This Research paper is my original work and has not been presented for a degree in any other University

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This Research paper has been submitted for examination with our approval as University supervisors.

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Abstract

This study investigated the impact of information technology (IT) on work organization, productivity change and employment using a hybrid of descriptive and analytic methodology. In particular, a labour demand function and a flexible cost functional form was specified for a single-product, three-inputs commercial banking firm. Pooled time-series and cross-section secondary data obtained from the firms' balance sheets and other records for the period 1980-1989 was analyzed using seemingly unrelated regression method (SUR). Both work organisation and employment were found to have been affected. The technology was found to be labour-saving and capital-using without compromising competitiveness of the innovating firms. Decreases in costs due to computerization were, however, found to be small in magnitude and not statistically different from zero at the 5% level of significance. This was explained by the underutilization of the technology and/or inappropriate information management systems in use. The policy issues arising from these findings are threefold. To protect employment opportunities from IT, an export-oriented production of computer peripherals, especially software housing, is necessary. Secondly, innovating firms stand to gain most from the technology if they rely on decentralized, front-office type of information systems management. Lastly, people working in highly-information based professions should invest in information technology skills.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Information technology (IT)[1] is not new in Kenya. As early as 1953, the then colonial government and Railway's Authority harnessed punch card tabulators in their operations. In the recent past, innovating firms in the country adopt state- of- the- art microelectronics or computer components distinguished from their rudimentary predecessors in their quality, superior functions and speed of diffusion. Many organisations, especially banking firms, have begun to use these new IT's in several production and operational processes that were incredible ten years ago.

Among the Information Technologies, Computers are dominant. While in 1961 there was only one mainframe computer, there were 1800 such units in the country in 1985.[2] The population of the component in the country is now estimated to be around 5000 units which is spectacular for a developing nation. The rapid developments in mini- and micro -computers and the interfacing of computer and telecommunications technologies during the last two decades have been responsible for this widespread diffusion of the

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[1] Information technology refers to all electronic, mechanical or a combination of both devices applied in the production, storage, retrieval and distribution of knowledge of all kinds. Among these devices, microelectronics, telematics, optoelectronics, software and systems analysis are outstanding. Artificial intelligence (AI) is soon joining the set. See John Bessant (1983) and Anderla George (1973) for details.

[2] Development Plan, 1989-1993, pp. 87. See Table 1 also.

technology. The dramatic fall in the cost of the components, miniaturization of their sizes and efficient performance attracted innovating firms to adopt the technology.[3] Changes in the business environment of the two decades also induced increased computer demand (Chow, 1967). In that period, organizations increased in size, geographic dispersion and sophistication forcing many of them to consider the practical gains to be captured in computer application in handling increased information flows.

The 100 or so firms reporting computer installation in Kenya in Scott's (1982) survey indicated that 12.94% were banking or financial institutions, 28.24% were manufacturing firms, 9.41% were energy enterprises , 7.6%0 were distributors or marketing firms, and 10.9% were service institutions (see Table 2, below). The distribution of computer installation since 1981 indicate expansion to be concentrated in government and service institutions, notably in the banking and finance Sector. This is probably because the activities of these organizations are largely information based and potential application of the technology is thus greatest. For instance, for the first time since independence, the 1989/1990 national budget and the 1989 population census were completely computerized. Among the banks, Barclays Bank has installed computers in more than half of its branches since 1983.[4] The

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[3] B.C. Sullivan (1985) calculates that to provide one megabyte of a component's memory would have costed approximately U.S. $ 32,000 in 1974: by 1977 this had fallen to 7,000 and by 1980 to 500; and the cost is now less than U.S $ 3 a megabyte.

[4] See Computers in Africa Vol.3 No. 6 p. 20

National Bank of Kenya, the Standard Chartered Bank, Kenya Commercial Bank and Grindlay's Bank and many others have innovated with the technology as well. The National Bank pioneered in computer aided banking (CAB) by introducing the system of computer terminals for bank tellers in all its branches to meet real- time customer service needs. Similar developments

Table 1 Number of Computer Mainframes and Computerised Accounting Machines In Kenya 1961-1981.

