K'njaro	458	523	368	548	359	300	429	428	223	230	387
Lindi[3]	-	-	-	-	-	-	-	-	-	-	-
Mara[2]	9	7	16	38	77	31	28	11	15	19	25
Mbeya[2]	25	27	113	88	156	81	99	96	99	83	87
M'goro	151	124	146	228	173	230	275	284	224	274	211
Mtwara[3]	-	-	-	-	-	-	-	-	-	-	-
Mwanza[2]	48	47	20	67	135	67	112	72	45	62	68
Rukwa	6	4	9	21	52	27	44	16	17	14	21
Ruvuma	287	293	431	226	402	211	361	438	386	211	325
S'nyanga	22	6	24	69	106	42	116	65	46	5	50
Singida[4]	-	-	-	-	-	-	-	-	-	-	-
Tabora	71	111	100	189	165	128	234	102	75	67	124
Tanga	261	216	258	349	465	412	403	352	350	259	333

Note: 1. Contained in DSM figure, 2. Vehicles registered in the region in that particular year, 3. Contained in Ruvuma figure, 4. Contained in Dodoma figure

Source: Central Motor Vehicle Registration Department and TLA

As may be observed from the table, Dar es Salaam holds the lead with 1,154 trucks followed by Kilimanjaro, Arusha and Tanga (northern regions) which together have 1048 trucks. Iringa, Ruvuma, Rukwa and Mbeya (the Southern regions) have 768 vehicles. The Central regions (Dodoma, Singida, and Tabora) have 417 trucks. If Dar es Salaam is excluded, the northern zone leads in the number of trucks available in those regions, followed by the southern regions and then the central zone. For the lake zone (Kagera, Mwanza and Mara) licensing figures, which give a reasonable reflection of available trucks, could not be obtained.

2.4 Regulation of the Trucking Industry in Tanzania

2.4.1 Definition and General Features

Joskow and Rose (1989) define economic regulations as referring to both direct legislation and administrative regulation of the prices and entry into specific industries or markets. Regulatory policies are thus public measures taken with the aim to serve an economic purpose, say, the control of rates, putting conditions on entry in the market say through setting minimum capital requirements, quality of service, etc. Barros (1995) observes, however, that entry regulation is usually accompanied by rate regulation. The argument often advanced to rationalise such government intervention in economic activities, is the need for corrective action to ameliorate effects of the different forms of market failure[18]. It is this argument that has made the subjection of a considerable amount of freight and passenger transportation to economic regulation, a significant feature in the case of transport operations (Winston, 1985).

The argument that is advanced by proponents of regulation is that, if there were a perfectly functioning market in place, the determination of quantity, quality

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[18]For an indepth discussion on the various reasons advanced justifying regulation see, among others, Noll (1989).

and price of transport services, subject to resource constraints and consumer preferences, would be left to it. They contend, however, that such an ideal situation does not exist (Moore, 1986). This justifies, therefore, the conspicuous presence and role of government in the sector to ensure the correct working of the market *(market regulation)*. The government intervenes as a regulator through issuing policies (rules and constraints) to guide operations in the industry (*operations management*). It also gets itself involved as an operator (owner of transportation facilities), and may wish to guide traffic movement on infrastructure (*traffic management*). Regulation is also practised for environmental, technical requirements of vehicles, energy preservation, etc. (Bayliss, 1992; Stubbs et al., 1980).

Reasons for government intervention are varied, depending on objectives of each country. For an agricultural economy like Tanzania, for instance, (discussed in section 2.4.2), the pivotal role played by transportation (especially road) and the desire to achieve balanced development, are cited to be among the factors that necessitated public sector participation in transport operations (Mwase, 1984). The industry has thus been perceived as being "strategic" for national economic development; hence the institutionalisation of ownership regulation.

The regulatory process has its own weaknesses, making economic regulation not to be without effects. The literature on economic theory of regulation and deregulation movement point to a number of factors behind the failures of the regulatory process. It is argued that the effects of regulation are likely to depend on a variety of factors. Among the factors include the insulation, regulated firms are accorded, from actual and potential competition and rents accrued to well-organised interest groups benefiting from regulation (Joskow and Rose, 1989).

It is pointed out in this case that entry regulation may generate deadweight losses and rent-seeking if regulators are influenced or '*captured*' by the regulated firm or consumers seeking cross-subsidies and turn it to their own ends (Stigler, 1971; Posner, 1971). Newbery (1994) observes in this respect that producers who are in the state sector have a comparative advantage in capturing the regulatory framework while those in the private sector, though not laggards, are not quite as adept. Other reasons include the motivation for regulation, the nature of regulatory instruments and structure of the regulatory process, the industry's economic characteristics, and the legal and political environment in which regulation takes place. Effects of regulation are likely therefore to differ considerably across countries, industries and time (Winston, 1993).

The impact or incidence of regulation is usually said to fall on: price levels (high relative to that pertaining in a competitive market), price structure (distorted relative to that of costs) and capacity utilisation (excess capacity due to forced retainment of unprofitable capacity in use). Predictions have also been made concerning the dynamic inefficiencies of regulated firms in the sense that there is always low productivity, slow technological innovation, and poor quality of management in such industries. Regulation is said to at best blunt and at worst pervert the incentives for efficiency and innovativeness (Moore, 1986; OECD, 1987). Deregulation is thus purported to overcome these problems (Moore, 1978; Winston, 1993).

With regard to trucking, the areas of investigation (details on the empirical studies on regulation in chapter four) have been on, among others, the economic conduct, i.e., on such issues as the rates charged and entry/exit restrictions (on routes, commodities) (Moore, 1986). Regulation is also noted to have discouraged cost-saving innovations, stymied productivity growth and restricted firm operations, thus raising operating costs and lowering revenues (Winston, 1993). Regulatory reforms are observed to have lowered shipping costs, eased entry/exit requirements and resulted in better services. It has also stimulated the trucking industry to make innovations in equipment, routing, scheduling, and communications (Winston, 1991).

In the next sections we discuss the history, features, transportation institutions and the effect of trucking regulation in the context of Tanzania.

2.4.2 The Capsule History of Trucking Regulation in Tanzania

Concern about the survival of the railways, which were argued to be the cheapest form of transport and so had to be protected, but were facing growing competition from road operators, led to the enactment of statutory regulations in the 1930s[19]. Initially, road operators were prohibited from transporting imported goods on roads parallel to the railway vide the "Carriage of Goods by Motor Vehicle (Prohibition) Ordinance" issued in 1934 (Hofmeir, 1973). No consideration was given, however, to actual costs of specific sections of the railway and the goods concerned (Hill, 1957).

The next stage saw the enactment of "Transport Licensing Ordinance" in 1956. Its functioning was based mainly on revisions of the freight rate structure with the purpose to single out and thus restrict the kind of traffic different types of transport operators could carry (Maro, 1986). This ushered in restrictive licensing on road hauliers. Two kinds of licenses were provided for in the Ordinance, namely, Public Carrier's License needed for the transport of goods for third parties and Private Carrier License for the carriage of goods belonging to the operator. The licenses were renewable and valid for two years. In 1962, an amendment was made to the 1956 Ordinance. The Transport Licensing Authority (TLA) was established.

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[19]Elsewhere, in the United States for instance, virtually all state regulation of trucks and buses was initiated between 1914 and 1931 by railroad interests due to failure of rail carriers, following the development of competition in the form of trucks and buses for short-haul traffic, to earn a "fair return". This has also been the case for most other industrial countries. The aim has been, in a majority of cases, to protect the market position of the railroads (Moore, 1986).

This was to be an executive body to oversee all commercial road transport. It also included, after 1963, inland water transport (Hofmeir, 1973).

In 1973, a Transport Licensing Act was enacted repealing the Transport Licensing Ordinance. In respect of goods haulage a Carrier's license (category B) was applicable. The Act stipulated that all transport operators have to apply for the road license from the respective licensing authority. The Central Transport Licensing Authority (CTLA) for inter-regional operators and Regional Transport Licensing Authority (RTLA) for operators operating intra-regionally.

The Act cites three main objectives of CTLA and RTLA; these are to: 1) regulate, monitor and control the demand and supply of road transport in the country through licensing, 2) promote road safety through mandatory vehicle inspection for all commercial vehicles prior to issuance of operating licenses, and 3) collect revenue for the government.

2.4.3 The Main Features of Trucking Regulation in Tanzania

2.4.3.1 License Issuance

As noted above transport licenses in Tanzania are issued for two main objectives. Firstly, the control of demand for and supply of transport services along different routes or geographical areas to ensure that routes and geographical areas are served in the best way possible. Secondly, as a means of collecting government revenue from the road users through the various fees charged. For goods haulage, category B license is issued for vehicles with carrying capacity of ¾ tons or more (Wangwe et al, 1989).

According to the Act, the discretion of TLA in issuing licenses is guided by a set of conditions. Among these include: the necessity or desirability of the service in the public interest, the applicant's reliability and financial ability, suitability of the routes on which a service is to be provided, applicant's previous conduct and the number and type of vehicles to be used under the license (URT, 1973).

Licenses are valid for two years and are renewable. There are also short-term or temporary licenses issued by authorities which are valid for 90 days. These are used by operators while waiting for responses on their license applications or for other operations authorities are responsible for (refer section 2.4.2).

Apart from the entry/exit function of licenses, license issuance is also exercised to control capacity. The number of vehicles included in a license and vehicle carrying capacities are all indicated in a license so that additional capacity being added to the market is known by licensing authorities.

2.4.3.2 Rate Control

Freight rates in Tanzania for intra-regional traffic, which caters mostly for haulage of agricultural produce, and inter-regional transportation of petroleum products have been set by the government by requiring the regions to adopt the transport costing done by NTC, with some adjustments to reflect regional conditions (Wangwe et al., 1989). Mwase (1988) contends that, in the case of Tanzania, where the objective has been to protect public transport firms and railway high value traffic from private firms and private road operators respectively, the method used has been that of setting the maximum rate that operators could charge.

The responsible organs for rate setting have been the Regional Transport Co-ordination Committees (RTCC) and the ministry responsible for transportation. Rates for inter-regional (other than petroleum products) and international traffic were, in principle, left to the market forces, to be negotiated by respective transport users or were determined through a tender system.

It is important to note here the role of the National Price Commission (NPC), established in the 1970s, in influencing freight rates. NPC was charged with the responsibility to control consumer prices by enforcing a pan-territorial pricing mechanism. This required traders to charge uniform price on items, at national level, irrespective of geographical variations. This made NPC have an indirect control over freight rates. According to this mechanism, buying and selling prices for various items were set by NPC. This left, therefore, transport operators with a limited room for manoeuvre (Mwase, 1980). So in practice almost all rates were, in one way or the other, fixed by the government (URT, 1994a; Maro et al, 1993).

2.4.4 Trucking Institutions

Another area touched by trucking regulation is that of institutions that deal with the haulage of goods. As noted earlier, both public and private firms, operate in the trucking industry. Public operators are of two categories, those whose core business is transportation, e.g., the RETCOs, and those institutions in which transport plays a supportive role to their main undertakings, like Tanzania Breweries Ltd. (TBL), Crop Marketing Boards and Co-operative unions.

As part of the regulatory environment surrounding the trucking industry in Tanzania, the Agricultural policy of Tanzania (APT) singles out the Regional Transport Companies (RETCOs) and Co-operative Unions, which are thus required to establish transport wings, to be the main transporters of agricultural products (URT, 1983). Cognisance is, however, taken of the role of private operators. To haul agricultural produce, private operators had to be sub-contracted by public operators to fill in identifiable transportation gaps. These players are discussed in detail in the next chapter.

2.4.5 Incidence of Regulation

In this section an attempt is made to examine the effects of regulation on the trucking industry in Tanzania. The coverage is provided to reflect developments that have taken place in the industry in the context of the SCP-model. The discussion is done by looking at the market structure created, conduct in terms of rates charged and performance via operational (in)efficiency and quality of services offered.

2.4.5.1 Market Structure

It is difficult to classify the road freight industry in Tanzania in terms of the market types conventionally used in economics as the type and quality of available data makes it almost impossible to obtain indicators such as, seller or buyer concentration, product differentiation, barriers to entry and market shares (and the way they change hands over the years seen, say, through the variability index) which facilitate making such a classification. This is not to mention the general difficulty involved in measuring and comparing these industry characteristics (Hay and Morris, 1991). However, particular elements of the requirements for the various types may be present.

Table 2.16 provides the characteristics of different markets. Oligopoly is, for example, characterised by large scale, a high degree of seller concentration, a high degree of product differentiation and high barriers to entry, with predictions of above normal profits. This, however, could be offset if there was a high degree of buyer concentration and a low degree of product differentiation. The degree of market concentration, in the absence of potential competition, is thus central to industry profitability[20]. Rosenbaum (1993) notes the presence, in market evolution, of a

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[20]The industry price-cost margin, M, is provided as the sum of the individual firms' profit margins, m_i, each weighted by the firm's market share, s_i, i.e., $M = \sum_{i=1}^{n} m_i s_i = \sum_{i=1}^{n} \frac{s_i^2}{\varepsilon}$; $m_i = s_i / \varepsilon$, where ε is the

dynamic association in the relationship between profits, entry and changes in concentration. The process works in such a way that market concentration affects profitability, profits in turn influence entry and entry feeds back by recasting future concentration and the system is defined.

It has been shown in the case of Tanzania that both, small and large, private and public, operators exist and survive. Whereas private operators have to compete and operate efficiently to survive and are able to negotiate rates, public operators assume monopoly status in certain segments of the trucking market, are forced to charge pre-specified government rates, make losses, but survive. Public operators through government subventions while private operators through, among others, charging high rates and being, generally, shrewd at business (Maro et al, 1993).

Table 2.16: Characteristics of Market Structure

Market Form / Market aspects	**Perfect competition**	**Monopolistic competition**	**Oligopoly**	**Duopoly**	**Relationship with profit**
Scale	Low	Low	High	High	Positive
Seller concentration	Low	Low	High	High	Positive
Buyer concentration	Low	Low	High/Low	High/Low	Negative
Product differentiation	Absent	High	High/Low	High/Low	Positive
Height entry barriers	Absent	Low	High	High	Positive
Profitability	Normal	Above* normal	Above* normal	Above* normal	-

Note: '*' Compared to perfect competition
Source: Adapted from T.T. Jones and T.A.J. Cockerrill (1984), Figure 2.4.

elasticity of demand for the product (Hay and Morris, 1991). So one would expect that in an unconcentrated industry where market shares of firms are small, profitability will tend to be low; and in concentrated industry characterised by relatively large market shares, profits will be higher.

Registration and licensing figures show that all operators have been able, though at varying degrees, to enter the market; the presence variability is, however, much more pronounced in the case of small and medium size firms.

The history leading to the emergence of the current structure of the trucking industry in Tanzania is dominated by the government desire to see increased public sector participation in trucking operations. The importance of the market price as an indicator of the kind of structure in place has, as a consequence, been affected. Mwase (1988) observes that, prices have not been decisive determinants of the development dynamics of the Tanzanian transport sector. Public firm's monopoly as stipulated in policy has not been that effective in deterring competition from small and atomistic private operators.

2.4.5.2 Market Conduct

This is looked at in terms of the freight rates that operators charged for the services. It was noted earlier that rates charged by operators in Tanzania had been set by the government in a manner that sought uniformity in charges (some kind of "rate averaging") across the country. The set rates have been observed to be below operating costs (Maro, 1989). This has mainly affected public operators who, because of service obligation, had to offer services irrespective of whether or not they made profits. The charging of such rates had an effect on the firms' real revenues, and have generated budgetary deficits which could only be offset through support from the government (Ndulu, 1986).

Government subventions have thus been used by public operators for financing of their day to day operations and replacement and expansion of operating equipment. As these subsidies have been of a guaranteed nature, not based on any performance indicators (defining passive sponsorship), public operators have tended to use them as an offset to some of their inefficiency driven costs. Elsewhere, high levels of subsidies have been demonstrated to be statistically related to high unit costs and low levels of productivity and have encouraged inefficiency (Anderson, 1983; Bly, 1987).

Private operators, on the other hand, have been able to avoid loss-making routes such as intra-regional traffic which is characterised by strict rate control. If they took part in this level of freight they have somehow manoeuvred and charged relatively high rates. They have also avoided poor roads if not guaranteed with commensurate rates (Maro et al, 1993). So rate control had in itself been a source of differential participation in the trucking market between the players (see chapter three).

Also important to note here is the likely tendency towards cross-subsidisation (one being taxed to support the other). It is generally taken for granted that cross-subsidisation in transport pricing has favoured the poorer, frequently rural areas, by providing them with service at prices only slightly above or even below long-run marginal costs (OECD, 1987). Tanzania has also practised cross-subsidisation which is observed via a number of scenarios. Cross-subsidisation across modes of transport, e.g., between rail and road; between functions in case of multifunctional entities with transport wings (as was the case with NMC); and goods ferried, i.e., high valued vs low valued (Mwase, 1988). It is also observed in the case of areas, matching distant high transport cost areas with nearby low transport cost areas; or long-hauls vs short-hauls (Amani et al., 1987).

2.4.5.3 Market Performance

At stake has been firm operational efficiency and the quality of services offered by these firms. It has been widely observed that public firms have been performing poorly (mismanagement, greater overhead costs, high km per truck, low average load factor) whereas private operators have operated efficiently and are reported to operate at lower average overhead costs, perform high average ton capacity per truck and own manageable and high tonnage fleets (Mwase, 1988, 1985; Beenhakker and Bruzelius, 1985; Mrema, 1979).

In terms of quality of service, the industry does provide a wide range of quality service dimensions on matters of safety, security, speed, quality of vehicles, etc. Additional service quality to what is known to be available in the general industry may result in higher charges. Government policy restrictions on competitive behaviour and survival guarantees to public operators (through ownership regulation) have had considerable effects on the quality of services offered. Measures which had the effect of stifling private initiative, through preferential allocations of vehicles, credits and foreign exchange, thus imposing constraints on the start-up of private firms, coupled with route and commodity regulation in favour of public operators, all contributed to the deterioration of the quality of trucking services.

Another effect related to quality of service is that of vehicular capacity which has been described to be inadequate (Wangwe et al., 1989). It is observed in addition that transport capacity varies considerably among the regions. Cases abound of failure to transport crops in various regions (Maro et al., 1993). Effective transport capacity has been reduced by factors such as poor condition of roads, old age of trucks and empty or negligible back haul (low load factor and lack of co-ordination) (Beenhakker and Bruzelius, 1985).

Skarstein et al. (1988) point to the fact that an overriding performance oriented problem, which has been conspicuous despite shortage of capacity, is the inefficiency in operating procedures and utilisation of the available trucking capacity. This, they contend, has especially been a problem with public operators and can, to a larger extent, be attributed to the regulatory framework through (low) freight rates and restrictive entry for certain types of cargo and routes. As a consequence, reliability and availability of transport services have all been negatively affected.

Mwase (1994) argues, on the other hand, that private sector transport services have been relatively better. He attributes this to the fact that most private operators are highly knowledgeable about the industry and flexible in decision making. And because of being cost conscious, they have been able to maintain their trucks better and make high utilisation of capacity through effective co-ordination of forward- and back-hauls.

The application of rate control and entry restrictions to certain segments of the trucking market, and the profound effects it had on operational flexibility in the industry as discussed above, necessitated a shift in policy stance. This shift has, however, been precipitated by the economic crisis the country has faced beginning late seventies. It may just be fair to suggest that the crisis helped set the basis for important macro-economic policy changes currently being effected, that have also touched operations in the trucking industry. The background to policy reforms and the current policy outlook, of concern to trucking operations, are discussed next.

2.4.6 Recent Policy Developments

2.4.6.1 Background to Policy Reform Measures

The economic crisis which beset Tanzania in the decade to 1985 has led the government to rethink about its policy stance leading to the eventual advocating of the need to review various policies governing operations in the transport sector (as it is for the whole economy). The crisis manifested itself in the following: extensive and persistent macro-economic imbalances, saving-investment gap, unprecedented rates of inflation, chronic balance of payments problems, run away budget deficit and the general slowdown in output growth (Ndulu, 1987). It is acknowledged in government policy documents, that this lacklustre economic performance, coupled with institutional rigidities imposing constrains on the adjustment process, and so aggravating the crisis, have negatively impacted on the operations of various economic agents in the country.

With regard to trucking, one effect has been through foreign exchange (forex) shortages, due to dwindling export revenues, experienced during the crisis period. This had a number of effects. Exchange controls and import restriction measures to protect reserves were among them (relaxed later as discussed earlier) (Ndulu, 1994). This affected importation of trucks and spare parts, thus adding to the problem of diminishing haulage capacity in the country. This underscores the notion that the fortunes of transportation industries in developing countries are tied to availability of forex, because of the import dependency with regard to transport equipment, which is not manufactured locally. Their import is also subject to the vagaries of the economic climate, especially fluctuating foreign exchange levels (Alokan, 1995)[21].

[21]In the case of Nigeria, the availability of an excellent road network, a strong local currency making it cheap to import vehicles, and a strong transport demand, made haulage as a business flourish. The industry had been profitable and expanding over the years, with no fewer than 38 firms joining each year between 1970 and 1980 (oil boom years, 1973-80), compared to an average of 30 annually prior to 1970 (Alokan, 1995).

At another level, the depreciation of the local currency, the Shilling, following structural adjustment measures, had profound effects as well on the sector. Prices of vehicles and spare parts soared, compounding further the problems of utilisation and maintenance of trucking capacity.

Budgetary problems were another source of problems. These made it difficult to, among others, adequately fund road works. Extensive deterioration of the road network attributed to, among others, lack of effective traffic management enforcement mechanism, allowing heavy, overloaded vehicles, to ply on the roads, and so negatively affecting the roads' durability and loading capacity could not, as a consequence, be effectively countered through appropriate maintenance (Heggie, 1995). This led to severe worsening of the condition of the road network, as insufficient allocations of resources for both, regular and periodic maintenance, and for rehabilitation works, were made available in successive years (URT, 1994a).

However, negligence of road investment and maintenance is another factor[22]. For example, Skarstein et al. (1988) report that, while in the neighbouring countries the public investment programme on roads is 15 percent of total public investment, in the case of Tanzania it is only 4 percent. It may also be recalled from figures provided in table 2.4, that credit allocation to transportation has been at an average of 2 percent of total bank credit. The highest amounts went to crop marketing boards who purchased, among others, the rolling stock that plied on the non-maintained roads.

[22]It is essential to insist that maintenance and road improvement require a lot of resources. To be effective they need to assume more than an ephemeral character; they have to be done perpetually. This is in the spirit of Downs' (1962) law (Winston, 1991). The argument is that once an improvement is made on any road, benefits will immediately flow from this investment in the form of lower travel time and less vehicle damage. The improved road will attract new travellers and prospectors to use it. This will put pressure on the road and cause another round of road deterioration. As such the amount spent might result in improved road (transportation) capacity that eventually faces the same problems as before. The cycle can be broken only through timely and consistent maintenance.

In terms of additional costs to the economy, Heggie (1995) reports that, a dollar reduction in road maintenance expenditures, typically increases VOC by USD 2-3. A paved road in good condition carrying average traffic flows, requires resealing or light overlays costing USD 23,000 per km every 7 years to keep it in good condition. This has a net present value (NPV), discounted at 12% over 25 years, of USD 17,688 per km. Such a road will, without maintenance, deteriorate from good to poor condition and increase VOC by about USD 5,000 per km, which has a NPV of USD 39,200 per km. These extra expenses find their way into increased transport costs and raise the net cost to the economy as a whole (refer footnote 20).

Poor roads reduce the economic life span of the rolling stock and adds immensely to the operating costs of operators. To be on the road operators have therefore to spend proportionately more resources on vehicle maintenance. Due to the poor condition of the road network, operators cannot effectively offer services to certain areas of the country, curtailing in the process, the availability of trucking services (especially crop evacuation, as evidenced by crop pile ups in some areas for lack of transportation) to those areas, and so limiting the scope of trucking firm operations.

It also has implications on the sustainability of the provision of quality trucking services to the public in addition to the profound effects on the economy as a whole (see also Appendix 1).[23]

At stake, and related to the above, is the efficiency (productivity) in the trucking sector. This was negatively affected as vehicle operating costs (VOC) increased, eating in the operators' revenues. VOC increase with poor quality of road. In the case of Tanzania, Stenberg et al. (1994) estimate (in 1989/90 prices) VOC for roads classified in good, fair and poor condition at Tshs. 15.06, 19.10 and 24.15 per ton-km, respectively.

2.4.6.2 The Current Policy Stance

Major policy shifts have occurred in line with the general reform measures currently being instituted around the world. In the PTA (Preferential Trade Area) region, national and sub-regional efforts are underway to deregulate, liberalise and privatise the public sector, and allow market driven allocation of resources for competitiveness, both nationally and internationally. Restrictions on prices and entry into the transport market are de-emphasised (Mwase, 1993).

[23]Sub-Saharan Africa is reported to have lost about USD 14 billion, representing the costs of reconstructing or rehabilitating roads in poor condition (1.2 billion per year, about 0.85 of regional GDP) of capital invested in roads (75% in forex) through lack of maintenance (Heggie, 1995). In the case of Tanzania, the World Bank estimated in 1990 that the economy was losing about USD 200 million per annum in direct economic costs as a result of road deterioration and inefficient operations in the road sector. Following implementation of the first phase of the USD 900 million World Bank managed, transport donors financed Integrated Roads Programme (IRP), the condition of the trunk (10,000 kms) and regional (17,730 kms) roads is as follows: trunk roads in good condition (27%), fair condition (43%) and poor condition (30%). Respective percentages for regional roads are 16, 48 and 36. The second phase of IRP which commenced in September 1994 is aimed at bringing about 80% of trunk roads and 50% of regional road networks to good condition by year 2000. The condition of most of the feeder and district roads (30,000 kms) and unclassified roads (30,000 kms) is poor (URT, 1994a). Improvement and maintenance of the district roads is being done following the establishment in 1991 of the *Road Fund* i.e., a special account comprising of the proceeds making up part of government general tax revenue, collected from an explicit road tariff, primarily from fuel levy added to all pre-existing fuel taxes and vehicle license fees, that is, those paid to gain access to the road network. The Fund is used for road maintenance, its disbursement is based on clear road selection and fund allocation criteria (Heggie, op cit.; Likwelile, 1994).

National transport policies are to a large extent influenced by what is happening elsewhere, and most specifically, at the sub-regional level. Tanzania is no exception. Factors constraining operations in the transport industry are being identified. Lack of effective planning, management and co-ordination between the transport sector and other sectors, between different modes and even within modes and institutions is acknowledged in the draft National Transport Policy (NTP) (URT, 1994a). It is pointed out that there has been no systematic empirical evaluation and analysis prior to decision making.

A review of policy documents in view of the changing circumstances is recommended. The stated objective in the draft policy is to build up a transport service (trucking inclusive) responsive to the constantly changing needs of other productive sectors. Commercial viability is to guide ownership pattern, allowing for fair treatment to both private and public operators. Licensing is to be tied to quality of service providing for qualitative controls that specify the requisite conditions and standards of transport activities. Pricing and vehicle allocation to be left to market forces (but closely monitored) and, for the latter, efficient utilisation.

Liberalisation measures under the transport sector recovery programme (TSRP, 1988-1992) are currently being instituted (URT, 1994a). These are aimed at removing barriers to entry into the transport industry, liberalise tariffs and improve availability of vehicular capacity through easing of the importation of vehicles and spares. With regard to freight rates, policy reforms seem to favour market determined rates, with recommendations that some indicative rates be set by government to guide the bargaining process (URT, 1994a).

Rizet and Hine (1993) observe, however, that ordinarily rates for transport should reflect distance and weight dimensions of transportation output. In general, they say, such rates decrease when either the distance or the tonnage increases. The reason being that these two characteristics are correlated in that consignment size tends to be high for long distance trips while for short trips, average consignment size tends to be much lower. Mwase (1988) contends that there are other factors that influence freight rates that need to be considered. These include road condition, length of haul, type and value of traffic hauled, the possibility of back-haulage, and competitors rates. Ability to enforce whichever mechanism is adopted should be critical in decision making.

So generally, economic regulations limiting transport operators to particular modes, on specific routes or for certain commodities are being de-emphasised. Under the measures, both public and private operators will be required to stand on their own and that they are expected to develop and sustain self-financing capabilities. It is also stressed that transport policy ensure efficient use of both infrastructure and mobile equipment (Mwase, 1994). One would only expect, in the case of all operators, improvements in service variability and availability and general improvement in most service attributes.

2.5 Features of Trucking Operations in Tanzania: A Compendium

This section tries to highlight observable features of the trucking industry in Tanzania and point out areas that need consideration in the performance evaluation exercise. As pointed out in section 2.3.2, the trucking industry in Tanzania is dominated by small private operators owning 1-5 vehicles, composed mostly of 7-10 toners. The large operators are mostly public. There are therefore both small and large and private and public firms operating and surviving in a regulated environment, with a segment of trucking operators faced with service obligation. This makes the question of scale economies an important one.

Operations in the Tanzanian trucking industry are of the truckload (TL) or client-based nature, i.e., supply on demand. Aspects of linehaul operations (terminal handling or consolidation) as is the case with less-than-truckload (LTL) operations do not feature or, at least, are not seen to. This can be explained by the fact that, unlike TL, LTL operations involve investing in terminals, a requirement beyond the ability of most operators in Tanzania. Entry in TL carriage is thus easy. There is little variability in TL operations in terms of load and shipment size. With such operations one would expect equipments, at least in the case of forward-haul, to be fully utilised all the way[24].

Related to this is the fact that industry operations are not network-based, i.e., there is no scheduling of activities. Load availability and road condition (mostly poor) guide operators' movements. Agricultural inputs and produce dominate the consignments, followed by industrial goods. Operator location which has a bearing on the geographical range of one's operations is thus a critical factor to the intensity of firm operations. This partly explains the distribution of trucks as shown in table 2.15.

In terms of policy, as discussed above, reform measures adopted since 1984 emphasise, among others, rationalisation of institutional structures with the aim to encourage efficient and market based operations. It is contended that operational restrictions have contributed to non-optimal operations in the various sectors of the economy (URT, WB and IMF, 1991).

With regard to the trucking sector a crucial issue, given the features and the problems facing the industry and the economy as a whole, would be to find out the role of regulation in shaping firm operations, especially its effect on the emerged firm size structure and ownership characteristics. Does it encourage trucking firms

[24]More on the differences between TL and LTL operations in chapter four.

to adopt a form of organisation that is inherently inefficient and nonconductive to productivity growth? Is there any alternative structure that can be adopted to enable efficient operations in the sector? What factors determine individual firm operations and whether, there is any need at all to continue with public sector participation in trucking operations at the present scale.

2.6 Summary

This chapter has discussed issues related to the trucking industry and its contribution to the Tanzanian economy (in terms of GDP, overall investment, share of freight traffic) with specific reference to the agricultural sector on which it very much relies as a source of freight traffic. Trucking occupies a central place for the development of the economy. It is dominated by small private operators, with registration figures showing about 75% of operators owning between 1-5 trucks. About 80% of trucks have carrying capacities of up to 10 tons.

Transport regulation is shown to have a considerable influence on trucking operations through its licensing system, rate regulation and service obligation requirement to public firms; making output exogenous to firm decisions. Another dimension is the implication of such policy on issues of scale of operation and utilisation of facility.

The effect of regulation, through the eyes of SCP-model, has thus been shown in three areas, i.e., the market structure where no clear picture, based on government policy intentions, can be discerned; conduct in terms of rates charged which appear to have caused deficits to common carriers and abandonment of certain routes by private operators; and performance operationally which has mostly been poor and quality of service which has suffered because of passive sponsorship and non-market driven operations. Much, as indicated in policy reform documents, needs to be done to smoothen operations in the sector.

Also examined are the factors driving the industry on both the supply and demand sides. Vehicle importation is shown to be dependent on income, foreign exchange position, and truck unit import price. With regard to traffic generation, regional GDP and population are shown to be attractive forces whereas road condition and freight rates are resistant factors.

