

TOTAL FACTOR PRODUCTIVITY CHANGE IN THE

GARMENT INDUSTRY IN NAIROBI:

A DATA ENVELOPMENT ANALYSIS

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DECLARATION

This research paper is my original work and has not been presented for award of degree in any other university.



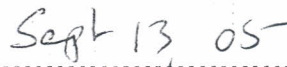
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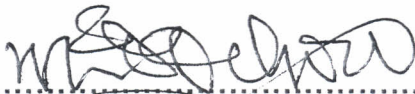
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DEDICATION

To my late father, Richard and my mum Dorcas

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List of Abbreviations

AERC	African Economic Research Consortium
AGOA	Africa Growth and Opportunity Act
CBS	Central Bureau of Statistics
CCD	Caves, Christensen and Die wert
CGE	Computable General Equilibrium
CMAP	Collaborative Masters Program
COMESA	Common Market for Eastern and Southern Africa
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DEAP	Data Envelopment Analysis Program
E	Efficiency
EAC	East African Community
EPZ	Export Processing Zone
EPZA	Export Processing Zone Authority
G7	Group 7
GDP	Gross domestic product
GoK	Government of Kenya
ICDC	Industrial and Commercial Development Corporation
ISIC	International Standard of Industrial Classification
LDCs	Least Developed Countries
LMDEA	Long memory DEA
MUB	Manufacturing under Bond
NGOs	Non-Governmental Organizations
NIC	Newly Industrialized Countries
OECD	Organization for Economic Cooperation and Development.
RECs	Regional Electricity Distribution Companies
RPED	Regional Program on Enterprise Development
SAPs	Structural Adjustment Programs
SFA	Stochastic Frontier Analysis
TFP	Total Factor Productivity
UNIDO	United Nations Industrial Development Organization
VAT	Value Added Tax
VRS	Varying Returns to Scale

Definition of terms

Total factor productivity

This is a measure of output per unit of total factor inputs. Factor productivity growth has been shown to be a major source of growth of aggregate output (Solow, 1975); Productivity depends on technological progress (changes in methods of production over time). Productivity is measured both as labour productivity and total factor productivity and this latter is computed allowing both for increasing returns and for differences in production function across sectors.

Efficiency

The concept efficiency entails a comparison between observed and optimal values of output and inputs of a production unit. This comparison takes the form of the ratio of observed to maximum potential to the observed input required to produce the given output (Odhiambo and Nyangito, 2003). It refers to the relationship between the actual outcomes of a productive process (Renato, 1998).

Technical efficiency

This is defined as the ability of a producer to grasp the available technology. Technically efficient production is that which uses a method that maximizes production from given quantities of factor inputs

Technical Progress

This is the use of new techniques and/or the introduction of new products. It can be measured by considering changes in the proportion of output using a particular technique, e.g. mechanization and the use of inventions.

ABSTRACT

The main aim of this study was to estimate total factor productivity (TFP) change of the firms in the Garment industry in Nairobi using panel data for the year 1989 and 2000. We employ data envelopment analysis (DEA) to compute Malmquist productivity indices, which are decomposed into two component measures namely efficiency change and technical change.

Total productivity growth is found, but there is noticeable variation among individual firms. The observed total productivity growth of 32.2 percent in the industry can be accredited to the recent market reforms being undertaken in the sector. The decomposed index shows high correlation between TFP and the catching-up effect, while the frontier shift shows regress. The latter mainly contribute growth in TFP. The calculated efficiency measure show that there is on average an input-saving potential of 65.8 to 89.3 percent.

The study shows that activities carried out in the industry should be registered regularly so as robust conclusions on the performance of the sector can be drawn in future. The banking sector and/or micro-finance sector should be encouraged to develop mechanisms to enable small producers to export. Appropriate manufacturing space for small-scale producers should be provided to allow them to be more productive and therefore, more competitive on both domestic and foreign markets. Electricity charges should be brought down to those prevailing in the competing countries. Lastly, the Government along side the large-scale industry and the Non-governmental organization (NGO) sector should assist small-scale producers improve the quality of their products by offering specialized training to workers in the garment industry.

“..... If economic planning is to concern itself with particular sectors [industries], it is important to know how a given sector [industry] can be expected to increase its output by simply increasing its efficiency without absorbing further resources. “

M.J. Farrell (1957)

CHAPTER ONE: INTRODUCTION

It is well documented that manufacturing has been the “engine of growth” for many countries in the 20th century. For example, in the short span of twenty-five years, beginning in the mid-1960s, Taiwan, Korea and Singapore raised their shares of manufacturing in Gross Domestic Product (GDP) by more than 15 percentage points as per capita incomes nearly quadrupled. The same has been true of countries in Southeast Asia, like Thailand and Indonesia, where manufacturing shares have boomed and living standards have grown rapidly. Low income countries in Latin America are also industrializing and increasing their manufactured exports with concomitant effect on national incomes (Biggs and Raturi, 1997).

Sub-Saharan Africa has been the outstanding exception to this development pattern. Manufacturing growth in the region has been stagnant. Today, manufacturing is only about 10 percent of GDP on average, only a few percentage points above its 1960s level. Manufacturing exports have picked up recently, but today still account for about the same 8 to 10 percent of total exports they did twenty-five years ago (UNIDO, 1998). The implications of this stagnation in manufacturing for economic transformation and modernization, and ultimately for African standards of living, are serious. How is the manufacturing success of other regions of the developing world compared with the manufacturing failure of Africa to be explained? More importantly, how can Africa get manufacturing going?

Since the mid 1980s, African countries have been urged to liberalize their markets in order to encourage business activity. Kenya, after some hesitation, embarked on a liberalization course in the early 1990s. The country removed foreign exchange controls, dropped quantitative restrictions on imports, reduced tariffs, and promoted exports. The impact on imports was dramatic. Between

1996 and 2000, the value of Kenya's imports rose by nearly half¹. Exports, on the other hand, increased by a much more modest 12 percent. Instead of boosting local industry, liberalization caused an imbalance between imports and exports that created serious problems in a number of sectors (Bigsten and Kimuyu, 2001).

Table 1.1: Percentage shares of Agro-related sectors in sub-Saharan Africa manufacturing value added.

ISIC	Sector	1960	1980	1990	1996
311	Food	21.7	17.5	21	22.4
313	Beverages	14.7	12.1	13.2	13.1
314	Tobacco	8.5	4.4	4.4	4.7
321	Textiles	8.4	10.2	9.2	8.7
322	Apparel	2.4	2.12	2.8	3.5
323	Leather	0.6	0.7	0.7	0.8
324	Footwear	2.1	1.2	1.3	1.1
331	Wood	7	3.9	2.7	2.9
332	Furniture	1.7	1.8	1.1	1
369	Non-metallic minerals	3.6	2.9	3.8	4.3
Total	Agro-related	70.6	56.8	60.2	62.7

Source: UNIDO global database (1997)

Table 1.1 shows that there has been little structural change in value added of the manufacturing sector.

The garment industry was one of those most noticeably affected by the surge in imports. In Nairobi, second-hand clothes, commonly called *mitumba*, were

¹ See GoK, National development plan, 2002-2008.

everywhere.² 'Exhibitions' selling a variety of imported goods, including new clothes, sprang up in the city centre, and hawkers took both new and used garments to offices and housing estates. These imported goods were cheaper than Kenyan products and rapidly gained favour with consumers. Not surprisingly, the change in the market is reflected in industry statistics. Official sources indicate that the clothing production index plummeted from a high of 378.6 in 1989 to only 154.8 in 1999, a drop of 40.9 percent (Ongile et al., 1996).

1.0 An Overview of the Garment Industry in Kenya

The Kenya garment and textile industry is composed of firms of varying sizes and technologies. The firms produce for local, regional and international markets (McCormick et al., 2001). Large firms employ more than 100 employees, medium-sized firms employ between 51 and a 100 employees, and small firms employ between one and 50 employees. Firms producing for international markets are mainly medium and large-sized while those producing for the domestic market are mainly small firms.

According to the survey done in 1989 and 2000 by McCormick, larger and smaller enterprises differ in the types of technology that they use. Large firms tend to engage in mass production and utilize industrial machines while small enterprises tend to use manual or electric powered machines. The firms' products in this sector include women's dresses, undergarments, children's clothes, shirts, shorts, trousers and T-shirts. Most of the garment-manufacturing firms are located in Nairobi, Mombasa and Nakuru.

² *Mitumba* is a Swahili word for second hand items.

1.0.1 Evolution of the Industry

The garment and textile industry in Kenya dates from the colonial period. As early as 1954, the industry had 74 enterprises employing 2,477 workers (Kinyanjui, 1992). Until recently, the garment industry was one of the most important manufacturing activities in Kenya. The industry grew rapidly in the immediate post independence period. It thrived because of the protection offered to firms under the import substitution strategy. It also grew because of government investment in the industry. The government through its parastatal - Industrial and Commercial Development Corporation (ICDC) - invested heavily in the garment and textile industry. Government-owned garment and textile industries were located in major towns in the country. The government had significant shares in textile firms such as KICOMI (Kisumu), Rivatex (Eldoret), Kenya Textile Mills (Thika) and Mountex (Nanyuki). Privately owned garment firms evolved and thrived in the import substitution era. Examples of these private firms were Yuken, Thika Cloth Mills, United Textile Mills, Sunflag, Spinners and Raymonds.

Garment firms, like manufacturing in general benefited from the protectionist policies that lasted until the mid 1980s. Like other manufacturing sectors, the garment and textile industry failed to create strong vertical and horizontal linkages with other sectors leaving these sectors vulnerable when the protectionist policies were abandoned (Sharpley and Lewis 1988; McCormick, 1999).

The development crisis characterized by heavy debt burden, falling income, unemployment and political instability experienced by African countries in the 1980s prompted a rethinking of development concerns. The Bretton Woods Institutions, the World Bank and the International Monetary Fund to which African countries were heavily indebted prescribed reform programmes popularly referred to as Structural Adjustment Programmes (SAPs) which were intended to enable African governments to put in place measures that would help to revive

their economies. SAPs embraced various monetary stabilization and market liberalization programmes. The stabilization programmes included civil service reform, foreign exchange deregulation and currency devaluation. Market reforms were aimed at opening up local markets through the reduction of import duties and tariffs. The latter measure had a significant impact on the previously protected firms, which were operating inefficiently, producing sub-standard goods, overpricing their products and producing below their output capacity.