Year	Mainframes*	Accounting Machines
1961	1	0
1962	1	0
1963	1	0
1964	3	0
1965	3	0
1966	4	0
1967	5	0
1968	8	0
1969	12	0
1970	17	0
1971	20	0
1972	24	0
1973	24	0
1974	28	0
1975	31	71
1976	34	93
1977	36	127
1978	48	167
1979	87	183
1980	85	357
1981	127	399

* These figures exclude micro,mini,and special purpose micro-computers used for industrial process control like those used by Kenya Pipeline company, Kenya airways and kenya external Telecommunications Corporation.

SOURCE: Scott, R.J. (1982); Computers in Kenya: Report on IDRC Sponsored Project, University of Nairobi figure, 5, p. 4.

Table 2. Distribution of Computers By Type of Business

Type of Business	*Frequency	Percentage
Banking and Finance	11	12.94
Energy	8	9.41
Insurance	2	2.35
Tourism	1	1.18
Central Government	3	3.53
Local Government	0	0.00
Computer Bureaux	5	5.88
Accounts/Auditors	1	1.18
Distributors/Marketing	6	7.06
Engineering Consultants	3	3.53
International Agencies	1	1.18
Transport/Communication	6	7.06
Education	2	2.35
Research	2	2.35
Manufacturing	24	28.24
Medical Services	1	1.18
Service Industry	4	4.71
Advocates	0	0.00
National Food Boards	3	3.53
No reply	2	2.35
TOTAL	85	100.00

*sic.
SOURCE: Scott, R.J, op. cit., Table 91, pp. 204.

took place at Grindlay's Bank International where the new NCR system 10000 series of computers are being used as teller terminals or as direct data input work stations. The Kenya commercial bank has computerized all its branches countrywide, about 245 outlets are using computer technology.[5] Many of the bank's operations including inter-branch clearing services, bank book -keeping and administration would certainly change. At the Standard Chartered, an Automatic Teller Machine (ATM), the first of its kind in Eastern

[5] The project is estimated to have costed more than KE 50m. See Daily Nation, January, 27, 1990 p. 10

and Central Africa has revolutionised cash withdrawal transactions ; customers can now withdraw cash 24 hours a day unassisted by a teller. Computer usage in the country has also been transformed. Of the 74 areas of application reported by Scott in his 1981 survey, a majority were routine activities (see Table 3 below), yet

Table 3. APPLICATIONS PROCESSED BY ALL 85 RESPONDENTS

Rank	Application	*Frequency	Percentage
1	General Ledger	67	78
2	Payroll	65	76
3	Sales Statistics	64	75
4	Sales Ledger	52	60
5	Budgets	51	60
6	Stock Control	50	58
7	Invoicing	50	58
8	Loan Accounts	43	50
9	Social Security	36	42
10	Asset Register	33	38

*sic.
SOURCE: Scott, R.J. Op cit. p.207 Table 8.12

now computer application extends to non -routine activities like travel ticketing and reservations where 77 tour travel agents already have their services fully computerized. In the hotel industry, Alliance chain of hotels, Sarova, Block and Casino outlets have in the recent months installed computer systems in their operations to enhance their customer information management and to improve the quality of their services. Computer usage in Kenya has extended to printing too with the Daily Nation having now fully computerized the production of its newspapers using Atex

computers with specialized newspaper production software.[6] Besides Nation newspapers, several other leading publications including Step Magazine, Health Digest, Development Horizons and African Urban Quarterly have opted for computer technology in their production line. In the communications industry, Kenya Posts and Telecommunications Corporation has automated 92% of its telecommunications connections, and would instal a further 26 large digital exchanges in the country by 1992, further deepening the diffusion of the technology. Computer usage in the country is clearly set to expand in the future and the choice problem across industries would be how to do it judiciously.

1.2 The Problem

While the demand for computer equipment and related software and services has increased in the country (see Tables 1, 2, and 3 above), their impact on employment, productivity and work organization has hardly been assessed. Yet, for correct policy formulation to be made regarding their impact on these things , thorough, contextually relevant studies are required.

The evidence drawn from the industrialized and newly-industrialized countries where the technology has been assessed is, however, limited for policy making in developing countries like Kenya because, the diffusion of the technology in these countries is deeper and production is well established. Differences in

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[6] See Computers in Africa, Op. Cit p.121

experience from the technology between the developed and developing countries is because, productivity arises both from the manufacture of the components and also from use. Countries like Kenya have to import the technology , often at a great cost. The technology is also prone to scale and scope economies so that application which is more pronounced in the developed or newly-industrialized countries leads to differences in experience between the two groups of countries.[7] Furthermore, the conflicting nature of evidence from such experiences makes a country-specific investigation desirable.[8]

1.3 Objectives of the Study

This study assesses the impact of diffusion of information technology on employment, work organization and productivity in Kenya's banking Sector. Specific objectives of the study are:

I to analyze the impact of diffusion of IT on the sector's productivity and employment using analytical techniques;

II to explore the extent of changes in work organization occasioned by the technology in the sector; and

III on the basis of results obtained in (I) and (II) above, to discuss the policy implications for the sector and other innovating firms in the economy.