The next chapter examines operations of the major players in the trucking business in Tanzania in light of the economic reform measures currently underway in the country.

CHAPTER III

THE ROAD FREIGHT CARRIERS IN TANZANIA

3.1 Introduction

As a follow up to chapter two, this chapter discusses the major players (transportation institutions as they were referred to there) in the freight haulage industry in Tanzania. As providers of trucking services, the freight hauliers are central to the functioning of the trucking industry and the economy as a whole. The chapter looks at their fleet sizes and examines various performance indicators on which the performance of individual firms is gauged. An attempt is made, within the confines of deficient data, at performing a comparative analysis between the operators individually and between their broad categories, i.e., public (parastatals and co-operative unions) and private. As it is pointed out later in the chapter, the indepth analysis in this study is based on the RETCOs. This set of firms receives thus relatively more coverage.

The functioning of the trucking industry (as demonstrated in chapter two) in any one country is predicated on the economic performance of the country in question. It is the output and transportation needs of various sectors in an economy which determine the output and growth of the transportation industry. The composition of traffic available for carriage depends on the type of economic activity prevalent in an economy, i.e., whether manufacturing, agricultural or service industries[1]. Changes in the economy, e.g., shifts from manufacturing to agriculture or vice versa, or in the performance of the economy generally, dictate the relative shares of these industries in the total road freight output and performance of road

[1]It was pointed out in chapter two that in the case of Tanzania, agricultural transportation dominates, followed by that of industrial products.

transport operators in general. As such, in the face of an economic crisis, as has indeed been the case in Tanzania, trucking firms perform poorly as well.

Yet having in place a reliable and cost effective transportation system is a *sine qua non* for economic recovery, e.g., improvement in agricultural production and marketing. Each operator will therefore be examined, looking at each ones relative importance and role in the trucking market. Specific mention is made of agricultural transportation, in view of the policy reforms now underway in the country.

3.2 The Regional Transport Companies (RETCOs)

RETCOs were established under the Trucking Industry Rehabilitation and Improvement Programme (TIRIP) sponsored (financially and technically) by the World Bank and its affiliate IDA (NTC, 1980; World Bank, 1977). They are decentralised, regionally based haulage companies, operating under the umbrella of the National Transport Corporation (NTC) which was established under the Public Corporation Act of 1969. Services provided by NTC (at a fixed charge) to the RETCOs include advice on planning, financial operational procedures, internal audit, legal services, transport operations, marketing and performance review, information and reporting systems, and human resources management services, including recruitment (URT, 1994a).

The establishment of the RETCOs came as a result of the dissolution of co-operative unions with transport wings and liquidation of UMITA. The ownership of RETCOs is diverse in arrangement. Shareholders differ from region to region. Mostly incorporated are the crop authorities, Regional Trading Companies (RTCs), co-operative unions (following re-establishment) and development councils. Each RETCO has a legal mandate to man its own activities and have own Board of Directors. Administrative mandate, however, is shouldered on the NTC which, as mentioned above, makes the various appointments and is responsible for technical supervision.

Their objectives are both general and specific to the region in which they are situated. Generally they are supposed to provide intra- and inter-regional freight transport for agricultural inputs and produce together with consumer goods. Specific objectives depend on the problems existing in anyone region, depending on the type of crops available.

The Articles and Memorandum of Association establishing the RETCOs describe them as common carriers. This means they should be prepared to carry for anybody, at the government set "reasonable" charge (through NTC's advice), especially in the case of intra-regional traffic, any goods which might be offered to them. They are thus guided by service obligation, in the sense that they cannot deny transport services to anyone requesting them. Other stated objectives include generation of employment and earning reasonable profits from operations to justify investments made (URT, 1994a)[2].

It has been suggested, however, that this legal framework has implications on the operations of the RETCOs. Mtaki (1988) contends that the legal framework within which they are perceived may be a source of slackness in performance on the part of RETCOs. Specifically, the practice of contracting with no observation to pre-requisites, liability acceptance in respect of damage to goods hauled which he argues they ought not, and their unclear status as common or private carriers. He

[2]But the service obligation requirement has its own implications. It makes the RETCOs' objective to be maximisation of social benefit in the form of honouring all requests for trucking services at affordable prices. That may mean producing trucking output even beyond the point of economic efficiency (price = marginal cost), in which case, the charges will have to be less than marginal cost (in the sense of providing cheap services to the general public). This means the RETCOs are not supposed to care much about making profits but concentrate on providing as much services as the requirements of the time would dictate. However, such an output level can only be produced at a welfare loss as, at this point, the marginal cost is higher than the marginal benefit (Gravelle and Rees, 1981). Their survival would have to depend on government compensatory payments, directly through subsidies or indirectly through, say, tax-exempted vehicle acquisitions, etc. It is unlikely that private operators can be attracted to operate under these circumstances.

recommends therefore that RETCOs be legally declared private carriers to enable them enforce proper contracting and commercial ideals. This way institutional and operational obstacles impinging on their performance can be removed.

So far there are ten RETCOs operating in the regions of Ruvuma (KAURU), Mtwara (KAUMU), Dodoma (KAUDO), Tabora (KAUTA), Mwanza (KAUMA), Morogoro (MORETCO), Kagera (KAGERA), Iringa (IRINGA), Mbeya (MBEYA) and Rukwa (RUKWA)[3]. In total (for 1992/93) they own 504 trucks (including tankers and trailers) of capacities between 5-15 tons. Total carrying capacity is 5,865 tons. At present KAUMA is the largest (in terms of fleet size) with 62 trucks (750 tons carrying capacity) while Iringa and Mbeya RETCOs the smallest with 35 trucks each (355 tons carrying capacity) (Maro, et al., 1993).

3.2.1 Indicators Guiding RETCO Operations

According to TIRIP, plans and prospects of the RETCOs centre around effective use of existing capacity in transport operations, regional co-ordination of haulage activities, reduction in vehicle operating costs and raising of truck availability ratio. The major programme components included providing technical assistance to help introduce modern trucking know-how, procurement of new trucks, rehabilitation of existing trucks, provision of truck repair facilities and financial assistance to improve the availability of spare parts. Also in the package was the assistance aimed at increasing the supply of trained trucking personnel through provision of instructors, teaching aids and workshop equipment. In principle, this was supposed to enable RETCOs gain economies of scale in maintenance and dispatching these by increasing vehicle utilisation rates. The RETCOs were also to benefit from the programme through the provision of technical assistance.

[3]The first five were established in 1980/81, Kagera 1983/84, Rukwa in 1988/89 while Iringa and Mbeya RETCOs in 1991/92. MORETCO, though established earlier, has been on and off in its operations.

To assist with operational benchmarking, performance indicators were set to guide RETCOs' efficient operations. These are provided in table 3.1. As a basis for their proposals, TIRIP examined the performance of public and private sector operations. Among the operational features they observe as characterising public firms include, low proportion of trucks in working order and low utilisation rate of the available trucks. This they attributed to inadequate maintenance, poor vehicle operation, lack of skilled management, poor incentives on the part of drivers and poor road condition.

Private operators, on the other hand, were observed to be relatively efficient compared to public operators. They are characterised to have had relatively high availability rate with sound financial incentives provided to their staff. Their operations were affected by poor road condition, shortage of spares and difficulty in obtaining trucks.

Judging from the above narration, one may contend that the basis for the recommended performance indicators were the performance levels achieved by private operators. The programme was thus supposed to assist the government institute measures that would lead to the improvement of public firm trucking operations. Improved measures were then set, taking such (private) figures as a basis (as reflected by improved figures in column three). Unfortunately, no data on private operations are given[4]. In the table, public firm performance measures achieved prior to the establishment of RETCOs are presented in column two.

All these measures were aimed at facilitating increased efficiency of trucking services, generate savings in costs per ton-km and avoid substantial capital costs of new trucks. The overall trucking sector was to benefit through improved supply of

[4]One would presume that factors determining developments on the demand side were taken into consideration when setting these indicators which are meant to guide efficient supply of trucking services. Also important is the nature of the basis for such improved measures, i.e., whether based on best practice in the industry. Unfortunately no such detailed information is provided.

skilled manpower from strengthening the National Institute of Transport (NIT) and technical assistance offered to NTC, an implementing agency for the project, which could then be consulted.

Table 3.1: Performance Indicators for Efficient Operation

	Prior to TIRIP	TIRIP Measure
Vehicle-km per truck per year	35,000	60,000
Ton-kilometres per truck per year	100,000	450,000
Truck availability	0.6	0.9
Truck utilisation	0.5	0.8
Staff vehicle ratio	4	2
Operating cost per km of actual traffic (excluding depreciation) Tshs	1.2	0.65
Operating ratio	over 1	0.85

Note: Truck availability is the number of operational trucks/total trucks, Truck utilisation is used capacity of available trucks in ton-kms/total capacity of available trucks in ton-kms and Operating ratio = operating cost/operating revenue.

Source: World Bank (1977)

3.2.2 Evaluation of RETCO Performance

RETCO performance is evaluated by first gauging each firm's performance to the TIRIP indicators and second, by comparing firm performance in terms of revenue-cost considerations.

3.2.2.1 With Respect to TIRIP Indicators

A look at selected performance indicators as presented in table 3.2 shows each RETCO to operate differently from the rest and that in a majority of cases, firms have not been able to meet TIRIP requirements. In the case of staff vehicle ratio, for instance, actual performance of an average of 3.4 per firm per year compares unfavourably with the required 2. Firms have exceeded the required figure by 70 percent. Relatively, Kagera-RETCO has performed better, with a figure of 3 while KAURU is the worst performer at 3.7. In terms of vehicle utilisation the performance is commendable as, on average, firms utilised trucks at the required rate of 0.8. KAURU performed poorly at 0.7, KAUTA was the best at 0.86. Also encouraging is the performed load factor, an average of 64 percent compared to the recommended 60. KAURU has done quite well in this regard with a score of about 72 percent, KAUTA having the lowest, about 59 percent.

Table 3.2: Actual Performance - Selected Indicators 1981/82-1992/93

	TIRIP	KAUMU	KAUMA	KAUDO	KAGERA	KAURU	KAUTA	Av.
Load factor (%)	60.0[a]	65.7	62.9	66.8	59.7	71.7	58.7	4.3
Staff vehicle ratio	2.0	3.6	3.4	3.6	3.0	3.7	3.4	3.4
Vehicle serviceability (%)	70.0[a]	63.2	69.4	63.7	60.0	69.2	59.1	4.1
Vehicle utilisation (%)	80.0	80.4	81.2	85.0	80.0	69.9	85.9	0.4

Note: All are average figures, (a) NTC recommendations
Source: NTC data files

The standard requirement for vehicle serviceability, given the Tanzanian conditions, is 70 percent (URT, 1994a). On average, the RETCOs performed at an annual rate of 64 percent, less by 6 percentage points per unit. KAUMA and KAURU have performed better at about 69 percent, KAUTA at 59 percent is the worst performer. In terms of ton-kms, the average figure for the six RETCOs per truck per year is 216,288 (an average of 9,084,100 ton-kms for an average of 42 trucks per firm), which is only 48 percent of the TIRIP requirement of 450,000 ton-kms. Table 3.3 presents other selected performance indicators for fiscal year 1991/92.

The indicators are tons/vehicle/year, kilometres/vehicle/year and staff-vehicle ratio. Also shown are fleet sizes and carrying capacity (in tons). One notices that in terms of kilometre coverage per vehicle per year, RETCO performance falls far short of the TIRIP requirement of 60,000 kms. On average a truck covered 25,580 kms, the best performer RUKWA having covered only 34,500 kms (about 58 percent)[5].

Table 3.3: Selected Performance Indicators for the RETCOs, 1991/92

Firm	Fleet Size	Capacity	Ton/veh/yr	Km/veh/yr	TKm/ veh/yr	Staff/veh Ratio
KAUTA	33	320	852	24,500	310,758	3.9
KAUMA	25	352	2,200	24,460	554,160	3.4
KAUMU	24	224	1,550	26,100	403,167	4.2
KAUDO	36	239	880	26,360	308,611	4.0
KAURU	35	521	2,130	27,360	520,914	3.4
KAGERA	20	359	2,040	29,380	588,450	4.0
RUKWA	36	358	1,305	34,500	387,889	3.3
Average	30	339	1,920	25,580	467,707	3.7
TIRIP	-	-	-	60,000	450,000	2.0

Source: Statistical Abstract, 1992; RETCO files

The TIRIP requirement of 450,000 ton-kms per truck per year was surpassed in the year under consideration by 17,707 ton-kms overall. KAGERA did very well at 588,450 ton-kms whereas KAUTA did badly at 310,758 ton-kms per truck in the year. With regard to staff vehicle ratio, the average RETCO performance is unfavourable, having utilised 3.7 staff per truck compared to TIRIP's 2. RUKWA (3.3) is the best in this regard, while KAUMU (4.2) is the worst.

3.2.2.2 Size, Revenue and Cost Comparison

Three aspects are looked at in the evaluation of RETCOs' performance, these are: (1) operating ratio (cost recovery argument), (2) average cost trend in relation to firm size, measured in ton-kms (scale economies argument) and (3) evaluation of freight rate changes overtime. The latter is intended to help show the effect of price

[5]Unfortunately no distinction is made, in terms of recording, between intra- and inter-regional operations to help explain if anyone of the figures could have been justifiable for either one of the traffic levels, or a combination of the two. It is presumed that TIRIP arrived at the figures after considering the fact that RETCOs were to engage in both intra- and inter-regional traffic levels.

regulation on the operations of the RETCOs, based on the assessment of RETCO performance as done by NTC.

With respect to operating ratio, it may be recalled that the TIRIP requirement was that firms' operating costs be 0.85 of operating revenue. This way firms would be able to recover operating costs. As shown in table 3.4, overall RETCOs performed well with the operating ratio of 0.56 per year for the average firm. KAUTA has the lowest (0.47) while KAUDO has the highest (0.74). This suggests that firms have been able to recover their operating costs. But good performance in this indicator is also shown to be related to the pricing mechanism and not efforts at reducing costs. In fact in the sample period average costs increased by 91 percent. Firms with low operating ratio are the ones situated in regions with high freight rates[6]. It is also important to note that operating costs do not cover vehicle investment expenses (interest on capital). As such good performance in operating ratio may not necessarily mean a firm is making profits (if we have this important cost component in mind).

It may be noted here that the usual expectations are that the wider the gap between unit cost and freight rate, the higher the profits attained. The average figures in table 3.4 for freight rate and unit costs show the gap to be in favour of freight rates (3.14 to 2.90), indicating that indeed profits could be made. However, based on observations made elsewhere, the picture is told not to be that rosy. URT (1994a) reports that freight rates (just like passengers fares) were fixed below break-even levels and were not reviewed regularly.

This must have had an inevitable effect of causing losses to public operators who were confronted with service obligation. It must have implications on these

[6]It is worth noting here that NTC was charged with the responsibility of proposing rates as they have the technical expertise to undertake the analysis of costing. Each region, through the Regional Transport Co-ordination Committee, adopted them while fixing rates for intra-regional traffic, with adjustments to reflect regional conditions. The RETCOs applied the regionally adopted rates.

firms' performance. RETCO survival must therefore be explained by something outside their earnings, i.e., through a variety of government subventions. The assistance usually extended to them in acquiring tax-exempted vehicles is among the aspects which help them offset some of their costs (see Beenhakker and Bruzelius, 1985).

Table 3.4: RETCO Operating Ratios, Freight Rates (Firm Averages), 1984-91

Firm	Operating Ratio	Freight Rate (Tshs)	Average Cost (Tshs)	Ton-km
KAUTA	0.47	3.21	1.90 (2)	6487900 (5)
KAUDO	0.74	2.97	4.07 (5)	11226000 (2)
KAUMA	0.48	3.35	4.72 (6)	8208500 (4)
KAUMU	0.52	3.20	1.92 (3)	8588100 (3)
KAURU	0.51	2.74	1.50 (1)	13568000 (1)
KAGERA	0.64	3.39	3.31 (4)	6426500 (6)
Overall	0.56	3.14	2.90	9084100
TIRIP	0.85			

Note: Costs, revenue and freight rates all reflect 1984 prices
Source: NTC and RETCO records

The scale economies aspect is another issue of interest, i.e., the comparison between average cost and firm size, measured in ton-kms (firm ranks are in brackets). KAURU is, on average, the largest and has the lowest average cost, the scenario also maintained by KAUMU in third place. This gives some indication that scale economies (i.e., average cost declining with firm size) may be present. However, KAUMA/KAGERA and KAUTA/KAUDO switch positions making the pattern to lose consistency.

On the last item, NTC, in its Annual Report and Accounts for 1989-90, describe RETCO operations to be marred with problems and weaknesses. Among the problems include uneconomic tariffs, tight liquidity position and failure by their principal customers to settle their debts. Other factors are poor roads causing high consumption of inputs and extensive damage to, and abnormal wear and tear, of the vehicles, rapid increase in the cost of new equipment, lack of skilled manpower and aged fleet. All these appear to suggest the need to exercise caution when analysing RETCO operations based on their cost-earnings performance.

3.2.2.3 RETCOs and Government Policy Change

The economic crisis has made the government to reconsider its passive sponsorship of institutions like the RETCOs which were granted government backing to cushion against operational losses. The economic policy framework paper (URT, WB and IMF, 1991) reports that the government had to seek budgetary savings in several areas. One way was to put restrictions on the provision of subsidies and transfers to parastatals. This implies that parastatals have to operate in a competitive environment and develop self-financing mechanisms.

In the trucking market, this requires the RETCOs to compete like anyone else in capital investment (as found in chapter two, truck importation depends on income, forex position and vehicle import price) and organisation of haulage activities. Already it is reported that, as a result of liberalisation in the provision of transport services, the RETCOs achieved only 78 percent of their planned freight targets in 1993 (URT, 1994a). It may be noted here that agricultural marketing and distribution of farm inputs have been liberalised, removing as a result public sector monopoly and so denying the RETCOs of a guaranteed source of cargo.

To improve their standing, and following the amendment of the Memorandum and Articles of Association, the RETCOs can now invite private participation in RETCO activities. This should open up possibilities of co-operation and co-ordination of trucking activities with private operators, or even arrangement of mergers with existing operators if the circumstances so dictate. Another policy reform is that which allows RETCOs to charge market determined rates. This way they can have the flexibility to adjust shipping rates to meet costs. They have also engaged themselves in staff rationalisation and retrenchment exercise to make sure they only employ the work force enough to man their operations (URT op cit.).

3.3 The Co-operative Unions

All co-operative unions (Coops) have their own trucking capacities which are kept at a central pool at union headquarters. They are supposed to cater for transport operations on the local and regional levels (URT, 1994a). Their fleet sizes for 1990/91 are presented in table 3.5 (figures for carrying capacities could not be obtained for all the years under consideration). It may be noticed that SHIRECU (Shinyanga) with 79 trucks is the largest followed by NYANZA (Mwanza) 71, KCU (Kagera) 55 and MBECU (Mbeya) 53 trucks. DARMCU (Dar Es Salaam) with one truck is the smallest in terms of fleet size while VUASU (Kilimanjaro) with 5 trucks holds a penultimate position.

If regions were to depend solely on Coop trucking services for haulage of agricultural crops, the lake zone (Shinyanga, Mwanza, Kagera and Mara) would be in a better position, with 215 trucks, i.e., about 40 percent of Coop trucking capacity. The southern zone (Iringa, Mbeya, Ruvuma, Lindi and Mtwara) follows with a total of 163 trucks, about 31 percent of the Coop trucking capacity. The northern zone (Arusha, Kilimanjaro and Tanga) has 69 trucks, about 13 percent of the capacity. Coop ownership of trucking capacity seems therefore to be very much related to the intensity of agricultural activities in their respective regions of domicile. Iringa, Mbeya, Ruvuma (the 'Big Four' if include Morogoro), Mwanza and Shinyanga are dependable agricultural regions in the country. The presence of private operators may as well be another reason. Coop capacity is required most in regions with few private operators.

Table 3.5: Co-operative Union Fleet Size (trucks), 1990/91

Co-operative union	Number of trucks	Co-operative union	Number of trucks
ARCU	23	MACU	32
BCU	14	MBECU	53
BUHA	7	KYERUCU	7
CRCU	9	MORECU	12
CORECU	10	MARCU	10
DARMCU	1	NYANZA	71
IMUCU	8	RCU	25
NJOLUMA	6	RURECU	28
KCU	55	SHIRECU	79
KNCU	20	SIRECU	14
VUASU	5	TABORA	13
LIRECU	11	TANGA	21
Total			534

Source: Co-operative Unions

Co-operative unions concentrate on haulage of crops (see table 3.6) which they procure and handle. They collect agricultural produce from primary societies which purchase these crops from farmers. Primary societies do not own trucks. They use union trucks and hire sometimes even from distant places. This should be costly if no proper routing schedule (vehicle planning) is in place. It does also substantially impact on the utilisation of available transport capacity.

Table 3.6: Purchase and Transportation of Crops by Unions (tons)

Year	Purchased (1)	Transported (2)	(2) as % of (1)	Balance (3)	(3) as % of (1)
1987/88	810,669	694,333	86	116,336	14
1988/89	531,336	519,319	89	62,016	11
1989/90	379,452	318,178	84	61,274	16
1990/91	230,259	255,922	78	74,337	22
1991/92	394,291	334,642	85	59,648	15
1992/93	312,929	275,041	88	37,888	12

Source: Co-operative Unions

As can be seen from the table, Coops do not carry all that is purchased, about 16 percent is left unhauled. A number of explanations could be accounting for the balance. Stated reasons include internal consumption, insufficient trucking capacity, together with crop loss during storage (Stenberg et al., 1994; Maro et al., 1993).

3.3.1 Evaluation of Coop Performance

Unfortunately, no meaningful data is available for Coop operating costs and output (ton-kms). An attempt is all the same made here to evaluate the performance of the Coops based on a few indicators and a comparison made with TIRIP measures. The indicators are presented in table 3.7. These include tons per vehicle per year, kilometres per vehicle per year and staff-vehicle ratio[7]. Data for the Coops based in the south are used.

It may be noticed from the table that on average the Coops performed 32,958 kilometres per truck in a year carrying 2,196 tons. They also utilised only 1.9 staff for each vehicle. Compared to TIRIP measures[8], Coop scores are satisfying in terms of staff vehicle ratio, having used a little less. MACU utilised exactly 2 staff while LIRECU used 75 percent in excess of the efficiency requirement. MBECU has one staff assigned to each vehicle.

Table 3.7: Selected Performance Indicators for Co-operative Unions, 1991/92

Firm	Location	Fleet size	Capacity	Ton/veh/yr	Km/veh/Yr	Staff/veh Ratio
RCU	Ruvuma	21	172	3,120	14,850	2.3
MBECU	Mbeya	12	111	2,750	30,000	1.0
NJOLUMA	Iringa	12	101	2,400	18,300	1.2
IMUCU	Iringa	8	76	2,640	57,600	1.1
LIRECU	Lindi	6	54	1,188	32,000	3.5
MACU	Mtwara	13	57	1,080	45,000	2.0
Average		12	95	2,196	32,958	1.9

Source: Field Survey, 1992

[7]In the case of Coops, one might need to be cautious while looking at the staff-vehicle ratio figure. There was lack of consistency on the way Coop authorities defined the Coop haulage unit.
[8]Although this comparison is made, also done for private operators, a strong case can only be made, i.e., whether a firm is efficient or not relative to TIRIP measures, w.r.t the RETCOs as the design of these measures was supposed to go hand in hand with the operational improvement oriented technical assistance package which was meant, in the main, for the RETCOs only.

Kilometre coverage for an average Coop is slightly above half (55 percent) of that recommended by TIRIP. IMUCU performed 57,600 kilometres per vehicle and used 1.1 staff per truck. It also has third highest amount of tonnage per truck (2,640) after RCU (3,120) and MBECU (2,750).

With regard to fleet utilisation, Coop fleets have been characterised as operating at low serviceability, high operating costs, poor management which has caused realisation of low load factor and utilisation levels as trucks are grossly misused by drivers through attending to unauthorised operations (URT, 1994a). Maro et al. (1993), however, report the utilisation rate of Coop capacity at 60 percent. This may not be that bad in view of the fact that Coops deal, in the main, with the seasonally influenced, mostly intra-regional, agricultural transportation.

3.3.2 Co-operative Unions and the Current Policy Environment

Government efforts to improve agricultural production are said to have, in part, been hampered by the operations of the Coops which, prior to 1990, were responsible for domestic marketing of traditional export crops. Some of the reasons cited are weak management, high operating costs and low efficiency (URT, WB and IMF, 1991). However, Coops had to deal with some operational constraints imposed on them by government. This was in the form of control over the scope of their activities (as they were limited to operate in their regions of domicile), service obligation with regard to agricultural haulage and charging of government set rates. These may as well have had substantial influence on their operations.

In realisation of this shortcoming, policy changes have been made and beginning 1991, following the adoption of co-operative policy, the Coops are free to plan their operations. That includes the freedom to determine their geographical coverage and range of activities. Liberalisation of agricultural marketing and prices means that they, like anyone else, should operate guided by the market forces. In the case of trucking operations, this opens the door for competition with other agents in all aspects of agricultural haulage. This should help them rationalise utilisation of their vehicular capacity and impiove operational efficiency.

3.4 Private Operators

As pointed out in chapter two, private transporters provide the bulk of road transportation services. They operate commercially and independently. In case of agricultural transportation, private operators are hired (sub-contracted) by co-operative unions and RETCOs to fill in supply gaps during crop evacuation periods, to haul Coop purchased crops. This could be acting to the advantage of private operators in that it relieves them of the costly effort, in time and money, of obtaining freight and consolidation of small loads; a task which taxes the operational flexibility of carriers. This way they are guaranteed of full loads (recall from chapter two that they concentrate on TL operations) and so lowering running costs and allows them to obtain wider profit margins.

Private operators' response to calls for their participation in offering transport services depends on a number of factors. The most notable are road condition and freight rates offered; favouring good roads and attracted to high rates. For example, Skarstein et al. (1988) observe that freight rates set by Regional Tender Boards in consultation with the Regional Transport Co-ordination Committees have been too low to attract private operators.

Also notable is their routing flexibility (with vehicles going anywhere provided the price is right) and lower overheads compared to public operators (see table 3.10). Unfortunately no statistics could be obtained to show the full extent of private sector participation in the industry. Most private operators do not ordinarily keep records. For those who keep, they are in most cases reluctant to release them. This could probably be due to the system not being transparent enough to assure them of the real intentions of the data required from them[9]. There are, therefore, no reliable data on the performance of the private sector fleet. There is, in addition, a dearth of studies that analyse private sector operations.

3.4.1 Evaluation of the Performance of Private Operators

Table 3.8 provides some information on the operations of a few private operators based in the southern regions. As can be noticed there is no data on operating costs and output (in ton-kms), this is information that is hard to come by. There are, judging from the indicators, variations in their operations. On average operators cover for each truck per year 40,000 kilometres, haul 3,800 tons and utilise 2 staff per vehicle.

Private sector performance appears to conform with TIRIP recommendation in terms of staff utilisation. In general, all firms have used staff within the region of two persons per vehicle.

Table 3.8: Operational Information for Selected Private Operators, 1992

Firm	Location	Fleet size	Capacity	Ton/ veh/yr	Km/ veh/year	Stf/veh Ratio
Kanji Lalji	Mbeya	30	439	900	60,000	2.8
Ruvuma Distributors	Ruvuma	12	127	2,500	48,000	2.8
Achimwene	Mtwara	9	90	3,600	28,800	2.6
Swalehe Silimu	Lindi	3	21	5,040	48,000	1.0
Omari Issaka	Lindi	4	28	580	30,000	1.3
Southern Motor Services	Mtwara	7	49	2,000	30,000	1.0
Abbas Transport Services	Mtwara	12	121	12,000	35,000	2.8
Average		11	125	3,800	40,000	2.0

Source: Field Survey, 1992

With regard to kilometre coverage, Kanji Lalji operated exactly as per TIRIP requirements, at 60,000 kms per vehicle per year, the least efficient in this case is

[9]This may be due to suspicion related to tax assessment and the general privacy, characteristic of private business rivalry.

Achimwene with 28,800 kilometres. Fleet sizes are small, an average of 11 trucks per operator. Most studies have acclaimed private operators for efficient utilisation of their fleets (Mwase, 1994).

3.4.2 Private Operators and Policy Changes

Constraints put on private sector participation in the trucking industry have been discussed in chapter two. It was noted there that despite the restrictions and preferential treatment accorded public firms, private operators have always taken part in the trucking market and wielded a lion's share. Most private operators preferred to operate on inter-regional routes where rates are economic and road condition good. They did not take part effectively in the intra-regional market due to price regulation and poor roads.

Policy changes have permitted private operators to enter into the various stages of agricultural marketing and export, and that efforts are being taken to revise and simplify regulations governing private sector participation in various activities, trucking inclusive (URT, WB and IMF, 1991). To facilitate increased participation of private operators, a need is stressed to improve road infrastructure, eliminate transport barriers, liberalise tariffs and provide appropriate credit facilities for acquisition of new vehicles. Liberalisation of cash crop procurement has already led to private buyers using their own transport to ferry purchases. Also liberalised are intra-regional trucking tariffs which are now to be determined by market forces. This is expected to help operators recover their costs and realise a satisfactory return on their investments (URT, 1994a).

This means that the position of private operators in the provision of trucking services is being reinforced and that the scope for their activities, in terms of geographical coverage, routes and goods, is expanded. It is anticipated this will further enhance their competitive edge in the industry to the benefit of the whole economy.

3.5 Comparative Analysis: RETCO, Coop and Private Firms

In this section a comparison of the performance of the three categories of trucking operators is attempted. This is done with the poor and, in some cases, unreliable data in mind. The comparison is intended to draw general conclusions with respect to operations in the industry. Three aspects are considered: production of trucking services, transport costing and a recapitulation of the various performance indicators as examined in the previous sections.

3.5.1 Production of Trucking Services

Table 3.9 gives trucking service production data as examined by Mwase (1984). Given the fact that operators' share of total fleet then is not substantially different from the situation now (refer table 2.2), this information (percentages) can still be applicable to the present situation. As can be noticed, the private sector dominates in both the number of trucks owned (about 70 percent) and the amount of trucking services they produce (about 60 percent). Parastatals (RETCOs in this group) follow with 23 and 34 percentages respectively. Coops hold the last position[10].

This only goes to show the indispensable position of the private sector in freight operations in the country. As such neglecting or discriminating against private operators may have serious consequences for the economy as a whole. They hold and wield such a vital position in the production of trucking services that

[10]Maro et al. (1993) estimate production of trucking services in 1992 to be 2370 million ton-kms, a 31 percent increase compared to 1984. No breakdown is provided to show each producer's share. Assuming the same proportions hold, private operators' share (i.e., 60 percent) would be 1422 million ton-kms, the public's being 948 million ton-kms (parastatals 711 million and co-operatives 237 million ton-kms).

policies aimed at improving trucking and the economy as a whole need, as a matter of necessity, to address them.

Table 3.9: Source of Transport Services in Tanzania

Sector	No. of lorries	% of total fleet	Production (m. ton-km)	% of total production
Private	6000	69.8	1080	59.7
Co-operatives	600	7.0	120	6.6
Parastatal	2000	23.2	610	33.7
Total	8600	100.0	1810	100.0

Source: Mwase (1984), Table 1

3.5.2 Transport Costing

Table 3.10 presents a sample of private and public operators. It shows that public firms have high overhead costs compared to private operators, private firms have relatively greater total transport costs and that average transport charges are higher for private than for public operators.

Mwase (1988) does not rule out the possibility of private operators boosting their figures to rationalise high freight rates[11]. He advises that the data be treated with some caution and that these figures may not provide a basis sufficient to make efficiency comparisons between operators.