The opening of markets in the early 1990s had a major impact on the industry. The availability of cheap imports - both new and second hand - drastically reduced demand for Kenya made garments. Retail chains such as Deacons and Njiris chose to import their products from South Africa. Hordes of other small-scale clothing retailers emerged and started retailing their products in what is popularly referred to as exhibitions. These small-scale traders travel to such places as Dubai, South Africa and Britain from where they source ready-made garments and shoes. What ought to be noted is that majority of these traders are women (EPZA, 2001).

The garment industry faced competition from a new form of trade in second hand clothes. The industry could not cope with the new competitors. For example, a garment making factory based in Nakuru, which was making women's garments for a major retail chain in Nairobi, closed down when the retail chain stopped sourcing products from it. It laid off its 200 workers, and shifted to making bed sheets for the low -income market. Major players in the garment and textile industries such as Kenya Textile Mills, Rivatex, Raymonds and Kisumu Cotton Mills closed down. Kenya's garment production has declined significantly since the 1980s (McCormick et al. 2001).

1.0.2 The Garment Industry and Export Promotion

As early as the late 1970s, the government of Kenya attempted to promote export oriented manufacturing. The policy incentives initiated to promote manufacturing exports included the development of industries in a wider sub-regional and continental basis. This initiative was accompanied by export promotion measures such as export compensation schemes. According to McCormick (1999), these early attempts to promote export oriented manufacturing did not succeed for two reasons. First, prolonged protectionism made it more profitable for firms to sell their products in the domestic market rather than in global markets. Second, firms were discouraged from taking advantage of export promotion schemes by bureaucratic delays, inefficiencies, and the corruption that surrounded them.

The government introduced the Manufacturing Under Bond (MUB) legislation in the mid 1980s in order to promote industries manufacturing for export. Firms operating under MUB are exempted from VAT on imported plant machinery, equipment, raw materials and other imported inputs. Firms are also allowed 100 percent investment allowance on plant machinery, equipment and buildings. The first MUB firms were founded in 1988 and, as of 2001, 79 MUB firms had been approved by the Investment Promotion Centre. Of these 79 firms, only 15 were operating in mid-2002. The majority of MUB firms closed down after the withdrawal of the Kenya garment quotas in the US market. There is, however, the hope that some firms will become viable with the implementation of the Africa Growth Opportunity Act of 1999 (GoK, 2001).

Export Processing Zones (EPZ) were initiated in the 1989-1993 Development Plan period. By 1994, there were six gazetted EPZs. A government body known as Export Processing Zones Authority manages the EPZs. There are 23 EPZs in the country. Of these, two are developed and managed by the private sector. EPZ firms are involved in many activities of which garment making is the most important. Investors in the EPZ are drawn from Denmark, the US, Taiwan,

Belgium, South Africa, Pakistan, Germany, China, India, the Netherlands, the UK, Sri Lanka and Hong Kong. The firms operate in designated areas and produce exclusively for export. Firms in EPZs enjoy several benefits including tax holidays, exemption from VAT and duties on machinery, and lower priced raw materials and intermediate inputs (EPZA, 2001).

Garment firms in Kenya are characterized by differences in production patterns. Some firms engage in the full range production activities. Others, especially some of the large exporters, are “cut-make and trim” (CMT) contractors. These firms are located within global commodity chains, which are characteristic of the global trade in garment production and retailing. Retail chains in developed country markets contract developing country firms to manufacture garments on their behalf. The retail chains provide the designs and raw materials required in production. The local firms cut and stitch the required garments which are then shipped to developed country’ markets.

The growth in exports has followed the recent enactment of the US government’s Africa Growth and Opportunity Act (AGOA), which allowed duty-free imports of many items from qualifying African countries in the American market. Regional exports are also being boosted by Kenya’s membership in the East African Community (EAC) and the Common Market of Eastern and Southern Africa (COMESA).

Table 1.2 shows the performance of firms in the EPZ between 1999 and 2002. In 1999, there were only twenty-two firms but the number of firms increased in 2002 to fifty-four. The value of exports also increased from Kshs. 3,020 million in 1999 to 9,741 million in 2002.

**Table 1.2: Exports, Investment, and Employment in EPZ
Garment Firms, 1999-2002**

	1999	2000	2001	2002
Number of Firms	22	24	39	54
Export Sales (Kshs. Million)	3,020	3,635	5,962	9,741
Investment (Kshs. Million)	5,941	6,107	8,950	12,728
Number of Employees	4,767	6,620	13,758	27,148

Source: Economic Survey, 2004

1.1 Statement of the problem

The garment industry has experienced productivity growth, which has been because of increased machines speeds and the introduction of special- purpose machines. Although special purpose machines speed up garment manufacture, they have not altered the technology, calling for equal numbers of operators and machines. Economies of scale are difficult to realize in clothing manufacture. The industry generally uses highly dexterous, but low-paid operators and standardized, relatively inexperience sewing. The limpness of textile fabric makes manipulation by machines extremely difficult. Consequently, even in large factories, automation is limited and human workers perform many tasks.³

According to McCormick (2002), productivity is often positively associated with firm age and entrepreneurial education levels. They therefore expected from their

³See McCormick et al., 1996

studies that the observed increases in both of these characteristics might have resulted in productivity improvements. Yet productivity, as measured by output per worker increased only slightly. What is not clear is whether the slight improvement in productivity implies a shift by the firms towards production of less input intensive garments or a change in production techniques towards more input saving production technology.

Therefore, this study estimated the production frontier for Nairobi garment industry. In so doing, it avoided making the assumption of full technical efficiency as in traditional production function estimation. Contrary to several studies that apply stochastic frontier models in the computation of TFP, the study employed Data Envelopment Analysis (DEA), a non-parametric technique which does not require specification of a particular form of the production function. Furthermore, using a method developed by Färe et al. (1992, 1994), Malmquist productivity indices are computed by the DEA method and TFP is decomposed into change in technical efficiency and technological change.

The DEA program has been used to examine the nature and cause of productivity growth in the garment industry in Nairobi for the period 1989 and 2000.

1.2 Objective of the Study

The main aim of this paper was to estimate total factor productivity (TFP) change of the small-scale garment firms in Nairobi. In the process, the paper analyzed the sources of productivity growth in the industry. Specific objectives of the study included:

- Measuring TFP change for each firm
- Determining the sources of productivity growth
- Recommending strategies and policies of institutionalizing efficiency improvements at the micro level in the industry.

1.3 Significance of the Study

The decomposition of the Malmquist productivity index into change in technical efficiency and technological change is particularly relevant to the garment industry in Nairobi. As mentioned above, there has been productivity growth in the industry, which mainly is explained by increased machine speeds and introduction of special-purpose machines (McCormick, 1996). This in effect implies technological change in the industry. But productivity growth could also be as a result of technical change. In light of the above reason, one may like to know whether this argument is valid. The estimation of production frontier served this purpose.

This study has been organized as follows. The next section provides a review of the previous studies of productivity growth in various sectors and situates this study in the literature. Section three explains the methodology. Section four explains the DEAP results and finally, in section five conclusions and policy recommendations for the study are drawn.

1.4 Scope of the Study

In the study TFP change of the garment industry in Nairobi was computed using panel data for the period 1989 and 2000. Nairobi was picked upon because of having many garment firms especially in the city centre, Uhuru, Kenyatta and Nyayo markets.

CHAPTER TWO: LITERATURE REVIEW

2.1 Theoretical Literature

Productivity growth of Kenya's manufacturing sector has attracted much academic attention in the past decade. Emphasis on productivity performance stems from the recognition that enhanced productivity, which will translate into greater production would boost the sector's contribution to export earnings thereby bringing about a speedy realization of the government's goal of diversifying the export base from agricultural products and generally promoting growth. Several studies have been done on total factor productivity (TFP) in both macro and micro economic sectors of different economies. The studies have utilized various methods in measuring the productivity index.

This section first compares three different ways of deriving TFP change: growth accounting, stochastic-frontier analysis (SFA), and DEA. Thereafter, it describes how the Malmquist-index of TFP change is calculated and decomposed into the two components of technological change and technical-efficiency change. The DEA method of obtaining TFP is applied in this study.

2.1.1 Growth accounting, SFA, and DEA

Arguably, the most widely used method for measuring TFP change is that of growth accounting. On the assumptions that output is produced using labour (L) and capital (K), and that the relative contributions to output growth of labour and capital are β_L and β_K , respectively, TFP change can be obtained as the residual of subtracting $\beta_L * L + \beta_K * K$ from output change.⁴ In principle, this accounting exercise can be conducted for any country using country-specific parameters.⁵ While growth accounting is attractive — also on account of its simplicity — it

⁴ Abramowitz (1956) succinctly called this residual component a "measure of our ignorance". Still, a substantial amount of "unexplained" growth tends to remain as Hulten (2000) reports in his 'biography' of TFP.

⁵ However, when studying several countries the parameter values for the United States (0.6 for β_L and 0.4 β_K)

requires several restrictive assumptions to hold. Among them is that of permanent technical and allocative efficiency. Product markets must be perfect so that the factor shares (β_L and β_K) reflect their respective marginal products. Agents are assumed to be maximizing and production equilibrium is reached under an optimal allocation of resources.

But, why should equilibrium conditions hold permanently? For the analysis to work they need not because parameters can be obtained by estimating a parametric production function. However, the drawback from such an approach is that the parameters are average values for the entire sample. If there are country features that are heterogeneous and the analysis attempts at highlighting those (e.g. heterogeneous technological change), growth accounting seems to be an inappropriate tool.

One way to circumvent the averaging problem is to rely on SFA. The approach is attractive in that it constructs a frontier of efficient observations, which envelops the relatively inefficient observations. An important advantage of the method is that it is able to handle outliers and that hypotheses can be tested in the usual (econometric) way. However, there are several important drawbacks as well. The production function is assumed valid for all observations and technological change is the same for all observations. Whether technological change is continuous and smooth and common to all observations can be questioned. It is also somewhat disturbing that a distributional form of the error term as well as a functional form of the production function has to be assumed.