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[7] Bresnehan for example has distinguished between productivity from computer use versus productivity from computer production or manufacturing.

[8] See Dickinson and Marsh (1978), Evans, J.(1980), Rada,J. (1980), and Nova and Minc (1980) for the conflicting evidence. Also see Bassant John (983).

1.4 Significance of the Study

This study intends to provide empirical foundation on which continued expansion of computer installation and implementation of IT based systems in the country could be rationalized. Secondly, the study intends to provide information that will enhance the timely detection of IT induced changes on skill requirements and work organization and therefore improved planning for the changes. Moreover, the study will generate useful investment information to human capital investors and to potential entrepreneurs in the informatics market.[9]

1.5 Outline of Remaining Chapters

The rest of this paper is organized as follows: in chapter two we review previous literature on the impact of the technology, especially regarding the methods employed and the empirical findings. In chapter three we discuss the variables used in the study, the theoretical framework, the estimated model and the statistical approach employed. In chapter four we discuss the analyzed data and report the findings of the study. Lastly, in chapter five we summarise and interpret the implications of the study for policy making.

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[9] See Daily Nation January 27, 1990, 28

CHAPTER TWO

REVIEW OF PREVIOUS STUDIES

2.0 Introduction:

In this chapter we review studies which have analysed the impact of information technology on employment, productivity growth and work organization . A review of recent research on this subject shows that they have relied on descriptive techniques[1] and that they have been concentrated on employment aspect with work organization and productivity growth receiving just a little coverage.[2] Similarly, the impact of the Technology on trade and occupational demand for labour has been overshadowed by the concern on employment per se. From these studies, IT components - computers and microelectronics appear to have similar influences on jobs, work organization, productivity and trade so that, the study of any one of the technology generates almost common information.

This chapter is in three sections. Section 2.1 deals with theoretical issues in measuring changes in technology. Section 2.2

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[1] the notable exceptions include Denny and Fuss (1983) and Robin C. Sickless (1985).

[2] These techniques,however,can be manipulated ,thus, limiting their usefulness in policy formulation. Fong Chan Onn (1987) reports a case where the management of a firm innovating with microelectronics concealed the information that 117 employees were laid off because of it. See Fong Chan Onn,p.38

discusses empirical results from these studies. In section 2.3 we summarize the review of literature and finally, in section 2.4 we briefly state our departure from these earlier work.

2.1 Theoretical Literature

Schumpeter's (1934) seminal work on the creative destruction of new technology is well known. He proposed a growth model in which a series of upward self-adjusting technological innovations led to structural transformation of the economy by altering the existing factor, process, product and organizational possibilities. Since then, productivity growth resulting from technical change[3] has been analysed through a number of concepts and theoretical formulations. Generally, technological change or productivity growth is construed as a shift in the efficient production surface of a firm (Pulley and Braunstain, 1984). Works by Jorgenson and Griliches (1967), R.R. Nelson (1964,1981), Denison (1962,1979), Robert M. Solow (1957,56), Abramovitz M. (1962) Caves, Christensen and Swanson (1981), R.,Steveson (1980), Pulley and Braunstein (1984), C.Jonscher (1984) Nestor E. Terleckyj (1984) and more recently Robin C. Sickless (1985) and Denny and Fuss (1983) have investigated the impact of technical progress and changes in traditional factor inputs on productivity growth . Concepts like scale-augmenting, labour-augmenting, disembodied technical

[3] Technical change can be caused by a change in knowledge, procedural methods or organization modes used to transform inputs into outputs. Stevenson (1980) defined a technological change as an inward movement in input space of the production - isoquant frontier.