It is important, however, to consider the operational features that characterise public and private operations while assessing their operations. It was pointed out in chapter two (refer table 2.11) that trucking capacity has a bearing on operating costs. Operating costs decline with the payload capacity of the vehicle. This suggests, among others, that it is advantageous to operate large size trucks, *ceteris paribus*. Of

[11]In case of passive sponsorship, where government subsidies are of a guaranteed nature, i.e., obtained simply upon submission to authorities of income statements that show losses incurred while performing public duty, and where possibilities exist for managers to capture the benefits of higher profits, public firms (which will therefore be facing soft budgets) may also be tempted to misreport, i.e., adjust upwards the cost curves and so conceal the true profits from authorities, to justify subsidy receipts and assure themselves of the profits, with the eventual effects on price-output relations that are to the disadvantage of the consumer.

the two, public operators own fleets composed of large trucks compared to their private counterparts. This may in part be explaining the differential cost performance between the two.

Table 3.10: Transport Costing for a Number of Transport Firms

	Dodoma Transport Agency[a]	Northern Province Roadways[a]	Ushirika Teeteeko Co.[b]	KAUDO (Dodoma)	KAUMU (Mtwara)
Miles/truck/year	25,227	12,750	18,037	20,820	14,393
Av. ton capacity/truck	10	9	9	8	8
Total direct fixed costs (Tshs/mile)	2.26	1.96	2.23	1.53	1.13
Total direct operating costs (Tshs/mile)	10.10	8.91	4.08	5.18	7.80
Total direct overhead costs (Tshs/mile)	0.92	1.74	3.37	1.76	1.63
Total transport costs (Tshs/mile)	13.28	12.61	9.68	8.47	10.56
Total transport charges (Tshs/mile)[c]	15.27	14.39	11.13	9.74	12.14
Average transport charges (Tshs/ton/mile)	1.53	1.60	1.24	1.22	1.52

Note: (a) private operators, (b) transport co-operative, the rest are RETCOs, (c) including 15% profit margin

Source: N. Mwase (1988), Table 1

Also important is the advantage of operating large fleets (if this is used to define firm size). As it will be shown in chapter five, large firm size has a bearing on cost performance. Operating characteristics are shown to be positively related to firm size and so, as firm size increases, operating characteristics also increase with a resultant cost saving effect on firm operations. Again it is public firms that are large in size compared to private operators.

3.5.3 Selected Performance Indicators

Table 3.11 summarises the information discussed so far with regard to the operations of the three major categories of operators. One notices that private operators own small fleets while the RETCOs' are the largest, they thus have higher total payload capacity. Tonnage carried per truck is small for the RETCOs but large for private operators; the same is the case with kilometre coverage. Staff utilisation is more effective in the case of private operators (they match TIRIP stipulations), the RETCOs seem to over utilise. Coops hold, on average, a middle position.

Table 3.11: Summary Performance Indicators: Averages (1991/92)

	Fleet size	**Capacity**	**Ton/ veh/year**	**Km/ veh/year**	**Staff veh. ratio**
RETCOs	30	339	1,920	25,580	3.7
Co-operatives	12	95	2,196	32,958	1.9
Private	11	125	3,800	40,000	2.0

Source: Own Computations

Rizet and Hine (1993) provide us with an opportunity to compare Tanzanian firms with those of other parts of Africa on kilometre coverage. They report, in the case of CFA Franc Zone (Cameroon, Côte D' Ivoire and Mali), that on average 12 ton trucks cover per year about 35,000 kms while 25 ton trucks about 50,000 kms. In the case of Pakistan the average truck coverage per year is 136,000 kms. Overall the Tanzanian experience resembles the general African situation (see section 7.6 chapter seven for factors responsible for this state of affairs)[12]. Compared to other parts of the world, the kilometre coverage is very much on the lower side; poor and undulating roads being the major contributors to the low coverage.

3.6 Choice of a Microcosm for Indepth Analysis

The comparative analysis carried out in this chapter has provided us with an opportunity to understand the general outlook with regard to individual firm

[12]An anonymous source has reported that an ongoing study covering the Republic of South Africa, Namibia, Zimbabwe, Zambia and Botswana has indicated that there are operators in the region, in the case of containerised traffic, who perform up to 200,000 km per vehicle per year.

performance based on the exogenously determined (TIRIP) partial performance indicators. A number of questions were put forward in chapter two requiring an indepth assessment of the cost-output relationship in the trucking industry with the current regulatory framework in mind.

To address those questions one needs to examine and compare operators, public and private, small and big, in terms of output and costs, given technology, factor inputs and their prices, and operating characteristics in light of the existing regulatory framework. Unfortunately, however, meaningful data for operational costs and output is only available for the RETCOs. This makes it impossible to make indepth direct comparisons between the major players in the industry.

Private operators have always been seen to operate efficiently; the opposite is the case with public operators (Maro et al., 1993; Mwase, 1994). The concern about the operating environment and firm operational features which are shaped by, among others, the regulatory framework can still be captured though by a study of the public firms. Obtaining the greatest benefits from regulatory reform may require a review of the status and operations of public enterprises.

As noted above, the RETCOs are public entities and constitute a set of firms that present a microcosm of a regulated sector in the trucking industry in Tanzania. They are firms whose operations have been very much influenced by policy prescriptions. In the regions in which they are situated, the RETCOs control an average of 25 percent of the trucking output, in ton-km (see table 3.12). It can be observed from the table that KAUMU, for instance, handled about 49 percent of freight traffic in Mtwara. KAGERA in Kagera region follows with about 34 percent. Only KAUMA of Mwanza has the lowest share (7 percent) followed by KAUTA (10 percent) of the Mwanza and Tabora regions' trucking markets.

Table 3.12: RETCO-Respective Regional Freight Shares, Averages 1987-91

	Regional Freight (000 tkm)	**RETCO Freight (000 tkm)**	**RETCO Share (%)**
KAUTA-Tabora	125152.82	12690.0	10.14
KAUDO-Dodoma	167490.88	45247.0	27.01
KAUMA-Mwanza	262769.32	18891.0	7.19
KAUMU-Mtwara	35886.78	17470.0	48.68
KAURU-Ruvuma	135464.84	21681.0	16.00
KAGERA-Kagera	55086.20	18682.0	33.91
Average			23.82

Source: Maro et al. (1993), RETCO and NTC records

This could as well be pointing to the degree of competition each RETCO faces in their respective regions, in terms of getting cargo. Chances of reaping monopoly profits (as made available to them through statutory stipulations) are higher for KAUMU and KAGERA than it is for KAUTA and KAUMA. Parastatal sector's share in the production of trucking services stands at 34 percent (refer table 3.9). The RETCOs are dominant among parastatal operators. A greater proportion of the public sector's share may be attributed to the RETCOs. So with regard to the entire country, RETCOs can be said to control about 30 percent (i.e., about one third of freight traffic) of trucking operations. This is quite a considerable amount.

The public ownership nature, service obligation, differing locational features, and the enjoyment of some operational autonomy, make it possible to derive important policy issues meaningful to the whole trucking sector in Tanzania, from the study of the RETCOs. Among the differing locational features is the condition of the road network firms use for the production of trucking services. The road network in Tanzania is poor across the country (recall regression results on the determinants of freight traffic demand obtained in chapter two). It is thus expected the cost performance in the industry to be very much influenced by road condition related factors, i.e., fuel and repair and maintenance expenses, which tend to be high on poor roads. Poor road quality causes substantial increases in vehicle operating costs (refer chapter five).

This is a national phenomenon, touching each and every operator. Thus differential performance across the regions covered by the RETCOs could very well remain reflected in an analysis involving a complete sample of the industry. It is thus possible to draw inferences for the whole trucking industry from the study of the RETCOs. This is the advantage this study makes use of. However, if this were not to be the case, whether the results obtained are specific to the RETCOs, and not of a wider application to cover the entire trucking industry in Tanzania, findings here should provide a motivation for future research.

This is made even more relevant by the fact that ultimately, the survival of anyone undertaking, private or public, depends on the efficiency of the operations rather than ownership characteristics per se (Estrin and Pèrotin, 1991). This realisation is backed by the policy reforms adopted starting 1984, which are aimed at promoting internal competition and thus requiring the RETCOs to compete, like anyone else, in the trucking market[13]. This does therefore alter their previous status when they enjoyed preferential treatment in licensing, allocation of lucrative routes, access to concessionary credits, vehicles, tyres, foreign exchange, etc.; and frees them from charging government predetermined rates. It also enables them have their own vehicle investment policies.

[13]Summers (1994) argues, however, that sustainability of such survival can only be guaranteed in the case of private ownership. He notes that public enterprises (PEs) that are observed to be well functioning and efficient are usually characterised by ephemeral successes, particularly when they are the result of public enterprise reform programmes. He notes further that the instances in which PEs succeed are typically the instances in which it makes the least difference whether the enterprise is public or private.

3.7 Summary

This chapter has attempted to examine the operations of Tanzania's freight industry carriers. A comparative assessment of the operators based on performance indicators suggests private operators to operate relatively more efficiently than their public counterparts. In any case, the achieved levels pale in comparison to those recommended under TIRIP, indicating general inefficiency in the operations of Tanzanian trucking operators.

Policywise, prior reform government restrictions on the market caused resource misallocation in the sector and hindered private sector's effective participation while protecting public firm inefficiency. Policy reforms promise a brighter future for the sector as all operators are exposed to the same and level playing field. The expectation is that this will improve services and reliability while enabling reduction of costs to shippers.

The next chapter draws from this and chapter two to expound further on the question of performance evaluation, an indepth analysis of which is based on the operations of microcosm, the RETCOs, and provide a framework for firm (RETCO) performance (efficiency) evaluation through a review of literature.

CHAPTER IV

PERFORMANCE OF THE TRUCKING INDUSTRY: THEORY AND REVIEW OF LITERATURE

4.1 Introduction

In chapter two, through the SCP-paradigm, it has been possible to examine the structure of the trucking industry in Tanzania and identify factors that have caused such a configuration. Conspicuous among the determinants has been the role of government (regulatory) policy (a derived element). But also important were factors basic to the trucking product itself, i.e., scale economies (intrinsic element) argument. The cost structure, entry conditions and the overall orientation of operations in the industry, e.g., issues of pricing, etc., (conduct) have been addressed.

The account provided in chapter three gives one an indication of the general tendency towards non-optimal operations in the Tanzanian trucking industry. Of concern is thus the question of industry performance, calling for an indepth assessment of operations in the industry. Issues which draw attention include productive efficiency and its change overtime, capacity utilisation, together with the factors determining them, e.g., regulatory policy. Also important is the question of whether or not the industry is characterised by scale economies and implications thereof.

This chapter is devoted to discussing the performance part as contained in the SCP-model setting, i.e., evaluation of firm operations. Buchanan (1969) observes that the relevant objectives and constraints are not necessarily those identified by the observing economist, but those identified by the people making the choices. It makes sense therefore to ask what options the decision makers (firms) perceived and what objectives they hoped to accomplish, subject to which constraints. Knowledge about agents' perceptions, beliefs and constraints can help one better understand the observed outcomes.

Two features stand out with respect to the structure of the trucking industry in Tanzania (as discussed in chapter two). These are ownership and firm size. All these have a bearing on firm (efficiency) performance. It is only instructive therefore that these two features be discussed with the aim to highlight the expected results from the performance evaluation exercise conducted in later chapters.

The coverage is thus directed at discussing first the central theme in performance evaluation, that is, the concept of efficiency. An attempt is then made at examining the rationale for firm inefficiency via presentation of the theory of the firm and theories that study implications of ownership characteristics on performance. Later a framework of analysis to be applied in the evaluation of inter-firm differences in performance and factors behind trucking firm operations is provided. A review of literature is also carried out, important operational parameters are highlighted and gaps this study endeavours to fill identified.

4.2 Efficiency: A Theoretical Exposition

4.2.1 The Concept of Efficiency

Efficiency characterises usage of resources. It essentially emphasises avoidance of wasteful resource utilisation. It is defined, as per Farrell, as a production unit's success in producing as large as possible an output from a given set of inputs. Practically, it is useful as a measure of economic performance. Increased efficiency is viewed as a viable complement to any policy formulation exercise geared towards increased production while conserving resource use. It therefore guides policy formulation by throwing light on achievements of the past goals (Russell and Young, 1983).

There are three types of efficiency measures which were first propounded by Farrell (1957). His basis was the rejection of the idea of an absolute measure of efficiency in which case one would have a predefined ideal situation, i.e., efficiency in an engineering sense. He proposed basing efficiency measurement on observed performance. By so doing performance relativeness can be captured, i.e., efficient relative to the *observed/empirical* best practice.

These measures are:

(i) *Technical efficiency* (TE): this shows how the same output could be obtained by using less inputs. A producer is thus technically efficient if an increase in an output requires a decrease in at least one other output or an increase in at least one input, and if a reduction in any input requires an increase in at least one other input or a decrease in at least one output. Inefficiency results from excessive input usage. It is therefore related to physical amounts of inputs.

(ii) *Allocative efficiency* (AE): this is also known as price efficiency; it is achieved when inputs are employed in cost-minimising proportions. Inefficiency is due to employing inputs in wrong proportions. It is related to the value of inputs.

(iii) *Total efficiency* (TOE): this is a combination (product) of the above two measures. The measurement of these three measures can be best illustrated by the use of the following diagram (figure 4.1).

efficiency index of 1. TOE can be measured as OB/OE. This can be readily decomposed, viz., OB/OE = (OD/OE)(OB/OD); with OB/OD identified as a measure of the allocative efficiency (AE). The ratio OB/OD is also the cost efficiency (CE) index of firm D.

4.2.2 Rationale for Firm Inefficiency

4.2.2.1 Theory of the Firm and Implications for Efficiency

Often, the discussion about firm efficiency employs the argument of firm size as well. Indeed, the advocacy of small firms has tended to employ the efficiency argument (You, 1995). This touches therefore the question of the determinants of firm size. The traditional analysis of firm size is conducted in the context of a competitive equilibrium. In a competitive equilibrium, the actual firm size will be the efficient size in the sense that the long-run average cost (LRAC) is minimised at that point (Hay and Morris, 1991). Thus in the production process, a firm will seek that method or technique which minimises its expenditures on resources (refer Farrell's efficiency measures presented above). So, in this case, the technologically-determined economies of scale (and scope) (to be discussed later in the chapter) are the principal determinants of firm size. The approach taking this view is thus referred to as the *technological approach* to the theory of the firm (You, 1995)[1].

You notes, however, that the efficient size of the firm has to be explained by more than technological factors. He contends that production technology alone cannot explain why at some point in the production process diseconomies of scale

[1]You (1995) cites other approaches to include: the institutional approach in which firm size is determined by transaction cost efficiency, industrial organisation approach in which firm size and its distribution (market structure) are determined by market power and the last approach is that of the dynamic models of the size distribution of firms, including stochastic models (growth rate of firm being independent of its current size and its past growth) , life-cycle models (the role of learning and so firm age in explaining its growth) and evolutionary models (in which case firms are obligated to continuously initiate technological and organisational changes in order to maintain or strengthen their competitive positions).

would set in and the LRAC curve slopes upward. Or even why some firms fail to take advantage of the presence of scale economies. One obvious solution, he says, is to conclude that the efficient firm size is indeterminate beyond the minimum efficient scale (MES).

This brings in the conception of a firm as a social organisation. As such costs are determined not only by the characteristics of production technology but by the effectiveness of the organisation in decision-making and implementation. The economies of scale at the production level are then limited by the diseconomies of scale in organisation technology. The ability of individual entrepreneur's willingness to take on risks, effectiveness of management and the inherent features of organisation, such as control and information, are some of the factors that will determine firm size and thus efficiency therein (Lucas, 1978; Prescott and Visscher, 1980).

In this approach, therefore, firm size is ultimately determined by the efficient allocation of given resources (including risk tolerance, managerial talent, knowledge and information, etc.) under given production and organisation technology. The average unit cost will thus be the sum of the average production cost and the average organisation cost; and this will be U-shaped, possibly with a more or less constant average unit cost over some range (Scherer, 1980). *Ceteris paribus*, the larger the economies of scale present in the production technology, the larger the efficient firm size (You op cit.). So the crucial issue here for efficiency is the question how a firm obtained its size, whether through administrative directives (mergers, nationalisation) without economic rationale or otherwise. The underlying principle, however, is that firm size be determined by efficiency reasons (Barros, 1995).

4.2.2.2 Ownership Characteristics and Firm Performance

It is evident from the above exposition that efficiency, a key concept in performance evaluation, relates to the way economic activities are organised and production processes structured. The main aim of firms must be to minimise costs (and so maximise profits). Relative performance of such entities then becomes central in their assessment, i.e., whether a firm (or industry) is efficient or not. Firms differ in the way they operate (use resources), making efficiency vary across firms within an industry. Inefficiency is rationalised by the existing organisational structure in an economy. As Summers (1994) and Mehran (1995) remark, ownership does matter (in addition to market conditions) in determining and influencing enterprise performance.

There are different explanations for this state of affairs, some address issues internal to a firm, some exogenous. Four explanations are proffered in the literature. Bruning (1992) cites three theories: Rent-Seeking à la Tullock-Krueger, Leisure-as-Output à la Stigler, and X-Efficiency à la Leinbestein. The fourth is the Principal-Agent theory à la Alchian-Demesetz-De Alessi (Plane, 1992; Vickers and Yarrow, 1989)[2]. This last theory will receive relatively much more coverage as it touches much more directly the feature that is alluded to here, i.e., ownership.

Rent-Seeking (RS) theory's main idea is that rent, i.e., payment to a resource in excess of its opportunity cost, serves as an enticement; it motivates people to seek government favour in order to secure individual gains. As a result rent seekers do not produce goods or services with market value (i.e., wealth). They instead, since they are concerned with the maximisation of their own interests, channel resources into socially wasteful activities, produce goods at high unit costs as they use inputs

[2]According to these theories, there is a negative correlation between the growth rate of gross domestic product (GDP), g, and the share of public enterprise output, PE, in GDP, i.e., PE/GDP. The higher the PE/GDP, the lower the g. Public enterprises are thus viewed as being disruptive of the conditions of Pareto optimality.

than is consistent with optimal management, in order to secure political grants or monopoly profits. Also government regulation may result in administered prices below the opportunity costs of goods. As the quantities offered at these prices are mostly limited, customers will then compete to get the benefits of subsidies. In so doing, some resources will be diverted to directly unproductive profit-seeking activities.

Leisure-as-Output (LO) assumes managers and resource owners to be rational and utility maximisers. One of the output components is leisure, a non-traded output. This is determined by resource agents who evaluate their contributions to traded verses non-traded output based on relative prices and opportunity costs. The allocation of effort in production must then be viewed as a trade-off between traded and non-traded output. Consequently, cost per unit of output may increase for some firms relative to others due to relative prices of traded and non-traded output varying among them.

In the *X-Efficiency* (XE) theory, performance is primarily explained by the economic and institutional environment of the firm. It seeks to explain the inability of firms to achieve maximum productive performance as due to lack of motivation within the organisational structure and/or lack of competition in the market, i.e., external motivation. A firm then is not always internally efficient, nor does it always behave as a cost minimiser. According to XE, lack of the threat of bankruptcy as the ultimate sanction of bad results and protection from competitive pressures produces not only allocative inefficiency, but generates inefficiencies within the firm.

Internally, presence of unspecified labour contracts (the individual is thus likely to choose a working position which is not the most productive for the firm) and individual resistance to change (because of individual disutility in moving from one effort position to another) and so hampering attempts to improve productivity, add to the reasons for inefficiency. So it is slackness in effort (i.e., that meant to

The principal's utility is given by:

$$U_p = U_p(\Pi - F) \qquad (4.2)$$

and the agent's utility by:

$$U_A = U_A(F, a), \;\; \delta U_A / \delta F > 0, \;\; \delta U_A / \delta a < 0, \qquad (4.3)$$

in that, the manager has an incentive to minimise his effort, because it generates disutility to him, and to attribute any poor outcome in terms of profits to random fluctuations in the economic environment, i.e., the state of nature. Thus the principal's problem is to choose $F(\Pi)$, the incentive scheme for the agent. In doing so he must recognise two constraints. First, the agent will behave in a self-interested way given the incentive scheme. Second, the incentive scheme must be attractive enough for the agent to be willing to participate in the venture with the principal. The ability of the agent to observe the state of the world and his attitude towards risk are critical aspects in determining the action he takes which is critical for the creation of the value for the firm.

The PA theory thus puts ownership at the centre of the rationale for firm inefficiency. It is important to note here that, in the case of public ownership (PEs), the *principal-agent* relationship (using property rights arguments) becomes blurred leading to ineffectiveness in the monitoring of activities. Non-profit maximisation objectives, absence of marketable ordinary shares in the firm and absence of an equivalent to the bankruptcy constraint on financial performance, the issues that characterise publicly owned firms, makes PEs different from private firms (Vickers and Yarrow, 1989).

Inefficiency is thus explained by mainly two explanations. The first regards the high correlation between the reward-cost schedule and the efforts of the individual that is characteristic of private firms, which lacks, however, in PEs. In this case the key to success is the practice of rewarding success and punishing failure. The pursuit of non-profit objectives, therefore, reduces compensation due to the fact that managers' bonuses are calculated as a function of earnings. The public manager (agent), on the other hand, has no direct interest in the residual income of the firm. The owner (principal) could use incentives, but with deterrent transaction costs.

The second concerns the fact that in privately owned companies, the shareholders are supposed to be efficient in forcing managers to maximise profit. If they are unsatisfied with the way the firm is managed, they can ask for the directors to be dismissed and possibly sell stock. This cannot be done in case of a public enterprise where the ownership is not transferable and the task of monitoring managerial performance is entrusted to government.

The operational features in the Tanzanian trucking industry as discussed in chapter two and the performance outlook shown in chapter three, seem to be explained by a synthesis of the above theories. The organisational set up has been a source of internal complacency, misallocation of resources and heavy reliance on government finances for survival; while the inhibition of private initiative killed the competitive spirit. These, together, caused the general lack of vigour in trucking operations in the country. There were, it appears, in-built attenuating circumstances to any efforts meant to enhance productive efficiency in the economy. Especially affected by this operational environment were public operators, a group in which the RETCOs belong.

Sub-sections that follow examine approaches used to evaluate performance of production units.

4.2.3 Framework for Performance Evaluation

4.2.3.1 The Cost Function Approach

One approach is to study the cost structure of firms/industry. It is through the estimation of the cost function that one gets, among others, information on scale economies, cost shares of inputs used in the production process, and productivity performance. It is only instructive to note that through duality theorem, as long as firms minimise costs[4], cost functions capture all the relevant information regarding the production structure of firms (Varian, 1984). It is thus sufficient to estimate a cost function to analyse the structure of production of a set of firms in an industry. Generally a cost function is specified as:

$$C = C(w, y) \tag{4.4}$$

where C represents costs, w represents a vector of inputs, y represents a vector of outputs. The cost function is homogeneous of degree 1, non-decreasing and concave in the factor prices. Cost variations are expected to move in the same direction as output and inputs. The more the output produced the more the cost and in the same way, the more the inputs used in the production process the more the costs incurred. The proportionate increase in costs relative to that in output is crucial. It is economically advantageous if the increase in cost is proportionately less to that of output, i.e., scale economies argument. Technological and/or managerial improvements make it possible to produce more output with same levels of inputs, or the same level of output with less inputs or lower level of expenditure (Stevenson, 1980).

[4]An important thing to note here is the cost consciousness which characterises most firms so that if faced with alternatives, given the input set and technology at its disposal, a firm would always go for the lowest cost alternative, *ceteris paribus*. Firms can thus be evaluated based on their cost performance, given the circumstances.

Effective input utilisation is also tied to the question of capacity utilisation. Increased capacity, e.g., increased capital, unaccompanied by increases in output lead to cost increases and a fall in productivity. On the other hand, fluctuations in output lead to underutilization of available input set, substantially increasing unit costs of production. These negatively affect cost efficiency. To evaluate relative firm performance, unit costs may be compared across firms (Waverman, 1988). The presence of inefficiencies irrespective of the initial cause is reflected as an upward shift in total and average cost functions, i.e., in a declining trend in cost efficiency. To counter this, measures have to be taken to increase productivity, whose growth signifies the ability to produce more and better output from given resources (Winston, 1985).

It should be noted that productivity growth, if there is any, translates into cost savings in terms of using less inputs to produce same level of output or produce more output from the same input levels (Hulten, 1983). To capture productivity growth, a time variable is introduced as an explicit argument in the cost function (Friedlaender and Wang Chiang, 1983). The function thus takes the form:

$$C = C(w, y, t), \tag{4.5}$$

where t is time. The elasticity of cost w.r.t. time gives the measure of the rate of productivity growth.

4.2.3.2 Frontier Production Function Approach

It is an indisputable fact that efficiency varies across production units. Analysis of efficiency (in practice) compares the performance of production units to some norm, the best practice or frontier (Bruning and Olsson, 1982). Deviations from this frontier are manifestations of X-inefficiency which can be used to uncover patterns of changing efficiencies (Majumdar, 1995). The benchmark then, for anyone interested in questions concerning efficiency, should be maximum output, and not some average amount (Grabowski and Mehdian, 1990). The frontier production function (FPF) becomes the natural reference since it provides the outer boundary of possible input-output combinations. It is the production function that sets the highest possible limit on the output which a firm can hope to obtain with a certain combination of factors at the given state of technical knowledge during the production period (Aigner and Chu, 1968). Firm efficiency is therefore measured relative to this norm.

The origin of the development of the FPF is Farrell (1957)[5]. On the basis of his work, Aigner and Chu fitted the production frontier as an envelope to a sample of observations. The formulation of the function takes the following procedure.

Let N be the number of firms in an industry, y be output, and x inputs. A set of production functions representing the blueprint technologies can be presented as:

$$y^j = f^j(x^j),\ y^j \in R+, x^j \in X, X \subset R^n_+,\ \ j = 1,\ldots,n \qquad (4.6)$$

The best practice or frontier production function (in a factor space $X \subset R^n_+$) for an entire industry consisting of a given set of N firms with the above presented production functions is defined by:

$$F(x) = \max_j f^j(x^j),\ \ x^j \in X,\ \ j = 1,\ldots,N \qquad (4.7)$$

Thus the FPF is an envelope of individual ex-ante production functions (showing the most efficient means of transforming inputs into outputs). The frontier

[5]Since then different types of frontier production function have been developed; each has its implications on the measure of efficiency. More on this in chapter six; refer Forsund et al.(1980) for the survey.

is therefore made up of those parts of the firms' production functions that yield maximum output for a given set of inputs, relative to the set of production functions applying to the industry.

The method constraints all observations to lying on or below the fitted production frontier. Thus the frontier consists of only the maximum output yielding input combinations (the best practices observable). No actual output would then exceed its potential. So that if, for instance, you have production frontier with Cobb-Douglas functional form of the type:

$$\ln y_j = \sum_{i=0}^{n} \alpha_i \ln x_{ij} + u, \tag{4.8}$$

α_i are factor elasticities and u an error term representing deviations from the frontier,

$$\sum_i \alpha_i^* \ln x_{ij} = \ln y_{ij}^* \geq \ln y_{ij}, \tag{4.9}$$

star for frontier function. Only the technically efficient firms satisfy the equality requirement and that the constraint becomes:

$$\sum_i \alpha_i^* \ln x_{ij} \geq \ln y_{ij} \tag{4.10}$$

To fit the production frontier as close as possible to the actual outputs, the distances between actual outputs and their potentials are minimised, i.e.;

$$Min \ln y_j^* - \ln y_j = \sum_i \alpha_i^* \ln x_{ij} - \ln y_j \geq 0 \tag{4.11}$$

Note that efficiency measures are often based on unit requirements of inputs. On the basis of the production function, an efficiency frontier is constructed by transforming the production function from the factor space into a space of input coefficients. This is made up of all points where the input coefficients (share of input to output) reach their maximum values along the rays from the origin (Forsund and Hjalmarsson, 1987). The input coefficient space may take the following form:

$$x = (x_1, \ldots, x_n), \quad x_i = x_i / y, \quad i = 1, \ldots, n \tag{4.12}$$

$$y^j = f^j\left(\frac{x^j}{y^j} \cdot y^j\right) = f^j(x^j\, y^j), \quad j = 1, \ldots, N \tag{4.13}$$

To obtain optimal scale, elasticity of scale, ε , is calculated. This is obtained as:

$$\varepsilon = \frac{\sum_i (\partial f / \partial x_i) x_i}{f} = \phi(x_1, \ldots, x_n) \tag{4.14}$$

Optimal scale is where ε = 1 on the frontier (see Forsund and Hjalmarsson, 1987, for more on this).

4.3 Efficiency and Trucking Operations

This section reviews the literature on the performance of transport firms while paying much more attention to trucking operations. Performance of other sectors in transportation is also examined for identification of important performance indicators that might be useful in the evaluation of performance of the Tanzanian trucking industry. The review centres around issues of trucking output, productivity performance, scale economies, capacity utilisation, and regulatory constraints. A subsection, devoted to literature on Tanzania, is also presented.

4.3.1 Nature of Trucking Output

Transportation product has weight and spatial dimensions. Transportation involves movement of goods over distances. Transportation output is thus traditionally expressed in volume and distance dimensions, e.g., ton-kms, as a *generic* description of the production of a transport firm. There are, however, many definitions of transportation output proffered in the literature stemming from the desire to add quality and technological factors. First, is the single-output-single-measure definition, in units-times-distance per unit time (UTD), e.g., ton-km per year; second, the single-output-many-descriptor approach which uses many dimensions of the same 'generic' UTD output, e.g., ton-miles, tons, traffic mix; and third, a single composite output as in hedonic specification, using the UTD-type measure as generic output; and finally the characterisation of transport output in terms of more than one product , e.g., passenger- and ton-kms (Jara Diaz, 1982). Most studies thus use UTD-type measures of output as the basic or generic notion of the transport product for cost function estimation.

The aim in choosing anyone of the definitions is always to use an output measure which better reflects the scale of operation of operators in question (Berechman, 1983). The most commonly used output measure for freight operations is ton-kms[6]. This has its own implications on the study and conceptual analysis of

[6]Oum and Yu (1994) distinguish between what they call available output measures and revenue output measures. Available output measures (such as truck-kms, train-kms, etc.) indicate essentially the level of capacity supplied, while revenue output measures (such as ton-kms, passenger-kms) indicate the level of output consumed by the users and the value they derive from them. It is preferable to use revenue output measures when public policy analysis is the purpose of the study especially for efficiency measurement. High efficiency measured in available output may imply that an operator with high kms (empty haulage) is efficient compared to a similar operator with high load factors. The economic efficiency measured in revenue outputs reflects the combined effects of managerial efficiency and the constraint imposed by the regulatory authority.

transportation industries. It adds another dimension to the output-efficiency relationship. For one thing, ton-kms are not homogeneous. One ton moved 100 kms is different from 100 tons moved 1 km both however make up 100 ton-kms (Daicoff, 1974).

The spatial nature of transportation product has therefore influenced supply analysis in transport economics. Cost functions have been estimated to shed light on performance of transport firms while taking into consideration this feature (Winston, 1985). The multiproduct approach has also been employed to capture this problem (Bailey and Friedlaender, 1982). Reference is, in this case, made to the concepts of economies of scope (advantages from joint production) and product specific economies (cost changes due to changes in level of one output leaving levels of other outputs unchanged).

Another aspect is that of quality of service. This has an influence on demand analysis. Transportation services cannot be stored and are consumed and their quality valued on individual basis. So issues of travel/shipment time, comfort, reliability of service, etc., are important attributes of transportation service. They have implications on evaluation of performance of transport firms. Hedonic specification of cost functions have been carried out to capture attributes that pertain to the quality of output (Spady and Friedlaender, 1978). A hedonic cost function attempts to control for the effect of the quality of output on total costs.

Transportation services are also subject to government regulations rationalised on different grounds. Price regulation and service obligation are common features. Performance evaluation might require taking this into account. Presence of regulatory constraints on operations lead firms to provide services in a manner that fails significantly to minimise costs and make efficient use of facilities (Friedlaender and Wang Chiang, 1983).