By contrast, DEA does not require any assumption about the functional form of the production function or economic agents' behaviour. Furthermore, there is no need to assume any specific distributional form of an "error term" and there is no need to assume perfect factor markets or optimal resource allocation. This is not to imply that the above approaches are to be ignored. In fact, there is need for simultaneous techniques since the policy implications are sometimes sensitive to

the methodology. In analyzing efficiency in the garment industry, the DEA has, however, some strength as compared to other parametric approaches. In this context, the managerial implications could be stated as follows: firms in the garment industry may find it difficult to impose that their operations are organized so as fit an a priori production function. They are more likely to agree that using less input for the same or large amount of output is better than using more. This is in favor of DEA as opposed to parametric procedures.

2.1.2 The Malmquist TFP index and its decomposition

TFP change is defined as the growth in output net of growth in inputs used. The measurement of TFP employed in this paper is based on the output-distance function and is due to Malmquist (1953).⁶ In using the output-oriented (or input-oriented)⁷ version of DEA, the paper follows the approach of Färe *et al* (1994) for calculating productivity growth in the garment industry in Nairobi.

The DEA-approach is based on Farrell (1957) and on extensions of his work by Charnes *et al.* (1978), related work by Färe *et al.* (1983, 1985) and Banker *et al.* (1984). In this approach, efficiency of a production unit (in the present case a country) is measured relative to the efficiency of all other production units, and subject to the restriction that all units are on or below the best-practice frontier.

To start with, suppose that we have an output possibility set:

$$(1) \quad P(x) = \{y: x \text{ can produce } y\}.$$

The output distance function with technology at time s , the initial period, can be defined as:

$$(2) \quad d^s(x, y) = \min\left\{\phi : \frac{y}{\phi} \in P(x)\right\}$$

⁶ See also Caves, Christensen, and Diewert (1982), Nishimizu and Page (1982), and Färe *et al* (1994). Coelli, Rao, and Battese (1998) and Cooper, Seiford, and Tone (2000) provide excellent introductions to the Malmquist TFP index

⁷ The two measures provide the same value under constant returns to scale (CRS), but are unequal when variable returns to scale (VRS) is assumed.

Note that when ϕ is minimized, y/ϕ is maximized. Thus this distance function measures the maximum possible output that a given amount of inputs can produce. It is a measure of technical efficiency. Similarly, we can define a distance function in relation to the technology in time t , the final period as $d^t(x, y)$.

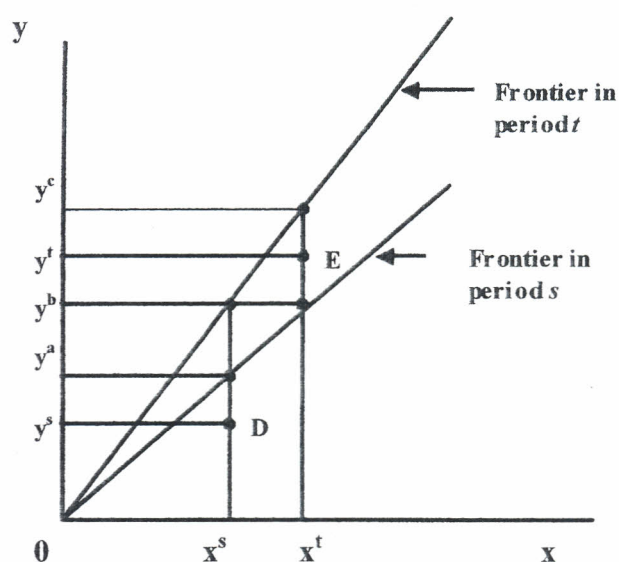


Figure 1 Decomposition of the Malmquist Productivity Index

The idea can be shown graphically by a simplified (one-input and one-output with constant returns to scale (CRS) technology) case. Points D and E in Figure 1 represent the input-output combinations of a production unit in periods s and t respectively. In both cases, it is operating below the production possibility frontier. In period s (correspondingly, period t), with input x^s (x^t), it should be able to produce y^a (y^c) if it has full technical efficiency. Then the technical efficiency is measured by y^s/y^a (y^t/y^c).

Productivity change can be measured by the part of output growth that is not contributed by input growth. In Figure 1, we can calculate a productivity index by $(y^t/y^s)/(y^b/y^a)$, where (y^t/y^s) is the output growth and (y^b/y^a) represents a movement along the production frontier in period s . This can be rewritten as $(y^t/y^b)/(y^s/y^a)$, where the numerator is a distance function for output in period t (y^t) with reference to the technology of period s and the denominator is the distance function representing technical efficiency in period s . This is precisely the Malmquist Productivity Index defined by Caves, Christensen and Diewert (1982 ; hereafter CCD), with reference to the technology of the initial period:

$$(3) \quad m_{CCD}^s = \frac{d^s(x^t, y^t)}{d^s(x^s, y^s)}$$

However, we can also choose the technology in period t as the reference in defining a productivity index. The Malmquist Productivity Index in relation to the technology of the final period can be defined as:

$$(4) \quad m_{CCD}^t = \frac{d^t(x^t, y^t)}{d^t(x^s, y^s)}$$

The two indexes appear to be identical in the simple case represented by Figure 1. However, they may or may not be the same in the cases of multiple inputs and varying returns to scale (VRS) technology. To avoid the arbitrariness in choosing the benchmark, Färe et al. (1992 and 1994) specify the Malmquist Productivity Index as the geometric mean of the above two indexes:

$$(5) \quad m(x^t, y^t, x^s, y^s) = \left[\frac{d^s(x^t, y^t)}{d^s(x^s, y^s)} \times \frac{d^t(x^t, y^t)}{d^t(x^s, y^s)} \right]^{1/2}$$

Färe et al. (1992) shows that this index is equivalent to:

$$(6) \quad m(x^t, y^t, x^s, y^s) = \frac{d^t(x^t, y^t)}{d^s(x^s, y^s)} \times \left[\frac{d^s(x^t, y^t)}{d^t(x^t, y^t)} \times \frac{d^t(x^s, y^s)}{d^s(x^s, y^s)} \right]^{1/2},$$

Where the ratio outside the brackets measures the change in technical efficiency between the years s and t . The geometric mean of the two ratios inside the square brackets captures the shift in technology between the two periods evaluated at x^s and x^t .

In Figure 1, the two components of the Malmquist Index as in Equation (6) is represented by:

$$(7) \quad \text{Efficiency change} = \frac{y^t / y^c}{y^s / y^a}; \text{ and}$$

$$(8) \quad \text{Technical change} = \left[\frac{y^t / y^b}{y^t / y^c} \times \frac{y^s / y^a}{y^s / y^b} \right]^{1/2}.$$

All the distance functions can be estimated by Data Envelopment Analysis (DEA). Ali and Seiford (1994), Grosskopf (1994) and Rao and Coelli (1998) explain clearly how the estimation can be done.

Färe et al. (1994) also estimate the production frontier for a variable returns to scale (VRS) technology and separates the "scale effect" from productivity changes. However, as pointed out by Grifell-Tatjé and Lovell (1995), a Malmquist index may not correctly measure total factor productivity (TFP) changes when VRS is assumed for the technology. Recently, Ray and Desli (1997) contend that there may be confusion in the simultaneous use of CRS and VRS technologies within the same decomposition of the Malmquist index. Here we confine our

analysis to the use of CRS as the reference technology in computing the productivity indexes.

2.2 Empirical Literature

In the transport sector, James Odeck (1993) obtains a decomposed Malmquist index to measure productivity growth in Norwegian Vehicle inspectorate. The input variable is taken as the number of days effectively worked in the station by personnel of all categories for the year and output is the total number of operations performed during the year. The calculated efficiencies show an input saving potential on average of 21-29 per cent throughout the sample period.

Penn-World Tables Mark 5 provides the basis of the study by Färe *et al.*, (1994). Data covers 17 OECD countries over the years 1979-88. Output (real GDP) is assumed to be produced using labour and capital. The authors find that on average over the OECD countries TFP change was 0.7 per cent per year. Technological progress explained TFP change in all countries and showed an annual average change of 0.85 per cent. Hence, TFP growth in OECD countries was driven entirely by innovation resulting in technological progress. Technical efficiency, by contrast, deteriorated slightly over time. Using the same method as Färe *et al.*, (1994) the present paper obtains similar results for a slightly larger sample of industrialized countries, however with one important exception: for one country technological regress is detected.

Cheng (1998) examines the sources of productivity growth in Chinese agricultural sector, by applying the DEA method to compute Malmquist productivity index. Gross value of agricultural products gives the output and the inputs comprise, cultivated land, power of machinery, chemical fertilizers and labour. Results indicate that the TFP growth in agriculture was as high as 7.8 percent per annum during 1991-1995. The decomposition results show that there was rapid technical progress along with a substantial decline in technical efficiency.

In Rao and Coelli (1998) the output variable is real GDP per capita with the inputs being labour and capital per capita. The data source from Penn-World Tables Mark 5.6 and cover 60 countries for the period 1965-90. For Latin America and North Africa/Middle East negative annual TFP growth is observed, while the highest TFP growth rate is that of Asia (0.99 per cent annually). The paper reports several cases of technological regress. For instance, among OECD countries Denmark, Italy, and the Netherlands belong to this group, whereas Africa and Latin America exhibit the largest numbers of such cases. Even among the Asian 'Tigers' there is one instance (Korea) of technological regress. Not surprisingly, change in technical efficiency is reported as being largest for those countries that experience negative technological change. Unfortunately, the authors do not comment on these cases, and they also refrain from questioning the occurrence of technological regress as such.

Tilley and Weyman (1999) uses TFP growth measured for regulated electricity companies using Malmquist indices. The regional electricity distribution companies (RECs) appear to have compensated for a tightening in the price control by reducing stock in 1995/96 and 1996/97, which may be due to improvements in operating efficiency. This results are more positive as compared to O'Mahony (1999) and Burns and Weyman-Jones (1994, 1996 and 1998) who used DEA or stochastic frontier model (SFM) analysis to evaluate this efficiency change in the regulated electricity distribution industry with conflicting results.

Karadag, Önder and Deliktas (2000) use panel data for the period 1990-1998 and employ data envelopment analysis (DEA) to compute Malmquist productivity indices. The indices are decomposed into two component measures namely efficient change and technical change. In their study they consider both the private and public owned manufacturing sub-sectors. Output is measured in value terms at constant 1981 prices. Labour, capital and raw materials are the main inputs. The study shows that there is no significant improvement in TFP

due to instability in the economy in 1990s. The improvement in TFP is mainly explained by efficiency change.