progress, capital embodied or neutral disembodied capital progress and residual factor in economic growth emerged from their efforts. The thread of argument in this literature is that, a given production function frontier shifts with time because of (1) improvements in organization (2) Improvements in capital goods, or (3) Improvements in the labour force. In particular, a labour-augmenting disembodied technical progress like a computer aided banking system (CAB), lowers the cost of banking service by improving the organization and co-ordination of certain banking activities (this author). Similarly, an accurate client account management and fast widhdrawal or loan processing procedures facilitated by the technology enables the bank to attract real-time prefering customers, thus, expanding clientele or deposit base for the innovating firm, allows for more loanable funds, spreads the risks of loan defaulters, and increases expected earnings. Alternatively, an Automatic Teller Machine (ATM) or electronic funds transfer system (EFTS) may replace labour and improve profit margin by reducing labour costs. What is more; an electronic transfer of money markets' paperwork by computer technology increases settlement efficiency of instruments and payment instructions, reduces the risks inherent in the physical delivery of the instruments and cheques and helps to eliminate settlement risks.[4] The impact of computer embodied technical progress on work organization, employment and productivity growth is thus big which

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[4] See Banking World Vol. 7 no. 9, September, 1989, pp.12

is why economists are now focusing on the future impact of information technology on economic growth of many economies .

Most recently, Wassily Leontieff (1986) and Dias Karunaratne (1986) have developed a dynamic input-output model to capture the impact of computer-based automation at the macroeconomic level. In their approach the economy is divided into a number of industries using 2 digits standard industrial classification (SIC). Their model is based on the postulated interrelationship of sectors each characterized by a common principal output and the combination of inputs required to produce that output. The average combination of inputs that characterize a sector is assumed to correspond to both the input requirements of alternative technologies and the weight with each alternative operates in the national economy. Technological change results into a change in these weights in which typically the newest technologies progressively replaces the older vintages. New technology also brings along with it new processes and products. The changing input-output structure of the economy as a result of ever-increasing information activities are captured by constructing numerical data organized for each year into four matrices of technical parameters describing the input structures of the economy during the year, i.e., current account requirements, capital goods for expansion and replacement, labour requirements by type and the final output demand structure. Factor use intensity is reflected in changing input-output demand requirements. This model is very appropriate for assessing the impact of technical change on employment, productivity and factor

demands by types but only at the aggregate level. It also suffers from other well known problems inherent in input-output models[5].

Apart from the input-output model, the productivity growth accounting framework and the duality theorem have been used extensively to capture the impact of technical progress on productivity change (Caves et al, 1980; 1981, and Burgess, 1974). The theoretical underpinning for the traditional productivity measurement is that an increase in time, T, is assumed to lead to improvements in the state of technology arising from disembodied technological change. A scale-augmenting, neutral disembodied, labour-augmenting, disembodied or capital-augmenting technical progress are captured by diverse theoretical formulations reflecting these assumptions. The exact approach taken in empirical investigation reflects the assumptions underlying the character of technical progress made by the researcher. Other basic issues of technology like separability, substitutability and the measurement problems associated with some of the postulated variables generate a set of unique methodology in empirical investigation (McFadden, 1979). The practical problems to be tackled in this kind of study are reflected by the various attempts to evaluate effect of technical progress on productivity growth by introducing time directly into the cost functions or alternately by using Research and Development (R+D) as a proxy variable or by exploiting the duality theorem and output elasticity of cost concepts (Pulley and

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[5] For instance, input-output models assume constant returns to scale technology. See Neil Karunaratne (1986)

Braunstein, 1984; Terleckyj, 1984; Caves et. al, 1981).[6] The widespread use of duality theorem in empirical investigation is because it reduces the difficulties inherent in alternative methods associated with the measurement of factor inputs or in a priori specification of correct production structures. Moreover, observations on a production transformation is easily obtained from ex post cost structures representing that technology.

The original productivity growth accounting framework proposed by Nelson (1981;1989) Solow (1956;1957) and Denison (1962;1979) attempted to decompose the contribution of specific factor inputs to the total output amount but their approaches ignored important quality differences in inputs. For instance, to overcome input measurement problems and their contribution to productivity change, these earlier studies used exogenous factor input prices. These prices were used to weight the various inputs as a way of measuring their own growth and subsequently their contribution to productivity change. The inappropriateness of this approach rests on the observed unreliability of price data as a true measure of increasing input use. Solow (1956) solved some of these problems by using factor shares to estimate output elasticities rather than factor prices. More recently, Sickless (1985) allowed productivity growth for specific factors to occur at rates that, although constant, vary among them. Dividing the credit for productivity

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[6] Caves et.al (1981) have sought to distinguish between shifts versus movements along efficient production surfaces so as to obtain appropriate measure of technical change on productivity growth. See Caves et. al (1981)

growth among each factor input, including technical progress is thus simplified. Unlike these previous studies, Sickless (1985) formulation facilitates the decomposition of productivity growth into a component identifying the pure shift unrelated to the level of factor use and a component identifying the gross scale effect due to changing factor utilization. This is really important when technology is scale augmenting.