4.3.2 Cost Structure and Scale Economies Controversy in Trucking

Cost models provide guidance to operators and regulatory boards (government agency) which need benchmarks to help set rates for service and/or monitor the sector. They are also important as a basis for estimating and comparing costs for competing operators and modes. Knowledge of the cost structure is tied to knowledge of an industry's technology. In the case of the trucking industry, however, a fundamental difficulty associated with studying trucking technology is finding an appropriate measure of output. As has been pointed out in section 4.3.1 above, aspects of origin-destination, commodity, size, and level of service are crucial in defining trucking output. Also important are the type of corridors utilised by a firm as well as the structure of the network over which the firm operates (Wang Chiang and Friedlaender, 1984).

Analysis of trucking technology and costs makes therefore a distinction between truckload (TL) and less than truckload (LTL) operations(touched in chapter two); each has its implications on operational costs. TL service typically carries a single truckload shipment that requires no consolidation and that can be sent directly to its destination once it is loaded. TL operations are thus largely invariant to length of haul, and there is little variability in load or shipment size. LTL on the other hand, takes place over a network of terminals and specific routes and typically carries small shipments that require consolidation at local terminals and may require another round of consolidation at break-bulk terminals. It involves, therefore, smaller shipment sizes, smaller loads, and slower service than TL for comparable length of haul. So whereas network effects may not be very important for TL operations as is the case for LTL ones, the allocation of traffic among various links and nodes affects their costs through equipment utilisation.

These operational differences have a bearing on technology and are important in analysing the various features of the trucking industry. Attention is drawn to *scale* and *density* economies[7]. Economies of density relate to savings that result from moving larger amounts of traffic over a fixed route system (network). It answers therefore, assuming operations on a network, the question whether a firm makes full utilisation of the existing network. Scale economies on the other hand refer to cost response to changes in output (size) or to output changes as a result of input (capacity) changes (Caves and Christensen, 1988). Cost functions are used in estimating the degree of scale economies or density economies in transportation industry. Most of the studies reviewed in this study are, however, related to the issue of scale economies as the firms being studied do not operate on any defined networks.

The issue of scale economies (falling unit costs as output increases) in the trucking industry, important for examination of the industry structure, has been controversial with most of the evidence inconclusive. Data limitations and the resultant cost function specification errors (use of single aggregate output measure and omission of network effects and output quality attributes) have been blamed for this state of affairs (Wang Chiang and Friedlaender, 1984). Also important is the output measure used in the estimation, e.g., whether one uses truck-kms or ton-kms and methodology adopted in the study of scale economies.

[7]Two other types of economies need mention. The first applies in the case of a multiproduct framework, i.e., the concept of *economies of scope*. This measures the cost advantages to firms of providing a large number of diversified products as against specialising in the production of a single output. It addresses therefore the convenience of producing more than one output (joint production). They are said to exist if costs of joint production are less than costs of separate production, i.e., $C(\sum_i Y^i) < \sum_i C(Y^i)$, the aspect of cost subadditivity (Bailey and Friedlaender, 1982). Evidence on scope economies is, however, reported to be inconclusive (Hay and Morris, 1991). The second is what Keeler (1989) refers to as *economies of integration* which relate to all the ways in which a large trucking firm can be more efficient than the smaller one. In this case the Survivor technique, which incorporates a number of different variables to explain survivor patterns, rather than allowing for size only, is used. In trucking such variables include speed of delivery, schedule reliability, or overall convenience of use by shippers. Critics of the technique argue that such inclusion may not be necessary for all that is attractive about a carrier will show up in the degree of customer acceptance, i.e., magnitude of output operated (Hay and Morris, 1991).

The inclusion of the operating characteristics in the cost function specification has led to conclusions that the industry is characterised by increasing returns to scale (Harmartuck, 1992). Noted in this case is the realisation that costs not only depend on the level of output but also on the way in which it is carried (Friedlaender and Wang Chiang, 1983). Two firms with identical factor prices and outputs in ton-kms could have very different costs depending on the nature of operating characteristics. For a transportation industry, operating characteristics - average load size, average length of haul, average firm size - are important and have a significant impact on costs. It is argued, therefore, that they should enter into the analysis of costs and technology (Winston, 1985).

The traditional view, in the case of trucking operations, points to the case of constant returns to scale. This is justified by the fact that the trucking market accommodates a large number of operators and that small operators continue to play an important role in the industry (McMullen, 1987; Grimm et al., 1989). Advantages enjoyed by large firms in terms of load consolidation, better information network, regularity of service, easy access to capital, etc., point in the direction of existence of scale economies in the trucking industry. In some cases where ostensible evidence of returns to scale has been found, it has been recognised that these were not returns to firm size, but to economies of density or utilisation. That the observable economies of scale are probably a function of the intensity to which a given geographical route pattern is utilised and not the total volume of the firm. These economies of scale in traffic density are equally available to large and small firm (Spady, 1979).

There are yet other studies that have found the industry to be characterised by decreasing returns to scale (Callan and Thomas, 1992). Efforts behind taking into account the heterogeneity of trucking output seem to be the kernel of the problem and the resultant inconsistencies. This makes policy conclusions potentially unreliable. As Jara Diaz (1982, p. 267) observes following the illustration in Spady and Friedlaender (1978), that "the pure UTD approach indicates counter-intuitive increasing returns, 'explaining' mergers and supporting regulation; on the other hand, the 'quality adjusted' UTD approach indicates acceptable constant returns, supports deregulation, but does not explain by itself industry behaviour".

Koenker (1977) estimated a cost function based on a time-series/cross-sectional sample of American trucking firms. His concern was on the optimal size of trucking firms and the cost adjustments to be incurred by firms in the time of unanticipated short-run fluctuations in the level of output. Explanatory variables used were average length of haul (ALH), average load (AVLOAD), and ton-miles. Firms larger than the estimated optimal size were found to dominate the industry, i.e., most firms were in the decreasing returns zone of the average cost curve. Average costs were shown to dramatically fall as length of haul and size of load increased since these factors are correlated with firm size.

Spady and Friedlaender (1978) considered the case where output qualities, i.e., size of shipment, length of haul, etc., are important; that is, when physical output varies with respect to these attributes. To take care of these, a hedonic cost function was estimated for the US trucking industry. Total costs were made up of labour costs, fuel expenditure and taxes, purchased transportation and other (included depreciation) assumed to be payments for capital services. A non-hedonic cost specification was also examined. This indicated the presence of rather dramatic economies of scale. The general hedonic cost function indicated the presence of mild diseconomies of scale. Their results indicate therefore that the cost function specification adopted has an influence on the results.

Olanrewaju (1987) studied economies of scale in the Nigerian road haulage system. He classified trucking operators into three groups: small scale operators, road haulage firms excluding National Freight Company (NFC), and road haulage firms including NFC. He adopted the cost function approach to the estimation of economies of scale. However, lack of data on the composition of output and operating characteristics prevented use of multiproduct approach. He obtained the following results. First, only very weak or no significant overall scale economies were observed in the cost function estimated. Second, larger trucks conferred economies of vehicle size on operators in the form of decreasing operating costs and increasing profit margin.

Xu et al. (1994) looked at the controversy surrounding the question of returns to scale in the transport sector. They acknowledge the fact that different studies have come up with different conclusions to the effect that the general consensus seems to be that the industry faces constant returns to scale. They examined the correlation between output characteristics (i.e., ALH and AVLOAD) and the level of output. They show that allowing output characteristics to change as firm size increases indicates that economies of scale may well exist in the trucking industry despite previous evidence to the contrary.

They regressed the cost function on output in ton-miles, the two operating characteristics and input prices for fuel, labour, capital and purchased transportation. Modest diseconomies of scale were found under the assumption that all other variables (especially ALH and AVLOAD) remain unchanged as firm size increases. They then specified the relationship between ton-miles and the operating characteristics. The calculated cost elasticity indicated presence of scale economies in the US trucking industry. They conclude that by allowing ALH and AVLOAD to change as a result of changing firm size, firms face increasing returns to scale.

Hsing (1994) examined the impacts of the US Motor Carrier Act of 1980 on, *inter alia*, returns to scale by estimating a generalised labour demand function for US trucking firms. Trucking labour demand was made a function of hourly wage rate, ton-miles, and binary variables standing for the Act and time. Both static and dynamic models were estimated. He found that returns to scale were higher for the deregulated as compared to the regulated period.

4.3.3 Network and Facility Management

Transport services require both basic (e.g., roads) and operating (e.g., vehicles) facilities to be offered. Operations (especially with less than truckload, LTL, haulage) take place in a network (nodes and links). Transportation firms have therefore to incur, in varying degrees, line-haul and terminal costs. The size of the network in terms of the length of the routes on the itinerary, number of stops, etc., and network configuration are determinant factors in cost performance (Fazioli et al., 1993). The extent of the importance of network effects, also known as corridor - specific nature of trucking traffic, has been demonstrated by Wang Chiang and Friedlaender (1984). They estimated a cost function that utilises network effects. Substantial economies of network configuration and network operations were found to exist. Well connected networks and concentrated traffic flows yield significant cost savings.

Vehicle management is another crucial factor for consideration in performance evaluation. The size of vehicles (carrying capacity), size of fleet, loading and unloading systems, routes covered, turn-around time, possibilities of securing back haul cargo, etc., are among important factors a transportation firm ought to observe. Problems of overloading are also pervasive (Fekpe and Oduro-Konadu, 1993). Bayliss (1992) reports that in a number of developing countries, 45 to 95 percent of all loaded trucks tend to be overloaded, frequently by substantial amounts.

Rizet and Hine (1993) report that in Africa it is common that vehicles of 12 ton design carry, as a result of overloading, on average about 15 tons, 25 ton design carry on average consignment estimated at 32 tons. The same study reports that in

Pakistan the 12 ton design vehicles carry on average 20 tons. The problem of vehicle overloading has also been pronounced in the PTA area making it an important transport policy issue both at national and inter-state level (Mwase, 1993).

Overloading is practised by some operators with the intention to cushion certain costs through increased payload. It, however, has long-term negative impact on vehicles, safety and infrastructure planning. It reduces vehicles' economic life span and can only be maintained through high repair and maintenance expenditures on the vehicles. Overloading does as well increase road roughness, deterioration of bridge decks and expenditures for road maintenance and rehabilitation (Gronau, 1994), affecting to a great degree, infrastructure planning appraisals with suggestions that these be based on actual loadings than legal loadings (Bayliss, 1992). These have therefore significant influences on operating cost and are therefore important for consideration in general performance evaluation of trucking firms.

4.3.4 Productive Efficiency

Productivity performance and productive (cost) efficiency are issues that are reviewed in this section. Factor productivity (total or partial) is one of the ways of measuring the (relative) performance of industries or firms in an industry (Waverman, 1988). Productivity measures relate output to input(s). Various studies have examined productivity performance in the trucking industry using, in the analysis, different methods and employing different factors/indicators.

Winston (1985) draws attention to applications of cost models that have focused dynamic questions such as the extent of productivity growth in the transportation industries. Econometric productivity studies, in this case, incorporate a time variable into the transportation cost function specification, the concern being with cost changes over time as opposed to output or revenue changes. Price regulation and service obligation are factors behind the bias. By estimating a cost function one can establish the factors behind productivity performance. The growth of total cost which, through simulation reflect productivity changes, can be attributed to output, factor prices, and a residual productivity effect.

Wang Chiang and Friedlaender (1984) conducted a cross-sectional study of the LTL operations in the US trucking industry in which they analysed the importance of network variables. A multiproduct cost function was developed and estimated that utilises network variables as arguments. Substantial cost savings, it was found, were possible to be realised by trucking firms that could achieve improved connectivity of their networks. Connectivity refers to the ratio of the actual number of connected links to the possible maximum number of connected links.

Caves et al.(1983) explored the sources of total factor productivity, TFP (defined as the ratio of an index of output to an index of input; indepth coverage in chapter seven) growth for US airlines using TFP regressions approach. Growth of output, average load factor, capacity and average length of haul were the independent variables used. Their results show that increases in output and load factor lead to substantial increase in TFP. Increases in capacity with unchanged output and load factor yield substantial declines in TFP, implying excess capacity during the sample period. Changes in average stage length were not found to be significant determinants of TFP growth. They suggest, as a result, that much of the TFP growth that they attribute directly to the improvement in capacity utilisation can be indirectly attributed to a change in public policy, i.e., airline deregulation.

Caves and Christenslen (1988) looked at factors explaining inter-industry differences in productivity growth. The study focused on the interrelationships between output growth and productivity growth using firm data for LTL operations. Scale economies, capacity utilisation, and economies of density were sorted out and their respective roles in measured productivity growth identified. Two approaches are discussed. One is the total factor productivity (TFP) regression procedure in which TFP is regressed on its sources. The second approach is the cost function method which relies upon estimates of cost elasticities. Extensive statistical work is however required in this case. The first approach is simple and that the TFP regression is straight forward to estimate and interpret. From a cross section econometric work, Caves and Christensten indicate that output and network factors potentially play an important role in determining the growth of productivity in the trucking industry.

Friedlaender and Wang Chiang (1983) did a study on productivity growth in regulated trucking industry in the US for the period 1965 - 1973. The rate of productivity growth, the nature of scale economies, elasticities of substitution, and the impact of operating characteristics upon costs overtime were evaluated. A single output measure was used in estimating a translog specified cost function and the multidimensionality of output was captured via utilisation of operating characteristics. These were: average length of haul (ALH), average load (AVLOAD), and average size (AVSIZE). The elasticities of cost with respect to time gives the measure of the rate of productivity growth. Output, factor prices, and operating characteristics were found to explain productivity growth.

Fazioli et al. (1993) looked at the cost structure and efficiency of local public transport companies in Italy. A translog cost function, with an indicator for network size, was estimated using time series data to analyse 40 regional buses in the Emilia Romagna Bus Companies group. The overall cost inefficiency is estimated by means of frontier cost function and calculation of overall cost efficiency index. Evidence of scale inefficiency and overall cost inefficiency is found. This is mainly attributed to sub-optimal scale and density. Implication of the results are then discussed in terms of regulatory reforms - licensing policy - to allow merger of small and medium size firms.

An application of the stochastic frontier approach to the study of cost efficiency in the trucking industry was carried out by Bruning (1992). The study was done in the case of Class I and II Common Carriers operating in the US in 1987. Costs were composed of maintenance, general administration, line-haul and terminal. He also included percentage of truckload freight hauled and average length of haul to reflect the carrier's size. The technique used calculates an index of efficiency for each carrier in the sample based on observed error term in a translog cost function. Carriers specific factors are also estimated using different regressions. This helped explain variations in efficiency measures for the cross-section of carriers. Type and size of motor carrier and the manner in which productive effort is organised seemed to play an important role in the firm-specific factors.

Thuong (1981) made international comparison of efficiency of railroads in relation to the production and cost functions. He decomposed operational efficiency into its technical and cost components. These components were estimated in relation to the production and cost functions. He used frontier specifications to estimate technical efficiency, TE, (actual output to be on or below the production frontier) and cost efficiency, CE, (actual cost to be on or above the cost frontier). He estimated efficiency for both freight and passenger operations. The variables used were: ton-kms and passenger-kms as output measures; total horse power, kilometres, annual number of employees (for labour), and fuel consumption as inputs. Estimated technical efficiency indices showed a general trend of improvement in technical performance with varying degrees, whereas estimated cost efficiency indices showed no general trend of improvement. Gaps between firms were much narrower in CE than in TE.

A study of efficiency of the railroad industry by use of a frontier production approach was carried out by Grabowski and Mehdian (1990). They measure revenue efficiency of the US railroad for the period 1951 - 1981. They use a ray-homothetic production function which allows returns to scale to vary with output and factor intensity. The frontier was constructed by use of corrected OLS. The approach makes it possible to determine to what extent revenue inefficiency was the result of operating at inappropriate scale and what part was due to wasting resources. Findings show that the main source of inefficiency was operation at decreasing returns to scale and little due to wasting resources.

Forsund (1991) made a comparison of parametric and non-parametric efficiency measures for the case of Norwegian ferries. He wanted to seek out the most efficient of the observed ferries. He used this frontier approach to provide a yardstick for the assessment of reasonable input requirements. Both were of a deterministic type. This restricts all observations to be on or below the function when calculating parameters. Data used included output in terms of total length run multiplied with capacity, fuel consumption in volume, labour in total wages, and capital in number of cars. Efficiency distributions were found to be quite similar for the two methods except for scale efficiency. In this case the parametric method indicated substantial unrealised scale economies while the non - parametric approach showed the largest and in some small ferries to be scale efficient.

4.3.5 Regulatory Constraints

It was mentioned in chapter two that regulation has its own effects on firm or industry performance. Winston (1985) documents three effects of regulation of surface freight transportation in relation to allocative efficiency. First, the static dead-weight loss from rate regulation, caused by setting rates in excess of long - run marginal cost. Second, the dynamic welfare loss from exit regulation that has precluded abandonment of service (mainly in railways). Third, the adverse effect of regulation on technical change and productivity. There are studies that have been carried out which have identified reasons behind the negative effects of regulation and have thus recommended measures towards deregulation to counter these effects (Blair et al., 1986; Moore, 1986; Rose, 1985).

Winston (1981) and Levin (1970) studied the welfare effect of rate regulation. Welfare loss was presented, respectively, as (1) a percentage of revenues for commodity groups carried and (2) the difference between the rate paid to the high cost carrier and the marginal cost (MC) of the low cost carrier times quantity actually transported by high cost mode (within the given mileage block). Two alternative pricing policies were examined to determine the amount of dead-weight loss caused by each, i.e., first-best pricing and Ramsey pricing. The use of marginal cost pricing was found to lead to greater inefficiencies in terms of traffic misallocation.

Friedlaender and Wang Chiang (1983) made an attempt to explicitly study the relationship between regulation and trucking costs or productivity. They examined the extent to which regulation affects the costs and productivity of the firms in trucking industry. Regulatory structures were examined in relation to operating costs (e.g. fuel) and productivity performance through utilisation of factors. A cost function was estimated. Costs were made a function of output in ton-kms, input prices (labour, fuel, capital, and purchased transportation), operating characteristics (average length of haul, ALH, average load, AVLOAD, percentage less than truck load, LTL, average size, AVSIZE, and insurance) and time. They argue that regulatory policy affects productivity growth through its effect on operating characteristics.

4.3.6 Literature on Tanzania

To the best of our knowledge, compared to other countries in Africa and elsewhere, not much has been done to empirically and rigorously evaluate operational performance of trucking firms in Tanzania. Mrema (1979) analysed operations of public companies vis-à-vis those of private operators. Load factors, occupancy ratio, profitability, and vehicle availability ratio were the indices used. Private operators were found to be more efficient than public operators. Mwase (1985) examined operations of the defunct National Road Haulage Company (NRHC). He used a descriptive analysis. Mismanagement was the main problem and this led to the collapse of the company. In another study carried out in 1978, Mwase describes the structural set up of the trucking industry in Tanzania. He found the industry to be dominated by small (1-4 trucks) private operators. This is despite the deliberate government policy to favour public operators.

Haule (1987) looked at labour productivity in the case RETCOs. He used an econometric approach to estimate labour productivity w.r.t some operational attributes. He found some productivity growth but cautioned on the robustness of the results. Likwelile (1987) studied economies of scale in the case of the RETCOs. A cost function specification was used that regressed total costs on output, tons, kms, and an index of direct variable costs. The results showed the industry to be characterised by scale economies. Bagachwa (1981) looked at capacity utilisation taking Biashara Transport Company (BITCO) as a case study. He found the firm to be operating at excess capacity which he attributes to fluctuations in demand, intra- and inter-modal competition and low vehicle availability.

Mwase (1988) looked at road transport pricing in Tanzania. He examined the transport costing for ten transport firms - five private and five public. He also looked at the translation of such costs into actual freight charges. Price control then practised by the National Pricing Commission (NPC) is also examined in relation to firm operations. NPC indirectly set the maximum chargeable transport rates by virtue of its setting maximum price for consumer goods taking into account transport costs. He finds that public owned transport firms had greater overhead costs than private transporters. The opposite is however the case with transport costs.

The reviewed studies on Tanzania do not offer a common gauge from a common pool of data to allow comparative assessment across firms by use of common evaluation indicators. In addition the aspect of efficiency hasn't yet been given the attention it deserves. No systematic attempt has been made to identify efficiency parameters on which to evaluate firm performance.

4.4 Summary

The theoretical discussion and review of literature identify important aspects that need to be taken into account in a study that endeavours to evaluate efficiency/performance of a transportation industry or firm. These can be broadly classified into: methodology, functional specification and important variables for inclusion in the analysis. We provide here a summary of the main issues. The details on the methodology adopted in this study are presented in chapters 5, 6 and 7.

The measure of trucking output is one such item. Traditionally, trucking output is measured in terms of ton-kms. It has been established that ton-kms are heterogeneous. This output measure is multidimensional with volume and distance components. Additionally, the quality of output is very much influenced by size of shipment, commodity type, level of service, reliability, average load, etc. This has made it necessary the use of multiproduct analysis and hedonic specifications.

The specification of the transport cost function is another area. Conventionally, transport cost functions have related cost (C) to output (y), i.e., C = C (y). Input prices (w) have been omitted. This violates cost theory stipulations which say that the arguments of the cost function are factor prices and output and so specify the cost function as C = C (w,y). Input prices in an uncontrolled economy play an important role in regulating demand and supply.

Performance/efficiency evaluation is very much emphasised. A yardstick however has to be set to act as a basis for establishing relative performance. There is need to identify important operating variables to facilitate effective evaluation. The way the industry is structured (firm size and ownership characteristics) and reasons for such a structure to be in place need also to be understood and examined in studying performance.

We gather from the body of literature (see Winston, 1985 for a wider survey; Bruning, 1992, among others) that motor carrier technology is heterogeneous. Significant differences are evident with respect to geographic area of operation, length of haul, fleet composition and facility size, load sizes, etc. All these are characteristics that distinguish performance among carriers. Each one of these features have an influence on cost and output performance, and consequently, upon the degree to which resources are employed to produce transportation output. Hence, the need to assess relative firm performance.

Ultimately, however, the choice of method of analysis to be used has, perforce, to be predicated on the conditions pertaining to the particular country (industry) in terms of data availability and their quality, structure of the industry, purpose of the study, etc.

The next chapter examines the determinants of operations in the trucking industry in Tanzania.

CHAPTER V

DETERMINANTS OF PERFORMANCE IN THE TRUCKING INDUSTRY IN TANZANIA: THE COST FUNCTION APPROACH

5.1 Introduction

The need to establish determinants of performance was stressed in chapter four. This involves, among others, the study of the cost structure of the industry in question. This stems from mainly two reasons. First, the traditional concern for the efficiency of allocation of resources (opportunity cost argument) and second, the more pragmatic reason in that costs to some extent determine prices, prices determine market share and that all these together determine the profitability of the firm (recall SCP-model in chapter two). Operators are thus expected to be cost conscious and that their main aim is to maximise profits through minimisation of costs, in which case the issue of scale of operations, *ceteris paribus,* becomes an important one. The organisational structure of the Tanzanian trucking industry and the general inefficiency in it, as pointed out in chapter three, together with the theoretical setting presented in chapter four, make the study of the cost structure an important one.

This chapter examines the determinants of performance in the trucking industry in Tanzania. This is done through estimation of the cost function. This will enable us identify factors that characterise the industry's cost structure and which are therefore important in the evaluation of the Tanzanian trucking industry. The theoretical aspects underlying cost function specification are discussed below before the presentation of empirical results.

5.2 Theory of the Cost Function

The cost function specifies the minimum possible costs of producing various outputs, assuming technical efficiency, at different prices (Varian, 1984). The most basic concept with which to characterise the productive technology available to the firm is the technology set, T. This describes the productive technology available to the firm. The technology set can be defined as:

$$T = \{\ (x,y): y \text{ can be produced from } x\ \}, \tag{5.1}$$

where x is the input vector and y the output vector. Optimality within T can be represented by a transformation function:

$$F(x,y) = 0, \tag{5.2}$$

which gives the input combinations x that can produce a given output vector y. In a single output case the production function takes the form:

$$y = f(x), \tag{5.3}$$

the transformation function is given by $f(x) - y$. Assuming free disposal we have:

$$T = \{\ (x,y): y \leq f(x)\ \}, \tag{5.4}$$

that is, extra units of the inputs x do not hamper production of output y and that decreasing the output bundle does not diminish the input requirement set. In other words, this implies that any unit can dispose of "unnecessary" inputs or outputs without any consequences for the use of other inputs or outputs.

According to duality theorem however (Varian, 1984), as long as firms minimise costs, the cost function will contain all the relevant information (scale properties, substitution possibilities, technology separability, etc.) concerning the technology, i.e., $C(w,y)$ is dual to $F(x,y)$. Firms are considered to operate in a competitive environment and that they are price takers in the input markets, i.e., input prices are exogenous to producers.

The minimum cost function becomes:

$$C(w,y) = \underset{x}{Min} \{ w.x:(x,y) \in T \} = w.x^*(w,y), \qquad (5.5)$$

where $x^*(w,y)$ is efficient, cost minimising input vector for producing the output vector y when factor prices are given by w; w.x is the inner product. If $y_i > 0$, w > 0, then C(w,y) and $c_i = \delta C / \delta y_i$ exist, i.e., costs are greater than zero and marginal cost is well defined for output that is produced in strictly positive quantity with positive input prices (nonnegativity). If $w' \geq w$, then $C(w',y) \geq C(w,y)$; the same applies in case of $y' \geq y$. That is increases in input prices or output must not decrease cost (nondecreasing in w and y). Cost functions are also concave and continuous in input prices meaning agents are expected to take optimal decisions, make appropriate substitutions, in an event of a rise in any input price. This makes the cost function assume the shape of an upturned bowl. Optimising agents are additionally expected to only react to relative prices (positive linear homogeneity).

The following information is obtained from cost function estimation:

(1) *Input cost shares*:

If we present the cost function in a logarithmic form, then the input cost shares can be obtained, applying the Shephard's lemma[1], by differentiating cost w.r.t input prices:

$$\frac{\delta \ln C}{\delta \ln w_i} = \frac{\delta C}{\delta w_i} \cdot \frac{w_i}{C} = \frac{x_i w_i}{C} = S_i, \tag{5.6}$$

where S_i is the cost share of input i.

(2) *Cost elasticity w.r.t output*:

The main idea is to find out how output changes affect the level of cost, i.e., if there is any systematic tendency for the cost function to increase or decrease with the scale of operations. Elasticity of cost w.r.t output represents percentage change in cost to a percentage change in output. It does also describe cost flexibility, the ratio of marginal cost (MC) divided by average cost (AC) (Chambers, 1988).

$$\eta(w,y) = \frac{\delta \ln C(w,y)}{\delta \ln y} = \frac{\delta C(w,y)}{\delta y} / \frac{C(w,y)}{y} = \frac{MC}{AC}, \tag{5.7}$$

where $\eta(w,y)$ is the elasticity of cost w.r.t output.

This measure is identical to elasticity of scale, i.e., elasticity of output w.r.t input as well as elasticity of size through its inverse (Nadiri and Schankerman, 1981). It can therefore be used as a measure of economies of scale. A magnitude of

[1]If the cost function is differential in w, then there exists a unique vector of cost-minimising demands that is equal to the gradient of C(w,y) in w. That is, if $x_i(w,y)$ is the ith, unique, cost-minimising demand, then $x_i(w,y) = \delta C(w,y) / \delta w_i$. Put in another way, $\delta C(w,y) = x_i(w,y)\delta w_i$, i.e., for a small change in input prices, δw_i, the change in cost can be approximated by the change in price multiplied by the amount of factor used.

$\eta(w,y)$ is an indicator on decisions about single vs multiple operations as it sheds light on whether or not there are cost (dis)advantages associated with any one of the decisions. The decision criteria are as follows:

$\eta(w,y) < 1$, increasing returns to scale, and so there are cost advantages from centralising or expanding operations,

$\eta(w,y) > 1$, decreasing returns to scale, and so small size firms are cost effective,

$\eta(w,y) = 1$, the case of constant return to scale, proportional increases are the same for cost and output.

(3) *Productivity Growth*[2]:

Another important and candidate management objective worth examining is productivity performance, with increased interest directed at total factor productivity (TFP) (as opposed to single input measures). TFP is defined as Q_{it} / X_{it}, where Q_{it} = output of firm i at time t and X_{it} = an aggregation formula for combining inputs. Thus to measure productivity, one divides the value of outputs produced by the value of input resources consumed. TFP is a measure of the growth in output that cannot be explained by growth in inputs and, as such, has been called a measure of the "unexplained residual", also known as multifactor productivity (Cowing et al., 1980).

It should be noted that productivity growth, if there is any, translates into cost savings. Productivity growth can therefore be described by use of the cost function and can be associated with a shift in the cost function over time. This is done through introducing time (t) as an explicit argument in the cost function

[2]A detailed discussion on productivity performance, together with a discussion on the productivity results in the trucking industry in Tanzania obtained from cost function estimation, is provided in chapter seven.

(Friedlaender and Wang Chiang, 1983). The cost function then takes the following form:

$$C(w,y,t). \tag{5.8}$$

Productivity growth is represented by a negative estimated coefficient on the time variable and is obtained by differentiating cost w.r.t time. A negative coefficient implies cost diminution over time. That is,

$$\theta(w,y,t) \equiv \frac{\delta \ln C(w,y,t)}{\delta t}, \tag{5.9}$$

where $\theta(w,y,t)$ is the rate of cost diminution; it represents the pure productivity effect.

5.3 Cost Function: The Case of Trucking Industry

It is apparent that different aspects are emphasised in different studies. Measures of firm size, network variables, fleet characteristics, quality related output dimensions, etc., are among the aspects widely debated as to their inclusion or otherwise in the trucking cost function specification. Transport cost functions have traditionally related cost (C) to output (y), C = C(y) (Koshal, 1970). Input prices have been omitted in violation of the theoretical stipulation. Winston (1985) considered the simple cost model used by Harris (1977)[3] to estimate the costs of rail freight transportation with a focus on traffic density, i.e., gauging average cost changes due to output increases holding the route system (miles of rail line) constant.

[3]The basic model used was: $C = \beta_0 RTM + \beta_1 RFT + \beta_2 MR$, where RTM is revenue ton-miles, RFT is revenue freight tons, and MR is miles of road. $\beta_2 > 0$ indicates presence of traffic density.

This, he contended, was a useful starting point for analysing the specification of transportation costs. In this case the cost function was specified as:

$$TC = \beta_0 + \beta_1(ton - miles) + \beta_2(tons) + \beta_3(route - miles) + \varepsilon, \qquad (5.10)$$

where ε is the error term. What this specification does is simply to separately take into consideration the volume (tons) and distance (miles) dimensions of freight output and examine their influence on costs.

Recent developments have been guided by the realisation of the fact that costs not only depend on the level of output but also in the way in which it is carried[4]. Operating characteristics, such as average load (AVD), average shipment size (AVSIZE), percentage less than truck load (LTL), average length of haul (ALH), etc., are suggested to be included when specifying the trucking cost function. These have a significant impact on transport costs; they are directly related to cost savings (Friedlaender and Wang Chiang, 1983)[5]. As ALH, for example, increases the proportion of costly and labour-intensive pick-up, consolidation and delivery operations, falls so that high values of ALH will be associated with lower costs and small labour shares through spread of these costs to longer haulage distance, *ceteris paribus*. As for AVD, greater vehicle loads should be associated with lower costs as

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[4]Another development addresses the 'purification' of transportation output by attempting to control for its quality through hedonic cost function specification. The cost function takes the general form: $C = C(\varphi(y,q), w; t)$, where $\varphi = y\phi(q)$ represents hedonic ('effective') output that is composed of the firm's physical output y and attributes that reflect quality q, e.g., firm's time of service; w is vector of input prices, and t a vector of operating characteristics (see Spady and Friedlaender, 1978) for details. However, as Bruning and Olson (1982) content, such adjustment may not be necessary. Shippers are the final determiners of quality and that rational as they are, given identical prices, they will always go for a high quality service. In a regulated market, prices may not reflect service quality differentials; output adjustments can. Shipper choice behaviour is reflected in either higher revenues or a higher output for the carriers producing quality transport service.

[5]Xu et al. (1994) show that output characteristics are positively correlated with and influenced by firm size. As a result when firm size increases, output characteristics also change in a direction that lowers unit costs. Possible explanations are that larger firms gain advantages from more extensive geographical coverage, better on-time performance and more sophisticated information systems.

such reflect greater operational intensity. Similar justifications can be made for the other characteristics.