Krüger, Cantner, and Hanusch (2000) study the 'East-Asian Miracle' from 1960 to 1990, splitting their data into two-time periods, namely 1960-73 and 1973-90. The paper is based on a fairly broad dataset covering 87 countries and drawing on Penn-World Tables Mark 5.6. Output is gross domestic product in international 1985 prices, labour is retrieved from the dataset, and while capital stock data are constructed from investment data by use of the perpetual inventory method. This increases the number of countries in the sample compared to other studies. The paper compares three groups of countries: the G7, Latin America, and a group of Newly Industrialized Countries (NICs). The authors find that the first period was characterized by factor accumulation, while in the second period, in addition to factor accumulation, there were effects of technology assimilation and learning along the lines of Nelson and Pack (1999). Over the second time period, three of the four NIC countries had positive TFP growth (the exception being Korea) where, on average, NIC productivity increased by 0.64 per cent annually. The corresponding figures for G7 countries and for Latin America were 0.76 and -0.70 per cent, respectively. Singapore had the fastest TFP growth (1.26 per cent) of all countries in the sample.

Turning to the change in technical efficiency, the average annual rate for NIC countries was 2.55 per cent, an impressive figure suggesting rapid catching-up. G7 countries had on average a positive change amounting to 0.58 per cent (where Canada lost relative to the frontier), while Latin American countries increased technical efficiency by 0.91 per cent annually. Finally, all NICs experienced technological regress, amounting to an average of -1.86 per cent annually. With the exception of Venezuela, also all Latin American countries faced negative technological change. And among the G7 countries, only five progressed technologically (the exceptions being Japan and the UK) with an average rate of change of 0.18 per cent for the group as a whole.

Forstner and Isaksson (2002) using DEA, a 'world-technology frontier' is constructed on the basis of data on 57 countries for the period 1980-1990. Growth in TFP and its decomposition into technology progress and change in technical efficiency are analyzed in this context. The paper shows that applying DEA in standard fashion results in a biased estimate of change in technical efficiency, due to implausible loss of memory about production techniques. An amendment to DEA called here Long-Memory DEA (LMDEA) is proposed in order to achieve accurate measurement of technical efficiency change. The application of LMDEA yields some new results that are largely in line with common perceptions of growth patterns.

Asai (2005) used the Malmquist productivity index to measure productivity. Inputs comprise labour, capital and materials for 30 broadcasters for period 1997-2003. The output quantity is measured as the sum of television and radio revenues divided by the price index of broadcasting advertisement service. Results show that on average the small-scale broadcasters have not operated efficiently. The Malmquist productivity indices indicate that technical efficiency has not improved, and on average the production frontier has deteriorated.

Biggs and Raturi (1997) investigated the productivity and competitiveness of African manufacturing. In their paper, they used statistical analysis of the effect of production and investment capabilities on firm technical efficiency will, thus, have to await better measurement of these technological capabilities. The paper established that specific kinds of technological capabilities of workers and managers are major determinants of enterprise productivity and competitiveness. In particular, learning-related technology capabilities that enhance the firm's capacity to build and augmented industry-specific human capital have an unambiguously positive impact on technical efficiency and competitiveness.

Adeola and Alaba (1999) investigate the relationship between productivity performance and energy consumption in the Nigerian manufacturing sector at both aggregated and disaggregated levels. The paper adopts a non-parametric approach to the measurement of TFP. A translog production form is used in measurement of the Tornqvist productivity index. It then specifies a regression model linking the estimated TFP growth with changes in energy use. Time series data for value added, net capital expenditure, labour, wages and salaries and energy consumption at industry level is employed. The perpetual inventory method is used to generate the capital stock series. Energy consumption comprises electricity and petroleum products. The paper establishes that energy consumption still plays a critical role in productivity growth in the Nigerian manufacturing sector. The industrial sector is still dominated by old energy-inefficient technology. However, there are prospects for enhancing energy efficiency.

Semboja (1993), in his study on energy and development in Kenya manufacturing sector investigates the relationship between productivity and performance in the Kenya manufacturing sector. In the analysis, he makes use of descriptive parametric (econometric) and non-parametric (CGE) approaches or methodologies. He argues that the performance of the industrials sector and its energy use have been the most target areas with respect to national energy conservation policies specifically aimed at improving energy end-use technologies.

McCormick et al., (1996) presents the situation of the garment markets and assesses their potential for contributing to Kenya's Industrialization. The data suggests that the markets lie somewhere between a true district and simple sectoral agglomeration of firms. Like many (Least Developed Countries) LDC clusters, the garment markets exhibit weak internal and external and division of labour that is supposed to be key to collective efficiency is totally lacking. Those inter-firm linkages that exist are often informal and at a low level. Evidence on

ethnicity, gender and education point to the important of entrepreneurs social and professional.

2.3 Overview of the Literature

Productivity measures are intended to identify changes in the level of production that cannot be explained by changes in inputs or in the characteristics of the original production process. Growth in productivity for a sector, other things being equal, implies improved performance. The literature on productivity growth studies is dominated by comparisons of cost ratios. In the absence of market prices, the cost ratio principle would not be directly applicable. But even if it was multiple outputs would result into several cost ratios each telling a different story.

A number of productivity studies have been based on estimation of average cost functions. This kind of analysis is at best only able to identify average practice productivity growth but not the productivity growth of the best units. The average cost function approach also leaves questions regarding the micro-structure and the second sectoral spread of productivity growth rates unanswered. This study is based on a non-parametric frontier production function. It makes use DEA framework which is a linear programming technique for constructing a non-parametric, piecewise linear envelope to the observed output and input data. The methodology has been previously applied in a number of studies as indicated in the literature. An alternative approach is employed to production frontier estimation. Using the econometric approach, all previous studies have to assume a specific form of production function. If the functional form is incorrect, the estimation will be spurious.⁸ In contrast, the DEA employed in this study is a non-parametric estimation method under which assuming the form of the production function is not necessary. Its major shortcoming is that tests of significance of the estimation, as those econometric cannot be carried out.

⁸ Spurious correlation is an observed sample correlation between two series which although appearing to be statistically significant, is a reflection of a common trend rather than a reflection of any underlying association.

CHAPTER THREE: METHODOLOGY

3.1 Model Specification

The output-oriented DEA model for a single output in this study can be formalized as follows; Consider the situation for the N firms in an industry each producing a single output by using K inputs. For the i^{th} firm x_{it} is a column vector of inputs, while y_{it} is a scalar representing the output. X denotes the $K \times NT$ matrix of inputs and Y denotes $1 \times NT$ matrix of output. T denotes the time period.

A Malmquist TFP index might not correctly measure TFP changes when variable returns to scale (VRS) is assumed for technology. Therefore, it is important to impose constant returns to scale (CRS) on any technology which is used to estimate distance functions regarding the calculation of Malmquist TFP index.⁹ The CRS has several practical advantages; the overall index is consistent with average product notion of productivity, it avoids computational problems and it is consistent with cross-section decomposition of technical efficiency.

It should also be noted that the assumption of CRS makes the analysis based on input saving efficiency (input-oriented) equivalent to analysis based on output increasing efficiency (output-oriented).

Assuming constant returns to scale (CRS) technology, the output-orientated linear programming (LP) model used to calculate $d_0^s(x^s, y^s)$ will be given by;

$$(9) \quad \left[d_0^s(x^s, y^s) \right]^{-1} = \max \phi, \lambda, \Phi$$

Subject to

$$-\phi y_{it} + Y_t \lambda \geq 0,$$

⁹ See Førsund in Fried (eds.) et al., (1992) and Berg et al., (1991).

$$x_{it} - X_t \lambda \geq 0,$$

$$\lambda \geq 0$$

The remaining three LP problems are simple variants of this:

$$(10) \quad [d_0^t \ (x^t, y^t)]^1 = \max \phi \ \lambda, \Phi$$

Subject to

$$-\phi y_{it} + Y_t \lambda \geq 0,$$

$$x_{it} - X_t \lambda \geq 0,$$

$$\lambda \geq 0$$

$$(11) \quad [d_0^s \ (x^t, y^t)]^1 = \max \phi \ \lambda, \Phi$$

Subject to

$$-\phi y_{it} + Y_s \lambda \geq 0,$$

$$x_{it} - X_s \lambda \geq 0,$$

$$\lambda \geq 0$$

$$(12) \quad [d_0^t \ (x^s, y^s)]^1 = \max \phi \ \lambda, \Phi$$

Subject to

$$-\phi y_{is} + Y_t \lambda \geq 0,$$

$$x_{is} - X_t \lambda \geq 0,$$

$$\lambda \geq 0$$

Where,

- λ is a NT x 1 vector of constants.

- ϕ is a scalar and its value will be the efficiency score for the i^{th} firm. It will satisfy $\phi \leq 1$, with a value 1 indicating a point on the frontier and hence technically efficient firm according to the Farrell (1957).

Note that in equations 11 and 12, where production points are compared to technologies from different time periods, the ϕ parameter need not be ≥ 1 . The point could lie above the feasible production set. ϕ and λ are likely to take different values in the above four LPs. The above four LPs must be calculated for each firm in the sample.

Output is measured in value terms at constant prices. Labour and capital are the main inputs. Labour was measured as total number of hours worked in production in one year.

However since capital stock (K_t) was not easily obtained as many people do not disclose it for various reasons, it was treated following Jorgenson definition. In Jorgenson (1969) sense, capital stock is measured as the net capital stock of machinery at constant prices and initial capital outlay. The net capital stock is computed with the help of a perpetual inventory method, based upon the following relation;

$$K_{it} = I_{it} + (1-\delta) K_{it-1}$$

Where K_{it} is stock of capital in period t

I_{it} is the quantity of investment in period t in sector i

δ is the rate of depreciation of capital obtained from CBS and the Ministry of Trade and Industry.

3.2 Data

The database was built upon surveys carried out by McCormick in 1989 and 2000 on the garment making firms in Nairobi. Variables and data definitions were adopted from Central Bureau of Statistics (CBS) definitions of International Standard of Industrial Classification (ISIC), industrial survey. The data covered establishments that employ one or more workers. Investment deflators taken from several issues of main Economic Indicators published CBS. Manufacturing industry wholesale price indexes were taken from several issues of Monthly Bulletin of Wholesale Price Index, published by Central Bureau of Statistics (CBS).