In Sickless formulation, input productivity growth for the ith input is given by:

$i = ie^{\sigma it}$, where i is the quantity of the input in constant productivity units. The dual input price to this input growth specification is described by:

$P_i = P_i e^{\pi it}$, where Pi is the input price. Using these two additional arguments, the cost function and the relevant cost share equations are modified. Productivity change (construed as a cost diminution) due to factor growth or due to changes in the relative price of inputs (measured in efficiency units) is then evaluated as the negative partial derivative of the cost function with respect to time. This analysis rests on the postulated dual relationship between costs and production functions. As long as the cost function is input- regular, the duality between $C=f(Q, W)$ and $Q=f(X_i)$ ensures that they contain the same information about production possibilities.

The duality theorem framework as proposed by Shephard (1970), and modified by McFadden (1979) maintains that: the selection of the optimal input mix for some output (q) $\in$ Q and some set of

exogenous input price (w) normally assumes a cost minimising behaviour, notationally given by;

(1) $C(q,w) = \min (w.X : x \in X(Q))$, where w is a vector of input prices, and X is the amount of inputs consumed in the transformation of (q). The properties of this function, C(q,w) is that:

(a) $C'(q,w) > 0$; $\forall\, w>0$ and $\forall\, q>0$,

(b) $dC(q,w)/dq>0$; and C(q,w) tends to infinity as Q approaches infinity. It is also non -decreasing in prices,

(c) C(q,w) is continues from below in q and continuous in w,

(d) $dC(q,w)/dw<0$, and lastly

(e) C(q,w) is linearly homogenous in w.

These properties ensure that a cost function approximates its dual production transformation, uniquely. This position has, however, been attacked by Burgess (1975) who showed that using the production function and its dual translog cost structure could lead to different results in the presence of non self-dual model specification using the same data set (see Burgess, 1957, pp. 102). Put differently, the translog cost function is merely an arbitrary second-order Taylor series expansion approximation to any twice-differentiable cost function (i.e, the resulting cost function is applicable only over a restricted range of relative prices). The choice of analytical framework also depend on whether technical progress is neutral or whether it embodies scale or scope economies in the production processes of a firm.

2.2 Empirical Literature

Pulley and Braunstain (1984) studied a firm that publishes 3 journal abstract indexes that automated its data processing operations using computer technology. The purpose of the study was to investigate whether automation could lead to reduced costs for current level of output (Q), over time with outputs held constant i.e., - d ln C/dt, or whether automation increased the opportunities for expansion in the firm both in scope and scale. The estimated translog cost function was of the form:

(1) $C(Y, W) = g(Y_i, \ldots\ldots, Y_m ; W1, \ldots\ldots\ldots, W_n)$, for n inputs and m outputs, Where Y_i are output levels and W_j are input prices to the unique dual production transformation defined by:

(2) $f(Y_1, \ldots\ldots, Y_m; X_1, \ldots\ldots\ldots, X_n) = 0$, where the x_i are input levels. When the minimized cost of producing the M goods given (Q), is less than the combined costs of producing them separately, i.e,

(3) $C(Y_1,..,Y_m; W) < C(Y_1, 0,....0; W)+...+C(0,...,0, Y_m; W)$; $Y1,.....,Y_m>0$ scope economies are said to exist and the degree of the scope is measured by:

(4) $Sc= (c(Y_1, 0,...,0; W)+...+ C(0,...,0,Y_m: W) - C(Y_1,...,Y_m;W))/C(Y_1,...,Y_m;W)$, and overall returns to scale by:

(5) $S= C(Y,W)/\sum_{i=1}^{m} Y_i \frac{dc(Y.W)}{dY_i}$ If S<1, then there are economies of scale (see Pulley and Braunstain, 1984). The results from this study indicated that for many firms, particularly those in the information industry, technological advance were non-scale or non scope neutral. The value of 0.86 for economies of scope indicated

that the costs of producing the mean values of the two outputs separately would be 86% greater than the costs of producing them jointly. They found too that average incremental costs were reduced by the switch to computer processing. Terleckyj (1984) confirmed non-neutrality of information technology in production processes by estimating the log form of a variable exponent production function using generalized least squares, i.e,

(6) $\ln Q = \ln a_0 + a_1 \ln L + a_2 (R \ln k) + a_3 \ln R$

where, L refers to labour, K to capital and R to research & development expenditures. In the same study, both scale or scope economies were found to exist in the industry.