The cost function that takes into account the operating characteristics takes the following form:

$$C = C(w, y, q, t), \qquad (5.11)$$

where w = vector of input prices, y = output, q = vector of operating characteristics, and t = time trend.

This study examines firms which are in operation; the interest being to evaluate their operational efficiency. The cost function approach is to help throw light on the determinants of performance of firms in the trucking industry in Tanzania and highlight their relative importance. The chapter is therefore concerned with the cost structure of the industry. RETCOs are common carriers in the sense that they have to carry all requests at predetermined prices. This makes cost-minimising behaviour appropriate. It is our contention that to be an efficient and competitive operator, a RETCO has to be cost conscious in the sense that faced with alternatives, given the input set and technology at its disposal, it will always have to go for the lowest (minimum) cost available means to produce output.

To estimate the cost function we need to specify the costs, outputs, factor inputs, and technological variables defining firm operations in the Tanzanian context. Operational data of the firms in question reveal the cost structure to be determined by output; factor prices for labour, capital services and fuel; and two operating characteristics, average length of haul and average load[6]. The problem is

[6]Because of the way operations are carried out and data kept in the trucking industry in Tanzania, it is empirically impossible to make further improvements/adjustments to the trucking output. Again, due to the fact that trucking operations in Tanzania are not network based, no network variables (to account for network utilisation and configuration) could be included.

on the appropriate functional form the cost function should take. We are reminded by the observation by Afriat (1972, p.568) that properties of the functions "are not deliberate empirical hypothesis, but are accidental to technical convenience of the functions" and by Chambers (1988, p.159) who observes that "choosing a functional form is more a craft than a science". Data availability and quality are critical together with the usefulness of the derived estimates to the economy/sector in question (Olanrewaju, 1987; Fazioli et al., 1993; Berndt and Khaled, 1979; Forsund, 1991).

A Cobb-Douglas specification is adopted. This form is chosen due to the nature of the available data and the information that is intended to be derived, especially the input cost shares. Additionally the specification is widely and fruitfully used in economic analysis[7]. The trucking cost function used in this study is as follows:

$$COST = A(TKM)^{\alpha 1}(PLAB)^{\alpha 2}(PCAP)^{\alpha 3}(PFUEL)^{\alpha 4}(ALH)^{\alpha 5}(AVD)^{\alpha 6}e^{\alpha 7TIME} \tag{5.12}$$

Its logarithmic form is as follows:

$$\begin{aligned}\ln COST = \alpha_o + \alpha_1 \ln TKM + \alpha_2 \ln PLAB + \alpha_3 \ln PCAP + \alpha_4 \ln PFUEL + \\ \alpha_5 \ln ALH + \alpha_6 \ln AVD + \alpha_7 TIME + u,\end{aligned} \tag{5.13}$$

where u is the error term obeying the classical assumptions. A restriction $\sum_{i=2}^{4} \alpha_i = 1$ is made to facilitate calculation of input cost shares and adhere to hom (1) requirement.

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[7]We are inspired also by its application by, among others, Thuong (1981). He carried out "A Comparative Study of Administration of Nationalised Railroads in the UK, France, West Germany and Japan".

5.4 Data Sources, Variable Definitions and Descriptive Statistics

Operational data from Tanzania's regional transport companies (RETCOs) covering the period 1984-1991 are employed in the regressions. The analysis is carried out for six companies: KAUTA (Tabora), KAUDO (Dodoma), KAUMA (Mwanza), KAUMU (Mtwara), KAURU (Ruvuma) and KAGERA (Kagera). The data was collected from the RETCOs, National Transport Corporation (NTC) and from various issues of Statistical Abstracts. Adjustments have been made on cost items to control for the effect of inflation. All costs reflect 1984 prices. An index of domestic prices of imported inputs ($p^m d$, 1984=100) has been used to adjust costs for imported inputs whereas national consumer price index (NCPI, 1984=100) was used for adjustment of labour costs, a local input[8].

TKM is the output measure which is two dimensional, volume in tons and distance in kilometres. Input prices are firm-specific. PLAB is the price of labour defined as expenditure on labour (salaries, wages and other emoluments paid to employees) divided by the number of employees. PCAP is the price of capital services. Payment for capital services comprises of expenditures on vehicle insurance, road licence, depreciation, tyres and tubes and repair and maintenance plus five percent (real interest rate) of operating costs as interest on capital. This is considered to be the firms' net operating property. It is therefore treated as the quantity of capital used in the production of trucking services. This is included so that we estimate a long-run cost function. Expenditures on capital services were then divided by firm net operating property to get the price of capital.

It should be noted that expenditure on repair and maintenance and tyres and tubes in the case of Tanzania where road standards are poor, does also to a greater

[8] $p^m d = p^m f.OER$, where OER is the official exchange rate and $p^m f$ is the foreign price index. The official rate is used because the firms being studied are parastatal companies and obtain foreign exchange through official channels. Imported inputs (fuel, spares, tyres and tubes, etc.) amount to about 90% of total operating costs. Data for the computations have been obtained from OECD data; Bank of Tanzania, Operations Reports; and URT, Economic Survey (various years).

extent give one a picture of the condition of roads. Such expenses tend to be high on bad roads since the economic life span of vehicle parts becomes drastically reduced. The magnitude and frequency with which operators incur these costs does very much reflect the condition of roads and thus also the cost of road use than capital servicing per se. The life of a set of tyres, for example, varies from 15,000-25,000 kms depending mainly on road condition (Wangwe et al., 1989).

As pointed out in chapter three, the production of trucking services depends on road capacity (width) and road durability (strength). As goods hauliers, RETCOs will be concerned with road's loading capacity which determines vehicle operating costs (VOC). The magnitude of VOC depends on the condition of the roads which in turn determine the road's quality of service. Operators face roads with differing qualities. It is cheaper to produce trucking services on good quality roads as VOC would be low. Vehicle maintenance expenses give a better reflection of the quality of roads, *ceteris paribus*. It is however difficult to separate out poor road-induced expenses from those due to normal repairs. This calls for great care when interpreting the effect of PCAP on costs. To a certain extent it should also approximate the price each operator faces for road use.

PFUEL is the price of fuel defined as fuel expenditure divided by the number of kilometres covered in a year, it is therefore in terms of truck-km. This is considered to be an effective price for fuel than the sale price which is pan-territorial, given the differing road standards and its differential effect on fuel consumption. ALH is average length of haul in kms defined as TKM/tons. It gives an indication of the number of kms covered to secure one ton of load. AVD is average load in tons, i.e., TKM/kms. This shows the amount of tonnage obtained by covering one km. TIME is for the time trend.

Table 5.1 shows the summary statistics of the variables used in the regressions to provide one with a picture of the magnitude of each variable for a typical firm. An analysis of the correlation matrix is also conducted in order to identify the extent to which the explanatory variables are collinear. The correlation coefficients are shown in table 5.2. For the most part the coefficients are small suggesting that multicollinearity is not a serious problem.

Table 5.1: Summary of Operating Statistics

Variable	Mean	Std. Deviation	Minimum	Maximum
Total cost (COST), Tshs	21254000	16265000	7890000	87360000
Freight Revenue (FREV), Tshs	41232000	16892000	13598000	87772000
Ton-kms (TKM)	9084100	3938300	1913000	18487000
Price of Labour (PLAB)	36550	23126	9065	95213
Price of Capital (PCAP)	7.60	2.58	3.65	15.85
Price of Fuel (PFUEL), Tshs/km	2.05	1.11	0.31	4.78
Average Length of Haul (ALH), kms	284.3	122.9	32.0	608.2
Average Load (AVD), tons	6.56	2.39	0.81	11.61

Source: Own Computations

Table 5.2: Correlation Matrix of Variables

	COST	TKM	ALH	AVD
COST	1.00000			
TKM	0.27539	1.00000		
ALH	0.07485	0.50438	1.00000	
AVD	-0.22903	0.72413	0.50797	1.00000

Source: Own Computations

5.5 Empirical Results

5.5.1 General Features

Pooled cross-section and time-series data have been used in the regressions. Pooled data are the merged time-series and cross-section data. It contains therefore both overtime and at a given time aspects of the data. This makes it likely for the disturbance term to consist of time-series-related disturbances, cross-section disturbances and a combination of both. This makes the assumption of constant intercept and slope unreasonable. If this is not taken into consideration while making the estimation, biased coefficients may result. Recognition of the fact that omitted variables may lead to changing cross-section and time-series intercepts is important; hence the need to use the covariance analysis, the fixed effects (FE) model, to avoid biased coefficients. This approach involves the introduction of dummy variables that allow the intercept term to vary overtime and over cross-section units, all having the same slope (Mundlak, 1978; Pindyck and Rubinfeld, 1991).

The covariance model takes the following general form:

$$y_{it} = \alpha + \beta x_{it} + \gamma_2 w_{2t} + \ldots + \gamma_N w_{Nt} + \delta_2 z_{i2} + \ldots + \delta_T z_{iT} + \varepsilon_{it} \tag{5.14}$$

where w_{it}= 1 for ith unit, i = 2, ..., N and 0 otherwise, z_{it} = 1 for tth time period, t= 2,..., T and 0 otherwise

The dummy-variable coefficients would therefore measure the change in the cross-section and time-series intercepts (with respect to the first unit in the first period of time, i.e., as reference unit and time period respectively). The decision to add such dummies is usually made on the basis of statistical testing. It involves the comparison of the error sum of squares (ESS) associated with ordinary least squares (OLS) and FE estimation techniques. If the ESS changes substantially, i.e., if there is a significant difference in ESS between the two approaches, with $ESS_{OLS} > ESS_{FE}$, we opt for the covariance model.

In the case of this study, the use of pooled data has been justified by the degrees of freedom problem. The application of the FE model is intended to isolate the influence of firm specific effects and time effects (a discussion on productivity performance these effects entail, is deferred to chapter seven) on the cost performance of firms being studied. The results of both simple pooling and FE model are presented in table 5.3.

Table 5.3: Cost Function Estimation Results

	Simple Pooling			Fixed Effects Model		
Variable	**Coefficient**	**t-ratio**	**Std. Error**	**Coefficient**	**t-ratio**	**Std. Error**
Constant	0.8425	0.2582	3.2625	5.6185	1.6471	3.4112
lnTKM	0.7595	3.6741	0.2067	0.4803	2.0885	0.1145
lnPLAB	0.4098	3.0811	0.1330	0.2285	1.9262	0.1186
lnPCAP	-0.0351	-0.2604	0.1350	0.2894	2.0772	0.1393
lnPFUEL	0.6253	5.0423	0.1240	0.4821	3.4758	0.1387
lnALH	0.2443	1.4525	0.0838	0.1540	0.8603	0.1790
lnAVD	-0.9004	-3.5437	0.2541	-0.5225	-2.5663	0.2036
TIME	-0.1074	-2.1024	0.0511	-	-	-
Z2(KAUDO)				0.9916	4.2989	0.2307
Z3(KAUMA)				0.3608	1.7272	0.2089
Z4(KAUMU)				0.1444	0.9830	0.1469
Z5(KAURU)				0.2298	1.1250	0.2042
Z6(KAGERA)				0.5298	3.5625	0.1487
T2(1985)				0.3714	2.4767	0.1500
T3(1986)				0.1180	0.6175	0.1910
T4(1987)				0.1522	0.6765	0.2250
T5(1988)				-0.0325	-0.1414	0.2297
T6(1989)				-0.2108	-0.8250	0.2555
T7(1990)				-0.3118	-1.1622	0.2683
T8(1991)				-0.5569	-2.0058	0.2777
	$Adj. R^2 = 0.48$		DW=1.24	Adj. R^2	0.78	DW=2.14

Our discussion is based on the FE model results. In this case firm and time effects have been taken care of via the introduction of qualitative variables (dummies). Company effects (KAUTA as reference firm) through $Z_i, i = 2,...6$ and time effects (1984 as reference year) via $T_j, j = 1985,...,1991$. The homogeneity of degree one in the input prices is imposed through input parameter restriction requiring them to add up to unity.

The results are satisfying in that all the variables, except ALH, bear expected signs and are statistically significant with PLAB at 90 percent and the rest at 95 percent confidence levels respectively. The goodness of fit, adjusted R^2, is 0.78 which is also satisfying. A DW-statistic of 2.14 indicates absence of autocorrelation. The computed F-statistic is greater than the theoretical F-value.

5.5.2 Economies of Scale

The coefficient on ton-kms (TKM), that is α_1, represents the elasticity of cost with respect to output. A value less than one implies that the minimum average cost is reached at output more than the sample mean (suggesting possibility of increasing output at economic advantage) and average costs are decreasing for a typical firm operating at mean operating characteristics and input prices. Our results show $\alpha_1 =$ 0.48, indicating presence of scale economies. This says that for a 1 percent increase in output costs increase by only 0.48 percent. In other words, if output increases by 100 percent, costs increase by only 48 percent. So a typical firm operating at the sample mean enjoys scale economies.

It may be of interest to note here that the results obtained here are supported by findings elsewhere, as reviewed in chapter four. Specific mention is made of the studies by Koenker (1977) and Xu et al. (1994). In their case, the estimated results of the cost function with specification resembling the one used here, showed the trucking industry in the U.S. to be characterised by scale economies. The results obtained here do not therefore represent an isolated case.

5.5.3 Input Cost Shares

The cost elasticities with respect to input prices are equivalent to the input cost shares. Cost shares have by definition to sum up to unity; this has been achieved via a restriction made on the input price coefficients. The study's results indicate that for an average firm labour accounts for 23 percent of total operating costs, expenditure on capital services accounts for 29 percent and fuel 48 percent. Fuel expenses comprise therefore a significant cost element in the production of trucking services.

Expenditure on capital services does, as noted earlier on, include repair and maintenance expenses which cover vehicle breakdowns that are mainly caused by the poor condition of roads. It is unfortunate that such expenses cannot be isolated from other components in the group. But the magnitude of these expenditures should provide one with an idea of the extent of poor-road-induced expenses on total costs and thus on firm operations. Firms' operating statistics show that about 45 percent of payments for capital services are made up of repair and maintenance costs, not an inconsequential proportion. A similar argument can be made with regard to fuel expenses. Poor roads do also contribute to increased use of fuel in such a way that bad roads tend to require high fuel consumption (litres/km) compared to good roads.

5.5.4 Costs and Operating Characteristics

The results indicate that the AVD coefficient bears a negative sign as expected. This implies that an increase in average load size leads to reduction in operating costs so that the larger the average load size the better in terms of cost savings. A positive sign on ALH on the other hand shows that increases in average length of haul would lead to cost increases. However, its effect is insignificant. But despite that one can still point out that long distance coverage in search of load is a feature facing firms in Tanzania and that it contributes to increased operating costs. This may be explained by the fact that distance coverage in search of load differs across seasons (Stenberg et al., 1994). Distances to reach the collection point are relatively shorter during the dry season and relatively longer during the rainy season as bad roads make accessibility difficult requiring one to make detours. This makes ALH behave inconsistently, and non-optimally for that matter, relative to movements in output. It is important to note here that, unlike AVD, increases in ALH, unmatched with load carriage, leads to increased costs, as such costs from increased distance coverage are spread to small consignments.

As for the trucking technology and thus cost function specification, the significance of the AVD coefficient validates our inclusion of operating characteristics in the specification of trucking cost function in the case of Tanzania. Operating characteristics help explain differences in firm cost performance.

ALH and AVD are also shown to be positively correlated with output (TKM), very much so for AVD (table 5.2). If output is used to measure firm size then what this means is that they are positively correlated with firm size (as observed by Xu et al., 1994). This implies that as output (size) increases, operating characteristics also increase and this will tend to reinforce the cost savings in case of a characteristic which is shown to have a cost saving effect. This observation appears to hold in the case of AVD with the exception of KAUTA, which had, in terms of size, to lie between KAUDO and KAUMU. There isn't a very clear pattern for ALH but one can still notice the fact that its distribution does somehow correspond with that of size. The first three largest firms have the largest ALH values (see table 5.5). This reinforces the argument about scale economies in the industry, i.e., larger firms seem to enjoy cost savings from their operations.

5.5.5 Firm Comparison

The results of the FE model shown in table 5.3 indicate that KAUTA's cost performance is significantly different from that of KAUDO (Z2) and KAGERA (Z6). The cost differences are however insignificant between KAUTA and KAUMA (Z3), KAURU (Z5) and KAUMU (Z4).

Table 5.4 shows that KAURU, KAUDO and KAUMU have high average values for ALH. This may explain the condition of roads in their respective areas of service and the longer distances they have to cover in search of goods. The three firms have also performed relatively better in terms of AVD which has been demonstrated to have a cost saving effect. In terms of size, measured in output, KAURU is the largest while KAGERA the smallest.

Table 5.4: Cost, Output and Operating Characteristics; Mean Values

	Overall	KAURU	KAUDO	KAUMU	KAUMA	KAUTA	KAGERA
TKM	9084100	13568000	11226000	8588100	8208500	6487900	6426500
ALH	284.34	361.39	315.81	330.36	174.69	295.45	228.31
AVD	6.56	9.45	6.45	5.95	5.77	6.28	5.48

Source: Own Computations

An attempt has also been made to examine firm performance by comparing each firm with the average firm by use of the estimated cost function. We use in this case what we call a cost comparison (CC) indicator which may be defined as:

$$CC = \frac{C^{AEC}(w,y,q)}{C^{FEC}(w,y,q)}, \tag{5.15}$$

where C^{AEC} stands for the average firm estimated cost function and C^{FEC} stands for individual firm estimated cost function. This indicator evaluates the estimated cost function of a firm by comparing it with that of the average firm. The indicator takes the value of one for the representative firm. Firms with comparatively higher costs have a CC value of less than one whereas those with lower cost levels have a score of more than one. CC helps show how different an individual firm is to the average firm in terms of cost performance so that if the aim would be to approach the average firm, efforts would have to be made to reduce costs by striving at finding an appropriate output, input prices and operating characteristics combination.

Table 5.5 presents the CC scores. If one were to group these firms based on CC scores then two categories emerge; the high score group comprising of KAGERA, KAUMA and KAUTA and the low score group comprising of KAUDO, KAUMU and KAURU. No firm matches exactly the representative firm.

Table 5.5: Cost Comparison and Cost Recovery Indicators

Firm	CC	CR
KAGERA	1.07	1.97
KAUMA	1.03	2.45
KAUTA	1.02	2.62
KAUDO	0.84	1.45
KAUMU	0.81	2.07
KAURU	0.73	2.03

Source: Own Computations

Another indicator used in comparing firm cost performance is the cost recovery (CR) indicator which is defined as:

$$CR = \frac{FRevenue}{OPCost}, \qquad (5.16)$$

where $FRevenue$ is freight revenue and $OPCost$ is the operating cost. The higher the score the better the chances to recover costs. This indicator helps know the ability of firms to recover their respective costs from the sale of trucking services. It can also be used as an input in the design of subsidy policy if subsidies are to be provided by the government to firms and, if compared to efficiency performance, it may shed some light on the justification of the rates charged (more on this in chapter 6).

Based on this indicator, KAUTA which belongs to the CC high score group appears to have the best chances at cost recovery while KAUDO which belongs to the CC low score group has the lowest cost recovery chances. It may be noted however, as done in chapter three w.r.t operating ratio which is an inverse of CR, that performance in this indicator may say very little about firm efficiency. Pricing mechanism has a substantial influence, it is susceptible to upward bias due to hiked rates and subsidies; it does not necessarily reflect efforts at controlling for costs.

5.6 Summary

This chapter was devoted to establishing the cost structure of the RETCOs. The main idea was to find out the determinants of performance and show their relative importance. Scale economies and comparison of RETCO performance on various issues have been attempted.

Regression results show that the trucking industry in Tanzania enjoys substantial scale economies. Fuel expenditure is demonstrated to have a considerable contribution on operating costs while labour's share is the lowest. Of the operating characteristics, average load contributes to cost reduction while the effect of average length of haul, although insignificant, is in the direction of increasing costs. Also discussed are chances facing each firm at cost recovery.

The next chapter examines productive efficiency in the trucking industry in Tanzania by use of frontier production function approach.

CHAPTER VI

PRODUCTIVE EFFICIENCY IN THE TANZANIAN TRUCKING INDUSTRY: FRONTIER PRODUCTION FUNCTION APPROACH

6.1 Introduction

Chapter five has enabled identification of determinants of performance in the Tanzanian trucking industry, factors that are important in evaluating inter-firm differences in performance. It was pointed out in chapter four that the best way to do this, i.e., analyse efficiency of productive units is to compare each unit with the observed best practice in the peer group. The frontier production function (FPF) becomes the natural reference since it provides, for the observed set of firms, the outer boundary of possible input-output combinations. The chief aim of FPF is to dispense with average measures of efficiency for an industry.

It has been pointed out by Forsund and Hernes (1990) that when choosing the approach to apply, all the information about the type of activity being studied must be drawn upon. They have brought to our attention the fact that any information about scale and substitution properties is best handled within a parametric approach. When knowledge about the underlying technology is weak, the most appropriate approach is the non-parametric. The two are in fact competing paradigms on how to construct frontiers, one uses econometrics techniques while the other uses mathematical programming techniques.

The purpose of this chapter is to analyse productive efficiency of the trucking firms, i.e., RETCOs, in Tanzania on the basis of frontier function approach. The frontier will thus represent the best practice within the RETCOs. Most specifically, deterministic parametric (DPF) and deterministic non-parametric (DEA) approaches are used.

The deterministic approach[1] is assumed to be able to define exactly the maximal possible output, given some set of relevant inputs and that it restricts all observations to be below or on the frontier when calculating the parameters. It also makes it possible to obtain a measure of efficiency for each observation. The two approaches, however, have their respective strengths and weaknesses. It is only instructive therefore to give an account of what these two approaches stand for before the empirical results are presented and discussed.

6.2 Data Envelopment Analysis (DEA) Approach

The deterministic non-parametric (DEA) method to measuring the relative technical efficiency of production units is based upon the work by Farrell (1957). He provided a methodology by which technical efficiency could be measured against an efficient frontier, based on observed performance, assuming *constant returns to scale* (CRS)[2]. As we may recall from production theory, the production function, $y = f(x)$, represents the technically efficient combinations of factors x to produce a given level of output y. But a technically inefficient firm may use the same inputs to produce less output, so observations of the physical inputs and outputs of firms in a particular industry may be more accurately described by the function: $y \leq f(x)$. In mathematical terms, *output efficiency* of the firm is $y / f(y)$, i.e., actual output

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[1]There is also a stochastic approach to estimating technical efficiencies. Given quantities of a list of inputs, this approach randomly defines maximal output. The functional specification takes the form: $y = f(x)e^{\varepsilon}$, where y is the output vector, x is the input vector, ε a vector of error terms and e the natural exponent. ε is composed of two independent components, ε = u + v, where v is a symmetrical two-sided error term which captures the effects of random factors outside firm control, observation and measurement error, and statistical noise. Thus v allows the frontier to vary across firms, or over time for the same firm, therefore providing the stochastic nature to the frontier. u is one-sided and is taken to represent deviations from the best practice production frontier; it captures therefore the firm specific effects of inefficiency relative to the stochastic frontier. By definition it has a value of zero, when the firm is on the frontier. The approach is however difficult to implement (see Forsund et al., 1980; Forsund, 1991; Bruning, 1992).

[2]So that when $T = \{(x, y)\}$, defines technology, CRS implies that if $(x, y) \in T$ and $k > 0$, then $(kx, ky) \in T$, too. Otherwise DEA technology will be referred to as a variable returns to scale (VRS) technology.

divided by production function specified maximum output. Alternatively, it is possible to use a production function to assess *input inefficiency*, by determining the scale by which inputs can be reduced and still achieve the same output level as before.

Farrell's proposal was that, to determine the efficient production function, only frontier data points should be utilised. The production frontier obtained is the boundary of the free disposal convex cone of the data set with no particular functional form. Data is used in this case to implicitly determine the production function without requiring a functional form and without estimating parameters (Schefczyk, 1993). Technical efficiency in this approach is defined as minimum input for any particular combination of output (Bjurek et al., 1990). Farrell's work has however been extended by, among others, Charnes et al. (1978) under constant returns to scale and Forsund and Hjalmarsson (1979) to the case of variable returns to scale (where technical efficiency is calculated relative to a technology that allows for increasing returns to scale, decreasing returns to scale as well as CRS, i.e., the degree of economies of scale varies with scale) technologies.

The DEA analysis assumes therefore only mild restrictions on the technology, which is said to consist of *convex* input and output sets enveloping the data points with linear facets (Odeck, 1993). Another assumption is that of *allocative efficiency*, representing the notion that increasing inputs does not decrease output. The efficiency measures under the DEA approach can be illustrated by the following diagram.

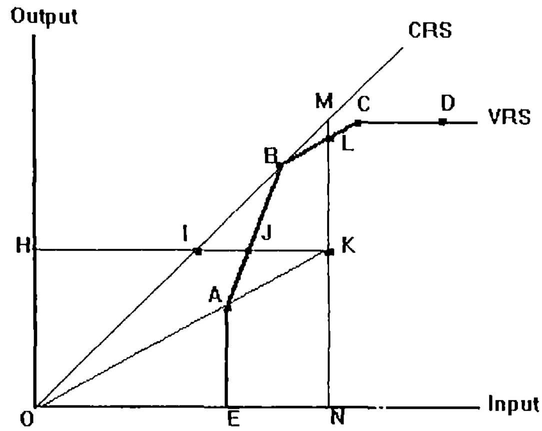

Figure 6.1: DEA and Efficiency Measures

The assumption about CRS implies that any multiple of input/output mix of an observed unit belongs to the feasible set. In figure 6.1 this would imply that points I and M are both feasible. Farrell's frontier is the line from the origin through B. Variable returns to scale (VRS) production frontier is obtained by joining a set of observations E, A, B, C, and D. Due to free disposability assumption the frontier extents indefinitely from D parallel to the input axis. Correspondingly, any observation in the line segment EA producing less output but using the same amount of inputs is also in the feasible set. All these observations are on, and do define, the VRS frontier and are therefore technically efficient[3]. Observation K on the other hand is inefficient as it is off the frontier. The general feature of DEA approach when specifying VRS is that units at both ends of the size distribution may be identified as efficient simply for lack of other comparable units (Forsund, 1991).

Technical efficiency is evaluated by using (i) *input saving* criterion which shows how large a proportion of the observed input usage would have been necessary if operations were on the frontier given the observed output quantity (horizontal movement along input axis towards the origin), inefficiency corresponds

[3]One special technical feature of DEA needs mentioning. Units located at the horizontal and vertical extensions of the envelopment surface will get efficiency values of 1. Such units are however not efficient in the Pareto sense as some of them will be using the same amount of inputs but producing less output (vertical segment) or using more inputs but producing same output (horizontal segment).

to an overutilisation of inputs given output and input mix; and (ii) *output increasing* criterion which compares observed output with potential output at the frontier given observed inputs (vertical movement along the output axis away from the origin), inefficiency reflects the failure to produce maximal output given inputs (Atkinson and Cornwell, 1994) (it thus measures also productivity, see chapter seven).

The measures are such that efficient units will have a score of 1 and the inefficient units a score of less than 1 since $X^* \leq X^o$ and $Y^* \geq Y^o$ (star for frontier and 'o' for observed input X and output Y respectively). The Farrell efficiency measures as generalised to VRS by Forsund and Hjalmarsson (1987) can be illustrated as follows (refer Fig. 6.1):

E_1 = input saving technical efficiency (= HJ/HK)

E_2 = output increasing technical efficiency (= NK/NL)

E_3 = gross scale efficiency (= HI/HK = NK/NM)

E_4 = pure scale efficiency, input corrected (= E_3/E_1 = HI/HJ)

E_5 = pure scale efficiency, output corrected (= E_3/E_2 = NL/NM)[4].

The DEA technique measures efficiency by estimating an empirical production frontier, fitting pieces of hyperplanes to envelope the observed input-output data. It consists of calculating the efficiency measure for each unit in turn while at the same time determining the location of the corresponding linear facets. The construction of the reference point involves a fundamental restriction that this point be at least as efficient as our observation, i.e., it must produce at least as much output using at most the amount of inputs used to produce the observed output bundle.

[4]The scale measures do not directly show input saving or output increasing as do E_1 and E_2. The calculation of these measures is of course only relevant when specifying VRS technology. The measure E_3, for example, is the ratio of the minimal input coefficients (or maximal productivities) at the frontier and the observed input coefficients of a unit, i.e., ξ^*/ξ^o (refer chapter four). The same interpretation holds for E_4 and E_5 which can be easily calculated according to the definitions provided above.

The inefficiency of a decision-making unit (DMU), as known in operations research literature, a firm in our case, is measured by the distance from the point representing its observed input and output values to the corresponding reference point on the production frontier. For input saving measure the procedure involves restricting output to equal observed output and solve the following linear programming problem for each unit:

$$\underset{\phi_{kj}}{Max}\, E_{1k}{}^{5} \tag{6.1}$$

Subject to

$$Y_{rk} \leq \sum_{j=1}^{n} \phi_{kj} Y_{rj}, r = 1,\ldots,s \tag{6.2}$$

$$E_{1k} X_{ik} \geq \sum_{j=1}^{n} \phi_{kj} X_{ij}, i = 1,\ldots,m \tag{6.3}$$

$$\sum_{j=1}^{n} \phi_{kj} = 1 \tag{6.4}$$

$$\phi_{kj} \geq 0, j = 1,\ldots,n \tag{6.5}$$

where Y_{rk} = output of type r for unit k, X_{ik} = input of type i for unit k, ϕ_{kj} = nonnegative weights generated from the model that define the reference unit (i.e., that are calculated as values to be assigned to each output and input in order to maximise the efficiency rating of the observation).

Constraint (6.2) states that the reference unit must produce at least as much output as unit k. Constraint (6.3) states that the efficiency corrected use of input

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[5] $E_{1k} = X_k^* / X_k^o$. So $Max E_{1k} \Rightarrow X_k^o \to X_k^*, i.e., X_k^o$ is reduced towards the direction and level X_k^*; $X \geq 0$ (nonnegativity). $E_{1k} = 1$ if unit k is efficient relative to the other units; other units will have a score of less than one. Thus technical efficiency is maximised when the organisation minimises its production costs.

($E_{1k}X_{ik}$) must at least equal the amounts employed by the reference unit. Constraint (6.4) restricts the best practice technology to VRS because the frontier is a convex envelopment of the data set.

The output increasing efficiency measure is then calculated by solving the following linear programme:

$$\underset{\phi_{kj}}{Max} \; 1/E_{2k} \; {}^{6} \tag{6.6}$$

Subject to

$$(1/E_{2k})Y_{rk} \leq \sum_{j=1}^{n} \phi_{kj} Y_{rj}, r = 1,\dots,s \tag{6.7}$$

$$X_{ik} \geq \sum_{j=1}^{n} \phi_{kj} X_{ij}, i = 1,\dots,m \tag{6.8}$$

$$\sum_{j=1}^{n} \phi_{kj} = 1 \tag{6.9}$$

$$\phi_{kj} \geq 0, j = 1,\dots,n \tag{6.10}$$

Observed outputs of unit k are now efficiency-adjusted upwards to be less or equal to outputs at the frontier reference point. In multi-output case, the correction factor is the same for all outputs implying a proportional change of observed outputs.

The following information is vital w.r.t the frontier:

$(\sum_j \phi_{kj} X_{ij}, \sum_j \phi_{kj} Y_{rj})$ defines the reference point,

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[6] $1/E_{2k} = Y^*/Y^o$. So $Max\; 1/E_{2k} \Rightarrow Y_k^o \rightarrow Y_k^*$, i.e., Y_k^o is increased towards the direction and level Y_k^*. $E_{2k} = 1$ iff unit k is efficient (i.e., $Y^o = Y^*$) relative to the other units which will have a score of less than 1 (i.e., with $Y^o < Y^*$).