Appendix 1 gives the overall performance of the Garment industry in Nairobi. Initial capital, level of employment in terms of persons, total output in terms of sales per year, capital and total number of hours worked in production for 1989 and 2000 are given in the table.

CHAPTER FOUR: EMPIRICAL RESULTS

4.1 The DEA Results

In this study, we employed the program DEAP 2.1 described in Coelli, 1996, to compute the distance functions through linear programming technique and then used them to calculate Malmquist productivity index as well as efficiency change and technical change for each firm. Following Färe *et al.*, 1994, productivity is decomposed in this way into changes in efficiency (catching –up effect) and changes in technology (innovation). We use DEA results based on the first year, 1989, to form the benchmark. In principle, the base year could have been any year however, with only two years at hand, we find it convenient to explore the development based on the first year.

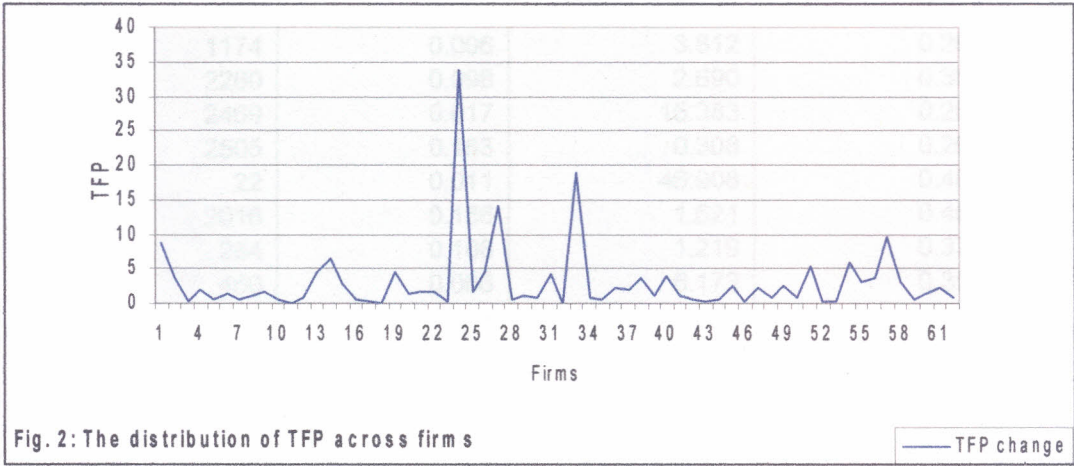
4.1.1 Total Productivity Growth

Table 4.1 below represents the TFP indices with 1989 as the base year. We notice that average productivity is at 1.322. There is thus an increased productivity throughout the period.

Table 4.1: Mean Efficiency, Technical and TFP changes in the Garment Industry in Nairobi

Year	Efficiency change	Technical change	TFP change
1989/2000	3.984	0.332	1.322

The distribution of TFP across firms is presented in Fig 2 below.



Turning to individual firms, Table 4.2 below shows own efficiency, efficiency change, Technical change and TFP change.

Table 4.2: TFP change in the Garment industry in Nairobi for 1989 and 2000

Firm	Census no.	Efficiency (1989)	Efficiency change	Technical change	TFP change
1	1131	0.030	32.881	0.263	8.634
2	292	0.037	12.807	0.280	3.581
3	289	0.136	1.278	0.315	0.402
4	158	0.042	6.632	0.313	2.014
5	850	0.058	1.717	0.262	0.449
6	751	0.031	5.242	0.290	1.518
7	109	0.093	2.324	0.301	0.700
8	657	0.046	3.898	0.268	1.046
9	722	0.019	6.391	0.264	1.686
10	735	0.053	2.013	0.291	0.585
11	1119	1.000	0.089	0.259	0.023
12	544	0.035	3.271	0.261	0.854
13	2287	0.040	11.805	0.386	4.551
14	2088	0.025	20.561	0.319	6.556
15	234	0.043	10.622	0.270	2.864
16	1065	0.049	2.038	0.273	0.556
17	431	0.247	0.621	0.264	0.164
18	1294	0.168	0.246	0.263	0.065
19	954	0.018	12.525	0.359	4.496
20	1030	0.274	3.202	0.397	1.271

21	2516	0.034	6.791	0.261	1.770
22	1465	0.018	4.427	0.394	1.745
23	974	0.082	1.185	0.266	0.315
24	2230	0.026	38.431	0.881	33.876
25	417	0.014	5.795	0.290	1.678
26	2069	0.036	8.452	0.517	4.373
27	1115	0.017	32.984	0.429	14.138
28	1391	0.069	2.356	0.263	0.619
29	1174	0.006	3.812	0.263	1.001
30	2260	0.098	2.690	0.361	0.971
31	2469	0.017	15.383	0.267	4.101
32	2505	0.163	0.308	0.264	0.081
33	22	0.011	46.908	0.405	19.011
34	2016	0.186	1.621	0.450	0.729
35	284	0.108	1.219	0.375	0.457
36	460	0.066	6.173	0.353	2.177
37	2476	0.243	2.753	0.722	1.988
38	181	0.016	13.166	0.277	3.649
39	1475	0.148	3.902	0.271	1.058
40	221	0.021	14.117	0.276	3.897
41	1432	0.107	2.620	0.379	0.991
42	1326	0.780	1.207	0.504	0.609
43	1816	1.000	1.000	0.390	0.390
44	725	0.125	1.742	0.263	0.457
45	847	0.029	8.017	0.313	2.509
46	151	0.497	0.547	0.297	0.163
47	1367	0.045	7.874	0.294	2.314
48	1824	0.454	1.497	0.596	0.892
49	745	0.078	4.768	0.250	2.502
50	1800	0.065	2.999	0.324	0.972
51	2403	0.064	12.42	0.422	5.233
52	2404	0.200	0.654	0.288	0.188
53	646	0.164	0.666	0.397	0.264
54	1819	0.044	11.816	0.501	5.918
55	2101	0.013	12.247	0.262	3.210
56	769	0.113	7.282	0.485	3.534
57	1327	0.028	27.068	0.350	9.482
58	1202	0.031	11.002	0.282	3.099
59	321	0.049	2.014	0.263	0.529
60	1810	0.026	5.138	0.298	1.533
61	2309	0.086	8.188	0.263	2.150
62	824	0.025	2.865	0.293	0.841
mean		0.127	3.984	0.322	1.322

The results so far are quite remarkable. Only 43 percent (26 firms out of the 62 firms) of the firms do not indicate productivity increase in the period. However, these results shed some light on questions regarding the performance of the garment industry, an area that is currently of much concern.

Table 4.3 below gives a summary of the firms according to whether they experienced an increase in total productivity or deterioration. A possible explanation for the improvement in productivities might be because of small garment producers in Nairobi being able to make use of opportunities generated by the recent market reforms in the manufacturing sector.

On the other hand, the deterioration in TFP by 43 percent of the firms under consideration could be explained by the following; the power problems that were plaguing the country in 2000. At the time of data collection, Nairobi was experiencing the first phase of power rationing during which all firms and households outside the city centre had their power cut for five hours per day, three days per week. This affected the productivity of the producing firms, most of who rely on electrically powered sewing machines. Some of the knitting firms use manual machines and some other firms have backup foot-powered sewing machines, but the effect of power cuts on productivity cannot be overestimated.

Another factor affecting productivity is the nature of the workspace. Many small producers, especially those in markets, work in spaces that are cramped and not designed for production. The situation in some of those markets has deteriorated markedly.

Declining demand may also have affected productivity. Businesses may simply be under-utilizing their capacity because they do not have enough demand for their products.

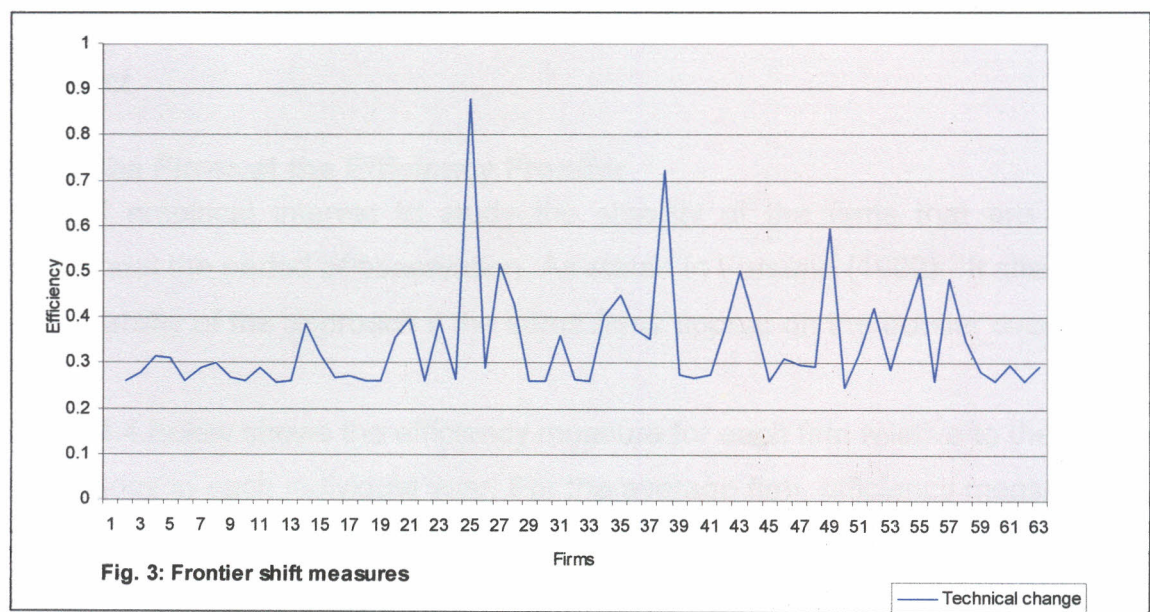
Table 4.3: Growth versus Deterioration in TFP

GROWTH		DETERIORATION	
Census no.	TFP change	Census no.	TFP change
1131	8.634	289	0.402
292	3.581	850	0.449
158	2.014	109	0.700
751	1.518	735	0.585
657	1.046	1119	0.023
722	1.686	544	0.854
2287	4.551	1065	0.556
2088	6.556	431	0.164
234	2.864	1294	0.065
954	4.496	974	0.315
1030	1.271	1391	0.619
2516	1.770	2260	0.971
1465	1.745	2505	0.081
2230	33.876	2016	0.729
417	1.678	284	0.457
2069	4.373	1432	0.991
1115	14.138	1326	0.609
1174	1.001	1816	0.390
2469	4.101	725	0.457
22	19.011	151	0.163
460	2.177	1824	0.892
2476	1.988	1800	0.972
181	3.649	2404	0.188
1475	1.058	646	0.264
221	3.897	321	0.529
847	2.509	824	0.841
1367	2.314		
745	2.502	mean	0.510
2403	5.233		
1819	5.918		
2101	3.210		
769	3.534		
1327	9.482		
1202	3.099		
1810	1.533		
2309	2.150		
mean	4.838		

4.1.2 Frontier Productivity Index

The frontier productivity indices, which are part of the decomposed total productivity as earlier outlined, are presented in Table 4.2 as technical change. The table shows no improvement in technological progress. A possible explanation for the regress in technology could be that, though the Garment firms in Nairobi have increased machine speeds and introduced special-purpose machines, this has not altered the technology.

The plots of frontier results in Fig.3 below indicate no shift in technology during the period under consideration. The frontier shift measure for all firms lies around and below one.



4.1.3 Catching-up index

The ratio of “own” efficiency measure, the catching-up effect presented in Table 4.2 as efficiency change shows on average an increase in efficiency in 1989 and 2000. A plot of catching-up effect against TFP in Fig.4 below shows that there is a relationship between the two.

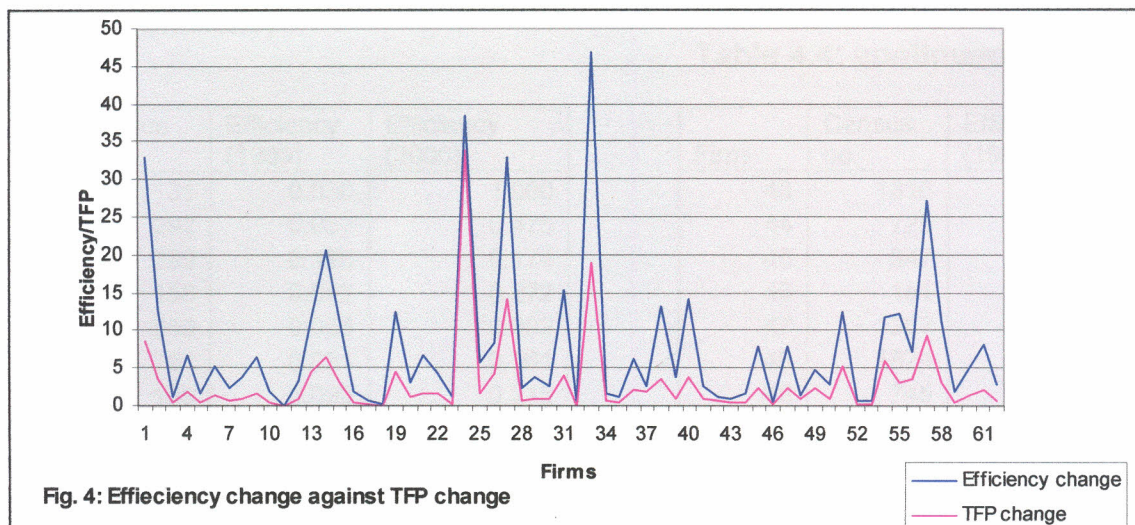


Fig. 4: Efficiency change against TFP change

The correlation coefficient as shown in Appendix 2 is 0.88. Since on average the frontier shift measure is a regress, the observed TFP increase is due to catching-up effect.

4.1.4 The Firms at the Efficiency Frontier

It is of empirical interest to study the stability of the firms that are efficient throughout the period of observation. As stated in Førsund (1992): “It strengthens the reliability of the approach if the same firms appear on the frontier over time.”

Table 4.4.below shows the efficiency measure for each firm relative to the frontier technology in each individual year. For the average firm, efficiency measures are 0.127 and 0.342 in 1989 and 2000 respectively. These results indicate that there is room for an efficiency increment of about 65.8 to 89.3 percent in the industry as a whole.

Considering individual firms, we find that two firms in 1989 and three in 2000 are fully efficient representing 3.2 and 4.8 percent respectively of the total firms under consideration.

Turning to the stability of the individual firms at the frontier, only one firm (census no.1816) can be characterized stable over time. Census no.1119 starts as efficient ($E=1.000$) in 1989 and falls in 2000 ($E=0.089$).

Table 4.4: Efficiency Results

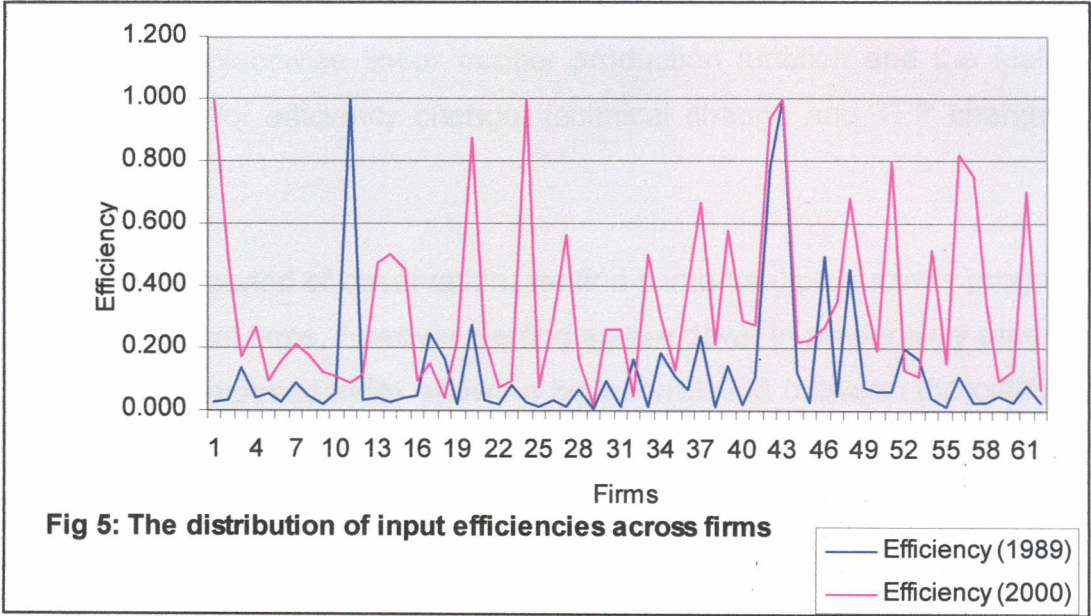
Firm	Census no.	Efficiency (1989)	Efficiency (2000)
1	1131	0.030	1.000
2	292	0.037	0.475
3	289	0.136	0.174
4	158	0.042	0.272
5	850	0.058	0.099
6	751	0.031	0.161
7	109	0.093	0.215
8	657	0.046	0.181
9	722	0.019	0.122
10	735	0.053	0.107
11	1119	1.000	0.089
12	544	0.035	0.114
13	2287	0.040	0.475
14	2088	0.025	0.504
15	234	0.043	0.458
16	1065	0.049	0.100
17	431	0.247	0.154
18	1294	0.168	0.041
19	954	0.018	0.227
20	1030	0.274	0.878
21	2516	0.034	0.232
22	1465	0.018	0.079
23	974	0.082	0.097
24	2230	0.026	1.000
25	417	0.014	0.078
26	2069	0.036	0.304
27	1115	0.017	0.563
28	1391	0.069	0.163
29	1174	0.006	0.024
30	2260	0.098	0.263
31	2469	0.017	0.259
32	2505	0.163	0.050
33	22	0.011	0.502
34	2016	0.186	0.302
35	284	0.108	0.132
36	460	0.066	0.409
37	2476	0.243	0.670
38	181	0.016	0.216
39	1475	0.148	0.576
40	221	0.021	0.292
41	1432	0.107	0.279
42	1326	0.780	0.941

Table 4.4: continued

Firm	Census no.	Efficiency (1989)	Efficiency (2000)
43	1816	1.000	1.000
44	725	0.125	0.218
45	847	0.029	0.230
46	151	0.497	0.272
47	1367	0.045	0.355
48	1824	0.454	0.680
49	745	0.078	0.372
50	1800	0.065	0.194
51	2403	0.064	0.798
52	2404	0.200	0.131
53	646	0.164	0.110
54	1819	0.044	0.517
55	2101	0.013	0.155
56	769	0.113	0.821
57	1327	0.028	0.749
58	1202	0.031	0.347
59	321	0.049	0.099
60	1810	0.026	0.133
61	2309	0.086	0.706
62	824	0.025	0.071
mean		0.127	0.342

Census no.2230 starts up as inefficient ($E=0.026$) in 1989, but ends up as fully efficient in 2000 ($E=1.000$). Generally, there is rise in efficiency for most firms in year 2000.

Fig.5 shows the distribution of input efficiencies across firms. A general pattern observed in the figure which shows the input efficiency based on the frontier of the individual year, is the variation between the difference years as shown in Table 4.4 above. The plot of input efficiency for 2000 lies above that for 1989.



CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this study, we have analyzed productivity growth in the Garment Industry in Nairobi for the 1989 and 2000. Data comprises of 62 firms which form panel data in the 1989 and 2000 surveys carried out in the city of Nairobi by Dorothy McCormick (I.D.S, University of Nairobi).

An approach which does not require price data or any specific economic assumptions about the economic behaviour has been employed. The framework is that of DEA piecewise linear frontier production function and the Malmquist index. Results for efficiency change, technical change and TFP change have been obtained.

Throughout the period of observation, we find some total productivity progress. In terms of individual firms, however we find a slow down in productivity progress in 2000. The decomposed index shows a high correlation between the catching-up effect and total productivity. The frontier shift effect is on aggregate a regress. This has slowed down the pace of TFP growth in the industry. In turn, the observed frontier shift effect is due to the observed instability, with respect to the efficiency measures. The growth in TFP is mainly contributed by the catching-up effect.

The DEA results for efficiencies shows an input saving potential on the average of 65.8 -89.3 percent throughout the sample period. With respect to efficiency measures, it is also noted that the rate of instability across the years of observation is rather high.

The explanation for the observed development in productivity could be because of the recent market reforms in the industry. On the other hand the deterioration

in TFP growth within some firms could be due to power rationing, nature of the workplace and the declining demand in the industry.