$\sum_j \phi_{kj} Y_{rj} - Y_{rk}$ is the required output increase to reach the frontier, and

$X_{ik} - \sum_j \phi_{kj} X_{ij}$ defines the required input reduction to reach the frontier. As for the scale properties , the following rules apply (see Forsund and Hjalmarsson, 1987):

$E_1 > E_2$ implies increasing returns to scale,

$E_1 < E_2$ implies decreasing returns to scale.

Note that the two measures are equal when the technology is CRS and that the input saving measure, E_1, with CRS as reference technology is equal to the gross scale efficiency measure, E_3, with VRS as reference technology. Any scale inefficiency is due to either decreasing or increasing returns to scale[7].

To determine what is the case one can, for unique solutions, inspect the sum of the weights, $\sum_j \phi_{kj}$, for the E_1 calculations with CRS technology. A sum of less than one means increasing returns to scale and a sum of more than one means decreasing returns to scale (Berg et al., 1991).

On the basis of the individual input saving and output increasing efficiency measures, the input saving/output increasing potential for the whole sector can be obtained. The resultant measures are known as structural efficiency (S) measures with (1-S) defining the potential saving. These, for input i and unit j, may be given as:

Input saving: $S_1 = \sum_j x_{ij} E_{1j} \Big/ \sum_j x_{ij}$ and output increasing: $S_2 = \sum_j y_j \Big/ \sum_j \frac{y_j}{E_{2j}}$

Critical in DEA analysis is thus the choice of the input and output variables; the choice of the functional form is not a consideration because of the non-

[7]In cases of increasing returns to scale, output measures will always overstate the cost reductions possible by eliminating technical inefficiency and understate them in cases of decreasing returns.

parametric nature of the model, this is its chief advantage. The calculated frontier may, however, be warped if the data is contaminated with by statistical noise. DEA has the advantage that it can handle multiple outputs and can also use qualitative measures as inputs or constraints (Majumdar, 1995).

6.3 Deterministic Parametric Frontier (DPF) Approach

The deterministic parametric frontier (DPF) approach was pioneered by Aigner and Chu (1968) following Farrell's work. It may be recalled that Farrell's boundary of the free disposal convex cone of the data set had no particular functional form. An approach that would handle statistical noise was deemed necessary. Aigner and Chu postulated that the boundary to the unknown production frontier can be represented by a certain a priori functional form, e.g., Cobb-Douglas specification. This means therefore that an explicit and, at times, restrictive functional form for the technology is imposed. The main idea of the deterministic parametric frontier (DPF) function is that all observations are restricted to be below or on the function when calculating the parameters. The frontier itself will as a result be on or above the set of observations. It is important to note also that, unlike DEA, DPF is restricted to single output situation. The simple (by use of linear programming) or squared (by use of quadratic programming) distance between these observations and the frontier is then minimised.

A DPF function takes the general form:

$$y = f(x)e^{u}, u \leq 0, \qquad (6.11)$$

where y = output and x = a vector of inputs.

Using a production function in Cobb-Douglas form (see Russell and Young, 1983; Bjurek et al., 1990), the DPF may then take one of the following forms:

$$\log y = \alpha + \sum_j \beta_j \log x_j + u,\ u \le 0, \tag{6.12}$$

where u is a nonpositive one-sided disturbance capturing the effects of inefficiency and is independently and identically distributed; x is independent of the disturbances.

Form (6.12) is amenable to statistical analysis with inferences made on the estimated coefficients. This provides one with a sense of confidence in the obtained results. Regression analysis (ordinary least squares, OLS) can therefore be applied on the function to obtain best linear estimates of the β_j coefficients. The obtainable function is an average one. The intercept coefficient is then corrected by shifting the function until no residual is positive and one is zero, i.e., to get the frontier function. The corrections, in this case, are done so that all the observed outputs are below or equal to the best practice. This is done by using corrected ordinary least squares (COLS) method (Forsund et al., 1980)[8].

Alternatively the following homothetic form with a Cobb-Douglas kernel specification, allowing in a simple way VRS, can be employed (Forsund, 1991):

$$y^{\alpha} e^{\beta y} = A \prod_j^{n} x_j^{a_j}, \tag{6.13}$$

where n is the number of inputs, A is a constant term that accounts for technical change, a_j the kernel elasticities for inputs and α, β the scale functions. In logarithmic form this function is linear in the parameters. To ensure the observed units are as efficient as possible, the sum of deviations from the frontier are minimised. The following linear programming problem is then solved:

$$Min \sum_i (\ln A + \sum_j a_j \ln x_{ij} - \alpha \ln y_i - \beta y_i) \tag{6.14}$$

subject to

[8]Bauer (1990) reports the relative advantages of COLS to MLE. MLE, he says, tends to outperform COLS in sample sizes larger than 400, whereas COLS tends to outperform MLE in sample sizes of less than 400, as is the case in this study.

$$\ln A + \sum_{j}^{n} a_j \ln x_{ij} - \alpha \ln y_i - \beta y_i \geq 0,\ i = 1,\ldots,n, \tag{6.15}$$

which expresses the on or below requirement. Linear homogeneity of the kernel function is guaranteed by $\sum_{j}^{n} a_j = 1$ and $\alpha, \beta, a_j \geq 0$ ensures the kernel elasticities and the scale parameters are non-negative. Interest is on the optimal scale. The scale elasticity function is:

$$\varepsilon(y) = \frac{1}{(\alpha + \beta y)} \tag{6.16}$$

Optimal scale then, with $\varepsilon = 1$, becomes: $y_{\varepsilon=1} = \dfrac{(1-\alpha)}{\beta}$.

Our requirement is to use a specification that would characterise frontier technology in a simple form and be able eventually to establish technical (in)efficiency for each of the firms being studied. It is also desired that a comparison be made between the results of the approach which is amenable to statistical inference (to provide some confidence in the results) and those of the approach (DEA) that is not. Alternative (6.12) is used in this study so that statistical inferences can be made on the estimated coefficients.

The employed Cobb-Douglas specification (with constant elasticity of scale) is, however, a very restricted function. This may tend to restrict efficiency scores. The use of a flexible function, such as the most popular translog form, requires a much larger (than what is available) sample size (the degrees of freedom problem) as more parameters are estimated. It is also important to note, however, that although there is technological sophistication to be gained from flexible functional forms, there is a price to be paid once one moves very much beyond Cobb-Douglas functional form. This is in terms of the estimation difficulty of the system of equations and loss of statistical efficiency by estimating an overly flexible functional form (Bauer, 1990). In our case some interesting comparisons can be made with

DEA results which, just like those of alternative (6.13), are not amenable to statistical interpretation[9].

Another aspect involves the choice of variables. In the case of the Tanzanian trucking industry[10], the dependent variable, output in ton-kms (TKM), is seen to be determined by the level of four inputs: labour (LAB), fleet total carrying capacity (FTC), fuel (FUEL), and vehicle maintenance expenses (MTN). The estimated function takes the following log-linear form:

$$\ln TKM = \alpha + \beta_1 \ln LAB + \beta_2 \ln FTC + \beta_3 \ln FUEL + \beta_4 \ln MTN + u, \quad (6.17)$$

u is the random term obeying standard assumptions.

6.4 Data Sources, Variable Definitions and Descriptive Statistics

Operational data from Tanzania's regional transport companies (RETCOs) covering the period 1984-1991 are used in the analysis. Six firms are covered, these are: KAUTA (Tabora), KAUDO (Dodoma), KAUMA (Mwanza), KAUMU (Mtwara), KAURU (Ruvuma), and KAGERA (Kagera). The data was collected from the firms and then cross-checked with the summarised reports at National Transport Corporation (NTC) and those reported in the various issues of the Statistical Abstract. The output measure is in ton-kms (TKM), as traditionally used to measure trucking output. Output in the case of the industry being examined is

[9]It may be pointed out that the resulting output frontiers from DEA and DPF (Cobb-Douglas) specifications do not have analogous transformation properties (Bjurek et al., 1990), hence the differences in efficiency scores. A translog specification was attempted but didn't yield meaningful results. However, findings by Ferrier and Lovell (1990) indicate that use of a restrictive form is not that crucial when comparing with non-parametric frontiers. Interest may be focused on similarities and dissimilarities of the distributions of the efficiency and scale properties.

[10]Discussions about the nature of the trucking output generally and for the Tanzanian industry particularly were made in chapters four and two respectively.

determined by the level of four inputs: labour, fleet total carrying capacity, fuel and vehicle maintenance expenses.

It was observed from the estimated cost function results (chapter 5) that labour, fuel and capital services were the inputs used in the production of trucking services. Fuel and capital services were shown to be major determinants. The two variables have something to say about the standard of roads on which services are produced. Expenditure on them tends to be high on bad roads. A great deal (45%) of capital service expenses are on repair and maintenance. Given such an operating environment, the specification of primal technology would require taking into account the role of such expenditures in the production of trucking services. It is through incurring such expenses that an operator can be on the road.

Labour (LAB) is measured in total number of employees for each firm. Fleet total carrying capacity (FTC) in tons is a measure of capacity for each firm. This is in recognition of the fact that a firm owns trucks with different tonnage capacities. As such number of trucks would conceal the actual and so differential carrying capacities among the firms. Fuel (FUEL) variable is in the number of litres consumed. This was obtained by dividing each firm's annual fuel expenditure by the applicable diesel pan-territorial price for the year.

Vehicle maintenance (MTN) is the annual repair and maintenance expenses reflecting 1984 prices. Its inclusion stems from the fact that, given the poor condition of roads in Tanzania, a firm that produces trucking services on a comparatively poor road network, spends a substantial amount of money on repair and maintenance. It is important therefore that this be treated separately in the production function specification.

Tables 6.1 and 6.2 show summary statistics of the variables (output and inputs) used in the analysis of the production structure and efficiency evaluation of the RETCOs. They provide one with an overview of the variables used and the magnitude of each variable for an average firm and individual firms respectively.

Table 6.1: Description of the Output and Input Data

Variable	Mean	Std. Deviation	Minimum	Maximum
Ton-kms (TKM)	9084100	3938300	1913000	18487000
Labour (LAB)	172	35	104	240
Capacity (FTC)	551	152	332	924
Fuel (FUEL)	521750	234680	181480	1240700
Maintenance (MTN)	3231100	1909800	1444304	7847000

Source: Own Computations

The correlation coefficients of the variables are provided in table 6.3. The analysis is done in order to identify the extent to which the explanatory variables are collinear. The coefficients are small indicating that multicollinearity is not a serious problem. The empirical results based on DEA and DPF approaches are presented in section 6.5.

Table 6.2: Summary Statistics of Output and Inputs - Firm Averages

	KAUTA	KAUDO	KAUMA	KAUMU	KAURU	KAGERA
TKM	6487900	11226000	8208500	8588100	13568000	6426500
LAB	125	218	187	169	175	156
CAP	386	561	669	428	626	634
FUEL	207280	219550	365130	919180	629000	759650
MTN	2524200	3993500	3811300	3754200	3411000	2392700

Source: Own Computations

Data used in the empirical work is pooled cross-section and time-series, for six firms over a period of eight years. This means, therefore, that both overtime and at a given time characteristics of data are present. This may not be without problems. For example, cross-section estimates which show at a particular 'point' of time situation are, as a result of pooling, treated as holding over the whole period of the time-series sample. This may not be the case and may lead to biased results, affecting the efficiency (stability of) estimates, hence the need to take such concerns into consideration. In the case of DPF, covariance analysis is applied. Whereas variable specification may be assessed by using F-statistic or adjusted R^2 in regression analyses (in determining the goodness of fit), no statistical counterpart exists in DEA. However, regression techniques generate a single set of parameters for the entire data set and one has then to work out observation-wise measures.

Under DEA, when optimisation of each unit's score is carried out, the comparator firm level observations are those belonging to different time periods. Hence, there is comparison overtime of the relative efficiency of each such unit. A comparison of relative efficiency characteristics for each of the observations is carried out with respect to observations belonging to the same year as the unit being compared to, as well as with respect to those observations belonging to different years. It brings in therefore the aspect of dynamic optimisation analysis (Majumdar, 1995). DEA generates observation-wise scores. One weakness though should be noted in the case of DEA, and that is, any firm on the sample can be made to look efficient through the increased use of inputs and outputs.

The comparison of DEA and DPF efficiency measures may thus serve to show the general robustness of the results.

Table 6.3: Correlation Matrix of Variables

	TKM	LAB	FTC	FUEL	MTN
TKM	1.0000				
LAB	0.3900	1.0000			
FTC	0.0162	0.3874	1.0000		
FUEL	0.3872	0.1580	0.1866	1.0000	
MTN	0.1813	0.2610	0.2217	0.2632	1.0000

Source: Own Computations

It was pointed out in chapters two and three that the firms in question operate under service obligation. This means that decisions with regard to output are exogenous to them. Cost savings on their part hinges very much on the management of inputs used in the production of trucking services. At the general level, the fact that trucking output is mainly made up of agricultural produce (seasonal in nature), re-enforces the argument that firms cannot do much, in terms of decision, to influence (increase) trucking output.

It is thus reasonable to assume that firms carried what was available for haulage; the question is how did they do it. Efficiency variations are then mainly due to differences in the utilisation of inputs in the production process and the input saving measure is therefore the most relevant in the case of the trucking industry in Tanzania and is thus used in this study. The analysis of efficiency done below is thus based on input saving technical efficiency; it is contended that efficiency improvement in the industry can be realised through reduction of input usage[11].

6.5 Empirical Results

6.5.1 DEA Results

Table 6.4 presents the efficiency scores (definitions as in section 6.2) for the six firms for each year. As can be observed from the table, firms managed to obtain the highest score of one in some years but have generally scored less than one, implying they have mostly been operating inefficiently relative to the best practice.

For the scale measure, a score larger than one indicates that a unit has a size larger than the optimal size (the case of decreasing returns to scale), a score of one indicates optimal size (CRS) and a score less than one indicates operation with less than optimal size (increasing returns to scale).

[11]Generally, although each measure is a simple transform of the other under homogeneity, they convey different information, since the firm may be able to adjust either inputs for a given output, or output for a given set of inputs, but not both (Atkinson and Cornwell, 1994).

Table 6.4: DEA and DPF Efficiency Scores

Firm	Year	$E_1 - DEA$	$E_3 - DEA$	Scale-DEA	$E_1 - DPF$
KAUTA	1984	1.00	0.57	0.29	0.59
	1985	0.99	0.57	0.34	0.53
	1986	1.00	0.97	0.86	0.52
	1987	1.00	1.00	1.00	0.49
	1988	0.90	0.55	0.49	0.41
	1989	0.99	0.65	0.49	0.47
	1990	1.00	1.00	1.00	0.53
	1991	1.00	1.00	1.00	0.45
KAUDO	1984	1.00	1.00	1.00	0.50
	1985	0.89	0.84	0.83	0.46
	1986	0.71	0.41	0.39	0.29
	1987	1.00	1.00	1.00	0.35
	1988	0.77	0.76	0.78	0.33
	1989	0.93	0.93	1.24	0.38
	1990	0.74	0.59	0.70	0.31
	1991	1.00	1.15	1.09	0.43
KAUMA	1984	0.65	0.14	0.11	0.22
	1985	0.60	0.16	0.14	0.22
	1986	0.72	0.54	0.52	0.37
	1987	0.65	0.42	0.38	0.34
	1988	0.69	0.50	0.47	0.37
	1989	0.73	0.67	0.91	0.39
	1990	0.95	0.78	0.75	0.38
	1991	1.00	1.00	1.00	0.43
KAUMU	1984	0.94	0.73	0.57	0.47
	1985	1.00	0.86	0.71	0.46
	1986	0.92	0.72	0.59	0.43
	1987	0.86	0.59	0.48	0.37
	1988	1.00	0.80	0.60	0.35
	1989	0.80	0.49	0.44	0.31
	1990	0.97	0.53	0.42	0.40
	1991	1.00	0.54	0.41	0.35
KAURU	1984	1.00	1.00	1.00	0.62
	1985	1.00	1.00	1.00	0.55
	1986	0.79	0.67	0.66	0.44
	1987	0.85	0.75	0.72	0.47
	1988	0.76	0.57	0.52	0.40
	1989	0.83	0.77	0.78	0.45
	1990	0.99	0.78	0.71	0.50
	1991	1.00	1.00	1.00	0.56
KAGERA	1984	1.00	0.51	0.18	0.43
	1985	1.00	0.72	0.30	0.40
	1986	0.76	0.45	0.27	0.37
	1987	0.74	0.39	0.23	0.36
	1988	0.65	0.29	0.31	0.29
	1989	0.79	0.48	0.45	0.33
	1990	1.00	1.00	1.00	0.41
	1991	1.00	0.85	0.67	0.41

Source: Own Computations

In general the scale measure has a value less than one indicating that firms have been operating at sub-optimal scales and that there is therefore room for activity expansion and increase in efficiency.

Table 6.5 shows the average efficiency scores for all the firms. The input saving scores indicate that KAUTA is the most efficient, with a score of 99% and KAUMA is the least efficient (75%). The average input saving score of 0.89 says that the average firm could reduce the amount of inputs used in the production of trucking services by 11% to produce the observed output, i.e., it could use only 89% of the inputs actually employed. So less inputs could be used to produce the current observed level of output.

Table 6.5: DEA Efficiency Scores - Firm Averages

	KAUTA	KAUMU	KAURU	KAUDO	KAGERA	KAUMA	Average	S_1
E_1	0.99	0.94	0.90	0.88	0.87	0.75	0.89	0.91
E_3	0.79	0.66	0.82	0.84	0.59	0.53	0.70	-

Source: Own Computations

Table 6.6 contains values for potential input levels for each firm. A comparison can be made with figures reported in table 6.2. One notices that substantial input reductions could be realised.

Table 6.6: DEA Frontier Input Values (Firm Averages)

	KAUTA	KAURU	KAUMU	KAUDO	KAGERA	KAUMA
LAB*	123	156	158	190	134	141
FUEL*	205480	553680	845860	190770	622940	245530
MTN*	2492000	3153800	3550600	3538700	2118400	2703900

Source: Own Computaions

Table 6.7 shows the DEA efficiency scores over the years. One notices a general decline in efficiency for the period 1984 - 1988 and that efficiency scores start to rise from 1989. The 1991 scores are higher than those of 1984. Liberalisation measures adopted beginning 1984 could explain the improvement in performance in that such measures have gained momentum in the latter years of the 80's and that firms, confident of the continuity of such policies which have eased availability of inputs and accorded to them much more operational freedom and autonomy in an environment which is increasingly becoming competitive, institute measures that enhance efficiency in their operations.

Table 6.7: DEA Efficiency Scores -Year Averages

	1984	1985	1986	1987	1988	1989	1990	1991	Average
E_1	0.93	0.91	0.82	0.85	0.80	0.85	0.94	1.00	0.89
E_3	0.66	0.69	0.71	0.69	0.58	0.67	0.78	0.92	0.70

Source: Own Computations

6.5.2 DPF Results

Two steps are involved in the construction of the DPF function. As the first step, OLS is applied. The second step involves the correction of the intercept coefficient by use of COLS. To check the likely biasedness due to use of pooled data, the fixed effects (FE) model is used (refer chapter five). The company effects (KAUTA as reference firm) are then used to compare firms' output performance.

6.5.2.1 OLS Results and General Features

The OLS regression results are reported in table 6.8. All the variables bear expected signs and that all, except FTC (in simple average function), are significant. MTN is the most significant of all followed by LAB and FUEL. Repair and maintenance expenses are thus a vital input in the production of trucking services. This justifies inclusion of these expenses as a separate variable in the production function specification.

The insignificance of FTC may be explained by the fact that, due to their statutory locations and position, each RETCO has a 'specified' area of operation which assures them of the availability of goods for haulage in any given period of a year (monopoly status). A considerable amount that each firm hauls is thus made less dependent on firm carrying capacity. This together with the fact that RETCOs receive trucks from transport donors through grant to the government, not based on independent investment decisions, makes the remaining three variables the most important, under the present arrangements, for consideration by management in the provision of trucking services.

Table 6.8: Production Function OLS Estimation Results

Variable	Simple Average Function			With Firm Effects		
	Coefficient	**t-ratio**	**Std. Error**	**Coefficient**	**t-ratio**	**Std. Error**
Constant	0.2159	0.4682	0.4612	0.1073	0.2887	0.3714
lnLAB	0.9643*	2.3522	0.4500	1.6072*	4.5939	0.3499
lnFTC	0.2182	0.7451	0.2929	-	-	-
lnFUEL	0.1219**	1.8448	0.0661	0.1038**	1.7195	0.0604
lnMTN	0.4763	6.1884	0.0770	0.4044*	5.6148	0.0720
Z2 (KAUDO)				-0.5730*	-2.4478	0.2341
Z3 (KAUMA)				-0.8137*	-3.9082	0.2082
Z4 (KAUMU)				-0.4894*	-2.4744	0.1978
Z5 (KAURU)				0.0152	0.0760	0.1994
Z6 (KAGERA)				-0.5874*	-2.8256	0.2079
Adj. R^2	0.96			0.97		

Note: ** significant at 90 percent confidence level
* significant at 95 percent confidence level

Another explanation may be related to the seasonal nature of the trucking business, especially with regard to haulage of agricultural crops. As observed by Stenberg et al. (1994), agricultural trucking activities (agriculture provides the lion's share of the goods carried by the firms in question) are concentrated in the July-November period, following harvest. For the rest of the period, i.e., December-June, most of the trucking capacity may remain idle as (agricultural) cargo becomes 'scarce'; in which case any increase in trucking capacity would not lead to a significant increase in output. It, on the other hand, points to the existence of excess capacity in the industry.

FTC was thus dropped from the production function specification and firm effects were instead included in the regression. These would reflect on firm-specific aspects of operation that influence the production of trucking services such as management, operating characteristics and the operating environment. The output elasticity of labour increases in magnitude and significance while those of fuel and vehicle maintenance decline slightly. All, however, are significant and bear expected signs. The production of trucking services is thus dependent on labour, fuel and maintenance of the trucks to make sure that they are road-worthy. These are the variables used in the construction of the frontier.

$\sum_j \beta_j = 2.1154$ which is greater than unity and thus supports the results in chapter 5 and those of DEA that the trucking industry in Tanzania is characterised by increasing returns to scale. This says that if input usage is increased by one percent output will increase by about 2 percent. There is potential therefore for expansion of activity/scale of operation in the industry.

Judging from the company dummies, KAURU's output is shown not to be significantly different from that of KAUTA. The remaining firms have output levels that are significantly less than that of KAUTA. KAUMA is down the ladder (with about 81% less output) followed by KAGERA, KAUMU and KAUDO.

6.5.2.2 DPF Construction and Input Saving Efficiency

To construct the frontier, corrected ordinary least squares (COLS) regression is applied (details on this particular process, i.e., the production frontier function itself in chapter seven). The regression results are shown in table 6.8.

The Kopp method as used by Russell and Young (1983) is employed to calculate the input efficiency measures. The Kopp measure of TE compares the actual level of input use to the level which could be used if firm i operated on the frontier, given the actual output of firm i and given the same ratios of input usage. The first task is thus to calculate the input ratios (r_i).

Let $r_1 = \dfrac{FUEL}{LAB}$, $r_2 = \dfrac{MTN}{LAB}$, $r_3 = \dfrac{LAB}{FUEL}$, $r_4 = \dfrac{MTN}{FUEL}$, $r_5 = \dfrac{LAB}{MTN}$ and $r_6 = \dfrac{FUEL}{MTN}$.

Let $LAB_i^*, FUEL_i^*$ and MTN_i^* denote the optimum use of inputs on firm i for output level TKM_i.

Then: $\ln LAB_i^* = (\ln TKM_i - 1.614 - 0.1038\ln(r_1) - 0.4044\ln(r_2))/2.1154$

$\ln FUEL_i^* = (\ln TKM_i - 1.614 - 1.6072\ln(r_3) - 0.4044\ln(r_4))/2.1154$

$\ln MTN_i^* = (\ln TKM_i - 1.614 - 1.6072\ln(r_5) - 0.1038\ln(r_6))/2.1154$

The input saving efficiency measure is computed as:

$$E_1 = \frac{LAB_i^*}{LAB_i} = \frac{FUEL_i^*}{FUEL_i} = \frac{MTN_i^*}{MTN_i}. \tag{6.18}$$

Table 6.9: DPF Input Saving and Structural Efficiency-Firm Averages

	KAUTA	KAURU	KAUMU	KAUDO	KAGERA	KAUMA	Average	S_1
E_1	0.51	0.50	0.39	0.38	0.37	0.34	0.41	0.41

Source: Own Computations

The DPF input saving efficiency scores for all the firms over the years are reported in table 6.4. The average input saving measures for the firms are reported in table 6.9. KAUTA has the highest score (51%) and KAUMA the lowest (34%). An average firm can reduce the amount of inputs by 59% to produce the current observed level of output.

As shown in table 6.10, input saving efficiency scores have been declining in the period 1984-1988 and that they are on a rising trend from 1989.

Table 6.10: DPF Efficiency Scores - Year Averages

	1984	1985	1986	1987	1988	1989	1990	1991	Average
E_1	0.47	0.44	0.40	0.40	0.36	0.39	0.42	0.44	0.41

Source: Own Computations

Table 6.11 shows the potential input levels, the figures that can again be compared with those in table 6.2. Substantial savings can be observed.

Table 6.11: DPF Input Values (Firm Averages)

	KAUTA	KAURU	KAUMU	KAUDO	KAGERA	KAUMA
LAB*	62	86	66	82	58	64
FUEL*	112070	311130	364330	87869	274800	113270
MTN*	1279500	1782200	1582900	1585100	910940	1176800

Source: Own Computations

6.5.3 Structural Efficiency

The structural efficiency measure indicates the input saving potential for the whole trucking sector (refer section 6.2). This is calculated on the basis of individual input-saving efficiency measure. Based on DEA, the total potential savings of inputs is around 9% (1-0.91). The input saving based structural efficiency measure for the DPF approach is 0.41 which says that there is a total input saving potential for the whole trucking sector of about 59%.

6.5.4 Capacity Utilisation

Another important issue worth discussing is that of capacity utilisation. It is important to note that the concept of capacity utilisation is related to that of productive efficiency. Excess capacity implies that output can be increased for the given level of input(s). It may be recalled that the output increasing measure of technical efficiency points to a similar effect with regard to output given the observed level of input(s). E_2 can thus be considered as a measure of capacity utilisation, in which case the best practice frontier, which defines the maximal amount that can be produced with the existing levels of inputs, becomes a capacity frontier. Under CRS E_1 and E_2 coincide and we have the measure of gross scale efficiency E_3, this becomes then the appropriate measure for capacity utilisation (Magnussen, 1994).

There is, in our case, a similarity in the distribution of the input saving measures for the two approaches (section 6.5.5). There is also substantial correlation (0.76) between $E_1 - DPF$ and $E_3 - DEA$ (see table 6.13). The $E_3 - DEA$ measure is therefore used here in the analysis of capacity utilisation.

From table 6.5 one observes that the gross scale efficiency score (E_3) shows a lower rate of efficiency than the input saving measure. The average firm is shown to score 0.70. Firms are therefore underutilising available capacity, i.e., are operating at less than optimal capacity. It says that there is potential for increase in capacity utilisation in the trucking sector of about 30%. That is, the utilisation of available inputs in the production of trucking services can be increased by the stated magnitude if the average firm operates with frontier technology. In this case KAUDO has the highest score (0.84), while KAUMA has the lowest (0.53).

6.5.5 Comparison of DEA and DPF Results

Since different frontiers are used to measure efficiency, the efficiency scores and potential savings generated by the two specifications are expected to vary. The desire is to see overall consistency between results of the two approaches. Table 6.12 presents a summary of results for the DEA and parametric (DPF) approaches. DEA specification generates higher efficiency scores compared to the DPF. This is reflected by the significant difference in the spread of efficiency scores generated from the two methods. DEA has the best firm (KAUTA) having scored an input saving measure of 0.99, the worst (KAUMA) being 0.75. DPF has, on the other hand, 0.51 and 0.34 respectively. Therefore, DEA results show firms to operate much more efficiently compared to when DPF is used. Translated into the potential cost reduction this implies that potential input savings are higher under the DPF specification (compare with figures in table 6.1). The resultant differences in potential (structural) savings are considerable.

Table 6.12: DEA and DPF Summary of Results

	DEA			DPF		
	Average	**Minimum**	**Maximum**	**Average**	**Minimum**	**Maximum**
E_1	0.89	0.60	1.00	0.41	0.22	0.62
E_1-Best	0.99			0.51		
E_1-Worst	0.75			0.34		
S_1	0.91			0.41		
LAB*	150	104	240	70	37	112
FUEL*	444040	20918	1278100	210580	7321	582550
MTN*	2926300	996570	7376200	1386200	534390	4252000

Source: Own Computations

It had been observed earlier, however, that under DEA specification (which envelops the data more closely) units at both ends of the size distribution (small and large) are likely to be identified as efficient due to lack of comparable units. In other words DEA is likely to boost efficiency scores for units. Its nonstochastic nature results in confounding statistical noise as inefficiency. The Cobb-Douglas specification on the other hand, imposes structure, both, on the technology and the distribution of inefficiency, and generates therefore lower values. Its parametric form commingles specification error with inefficiency (Ferrier and Lovell, 1990). The two approaches are thus bound to generate differing results, with the parametric ones lower in magnitude.

Despite the differences one can still observe similarities in the ranking of firms based on efficiency scores. Both specifications rank firms in a similar way with KAUTA as the most efficient in the group and KAUMA the least efficient. The only exception is with KAURU and KAUMU which switch positions (second and third). So whatever the specification, the general picture we get with regard to firm performance, is the same. In fact even the average function, with firm effects, provided us with a similar picture. Also similar is the efficiency performance over time[12].

It is also of interest to look at the distribution of the input saving efficiency scores in the two specifications. The Spearman rank correlation between the input saving scores is fairly good at about 0.64. This indicates that there is similarity in the distribution of the measures under the two approaches.

Table 6.13 presents the correlation coefficients of the input saving, gross scale efficiency and output (as a measure of firm size). Of the two efficiency measures, although all are positively related to size, only gross scale efficiency measure shows to have a substantial correlation with size, about 0.68. Firm size has,

[12]It would have been of interest to compare RETCO performance here with that based on the TIRIP performance indicators (discussed in chapter three). Unfortunately, it is difficult to provide any meaningful ranking of firms based on TIRIP measures as one could only observe some interchangeability in the way firms performed with respect to the individual indicators.

therefore, an influence on efficiency. Input saving measures in the two specifications are also substantially correlated, about 0.71.

Table 6.13: Correlation Coefficients Between Size (output) and Efficiency Measures

	TKM	$E_1 - DEA$	$E_1 - DPF$	$E_3 - DEA$
TKM	1.0000			
$E_1 - DEA$	0.4491	1.0000		
$E_1 - DPF$	0.3601	0.7050	1.0000	
$E_3 - DEA$	0.6773	0.6546	0.7593	1.0000

Source: Own Computations

6.6 Summary

This chapter has followed up the discussion carried out in chapter three which indicated a general tendency at inefficient operations in the trucking industry in Tanzania and findings in chapter five which established determinants of performance in the Tanzanian trucking industry. The aim here was to evaluate productive efficiency by use of frontier function approach to facilitate inter-firm comparison of performance.

The results show the existence, both for individual firms and the whole (regulated) sector, of great potential to cost reduction in the sense that less amounts of inputs were actually necessary to produce the observed amounts of trucking services. In terms of capacity utilisation, the result indicate possibility of increased use of available capacity to economic advantage. Linked to that is the observation on the scale of operation. The results indicate that firms have been operating at sub-optimal scales (sizes). There is room for activity expansion to reach the optimal plant size. In terms of firm performance KAUTA is, relatively, the most efficient whereas KAUMA the most inefficient. Overtime, the trend after 1989 is encouraging in that efficiency scores are on the increase.

Although there are differences in the magnitude of the efficiency scores between DEA and parametric specifications, the message that there is need to emphasise efficient utilisation of the resources in the production of trucking services, is driven home by both approaches.

The next chapter examines productivity growth in the trucking industry in Tanzania.