5.2 Policy Recommendations

Nevertheless, the results presented here shed light on the performance of the garment industry as a whole. An obvious policy recommendation is to continue registration of the activities carried out in the industry so that in future, robust conclusions on the performance of the sector can be drawn.

We also encourage the banking sector and/or micro-finance sector to develop mechanisms to enable small producers to export. The availability of financial instruments to guard against commercial risks for small-scale producers wishing to sell their products in other countries of the region would go a long way towards enabling these firms to enter the export market.

Another measure is to provide appropriate manufacturing space for small-scale producers. This would allow them to be more productive and, therefore, more competitive on both domestic and foreign markets. This might involve designing appropriate facilities and providing incentives to investors who are willing to build or renovate such space for rental or sale.

Regarding power supply, a measure that would benefit the entire manufacturing sector, is to bring electricity charges down to those prevailing in competing countries. This will undoubtedly involve a major restructuring of the power sector, possibly including allowing those who generate excess power to sell it directly to industrial users.

We encourage government, large-scale industry, and the Non-Governmental Organization (NGO) sector to assist small-scale producers to improve the quality of their products in order to make them more competitive both on the domestic market and in the region. This might involve working with producers, especially those in clusters like Uhuru Market, to offer specialized training to their workers.

In the longer term, it should involve improving the quality of training being offered in youth polytechnics and commercial colleges.

5.3 Limitations of the study and Areas for Further Research.

The two surveys carried out did not address the TFP objective, therefore data from the studies may lack some components or may include some that are not necessary in computing TFP. In addition, in the DEA method applied in TFP determination, tests of significance of the estimation as those in the econometric approach cannot be carried out. However, it is hoped that these limitations are not of great substance to affect the results of the model.

Using the above results, decision makers should be able to identify the possible causes of inefficiency as well as regress in the productivity within the industry. For decision makers, it is important to know firms that define the frontier and their relative weights. This is because it is the relative ratio of "own" efficiency (catching-up effect) that explains total productivity development.

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APPENDICES

Appendix 1: Overall performance of the Garment industry

1989							2000				
Firms	Census no.	Initial Capital	no. employ	Sales(Kshs)	capital	Hrs/yr	no. employ	Sales(Kshs)	Capital	Hrs/yr	
1	1131	1500	5	600000	8471	3120	3	792000	12951	3484	
2	292	250	3	114000	34624	3276	10	375000	39754	2886	
3	289	4000	7	463500	73038	3276	16	208000	116651	3120	
4	158	10000	2	171000	107972	3692	1	432000	128832	4732	
5	850	10000	3	205200	19000	4004	1	45000	7448	3120	
6	751	8000	1	79800	25745	2808	1	156000	75440	2964	
7	109	8000	1	324000	37940	3744	2	234000	107972	2808	
8	657	3000	2	141000	14056	3432	1	104000	24996	2184	
9	722	3000	1	42240	10317	2496	2	93600	23823	3120	
10	735	2000	3	139200	37484	2704	1	106800	66658	3276	
11	1119	2000	5	2430000	10434	2756	2	80000	16664	3900	
12	544	1500	3	87000	10763	2964	1	81600	13670	3120	
13	2287	3000	3	157800	125310	3380	1	840000	249297	3120	
14	2088	22000	1	62760	41800	2600	6	728000	164079	3276	
15	234	3000	4	107400	12195	2808	5	356000	35734	2912	
16	1065	5000	3	139200	23427	3120	6	97500	41661	3744	
17	431	2000	3	540000	9371	3276	1	100000	16664	2730	
18	1294	3000	5	480000	12285	3380	2	40000	24440	4082	
19	954	5000	2	54000	85975	2652	1	357000	198527	3120	
20	1030	2500	3	906900	67750	3224	2	1624000	321614	2808	
21	2516	2500	1	53850	6775	3224	3	260000	19280	4914	
22	1465	12000	3	57000	97560	2808	3	142320	277643	3016	
23	974	3000	5	286200	20585	3900	4	81200	27045	3380	
24	2230	200000	2	115200	389120	3536	11	4992000	1527425	2652	
25	417	2000	8	36000	32520	2808	1	105600	95293	4316	
26	2069	90000	3	119400	171000	2652	2	948000	671232	3770	
27	1115	34250	4	90000	255441	4212	2	1188000	315179	3588	
28	1391	1000	2	84000	5217	3692	3	83000	8332	3120	
29	1174	2000	1	7800	5420	2548	1	11440	7941	3276	
30	2260	20000	3	400200	119601	3640	1	375000	181632	2808	
31	2469	1500	2	54000	13756	3640	3	208000	31764	3120	
32	2505	2000	2	261000	11390	1768	1	37000	17298	3120	
33	22	40000	4	42000	20634	4420	3	1152000	476465	2912	
34	2016	50000	5	654600	171950	2808	3	708000	397054	3640	
35	284	10000	11	360000	134768	2652	1	204350	193253	3120	
36	460	8000	1	192000	60800	2808	1	728000	229622	3432	
37	2476	100000	7	840000	521703	2756	3	2360000	833228	3692	
38	181	1500	2	48000	17615	3276	2	182000	51617	2886	
39	1475	3000	2	280800	8170	3276	3	384000	30855	2496	
40	221	800	1	61800	23751	3276	1	265000	47252	3276	
41	1432	10000	6	375000	103170	3120	4	486000	238232	3120	
42	1326	30000	5	2640000	289970	2704	1	1740000	300000	2964	
43	1816	25000	7	3060000	117139	2444	2	1550000	208307	2808	
44	725	1000	3	100080	3439	3120	1	105720	7941	3276	
45	847	20000	3	96600	54200	3432	1	338800	158821	3536	
46	151	2000	3	1680000	54895	3432	1	260000	72121	2964	

47	1367	10000	5	137400	46855	3120	4	416000	83322	3744
48	1824	50000	5	1686000	407349	2964	6	1560000	467694	2964
49	745	50000	4	305200	284766	3120	1	840000	432457	3120
50	1800	10000	4	222000	91886	3120	2	252000	131763	3276
51	2403	30000	4	251200	170859	3120	7	1338000	259474	2782
52	2404	8000	2	558000	32760	2964	4	124800	65175	3120
53	646	50000	6	642000	397062	3120	4	99000	46770	3276
54	1819	50000	4	170896	234279	3120	2	1144000	416614	3120
55	2101	500	1	37200	17811	3276	3	145000	20000	4004
56	769	30000	7	543000	253021	3848	3	1934400	449943	3276
57	1327	5000	2	93600	102980	2964	1	1872000	301761	5278
58	1202	5000	3	93000	35878	3120	1	300000	45568	3120
59	321	500	2	71400	6260	3640	2	60300	9998	3744
60	1810	5000	3	72000	58173	2704	3	145500	71778	3640
61	2309	700	1	38100	1897	3276	3	240000	5558	3588
62	824	5000	3	84000	107768	2912	4	60000	19164	3588

APPENDIX 2.

```
. correlate
(obs=62)

           | effici~e tfpcha~e
-----+-----
efficiency~e |    1.0000
tfpchange   |    0.8802    1.0000
```

APPENDIX 3

```
. summarize
```

Variable	Obs	Mean	Std. Dev.	Min	Max
efficiency~e	62	7.843016	9.666121	.089	46.908
tfpchange	62	3.023048	5.179601	.023	33.876

APPENDIX 4

Results from DEAP Version 2.1

Instruction file = table1.ins
Data file = Table1.prn

Output orientated Malmquist DEA

DISTANCES SUMMARY

year = 1

firm no.	crs te rel to tech in yr *****			vr te
	t-1	t	t+1	
1	0.000	0.030	0.116	0.032
2	0.000	0.037	0.134	0.044
3	0.000	0.136	0.452	0.166
4	0.000	0.042	0.134	0.057
5	0.000	0.058	0.221	0.083
6	0.000	0.031	0.113	0.032
7	0.000	0.093	0.337	0.125
8	0.000	0.046	0.179	0.058
9	0.000	0.019	0.074	0.025
10	0.000	0.053	0.188	0.054
11	0.000	1.000	3.873	1.000
12	0.000	0.035	0.132	0.036
13	0.000	0.040	0.123	0.052
14	0.000	0.025	0.085	0.025
15	0.000	0.043	0.166	0.044
16	0.000	0.049	0.182	0.056
17	0.000	0.247	0.942	0.253
18	0.000	0.168	0.639	0.197
19	0.000	0.018	0.057	0.019
20	0.000	0.274	0.916	0.328
21	0.000	0.034	0.130	0.038
22	0.000	0.018	0.055	0.019
23	0.000	0.082	0.313	0.115
24	0.000	0.026	0.050	0.038
25	0.000	0.014	0.049	0.014
26	0.000	0.036	0.089	0.039
27	0.000	0.017	0.044	0.029
28	0.000	0.069	0.263	0.087
29	0.000	0.006	0.024	1.000
30	0.000	0.098	0.304	0.131
31	0.000	0.017	0.065	0.022
32	0.000	0.163	0.615	1.000
33	0.000	0.011	0.041	0.017
34	0.000	0.186	0.473	0.214
35	0.000	0.108	0.306	0.118
36	0.000	0.066	0.221	0.070
37	0.000	0.243	0.356	0.275
38	0.000	0.016	0.062	0.019
39	0.000	0.148	0.562	0.156