CHAPTER VII

PRODUCTIVITY GROWTH IN THE TANZANIAN TRUCKING INDUSTRY

7.1 Introduction

As pointed out in the introductory chapter, improvement of operational performance in the various sectors of the economy, trucking inclusive, is accorded high priority in Tanzania as part of the economic reforms currently underway in the country. Performance analysis (cost efficiency in this case) has thus become important in the process that is aimed at identifying areas and determining the scope for improvement in operational efficiency in the economy. The central aim is to find potential ways that will help save on inputs, increase output and generally reduce costs.

Productivity (gauging output produced to inputs used in the production process) performance is a central concept in this regard. Productivity improvement has implications on the utilisation of scarce resources in the production process in the sense that growth in productivity is indicative of ability to produce more and better output given resources. It has, therefore, cost saving effects. Knowledge about the extent of productivity growth in the industry is crucial in addressing the question how productive efficiency has developed overtime and so assists in charting future direction with regard to steps to be taken to improve efficiency and see how individual firms have performed and reasons for such performance.

The trucking sector is pervasive in its role in the Tanzanian economy since trucking services are used by every sector. Strong productivity growth in the industry is thus particularly important. As observed in chapters before this, generally the performance of the trucking industry has been less than satisfactory. This chapter follows up these findings and examines productivity performance of the RETCOs, a microcosm of the regulated trucking sector in Tanzania.

7.2 The Concept of Productivity

Productivity is generally defined in terms of the efficiency with which inputs are transformed into useful output within the production process (Cowing and Stevenson, 1981). Its measurement is an attempt to assess the performance of industries and/or individual firms in using real resources to produce goods and services. The framework for measurement is a production function describing the relation of output and inputs and an index formula consistent with this production function. The basic problem is to use data on the prices and quantities of inputs and outputs to allocate the growth of output (Q) among the growth rates of inputs (X) and efficiency parameter (A) (Hulten, 1983).

In the aggregate form, the production function takes the general form:

$$F(Y_t, X_t, t) = 0 \tag{7.1}$$

where t is a shift parameter which allows for changes overtime in productive efficiency. In a one output-two input case (K for capital and L for labour), asuming neutral and disembodied technical progress[1], we have:

$$Q_t = A(t)F(K_t, L_t) \tag{7.2}$$

where A(t) allows for shift in the production function. Differentiating with respect to time we get:

$$\dot{Q}_t = \dot{A}\,F(K_t, L_t) + A\frac{\delta F}{\delta K}\dot{K} + A\frac{\delta F}{\delta L}\dot{L} \tag{7.3}$$

[1]A *neutral* diesmbodied technical change (Hick's definition) is one which neither saves nor uses either factor and leaves the rate of marginal rate of substitution unaltered, other wise we have input-using (-saving) technical change and so *non-neutral.* Technical progress is alternatively assumed to be *embodied* in the factors of production in the sense that one has to invest in the inputs to gain benefits (Wallis, 1979).

a dot on a variable indicates the derivative of the variable w.r.t. time (e.g., $\dot{Q} = dQ / dt$). Growth rate (i.e., proportionate rate of change) of output becomes:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A} F(K_t, L_t)}{Q} + A \frac{\delta F}{\delta K} \frac{\dot{K}}{Q} + A \frac{\delta F}{\delta L} \frac{\dot{L}}{Q} \tag{7.4}$$

If a competitive environment in input and output markets is assumed, i.e., each input is paid the value of its marginal product ; the factor income shares[2] may be used for weighting.

$$\frac{\delta Q}{\delta K} = A \frac{\delta F}{\delta K} = \frac{P_K}{P}; \ \frac{\delta Q}{\delta L} = A \frac{\delta F}{\delta L} = \frac{P_L}{P} \tag{7.5}$$

where P, P_K, P_L are prices of output, capital and labour respectively. Substituting these into the growth rate expression and denoting S_k ans S_l for capital and labour income shares we get:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + S_k \frac{\dot{K}}{K} + S_l \frac{\dot{L}}{L} \tag{7.6}$$

The above equation shows the rate of change of output as the sum of the rate of change of total factor productivity (TFP), i.e., $\dot{A}/A$, and the weighted average of the rates of change of capital and labour inputs[3]. Rearranging the above expression we get:

[2]Otherwise the analysis could employ unobservable output elasticities with respect to input. Elasticity of output w.r.t. capital, for instance, is: $\varepsilon_k = \frac{\delta Q}{\delta K}\frac{K}{Q}$, $\frac{\delta Q}{\delta K} = \frac{\varepsilon_k}{K} = \frac{P_k}{P}$. It follows that $\varepsilon_k = \frac{P_k K}{PQ} = S_k$, in Solow's notation. If constant returns are assumed, then $S_k + S_l = 1$.

[3]The equation can also be transformed into the contribution equation that allows for the analysis of the change in output, say, per unit of labour. The following equation can be applicable (note that use is made of the fact that weights sum to one): $\frac{\dot{Q}}{Q} - \frac{\dot{L}}{L} = \frac{\dot{A}}{A} + S_k \left(\frac{\dot{K}}{K} - \frac{\dot{L}}{L}\right)$. THe left hand side represents the growth rate of output per unit of labour while the term brackets stands for the rate of change of capital-labour ratio (Duke et al., 1992).

$$\frac{\dot{A}}{A}=\frac{\dot{Q}}{Q}-S_k\frac{\dot{K}}{K}-S_l\frac{\dot{L}}{L} \tag{7.7}$$

where all others are measurable except $\dot{A}/A$, a Solow residual (SR), which stands for rate of change of total factor productivity (TFP) (also known as mulifactor productivity)[4]. It is a measure of economic progress; it measures the increase in output over and above the gain due to increases in inputs. It therefore attributes growth in output to factors other than changes in the physical quantities of inputs. The above presentations describe aggregation in continuous form. In empirical practice, however, the Tornqvist formula is used, in which case the rate of change in output or an input is calculated as annual diffrences in the logarithms of the variables; these replace the continuous growth rates. For instance, $\dot{Q}/Q = \ln Q_t - \ln Q_{t-1}$ (see Hulten (1983) for more on this).

7.3 Methods of Analysis

7.3.1 Overview

Which approach one uses to measure productivity depends on how one defines it, based on the nature of the activity under consideration. Various definitions of productivity are proffered in the literature. Such include the ratio of outputs to inputs, that is, looking at the rate at which inputs are transformed into outputs (technological concept); relationship between actual and potential output (engineering concept) and; referring productivity as efficiency of resource allocation, i.e., allowing prices to reflect real economic costs (economist concept) (Ghobadian and Husband, 1990). Traditionally the study of productivity has concentrated in relating a measure of

[4]THere are partial measures of productivity, the most common being output per unit of labour. These have, among the advantages, computational simplicity and feasibility given the general availability of the required aggregate labour input data. Among the weaknesses is the inability one is faced with in identifying causal factors accounting for observed productivity growth. The introduction of say more efficient vintages of capital, the realisation of scale economies, and the employment of better-trained manpower all show up in the form of increases over time in labour productivity. Again what such measures do is merely document the amount of an input used on producing a unit of output while they provide unsastifactory measures of true productivity change. For more on this, see among others, Hooper (1987) and Nadiri (1970).

output to a measure of input, with differences in definitions and the method of measurement of inputs and outputs[5].

With regard to transport operations, one of the methods applies the value-added (VA) concept of productivity, in which case intermediate inputs are subtracted from total production. But previous studies have shown that this led to substantial overestimates of productivity growth in the industry. The extent of the bias was even more pronounced in cases where partial productivity measures were used (Hooper, 1987). It is highly recommended that great care be taken in correctly defining outputs and inputs and that scale and scope effects have a role to play in productivity gains in the industry. Also crucial is the need to take account of firm-specific effects, especially route structure, choice of scale and technology, capacity utilisation and the effects of regulation (Duke et al., 1992).

Indeed productivity change in transport activities can be attributed to a number of forces at work in the external environment in addition to specific actions taken by firms. Transport operations are often regulated, as such the regulated environment has a considerable influence on transport firms' productivity performance. On the other hand the potential for increasing productive efficiency in transport industries may arise through the effects of increasing scale of operation, efficient utilisation of available capacity or investment in new capital equipment (Winston, 1993).

Again, transportation output is multidimensional. Specifically volume and distance dimensions are important. Failure to take account of the complex nature of output gives rise to difficulties in explaining cost differences among firms operating, say, different networks with differential rates of capacity utilisation. This makes it important to consider firm effects in transport firm productivity studies (Jara Diaz, 1982).

[5]For an overview of recent developments in productivity measurement see Cowing and Stevenson (1981).

7.3.2 Approaches Employed in the Case of Tanzania

The objective is to provide measures of productivity growth in the trucking industry in Tanzania and see how they have developed overtime. Also important is to determine relative firm performance with regard to past achievements, i.e., if there has been any advancement from the past experience and if use has been made of the best practice technology.

Two approaches are used to evaluate productivity performance in the trucking industry in Tanzania employing information obtained in chapters five and six. The first makes use of the traditional setting, evaluation of cost efficiency, by use of the cost function estimation results obtained in chapter five. The examination of intertemporal cost efficiency (a dual to TFP growth) is intended to show the annual rates of TFP change registered by the RETCOs.

The second approach utilises the engineering concept of productivity; it is thus linked to the parametric frontier production function. The estimation of the production function with a time variable and firm-effects will help determine if there has been technological progress. Its econometric implementation helps obtain parametric estimates which are important for the evaluation of individual input productivity. It will also indicate, through construction of the frontier function, technical efficiency change, and so see how firms have been fairing in terms of efforts to reach frontier productivity levels. This latter information is vital for capturing another dimension in productivity performance, i.e., productivity gains or losses summarised as changes in the efficiency with which a known technology is applied in the production of trucking services in Tanzania.

However, as Hooper (1987) rightly observes, the practical reality in many areas of transport is that inadequate records are maintained on inventories of assets, utilisation rates, maintenance and capital expenditure. The measurement of transport output may also be a problem; in most cases important output characteristics are not taken into account, and this can lead to seriously biased results.

The problem of data is acute in Tanzania (refer chapters five and six, sections on data). This is one of the reasons a set of methods is used in the study for purposes of cross-checking the results. The use of different methods will help determine the robustness of the results with respect to the general trend, on which importance is attached, in productivity performance in the trucking sector in Tanzania. The approaches are presented below.

7.3.2.1 Index Number Approach

A more comprehensive index number approach to the measurement of productivity is based on total factor productivity (TFP) measures (compared to those based on single or partial factor productivity measures). This approach has been shown to provide robust results with the observation that the use of output cost elasticities or input cost shares which are defensible proxies for input cost elasticities (and not revenue shares which bore no direct relationship to input requirements) is a more satisfactory procedure in the aggregation exercise (Freeman et al., 1985; Hooper, 1987)[6].

TFP may be defined as the ratio of aggregate output (Q) to aggregate input (X), i.e., $TFP = Q_{it} / X_{it}$, where Q_{it} is output of firm i at time t and X_{it} is an aggregation formula for combining the inputs used in the production process, i.e.,

$$X_{it} = \sum_i S_i x_{it} \tag{7.8}$$

where S_i is input i's cost share.

It should be noted that productivity growth, if there is any, translates into cost savings. A mirror image to TFP is cost efficiency (CE) which is measured as unit cost (C/Q) divided by an aggregate index of input prices (W). Like TFP, CE is a measure

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[6]Hooper (1987) notes that an output cost elasticity measures the rate of change of cost relative to the rate of change in individual output quantities. The significance of using cost elasticities is that they reflect changes in resource requirements as the output mix varies overtime. It is thus applicable in a multiproduct situation.

of the real resource cost of production. Improved cost efficiency lowers this cost. Factors other than changes in input prices are responsible for changes in CE (Waverman, 1988; Hulten, 1983). CE may be represented as:

$$CE = (C/Q)/W \tag{7.9}$$

where $W = \sum_i S_i w_i$; S_i is the cost share of input i and w_i is input i's unit price. To measure productivity growth one looks at CE changes overtime, i.e., CEG (G for growth):

$$CEG = \frac{CE_t}{CE_{t-1}} = \frac{(C/Q)_t}{W_t} / \frac{(C/Q)_{t-1}}{W_{t-1}} \tag{7.10}$$

Invoking logarithms we get:

$$\ln CE_t - \ln CE_{t-1} = \ln(C/Q)_t - \ln(C/Q)_{t-1} - (\ln W_t - \ln W_{t-1}) \tag{7.11}$$

where $\ln W_t - \ln W_{t-1} = S_L(\ln w_{L,t} - \ln w_{L,t-1}) + S_K(\ln w_{K,t} - \ln w_{K,t-1})$
$+ S_F(\ln w_{F,t} - \ln w_{F,t-1})$.

L, K and F stand for labour, capital services and fuel respectively.

It may be noted that the Tornqvist index can also be used to study productivity differences among firms. Difference in CE across firms can be obtained in the same manner as intertemporal differences, i.e., for firms n and m, for example, look at $\ln CE_n - \ln CE_m$.

7.3.2.2 Frontier Production Function Approach

This approach seeks to measure and explain variations in total factor productivity of observations relative to the best practice or frontier function. The genesis of this approach is the work by Farrell (1957). The frontier production function defines for any set of observations, the outer boundary of possible input-output combinations. The amount by which measured TFP is less than the potential, based on the best practice, is conventionally defined as technical inefficiency (recall the presentation in chapter six). This approach helps decompose changes in TFP into technical progress and changes in technical efficiency (Nishimizu and Page, 1982).

The starting point is the production function which indicates the maximum output obtainable from a given set of inputs that are used as efficiently as possible. This functional relationship between outputs and inputs which characterises the production processes of a well-defined economic entity, a firm in this case, may be (following Nishimizu and Page) represented by the following transformation function:

$$G(y_{st}, x_{st}; s, t) \leq 0 \tag{7.12}$$

where y and x are respectively the vector of outputs and inputs of firm s at time t. Let us suppose that the output vector is separable from the input vector, and that there exists an appropriate aggregate index of output. The production relationship can then be represented as:

$$y_{st} \leq g(x_{st}; s, t) \tag{7.13}$$

where y_{st} represents the index of aggregate output of firm s at time t. The usual regularity assumptions are assumed to hold by g. For any observed combination of output and inputs of a firm, the above inequality holds when the observed firm is not employing its inputs with the productivity level of best practice at the observed input mix. Denoting by s^*, t^* and y^* the potential or best practice productivity and output levels, we can rewrite the above relationship for an interior firm operating at less than the best practice as:

$$y_{st} = g(x_{st}; s, t) \tag{7.14}$$

$$< g(x_{st}; s^*, t^*) = x^*_{st}. \tag{7.15}$$

g is assumed to be well-defined over s ant t; and it represents the presumption that a firm possesses good technological or economic reasons in operating away from its potential frontier.

One way to measure a firm's efficiency would then be to compare its observed output level to the output determined by the production function. Let us define the potential level of total factor productivity relative to the actual observed level of total factor productivity for such a firm as the minimum possible factor of reduction in potential output that can be produced with the observed inputs employed at the actual productivity levels:

$$\sigma(s,t) y^*_{st} = g(x_{st}; s, t), (0 \leq \sigma \leq 1) \tag{7.16}$$

Alternatively $\sigma(s,t)$ may be defined as the maximum factor of increase in actual output that can be produced with the observed input employed at the potential productivity levels:

$$\frac{1}{\sigma(s,t)} y_{st} = g(x_{st}; s^*, t^*) \tag{7.17}$$

Within this framework the two definitions[7] are equivalent and $\sigma(s,t)$ may be reduced to an output level comparison between y (actual) and y^* (frontier) at the observed input mix x_{st}:

[7]The original definitions to this effect are due to Malmquist (Forsund, 1993); a discussion of the Malmquist index in productivity comparison is provided by Caves et al. (1982). An indepth discussion on frontier functions in chapter six.

$$\sigma(s,t) = y_{st} / y_{st}^{*}, \tag{7.18}$$

i.e., the ratio of actual output to frontier output (also known as output increasing technical efficiency). It evaluates therefore a firm's efforts at reaching frontier productivity levels.

Over any given set of firms the frontier production function provides information on the subset of firms which define the technological state of the art. Its movement over time, however, does not represent changes in the relative efficiency. The rate of change of $\sigma(s,t)$, that is, $\dot{\sigma}(s,t)$ does represent these changes. These represent the rate at which any observed firm is moving toward or away from the best practice frontier. $\dot{\sigma}(s,t)$ may be referred to as the rate of technical efficiency change. For a firm that sustains best practice productivity overtime, $\dot{\sigma}$ assumes a value zero, for others it will be positive (negative) as the firm experiences a decreasing (increasing) gap with its potential productivity levels.

Knowledge of this information is vital for policy. It reduces the chances of misdirecting efforts, i.e., whether to focus on accelerating the rate of innovation or encourage the rate of diffusion of best practice technology. This distinction between technological progress and changes in technical efficiency is particularly important for Tanzania like economies. For given the level of technology, explicit resource allocation may be required to reach the best practice level of technical efficiency over time.

A Cobb-Douglas specified production function, though restrictive, is used in this case (justified by the kind and amount of data available and the sample period covered)[8]. Trucking output is measured in ton-kms (TKM) and is determined by the level of three factors: labour (LAB), fuel (FUEL) and maintenance expenses (MTN). Firm-specific effects are also included in the estimation (through qualitative variables) to help explain output differences among firms emanating from factors

[8]A flexible form like the translog specification would have been most favourable. However, this did not give meaningful results. More on variable definitions, justification and other arguments for this specification in chapter six.

specific to each firm. The deterministic approach is used here. This utilises the whole sample of observations but constraints all observed points in output space to lie on or below the frontier[9].

The functional form used may be represented as:

$$y = A\prod_{i=1}^{3} x_i^{\alpha_i} e^{\beta_i t} \tag{7.19}$$

where y is output in TKM; x_i stands for inputs (LAB, FUEL and MTN); and A, α_i are parameters to be estimated. A is an efficiency parameter and α_i represent the coefficient of flexibility of the marginal productivity of an input factor. Their sum indicates the returns to scale.

The interest here is on the value of σ_{st} and how it has developed overtime together with technical progress. The inclusion of the term $e^{\beta_i t}$ in the specification will explain the variation of output due to *disembodied* technical progress, i.e., that simply due to the passage of time with benefits freely available (Solow, 1957). Thus the change in output with respect to time, $\delta \ln TKM / \delta t$, holding all factor inputs constant, represents the rate of total factor productivity change.

[9]Other approaches include: 1) probabilistic approach which allows for a pre-specified percentage of the most efficient observations to lie above the frontier (Timmer, 1971) and 2) a stochastic approach that specifies both an efficiency distribution and pure random variations in the error structure of the estimated frontier. These approaches are, however, convoluted in their implementation (Forsund et al., 1980).

7.4 Empirical Results

7.4.1 Productivity Growth as Shift in the Cost Function

The results which were obtained from the cost function estimation in chapter five are used here. The elasticity of cost with respect to time gives the measure of the rate of productivity growth overtime; viewing productivity change as a time related shift in the cost function. The results from the simple pooling regression show that there has been productivity growth of about 11 percent in the study period. However, when the FE model is examined one observes that compared to the year 1984, costs have been significantly higher in 1985, insignificantly higher in the next two years and that there has been insignificant declines in costs in the years 1988, 1989 and 1990 before they significantly fell in 1991. So except for 1985 and 1991, the rest of the period shows no significant changes on operating costs. There has therefore been no productivity growth in the sense of falling costs overtime (or technological change for that matter).

7.4.2 Cost Efficiency Trends

Information on input cost shares obtained from the long-run cost function estimation in chapter five is used here for aggregation of the input price index (W). The aggregation thus takes the following form:

$$W = 0.23LAB + 0.29CAP + 0.48FUEL \qquad (7.20)$$

A two stage calculation is then performed to determine first, cost efficiency levels for each firm for all the years (unit cost divided by W) and second, the growth trend or intertemporal differentials of cost efficiency indexes over the sample period through Tornqvist approximation, i.e., $\ln CE_t - \ln CE_{t-1}$.

Table 7.1 contains information on cost efficiency levels over the years for all the firms being studied. As can be noticed, the cost efficiency levels are very low, meaning there has been very low productivity performance. The average annual cost efficiency rates are quite low. On average, KAUMA performed marginally better, although a considerable jump in 1986 must have had a stupendous positive influence on the average; otherwise the firm is distinguished for its very low scores with quite dramatic drops. KAUDO and KAUTA follow; KAURU is the worst performer. This is the situation for all the years in the sample period.

Table 7.1: Firm Cost Efficiency Levels and Indices

Firm	1984	1985	1986	1987	1988	1989	1990	1991	Average
KAUTA	0.00052 (100)	0.00089 (171)	0.00106 (204)	0.00086 (165)	0.00026 (50)	0.00016 (31)	0.00011 (21)	0.00006 (12)	0.00005
KAUDO	0.00172 (100)	0.00243 (141)	0.00156 (91)	0.00047 (27)	0.00037 (22)	0.00030 (17)	0.00037 (22)	0.00008 (5)	0.00009
KAUMA	0.00178 (100)	0.00140 (79)	0.00398 (224)	0.00030 (17)	0.00032 (18)	0.00011 (6)	0.00011 (6)	0.00007 (4)	0.00010
KAUMU	0.00050 (100)	0.00065 (130)	0.00086 (172)	0.00065 (130)	0.00011 (22)	0.00015 (30)	0.00010 (20)	0.00012 (24)	0.00004
KAURU	0.00041 (100)	0.00059 (144)	0.00085 (207)	0.00012 (29)	0.00014 (34)	0.00009 (22)	0.00007 (17)	0.00005 (12)	0.00003
KAGERA	0.00092 (100)	0.00016 (17)	0.00114 (124)	0.00034 (37)	0.00042 (46)	0.00019 (21)	0.00010 (11)	0.00009 (10)	0.00004
Overall	0.00010 (100)	0.00010 (114)	0.00016 (170)	0.00005 (68)	0.00016 (32)	0.00002 (21)	0.00001 (16)	0.00001 (11)	0.00001

Note: In brackets are CE indexes with 1984 as base year.
Source: Own Computations

To augment the discussion, the CE indexes are used. They help show the situation much more clearly. An index greater than 100 means a higher rate compared to the base year CE level. It may be noticed that there has been a general marked decline in cost efficiency over the years and that the variations between the years are quite pronounced, with noticeable differences between the initial and terminal years. An average decline in the index is in the tune of 89 percent.

Figures for cost efficiency growth (CEG) have also been worked out and the results reported in table 7.2. CEG shows changes in CE that have been recorded by the firms over the years. The picture depicted from the table is that cost efficiency has, on average, declined by about 17 percent annually. Only in 1985 and 1987 were there a rise in cost efficiency of about 29 and 3 percentages respectively from previous year recordings. The highest decline was in 1988 (of about 40 percent), followed by 1991 (39%) and 1989 (30%). In terms of firm performance, KAUMA has recorded the highest average annual fall in cost efficiency of about 38 percent followed by KAUDO, 21 percent. KAUMU appears to have, on average, experienced no change in its cost efficiency.

Table 7.2: Cost Efficiency Growth Trend

Firm	1985	1986	1987	1988	1989	1990	1991	Average
KAUTA	0.46	-0.03	0.47	-0.94	-0.29	0.02	-0.80	-0.16
KAUDO	0.35	0.16	-0.52	-0.40	-0.26	0.07	-0.90	-0.21
KAUMA	-0.25	-1.57	0.04	0.33	-0.65	-0.12	-0.42	-0.38
KAUMU	0.27	0.14	0.10	-0.71	0.44	-0.29	-0.01	0.00
KAURU	0.27	0.10	-0.21	0.07	-0.36	-0.42	-0.04	-0.08
KAGERA	0.65	-0.34	0.28	-0.75	-0.69	-0.25	-0.15	-0.18
Overall	0.29	-0.26	0.03	-0.40	-0.30	-0.17	-0.39	**-0.17**

Source: Own Computations

The findings here support those of the fixed effects model, that is, the firms being studied have not registered any productivity growth during the sample period. In fact this decline in productivity has been happening when the overall levels of productivity (cost efficiency) have been infinitesimal, in all cases less than one percent.

7.4.3 Frontier Function Estimation Results

Timmer (1971, p.788) notes that "the reason for estimating the production functions at all is to find the 'right' way to correct for differential use of the factors of production. Otherwise, there is no way to judge one state's performance relative to that of another when different factor amounts and proportions are used". The approach by Russell and Young (1983) is borrowed here. To construct the frontier, corrected ordinary least squares (COLS) regression is applied. This involves making an appropriate shift on the intercept until no residual is positive and one is zero. The largest positive estimated residual is 0.3714; this is used to shift the intercept[10].

The frontier production function, with the time variable, becomes:

$$TKM^{*} = 1.614\,LAB^{1.6072}\,FUEL^{0.1038}\,MTN^{0.4044}\,e^{-0.0904t} \qquad (7.21)$$

where TKM^{*} denotes the maximum value of output obtainable given levels of inputs (i.e., if frontier productivity obtains). Productivity levels, matching firm actual output to frontier output, is obtained by using the following formula:

$$\sigma = \frac{TKM}{TKM^{*}} \qquad (7.22)$$

Productivity levels have been calculated and are reported in table 7.3. In terms of individual firm performance, KAUTA and KAURU operated with frontier technology in only the year 1984, with the σ value of 1. On average KAUTA leads with an average annual productivity score of 0.72 followed by KAURU with 0.71. KAUMA (with 0.34) is the last performer. The penultimate position is held by KAGERA (0.41). Overall productivity performance over the sample period for all

[10]Full presentation of the results, including the firm effects were presented in table 6.8, chapter six.

firms stands at 0.51 annually. The year 1984 was the best with an average firm performance of 0.67. There was a general decline to 0.36 in 1988 before it started rising in 1989 to the eventual level of 0.56 in 1991. It may be recalled that a similar pattern was observed with the efficiency scores presented in chapter six. There was a decline during the period 1984-88 and a rising trend during 1989-91.

Table 7.3: Parametric Frontier Function Productivity Measures

Firm	1984	1985	1986	1987	1988	1989	1990	1991	Average
KAUTA	1.00	0.80	0.76	0.70	0.46	0.63	0.81	0.56	0.72
KAUDO	0.71	0.60	0.24	0.34	0.30	0.39	0.25	0.52	0.42
KAUMA	0.13	0.13	0.39	0.33	0.38	0.43	0.40	0.53	0.34
KAUMU	0.64	0.61	0.52	0.38	0.33	0.27	0.45	0.33	0.44
KAURU	1.00	0.88	0.55	0.62	0.45	0.57	0.70	0.93	0.71
KAGERA	0.53	0.47	0.39	0.37	0.23	0.30	0.49	0.48	0.41
Overall	0.67	0.58	0.48	0.46	0.36	0.43	0.52	0.56	**0.51**

Source: Own Computations

Another aspect of interest has been to examine the effort at catching up with frontier technology that has been registered by the RETCOs. Overall, as the scores indicate, firms have not been able to keep up with the best practice productivity (technology). As such the relevant comparison worth concentrating efforts on has been with the previous year experience. This has been carried out by looking at σ which in this case was obtained as: $\ln \sigma_t - \ln \sigma_{t-1}$, i.e., the annual differences in the logarithms of the productivity scores.

The picture presented in table 7.4 is discouraging. Overall, there has been an average annual decline of about 1 percent in productivity performance. This is on top of the fact that productivity levels, relative to best practice, have been low. Only KAUMA had a score of zero in 1985 which indicates rather maintenance of a previous non-optimal position (σ = 0.13 in table 7.3) than sustenance of frontier technology.

Table 7.4: Technical Efficiency Change

Firm	1985	1986	1987	1988	1989	1990	1991	Average
KAUTA	-0.22	-0.05	-0.08	-0.42	0.31	0.25	-0.37	-0.08
KAUDO	-0.17	-0.92	0.35	-0.13	0.26	-0.44	0.73	-0.05
KAUMA	0.00	1.10	-0.17	0.14	0.12	-0.07	0.28	0.20
KAUMU	-0.05	-0.16	-0.31	0.14	-0.20	0.51	-0.31	-0.09
KAURU	-0.13	-0.47	0.12	-0.32	0.24	0.21	0.28	-0.01
KAGERA	-0.12	-0.19	-0.05	-0.48	0.27	0.49	-0.02	-0.01
Overall	-0.12	-0.12	-0.02	-0.23	0.17	0.16	0.10	**-0.01**

Source: Own Computations

Otherwise there has been a substantial departure from frontier productivity levels. Our σ measure shows that this problem is compounded by further movements (negative) away from previous year, though less than optimal, performance. The few gains that were recorded refer to efforts at regaining previous levels which are not potential productivity levels. KAUMA the most inefficient RETCO has, on average, tried to uplift its performance by about 20 percent annually. The years 1989, 1990 and 1991 show firms to have registered positive efforts by about 17, 16 and 10 percentages respectively, in line with the efficiency trends reported in chapter six (it may be recalled that positive numbers indicate efforts at reducing the gap with previous year performance).

Another information that can be gathered from the econometric estimation of the production function concerns technical progress. The firms' overall output is shown to have been declining at the rate of 9 percent based on the change in output w.r.t time. This is due to disembodied technical retrogression experienced during the sample period. It appears, therefore that overall, the productivity gains observable during the period 1989-91 have been outweighed by the poor productivity performance recorded during 1984-88 and the recorded technical retrogression which characterised the set of firms during the period under discussion.

7.4.4 Individual Input Productivity Measures

It must be noted that at any given level of inputs, an interior firm's effort to reach its potential output may entail changes in output elasticities. So output elasticities with respect to inputs are used for discussion here. It was noted before that these elasticities represent coefficients of flexibility of marginal productivity of an input. These are 1.6072 for labour, 0.1038 for fuel and 0.4044 for maintenance expenses.

There are economies therefore in increased use of labour in that a one percent increase in labour utilisation leads to 1.6 percent increase in output. This is not the case with fuel and maintenance expenses. A one percent increase in fuel use, for instance, leads to a mere 0.1 percent increase in output and only 0.4 percent rise in output in case of a similar increase in maintenance expenses.

7.4.5 Comparison of Results

This section compares the results from the two approaches used to analyse productivity performance in trucking operations in Tanzania. In all cases a general decline in productivity over the sample period is detected. As shown in table 7.5, cost efficiency levels are very low, less than one percent with an average annual decline of about 17 percent. Based on frontier estimates, the RECTOs have on average performed at 51 percent of potential productivity. Generally there has been an annual decline of about 1 percent in technical efficiency during the period. This should not conceal the considerable fluctuations experienced between years. KAUDO, for instance, registered a decline of about 92 percent in 1986 but recorded a rise in efficiency of about 73 percent in 1991 compared to 1990. Frontier technology had, however, not been reached.

Table 7.5: Average Productivity Scores-Summary

	Average Productivity Level	Average Growth Trend
Cost Efficiency	0.00001	-0.17
Technical Efficiency	0.51	-0.01

Source: Own Computations

There are differences between the two approaches in terms of the trends of CE indices and the DPF results. The latter approach, consistent with the efficiency trends reported in chapter six, show a rising trend after 1989. The opposite is the case with CE scores. It may be recalled, however, that the simple pooling in cost function estimation did also indicate positive productivity growth over the sample period. Even in the case of the FE model, although cost differences between the years 1988-90 and 1984 are insignificant, the coefficients bear negative signs, indicating insignificant declines in costs.

Our discussion on the CC and CR indicators, presented in chapter five, showed that the more inefficient firms based on CC scores are among the ones with high CR ratios. KAUMA for instance which is the worst performer, efficiency-wise, has the second highest CR score, which may only be indicative of the influence of high freight rates applicable in the region of domicile. KAUMA does, however, wield only 7 percent of the freight traffic in Mwanza region. KAUMA does therefore only take advantage of the fact that it is domiciled in a region with one of the highest rates, saved also of course, by its public ownership nature (chapter three, table 3.4).

With the cost function one is dealing with the valuation part of the operations, i.e., production of trucking services in this case, if one is dealing with an environment that is regulated. Such an environment may cause costing behaviour, and so cost trends, to be confounded by many factors. Various regulatory measures (administrative) availing relative (dis)advantages to the firms in question, which are not necessarily reflective of the individual firm efforts in the provision of trucking services, and the fact that during the sample period price controls were in effect, for instance firms faced pan-territorial prices in the case of, say, fuel, must be contributing to the mixed up in the cost efficiency trend that is observed here.

The two approaches also show variations in the results with regard to the levels productivity. Nevertheless, and most important, is the fact that they all indicate a general decline in productivity during the sample period.

7.4.6 Determinants of Productivity Performance

An attempt was also made to establish other factors that explain TFP growth, i.e., *TFPG*. The factors chosen include growth in output (*TKM*), average length of haul (*ALH*), average load (*AVD*) and fleet carrying capacity (*TFC*). It is contented that there is a strong relationship between output and productivity growth through increased utilisation of capacity (see also Caves and Christensen, 1988; Hulten, 1983 for a similar argument). As shown in chapter five section 5.5.4, operating characteristics have a strong influence on the production of trucking services, through their cost saving effect.

TFP regression was made and the following results were obtained:

$$TFPG = \underset{(1.9916)}{0.5224} + \underset{(1.6855)}{0.7524} \ln TKM + \underset{(0.4296)}{0.4296} \ln ALH - \underset{(-0.4486)}{0.2027} \ln AVD$$
$$+ \underset{(4.8295)}{4.7549} \ln TFC, \qquad Adj.R^2 = 0.39 \qquad (7.23)$$

The results show only output growth and carrying capacity to be significant at 10 and 1 percent significance levels respectively. So growth in output and carrying capacity significantly explain productivity performance. Operating characteristics (somehow reflective of individual firm effort, though in large part, regulation driven) were not found to be significant determinants of performance. A regression with firm effects was also attempted. The results showed such effects not to be significant determinants of productivity growth. The effect of the general operating environment (the firms in question are all publicly owned) must have a bearing on individual firm performance.

7.5 A Note on Trucking Productivity in Africa

It is of interest to see how productivity performance experienced in the Tanzanian trucking industry compares with that of other countries in Africa. The work by Rizet and Hine (1993) on CFA Franc Zone (Cameroon, Côte D' Ivoire and Mali), the results of which they contend are not untypical of the rest of Africa, provides one with an opportunity to make an observation on the operational efficiency in the road freight industry in the continent. The study observes that generally, the trucking industry in Africa is characterised by low efficiency levels and that there are certain factors which militate against improved performance in the sector. Three factors are cited.

First, vehicle productivity (directly related to the size of the load and the annual distance travelled) per kilometre travelled is observed to be low. High degree of empty running (dead-heading, i.e., unproductive travel time), narrow partitioning of the transport markets due to route and commodity regulation, and seasonality of traffic, mostly dependent on the movement of seasonal agricultural products, causing less stability in the trucking market in terms of load availability for the rest of period, are among the attendant factors.

Second, effect of total distance travelled on fixed costs. On average there is lower kilometrage per truck per year making the spread of such costs to be limited to fewer kilometres. Among the factors causing this are the use of single drivers and so limiting travel time; restriction and discouragement of night driving for safety reasons narrowing activity period (in terms of the number of hours of service); institutional factors (in most cases unclear) which guide traffic management and loading/unloading practices thus causing delays; and general restrictions on competitive behaviour (route and commodity restrictions) which occasion low activity level for most vehicles.

Third, the consumption of variable factors of production (i.e., those which vary with distance), e.g., fuel, tyres, repair and maintenance expenses, etc., are observed to be on the high side. The main factors for this include the generally poor road surface quality due to unchecked attrition, rolling terrain as opposed to flat straight roads on which vehicles ply, and poor vehicle maintenance practices. They, additionally, observe that prices of most of the inputs are high, causing increases in operational costs with the resultant effect of stymieing productivity growth and the ultimate negative effect on trade and general development of the continent.

7.6 Summary

This chapter was devoted to examining productivity performance in the trucking industry in Tanzania. This was done by using both the traditional approach (to determine total factor productivity levels and growth trends) and the frontier approach to identify firm efforts at reaching potential (best practice) productivity levels and efforts at maintaining or building on past achievements. An attempt has also been made to see if there has been any technical progress recorded through inclusion of a time variable in the production function estimation.

The results indicate a general decline in total factor productivity over the sample period. This has been due to both technical retrogression and deterioration of technical efficiency. In terms of magnitude, the latter dominates. This implies that productivity slowdown in the trucking sector is also due to failure by the firms in question to both, maintain and build on achieved levels of efficiency and make use of the available or known best practice technology. The next chapter discusses policy concerns as derived from the empirical analyses.

CHAPTER VIII

POLICY IMPLICATIONS AS DERIVED FROM THE EMPIRICAL ANALYSIS

8.1 Overview: Hypotheses Testing Revisited

This study set itself to evaluate the performance of the public trucking industry in Tanzania. It has reviewed its structure of the entire trucking industry in Tanzania, showing how it had evolved overtime, and examined regulatory policies and effect thereof on firm performance. The discussion was done within the purview of the nature of the economy and its performance, with special emphasis on the economic crisis and policy reform era. An attempt has also been made to perform a comparative analysis and review the operational practices of various players in the industry by use of partial performance indicators. A microcosm of the industry for indepth analysis was then picked and from the analysis of the microcosm, the main determinants of performance in the public trucking industry have been examined, so also has been productive efficiency, for which its development overtime has been studied.

The general tendency towards inefficiency in the industry, widely acknowledged in various literature on Tanzania, was to be studied via the testing a set of hypotheses based on the operational data of the microcosm. These addressed issues of lack of productivity growth, non-optimality in the scale of operations, non-optimal capacity utilisation and the importance of operating characteristics, reflecting the role of regulatory policies, on firm operations.

The findings in this study do not reject anyone of the above restated hypotheses. The results in chapters five (cost function estimation) and seven (measurement of productivity growth) indicate that, indeed, the public trucking industry in Tanzania has not experienced any growth in productivity. There has been no shift in the cost function in a manner indicative of productivity change, cost efficiency levels have been extremely low and declining overtime, and that there have been substantial departures from best practice technology, in the sense that firms have failed to utilise resources with potential productivity. Additionally, in the overwhelming number of cases, firms have failed to even maintain past, though non-optimal, achievements, losing in the process any cost advantages that were at their disposal.

The average firm has been shown, through cost function estimation, to have operated at an output level far less than that consistent with the minimum average cost level. The estimated production function has also shown via the sum of input elasticities that the industry is characterised by scale economies. There exists therefore possibilities for firms to expand operating scales to economic advantage, suggesting that firm operations have been at sub-optimal scales. The same observation is made in the case of the frontier production estimation by use of the scale efficiency measure. The frontier estimation evidences in addition, via the capacity frontier, that firms have not made full use of capacity at their disposal; suggesting a case of excess capacity in trucking operations in Tanzania.

Operating characteristics were included in the cost function specification to see if they had any role in defining and influencing trucking technology and general operations of trucking firms in Tanzania. The results suggest they have an important cost saving effect on operations and so need to be considered when evaluating individual firm performance. Where operations are regulated (ownership characteristics being critical here) in terms of route and commodity licensing, operating characteristics help explain the differential advantages or disadvantages firms face as a result of regulatory restrictions. Such restrictions impact on the average load and distance a firm can achieve while producing trucking services.

These findings, although derived from a set of firms, they may be symptomatic of what is happening in the whole trucking sector in Tanzania, and may thus have important policy implications with regard to the functioning of the whole of this distinctive sector. It is the aim of this chapter to expound further on the findings and highlight policy concerns derivable from them. The results are discussed while advancing policy options with regard to future operations within the industry. Among the issues dwelled upon include structure of the industry, the cost structure, the vital issue of infrastructure investment, pricing of trucking services, capacity utilisation, and implications of the efficiency and productivity measures on the operations of the sector.

8.2 Structure of the Trucking Industry

It may be recalled from the SCP-model stipulation that the concept of structure is about, among others, the degree of concentration in the market (number of suppliers and buyers and their relative sizes) and conditions for market entry. Results in this study give testimony to the presence of scale economies in the trucking industry in Tanzania. This suggests that there are cost advantages in trucking operations with larger compared to small sized operators. Ordinarily, in such circumstances, one would expect the presence of large firms and tendencies toward mergers (in the absence of a constricting environment), as small operators find it difficult to cope (being cost disadvantaged) in offering trucking services.

The trucking industry in Tanzania has both small and large operators offering trucking services. A few which are big are in most cases parapublic, established by government legislation and survived through stipulations giving them monopoly status in certain segments of the market, and via enjoying government preferential treatment especially in terms of financial assistance for investment in vehicles. As such they do not have independent investment policies to react spontaneously to economic signals requiring expansion or contraction of firm size. This calls for some caution in interpreting the findings that suggest presence of scale economies.

In addition to the fact that there are cost advantages with big operations, the results might also be reflecting the fundamental problem facing the industry, that is, the prevalent inefficiencies (to be discussed in section 8.6) in the utilisation of available resources. This is not to rule out the role of size though, for as Beenhakker and Bruzelius (1985) observe, it is primarily the small truck-owners who fail to make proper use of their trucks because they cannot compete on equal terms with large operators. On the whole, however, competitive features dominate inclinations towards monopoly. Various findings attest to that.

Licensing figures indicated a surge in the registration of small private operators in the post-economic reform era, during which the commercialisation of economic activities is encouraged. This is a reversal of the prior period when the registration of big publicly owned firms dominated. All along, however, small operators have dominated in number, their market share having grown overtime. Large operators have, on the other hand, declined. Entry easiness, nature of the trucking product and problems of maintaining large fleets are possible explanations.

The importation of trucking capacity, previously restricted and dependent on government forex reserves, provide clear signs of the emergence of a competitive environment. The health of the economy (size of GDP), importers' own sources of funds and vehicle unit import price are variables that play a key role in vehicle importation. Vehicle import is positively related to the first two, inversely to the unit import price; quite in line with economic theory. This calls for the nourishing of the emerging competitive environment for the good of the industry and the economy as a whole.

Also important are factors that determine the spread of trucking services in the country. Vehicle registrations show truck distribution in the country to be concentrated in regions which have high intensity and spread of economic activities. The estimated freight demand function showed that population, which gives a reflection of the size of the market and extent of available productive resources (with a relatively high correlation coefficient, 0.61, with trucking output), and regional income (GDP) are important factors in explaining the generation and distribution of trucking services in the country. This should suggest therefore that the structure of the economy does have a considerable influence on the developments in the trucking industry.

The structure of the Tanzanian economy, in terms of the spread and relative shares of agriculture, industrial and service activities, hasn't changed much over the years. Agricultural produce dominates freight traffic, followed by manufactured goods. This might be explaining the reasons behind hauliers having operational bases in places where they are. Any changes in the mix of economic activity in the economy (and so sources of freight) should be expected to also alter the structure of trucking and operations therein. This calls for having in place policies which recognise the operational flexibility inherent in the industry.

It may be noted that, the current reform measures may alter or widen the sources of freight, to include increasing freight from industrial and service sectors, and so cause a reconfiguration of the way trucking operations are structured. Present indications are that there are still high freight demand possibilities in the agricultural sector compared to the industrial sector; the latter requiring strong revitalisation to match what agriculture has to offer.

It is important as way of concluding this section to draw attention to the discussion provided in chapters two and four. Concern is about the sustainability of the structure that develops. In chapter two it was shown that firm size and ownership are distinctive characteristics of the structure of the trucking industry in Tanzania. The influence of government policy has, however, been central to the layout of these features.

The theoretical discussion presented in chapter four showed these features to have a considerable bearing on firm performance, as they affect the *effort-cost-reward* configuration and the effectiveness of the whole mechanism for monitoring of operations in an undertaking. To guarantee optimal utilisation of resources and creation of maximum value for the firm, it is recommended that firm size be determined by efficiency argument, as opposed to government directives not backed by economic rationale. Public ownership does not present the best of the arrangements if sustainability in the successful and efficient manning of productive enterprises is the objective. The "atmospherics", i.e., the externalities resulting from government efforts to shore public firms up, through preferential treatment and various exemptions (import duties, etc.) to make them survive, may just be too costly in terms of fiscal drain and the likelihood of compounding distortions in the rest of the economy, to rationalise public sector participation in trucking operations.

8.3 Industry Cost Structure

Another element of industry structure is the structure of costs, treated separately here because of its considerable and conspicuous bearing on firm operations. Firm profitability, market share, prices, and general survival, etc., are very much predicated on how costs are managed; the general organisational structure of the industry, defining the overall operating environment, playing an important role.

The cost function estimation showed that of the three inputs used in the production of trucking services, fuel expenses make up nearly half of total operating expenditures (at 48%). Capital services constitute 29 percent, while payment to labour services, 28 percent of total operating costs. This cost outlook says something about the operating environment in which trucking services are provided in Tanzania.

Ordinarily fuel use per kilometre is high on poor than on good roads. In this case the effect of poor road condition has become vivid through the high expenditure on fuel and payments for capital services; 45 percent of which are on vehicle repair and maintenance. It has been shown that the effects of poor road condition translate into high vehicle operating costs and freight rates, with an eventual welfare effect on the users of trucking services. This calls for the need to direct efforts at the improvement of the road network (see section 8.4).

The role of operating characteristics is another issue worth deliberating upon. It has been determined that average load (AVD) and average length of haul (ALH) have a cost saving effect; in our case AVD specifically. It is logical to expect increases in ALH, beyond the optimal level, to result in increased costs. Uncontrolled distance coverage limits the spread of distance related costs, unmatched with a corresponding amount of cargo, to small consignments. Such kind of operations become a source of the costly dead-heading. As noted before, operating characteristics define somehow regulatory restrictions that affect operators in the trucking market. They reflect the "room for manoeuvre" as far as firm operations are concerned (in terms of routes, commodities and possibilities of securing backhaul cargo). It is thus important for policy that regulatory (licensing) authorities promote policies that are non-inhibiting to the securing of larger loads and coverage of 'matching' distances. This would ensure lower costs, high productivity and increased cost efficiency.

Another important issue concerns the role of vehicle size in determining the structure of operating costs. It has been observed that operating costs tend to decrease with the payload of the vehicle used. That the scope for profit-making lay with the intensive use of large vehicles. In Tanzania, a majority of vehicles are small in size. This must have been dictated by the economic environment in which hauliers offer their services, most specifically, the road configurations which make it convenient to use small trucks. Improved road condition (see section that follows), in terms of width and strength is expected to alter the situation in favour of the less costly to operate large vehicles. This points to the importance of having unrestrictive policies. There is need to have policies which encourage effective utilisation of fleet while leaving vehicle investment decisions to operators.

8.4 Infrastructural Development

Related to the above is the issue of the development of infrastructure. It has been pointed out that roads have a critical role to play in the production of trucking services. Roads' services fall under roughly two categories, i.e., loading and access. These require the infrastructure to be strong, durable and wider. These have a bearing on how much operators will spend in terms of operating costs (which tend to increase with poor roads), with an eventual effect (deterioration) of the quality of trucking services offered (refer Appendix 1). In terms of the whole economy, the economic loss inflicted on a country are enormous. Heggie (1995) estimated that a paved road requiring funds for resealing with NPV of USD 17,688 per km, to keep it in good condition, may cost the nation, in terms of increased VOC, an amount with NPV of USD 39,200 per km. Tanzania is already estimated by World Bank to be losing about USD 200 m annually from poor roads.

So the road network (condition of) has an important role in determining the flow of traffic in the country. It affects operations of hauliers and growth of the trucking industry as a whole. The index representing road condition (WRD) was shown to play a significant role in determining the flow of freight traffic in the country. Also important is the impact of average length of haul (ALH) in influencing operating costs. Due to the poor quality of almost the whole road network, ALH's role was found to be insignificant, suggesting also that operators had to cover longer distances than optimal to find cargo for ALH to have any cost saving effect at all.

This is a likely scenario during the rainy season when certain sections of the road network become impassable, forcing operators to make long detours in search of (the same amount of) cargo. Trucking services, which are so important to the economy, had to be provided, the poor condition of roads notwithstanding.

The effects of poor roads were to be felt via increased operating costs, the burden of which was borne by shippers through hiked rates (freight rates being significant in determining traffic flows, as a resistant factor). Poor roads do also significantly impose constraints on the spread of trucking services and scope of operators who could not offer trucking services to a wider economy because poor roads impeded accessibility to most areas. Policies should therefore be directed at the development of infrastructure and that efficient use be made of such capacity.

This calls for the need for appropriate infrastructure pricing policies to be used to check against misuse of the road network. A note should be in order here. As we are reminded by the Downs' (1962) law, any improved road will attract new users, and with that, increased traffic flow (as both user cost savings and induced benefits are realised) putting another round of pressure onto the "new' road. So unless ephemeralism is done away with, with respect to road improvement and maintenance, resources spent on such works will only be openings for new and even more costly rounds of road infrastructure investment. This cycle can be broken only if infrastructure is priced and invested in more efficiently.

8.5 Pricing of Trucking Services

Another very important aspect arising from the empirical analysis, relates to the pricing of trucking services. Current arrangements (as covered by the sample period) tend to reward inefficient operators. It was found that, based on the cost recovery (CR) indicator, KAUMA, for instance, had the second best chances to recover operating costs. It may be noted that CR is susceptible to upward bias due to the influence of rates (matching revenue and operating costs). Based on the input saving efficiency measures, however, KAUMA is the worst performer among the RETCOs. The picture also reflected in its productivity performance. The justification of the rates that were approved to apply in the regions is called into question here.

The question is then what should be the basis for setting freight rates. Definitely the output dimensions, weight and distance, should form the basic arguments for such an exercise. Ordinarily, rates relate inversely to an increase in anyone of the two dimensions. There are, however, other factors. These include road condition, type and value of traffic, possibility of backhaul cargo, etc., and no doubt, an effective enforcement mechanism. This makes us revisit what we advocated earlier, that is, on reliance on the market forces. Rate setting is best if left to the market forces, where a carrier and a shipper negotiate based on the circumstances of the time. Critical in this regard is the flow of information on the basis of which informed negotiations can be made by the parties. The government's role is thus to make sure it facilitates an even playing field for the interactions taking place in the trucking market. Provision of trucking related information is a crucial service.

8.6 Efficiency/Productivity Implications

The core of the subject matter of this study lay with the examination of the operational practices of trucking firms, especially, level of efficiency in the operations of the public trucking industry and firms within it. Given the nature of the Tanzanian trucking industry, it was found logical that emphasis be put on the input utilisation side. It was envisaged that costs could be substantially saved through the rationalisation of the use of resources that are employed in the production of trucking services. Emphasis was thus placed on the input saving measures which show the proportion of inputs necessary for the actual observed output. These were calculated and the potential cost savings worked out at, both, the level of the firm and for the whole set of firms (referred to as the whole industry).

On the whole, firms were shown to have operated inefficiently in the sense that far more amounts of inputs were used than actually necessary to produce the observed trucking output. This means reductions in input utilisation could be made without affecting the level of trucking output. For an average firm, the savings are in the tune of 11 percent in case of DEA methodology, and as much as 59 percent in the case of parametric approach. Prominence in terms of policy is attached to the main message, that is, the average firm could save on the use of resources for which other uses could be found.

Savings are also reported to be quite substantial for the industry as a whole. The structural efficiency measure for the two approaches reveal potential savings of about 9 percent in the case of DEA and 59 percent in parametric. In the case of the trucking firms used in this case, i.e., the RETCOs, their statutory positions allowing them guaranteed sources of cargo might be masking much deeper inefficiencies in the sector. Rationalisation (appropriate reductions) in input utilisation is thus highly recommended if the current output levels are maintained. This should, however, go side by side with the overall improvement in the operating environment, including improvement in the condition of roads and removal of operating restrictions and obligations, so that firms shape their operations on the basis of cost-effectiveness.

The examination of the efficiency trends indicate that there was a general decline in efficiency in the period 1984-1988. This was reversed and a rise in efficiency was recorded in the period 1989-1991. This change in performance is attributed to policy reform measures initiated starting 1984 if reference is also made to policy discussions made in chapters two and three. Following the institution of liberalisation policies, the operating environment has gradually become competitive.

Availability of inputs has been eased and, as far as the RETCOs are concerned, this has seen an increase in their operational autonomy. The effect of these policy reform measures must have gained momentum and entrenched themselves in the latter reform years, giving operators the confidence to make and adopt cost-effective operational decisions. This reinforces the arguments for moving further towards liberalisation of the trucking market.

Improved operations require advancement in productive efficiency, i.e., that productive efficiency grow overtime. This has a bearing on the possibility of using the same amount of inputs to produce more and better output. The relevant concept here is that of productivity growth. Findings in this study show firms to have operated at very low cost efficiency levels. There has in addition been a general decline in productivity in the industry. Lack of impetus among the operators could be an important factor behind this kind of performance, urging for a careful review of the principal-agent relationships.

An important issue for policy regards the ability of firms to make use and improve upon past performance. This has been shown to be lacking in the case of Tanzania. The results show that there has been both, a substantial departure from best practice productivity levels and deterioration of technical efficiency. The industry had also experienced technical retrogression. This means that efforts aimed at improving performance in the trucking industry in Tanzania should aim at the institution of measures meant to (i) accelerate the rate of innovation and (ii) encourage the rate of diffusion of best practice technology, as firms build on past achievements. We have seen from the results that firm-specific effects play an important role in output determination, and so, on the way resources are utilised; but played an insignificant role in the process of innovation. It's important therefore that operational autonomy on the part of individual firms be ensured.

The Tanzanian situation appears to resembles that of most other countries in Sub-Saharan Africa. Among the measures, important for productivity improvement, are the ones aimed at increasing vehicle maintenance capability and productivity. This requires controlling for load size and distance coverage to reduce dead-heading, control for costs, both fixed and variable, and rationalisation of institutional arrangements to remove restrictions on competitive behaviour. Freeing operations from the seasonal nature of the business, due to its heavy dependence on the haulage of agricultural produce, calls for operational diversification on the part of trucking operators. This they can achieve through studying the changing activity mix in the economy and adapting themselves accordingly. This way they will ensure that they widen the scope for their operations and so further help save on operating costs.

8.7 Capacity Utilisation

Though very much related to discussions made above, another aspect important for policy concerns capacity utilisation. How effectively an operator utilises capacity in hand is important for cost efficiency. Underutilisation of capacity may cause vehicle stock depletion and translating this into high vehicle operating costs as part of fleet is kept idle to degenerate. Existence of excess capacity is bad for it stretches meagre resource to the maintenance of capacity that is unproductive, and so adds unnecessarily to operators' costs.

In the case of trucking operations in Tanzania, capacity utilisation is reported at 70 percent. Low utilisation may be due to low traffic demand or inefficiency in firm operations in terms of organising for cargo, e.g., co-ordination of truck movements for securing return load, etc. It is important to note here that, DEA, which is the approach used for construction of the capacity frontier, tends to boost efficiency scores. It is therefore quite possible that the actual capacity utilisation is below the rate reported here.

With regard to the companies used in the analysis, scarcity of cargo for haulage may not be considered such a big problem. They, however, do not have independent investment (input hiring) policies. In addition to the fact that the firms do not make effective use of capacity at their disposal, the RETCOs might also be owning capacity above what they would have acquired if their decisions were dictated by the forces of the market. A review of the vehicle acquisition and general hiring policies is quite in order. The liberalisation measures which have addressed this aspect of firm operations are justified and should be emphasised.

8.8 Policy Stance: A Synopsis

It will be important to put all that has been presented above in a nutshell. The section thus only highlights the main findings especially with respect to policy issues. It has been observed in the findings of the study that although the trucking industry in Tanzania is dominated by small owner-operators, there exists a significant potential for large size operations. The realisation of economic advantages derivable from expanded scales of operation require, however, streamlining of resource use so that production inputs are employed much more cost efficiently.

It is observed also that inefficiencies and lack of productivity growth seen to be quite significant in the public trucking industry in Tanzania, stem mainly from lack of impetus on the part of operators. This is a result of restrictive and protective regulatory policies. Careful removal or rationalisation of these policies should be to the economic benefit of the sector and economy as a whole. The objective should be to entrench more efficiency-oriented approach to managing trucking operations and the economy generally. Regulatory policy has therefore to imbuel confidence, facilitate competition, should be predictable (to avoid uncertainty) and fair.

Overall policies should be directed at removing impediments to free flow of traffic and firm operations in the trucking market for enhanced productive efficiency and ensure effective operator participation; improvement of vehicle acquisition and maintenance to facilitate increased vehicle productivity; infrastructure development so that the effect of poor road induced costs are controlled and pricing mechanism which has to be left to the dictates of the market forces to prevent misallocation of resources.

CHAPTER IX
SUMMARY

9.1 Overview

Premised on the poor showing of the Tanzanian economy, which is attributed in part to the unsatisfactory functioning of the transportation industry, raising therefore the need to find remedial measures, this study sought to empirically evaluate the performance of trucking operators. The study has, in the main, been confined to the public subsector on account of data availability. The aim has been to identify operational determinants and assess firm efficiency in the utilisation of resources. Considered to be crucial has been the operating environment shaped in large part by the regulatory policies (legislative and administrative), that have been responsible for the structure of the industry (ownership and firm size) that has emerged and which has, as a consequence, been a source of deficiency in firm performance within the industry.

The role of the trucking sector, its structure, regulatory framework and its effect together with the current policy reform measures have all been discussed. Also conducted is a comparative assessment of the operations of the major players in the trucking industry in Tanzania. This enabled choice of a microcosm on which an indepth analysis is based. The theoretical arguments behind efficient size of firm and the ownership implications on efficiency have also been dwelled upon. Empirically, the cost function has been estimated for the purpose of identifying the determinants of performance, frontier approach employed to evaluate relative firm performance vis-à-vis that of the best practice within the microcosm, and intertemporal productivity change examined.

9.2 Highlights of Major Findings

The first issue relates to the role of regulation. It has been shown that through its licensing system, rate regulation and service obligation requirement to public operators, the regulatory framework had negatively affected the performance of the trucking industry in Tanzania. The ownership and firm size configuration that developed has been far from that dictated by market forces (efficiency) and this had consequences on the operations in the industry. Quality of trucking services has been poor, effective participation of private operators hindered, while the inefficient public operators have been protected, and so, costly draining national resources.

The examination of supply and demand in the trucking sector indicates the emergence of a competitive environment resulting from the institution of economic reform measures. On the supply side, income, private agents' foreign exchange positions and vehicle unit import price are key to the importation of trucking capacity in the country. This contradicts the situation before policy reform measures when everything depended on government resources. On the demand side, the flow of freight traffic is dependent on regional output, population, road condition and freight rates. Positively related to the first two, inversely to the latter two.

A comparative assessment of the operations of public and private operators based on partial performance indicators showed private operators to be relatively efficient. Overall, however, based on the exogeneously (World Bank, 1977) determined performance indicators, tendencies towards inefficiency in the industry have been detected.

The cost function for the microcosm has been estimated and determinants of performance established. Substantial scale economies appear to characterise the industry suggesting existence of cost advantages to activity expansion, full realisation of such advantages though require improvement in the efficiency with which resources are utilised. Fuel is a major cost item followed by capital services and labour. This suggests the dominance of road condition related expenses in trucking operations. Cost saving possibilities are also shown to lie with best use of the operating characteristics like average load factor.

Based on the frontier approach, potential cost savings have been identified. Inter-firm efficiency evaluation has been carried out, with the results showing that firms have generally been inefficiently utilising the resources. Both scale of operation and capacity utilisation have been below the optimal levels. KAUTA (Tabora) is shown to be relatively the most efficient while KAUMA (Mwanza) the worst performer. There is shown to be a trend towards increased efficiency in the post 1989 period. This is attributed to the entrenchment of reform measures.

Productivity change has been examined. It has been found that there has been productivity decline during the sample period, in addition to the observed technical retrogression. An analysis of technical efficiency change has shown firms in the microcosm to have failed to make use of the existing best practice technology and to maintain and build on past achievements.

9.3 Limitations of the Study and What Remains to be Done

An attempt has been made to do what has been done in this study with the intention to provide, in an informed manner, inputs for the ongoing discussions on economic reforms being implemented in Tanzania. Revitalisation of the trucking sector is of utmost importance to the smooth functioning of the economy. To achieve this one needs to understand and take stock of effects of past policies, the task this study set itself to accomplish. The study cannot claim, however, to have been exhaustive in its coverage. Many impediments stood on the way leaving room for future research work in the area.

The most critical factor has been lack of data. This did in a big way shape the scope of the study. As pointed out before, an effective evaluation of the trucking industry would require including both public and private operators into the indepth analysis done based on the study of the microcosm, the publicly owned RETCOs. Such a limited sample would, in its own way, lead to biases of some sort as these firms' operations are also dictated by factors other than those deriving from the pure functioning of the market.

This brings in the question of the applicability of the results to the whole trucking sector. Although the spread of the set of firms studied, locationwise, and the dominance of the influence of road condition related factors in firm performance might warrant such a generalisation, the best way would again have been to use a wider coverage involving an expanded set of firms, encompassing aspects of size, ownership, location, specialised undertakings, etc. Indeed whether the results obtained in this study are specific to the RETCOs or are of wider application should motivate further research. All this, however, depends on data availability, which, present arrangements makes it difficult, if not impossible, to obtain.

Enough latitude needs to be given to the reform measures being instituted to judge their effectiveness. Future research would be best saved from an expanded sample period. So even within the post reform period itself, evaluation allowing for structural breaks based on when a certain set of policies were adopted and their likely effects on operations in the industry, could provide enough light as to which policies are the most effective and which are not and how to improve and build on what has been achieved in the past.

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APPENDIX 1

THEORY OF ROAD-USER CHARGES

We provide here a theory of road-user charges, in a shortened form, to help show how the condition of road affects the cost of producing road services and how it affects the quality of such services. The theory is a simplified version of the analysis done by Small, Winston and Evans as presented in Gronau (1994).

Road, crudely put, offers two basic services: access and loading capacity. The marginal costs of producing these services depend on two different attributes of the road: its capacity (that is, width) and its durability (that is, strength). The wider the road, the cheaper it is to produce vehicle services. Different users, for example private cars and heavy vehicles, require these services in different proportions and the contention is that they should be charged different prices for using them (we will not go that far in our presentation here).

We focus in this case on the loading element of the road service that is crucial for road hauliers. This has a direct impact on operators' operating costs. The total cost of the system consists of the direct travel costs V (vehicle operating costs and time costs) incurred by operators and users, and road costs (consisting of maintenance, M, and capital costs, K) borne by the road authority:

$$C = V + M + K. \tag{A.1}$$

The direct costs depend on the number of vehicles (X) and the direct cost per vehicle (v). The cost per vehicle depends, in turn, on the road's quality of service (S),

$$V = Xv(S), \tag{A.2}$$

and decreases the higher the road's quality of service (that is, $v_s < 0$, and $v_{ss} > 0$). The road's quality of service deteriorates with the number of passing vehicles, but increases with the standard of the road, which, in turn, depends on maintenance outlays and the strength of road D (that is its thickness):

$$S = S(X, M, D), \tag{A.3}$$

$$S_X < 0,\ S_M > 0,\ S_D > 0. \tag{A.4}$$

Alternatively, maintenance costs can be said to depend on the quality of service set by the road authority, the traffic load and road strength. The higher the quality of service and the heavier the load, the greater the costs, and the stronger the road, the cheaper it is to preserve its standard:

$$M = M(S, X, D), \tag{A.5}$$

$$M_S > 0,\ M_X > 0,\ M_D < 0. \tag{A.6}$$

Finally, capital costs increase with the road strength $K_D > 0$. In the short-run, when the strength of the road (D) is given, the short-run marginal costs of loading depend on the maintenance policy. When maintenance is completely unresponsive to road conditions, the marginal costs depend on the damaging effect of the vehicle and on its repercussions on vehicle operating costs:

$$C_X = v + Xv_X = v + Xv_S S_X > v. \tag{A.7}$$

The traveller observes his own costs v, and $Xv_S S_X$ is the externality he imposes on other users. This externality depends on the number of users (X), the damaging effect (S_X) and the marginal effect of quality of service on direct costs (v_S).