40	0.000	0.021	0.077	0.025
41	0.000	0.107	0.332	0.126
42	0.000	0.780	1.526	0.863
43	0.000	1.000	2.905	1.000
44	0.000	0.125	0.476	0.288
45	0.000	0.029	0.099	0.036
46	0.000	0.497	1.724	0.624
47	0.000	0.045	0.158	0.052
48	0.000	0.454	0.790	0.551
49	0.000	0.078	0.164	0.100
50	0.000	0.065	0.206	0.076
51	0.000	0.064	0.174	0.082
52	0.000	0.200	0.721	0.218
53	0.000	0.164	0.297	0.210
54	0.000	0.044	0.099	0.056
55	0.000	0.013	0.048	0.015
56	0.000	0.113	0.275	0.177
57	0.000	0.028	0.085	0.031
58	0.000	0.031	0.113	0.036
59	0.000	0.049	0.187	0.057
60	0.000	0.026	0.086	0.027
61	0.000	0.086	0.328	1.000
62	0.000	0.025	0.076	0.028
mean	0.000	0.127	0.388	0.190
year =	2			

firm no.	crs te rel to tech in yr *****			vrs te
	t-1	t	t+1	
1	0.263	1.000	0.000	1.000
2	0.135	0.475	0.000	0.590
3	0.057	0.174	0.000	0.175
4	0.085	0.272	0.000	0.348
5	0.026	0.099	0.000	1.000
6	0.049	0.161	0.000	0.178
7	0.071	0.215	0.000	0.238
8	0.050	0.181	0.000	1.000
9	0.033	0.122	0.000	0.141
10	0.032	0.107	0.000	0.108
11	0.023	0.089	0.000	0.099
12	0.029	0.114	0.000	0.188
13	0.215	0.475	0.000	0.504
14	0.177	0.504	0.000	0.528
15	0.128	0.458	0.000	0.569
16	0.028	0.100	0.000	0.108
17	0.041	0.154	0.000	0.530
18	0.011	0.041	0.000	0.048
19	0.091	0.227	0.000	0.236
20	0.462	0.878	0.000	0.880
21	0.060	0.232	0.000	0.318
22	0.038	0.079	0.000	0.082
23	0.026	0.097	0.000	0.099
24	1.503	1.000	0.000	1.000
25	0.024	0.078	0.000	0.095

26	0.201	0.304	0.000	0.340
27	0.264	0.563	0.000	0.641
28	0.043	0.163	0.000	0.825
29	0.006	0.024	0.000	0.055
30	0.107	0.263	0.000	0.268
31	0.071	0.259	0.000	0.293
32	0.013	0.050	0.000	0.060
33	0.316	0.501	0.000	0.511
34	0.155	0.302	0.000	0.342
35	0.052	0.132	0.000	0.137
36	0.169	0.409	0.000	0.448
37	0.511	0.670	0.000	0.735
38	0.063	0.216	0.000	0.259
39	0.161	0.576	0.000	1.000
40	0.083	0.292	0.000	0.301
41	0.124	0.279	0.000	0.297
42	0.469	0.941	0.000	0.970
43	0.441	1.000	0.000	1.000
44	0.057	0.218	0.000	0.513
45	0.078	0.230	0.000	0.249
46	0.083	0.272	0.000	0.303
47	0.107	0.355	0.000	0.391
48	0.420	0.680	0.000	0.699
49	0.215	0.372	0.000	0.392
50	0.065	0.194	0.000	0.201
51	0.384	0.798	0.000	0.809
52	0.039	0.131	0.000	0.139
53	0.031	0.110	0.000	0.113
54	0.293	0.517	0.000	0.544
55	0.041	0.155	0.000	0.177
56	0.472	0.821	0.000	0.881
57	0.283	0.749	0.000	1.000
58	0.099	0.347	0.000	0.380
59	0.026	0.099	0.000	0.106
60	0.039	0.133	0.000	0.143
61	0.185	0.706	0.000	1.000
62	0.019	0.071	0.000	0.074
mean	0.159	0.342	0.000	0.430

[Note that $t-1$ in year 1 and $t+1$ in the final year are not defined]

MALMQUIST INDEX SUMMARY

year = 2

firm	effch	techch	pech	sech	tfpch
1	32.881	0.263	31.333	1.049	8.634
2	12.807	0.280	13.318	0.962	3.581
3	1.278	0.315	1.054	1.212	0.402
4	6.432	0.313	6.116	1.052	2.014
5	1.717	0.262	12.089	0.142	0.449
6	5.242	0.290	5.613	0.934	1.518
7	2.324	0.301	1.907	1.219	0.700
8	3.898	0.268	17.386	0.224	1.046

9	6.391	0.264	5.725	1.116	1.686
10	2.013	0.291	2.009	1.002	0.585
11	0.089	0.259	0.099	0.899	0.023
12	3.271	0.261	5.259	0.622	0.854
13	11.805	0.386	9.772	1.208	4.551
14	20.561	0.319	20.814	0.988	6.556
15	10.622	0.270	12.919	0.822	2.864
16	2.038	0.273	1.944	1.049	0.556
17	0.621	0.264	2.093	0.297	0.164
18	0.246	0.263	0.243	1.010	0.065
19	12.525	0.359	12.575	0.996	4.496
20	3.202	0.397	2.685	1.192	1.271
21	6.791	0.261	8.307	0.818	1.770
22	4.427	0.394	4.231	1.046	1.745
23	1.185	0.266	0.863	1.372	0.315
24	38.431	0.881	26.563	1.447	33.876
25	5.795	0.290	6.757	0.858	1.678
26	8.452	0.517	8.708	0.971	4.373
27	32.984	0.429	21.788	1.514	14.138
28	2.356	0.263	9.510	0.248	0.619
29	3.812	0.263	0.055	68.733	1.001
30	2.690	0.361	2.050	1.313	0.971
31	15.383	0.267	13.273	1.159	4.101
32	0.308	0.264	0.060	5.097	0.081
33	46.908	0.405	30.303	1.548	19.011
34	1.621	0.450	1.599	1.013	0.729
35	1.219	0.375	1.165	1.047	0.457
36	6.173	0.353	6.370	0.969	2.177
37	2.753	0.722	2.678	1.028	1.988
38	13.166	0.277	13.341	0.987	3.649
39	3.902	0.271	6.395	0.610	1.058
40	14.117	0.276	12.237	1.154	3.897
41	2.620	0.379	2.356	1.112	0.991
42	1.207	0.504	1.124	1.074	0.609
43	1.000	0.390	1.000	1.000	0.390
44	1.742	0.263	1.778	0.980	0.457
45	8.017	0.313	6.943	1.155	2.509
46	0.547	0.297	0.485	1.128	0.163
47	7.874	0.294	7.519	1.047	2.314
48	1.497	0.596	1.268	1.181	0.892
49	4.768	0.525	3.925	1.215	2.502
50	2.999	0.324	2.637	1.137	0.972
51	12.412	0.422	9.857	1.259	5.233
52	0.654	0.288	0.637	1.027	0.188
53	0.666	0.397	0.538	1.237	0.264
54	11.816	0.501	9.735	1.214	5.918
55	12.247	0.262	11.767	1.041	3.210
56	7.282	0.485	4.964	1.467	3.534
57	27.068	0.350	31.799	0.851	9.482
58	11.002	0.282	10.548	1.043	3.099
59	2.014	0.263	1.863	1.081	0.529
60	5.138	0.298	5.371	0.957	1.533
61	8.188	0.263	1.000	8.188	2.150
62	2.865	0.293	2.630	1.089	0.841
mean	3.984	0.332	3.653	1.091	1.322

MALMQUIST INDEX SUMMARY OF ANNUAL MEANS

year	effch	techch	pech	sech	tfpch
2	3.984	0.332	3.653	1.091	1.322
mean	3.984	0.332	3.653	1.091	1.322

MALMQUIST INDEX SUMMARY OF FIRM MEANS

firm	effch	techch	pech	sech	tfpch
1	32.881	0.263	31.333	1.049	8.634
2	12.807	0.280	13.318	0.962	3.581
3	1.278	0.315	1.054	1.212	0.402
4	6.432	0.313	6.116	1.052	2.014
5	1.717	0.262	12.089	0.142	0.449
6	5.242	0.290	5.613	0.934	1.518
7	2.324	0.301	1.907	1.219	0.700
8	3.898	0.268	17.386	0.224	1.046
9	6.391	0.264	5.725	1.116	1.686
10	2.013	0.291	2.009	1.002	0.585
11	0.089	0.259	0.099	0.899	0.023
12	3.271	0.261	5.259	0.622	0.854
13	11.805	0.386	9.772	1.208	4.551
14	20.561	0.319	20.814	0.988	6.556
15	10.622	0.270	12.919	0.822	2.864
16	2.038	0.273	1.944	1.049	0.556
17	0.621	0.264	2.093	0.297	0.164
18	0.246	0.263	0.243	1.010	0.065
19	12.525	0.359	12.575	0.996	4.496
20	3.202	0.397	2.685	1.192	1.271
21	6.791	0.261	8.307	0.818	1.770
22	4.427	0.394	4.231	1.046	1.745
23	1.185	0.266	0.863	1.372	0.315
24	38.431	0.881	26.563	1.447	33.876
25	5.795	0.290	6.757	0.858	1.678
26	8.452	0.517	8.708	0.971	4.373
27	32.984	0.429	21.788	1.514	14.138
28	2.356	0.263	9.510	0.248	0.619
29	3.812	0.263	0.055	68.733	1.001
30	2.690	0.361	2.050	1.313	0.971
31	15.383	0.267	13.273	1.159	4.101
32	0.308	0.264	0.060	5.097	0.081
33	46.908	0.405	30.303	1.548	19.011
34	1.621	0.450	1.599	1.013	0.729
35	1.219	0.375	1.165	1.047	0.457
36	6.173	0.353	6.370	0.969	2.177
37	2.753	0.722	2.678	1.028	1.988
38	13.166	0.277	13.341	0.987	3.649
39	3.902	0.271	6.395	0.610	1.058
40	14.117	0.276	12.237	1.154	3.897
41	2.620	0.379	2.356	1.112	0.991
42	1.207	0.504	1.124	1.074	0.609
43	1.000	0.390	1.000	1.000	0.390

44	1.742	0.263	1.778	0.980	0.457
45	8.017	0.313	6.943	1.155	2.509
46	0.547	0.297	0.485	1.128	0.163
47	7.874	0.294	7.519	1.047	2.314
48	1.497	0.596	1.268	1.181	0.892
49	4.768	0.525	3.925	1.215	2.502
50	2.999	0.324	2.637	1.137	0.972
51	12.412	0.422	9.857	1.259	5.233
52	0.654	0.288	0.637	1.027	0.188
53	0.666	0.397	0.538	1.237	0.264
54	11.816	0.501	9.735	1.214	5.918
55	12.247	0.262	11.767	1.041	3.210
56	7.282	0.485	4.964	1.467	3.534
57	27.068	0.350	31.799	0.851	9.482
58	11.002	0.282	10.548	1.043	3.099
59	2.014	0.263	1.863	1.081	0.529
60	5.138	0.298	5.371	0.957	1.533
61	8.188	0.263	1.000	8.188	2.150
62	2.865	0.293	2.630	1.089	0.841
mean	3.984	0.332	3.653	1.091	1.322

[Note that all Malmquist index averages are geometric means]

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