Studies in the banking sector exploiting duality theorem arrive at conclusions similar to those by Tarleckyj (i.e, Kilbride et. al, 1984; Bell and Murphy, 1968; Benson, Hanweck and Humprey, 1982; and Clark, 1984). To test for the presence of economies of scale in banking industry, Kilbride, McDonald and Miller (1986) specified and estimated a generalized translog cost function of the form:

(1) $C_i^{(\lambda^0)} = Bo + B_1 Q_i^{(\lambda^1)} + B_2 W_i^{(\lambda^2)} + B_3 r_i^{(\lambda^3)} + B_4 P_i^{(\lambda^4)} + U_i$

Where C = average of total operating expenses

W = price of labour

r = the price of loanable funds

p = the price of real capital inputs and

U_i = the stochastic error term

Q = the bank output measured by an unweighted sum of the bank's earning assets.

Again, results from this study indicated the existence of economies of scale and scope in the industry.

Denny and Fuss (1985) studied the impact of IT on employment and productivity using analytical methods. They assumed a production process characterized by variable elasticities of substitution, non-homothetic output expansion effects, and non-neutral technical change that is estimable at the firm level. The appealing aspect of their model is that it (1) allows for differences in quality of factor inputs, (2) captures technical change which biases substitution parameters, and (3) recognises that "independent" variables in regression equations can be endogenous rather than exogenous as assumed in other models. Their basic production function allowed for a labour demand function to be developed from it to explore the impact of automation on occupational demand for labour and factor elasticity of substitution. In a two-stage model of the demand for labour by occupations which they developed, the impact of diffusion of automated direct distance dialling (DDD) on the demand for factors of production, including occupational groups was investigated. In their postulation,a cost-minimizing firm chooses the shares in nominal value-added of the categories of labour and capital given level of output (Q), and specific technology so as to minimize the cost per unit of aggregate real value added; and then for any (Q) and (T) the firm selects the quantities of aggregate real value added and materials to minimize the cost of production. The resulting elasticity of demand for various categories of labour are

then computed using several elasticity concepts such as price, output and technical change elasticities and the labour demand function given by:

(2) $L_1 = L_1(W_2^{Ri}, P^R_k, P^R_m, Q, T)$, Where $W^R_j = W_j/W_1$, $j \neq 1$

$P^R_k = P_k/W_1$

$\dot{L}_1 = (1/L)\ (dL_1/Dt)$

$\dot{Q} = (1/Q)\ (dQ/dt)$

$\dot{L}_1 = \sum_j^4 -2e_{ij}\dot{w}_j^R + e_{1k}\dot{P}_k^R + e_{1m}\dot{P}_m^R + e_1 Q.\dot{Q} + e_{1t}\dot{T}$, where e_i is a measure of elasticity of variable Xr with respect to Xs.

When price elasticities are calculated at the mean observation, factors X_i and X_j are technological substitutes if $dlnX_j/dlnT$ and $dlnX_j/dln\ T$ are of opposite sign (holding output and factor prices constant). The factors are complements when the sign is similar.

The results from this study again indicated that automation affected the demand for clerical jobs and whiter-collar workers by Bell Canada Telecommunications. The cross price elasticities between capital and operators, for example, indicated substantial price substitutability (see Denny and Fuss Table 2, pp. 170). The relevant elasticities of substitution at the mean were reported to be -0.098, 0.905, 1.08 and 0.615 for operators, plant craftsmen, clerical workers and white collar workers respectively using 1952 as the benchmark. Automation of the industry by Bell Canada was capital -using and labour- saving, with labour saving Impact being felt most severely by the least skilled workers.

Both descriptive and analytic studies generate evidence that

support the contention that IT-based automation leads to scale economies and employment of certain categories of manpower and not others. Hak K. Pyo (1987) surveyed a sample of 40 users of the equipment both for office automation (OA) and Factory automation (FA) in the republic of Korea.[7] The diffusion of Microelectronics technology in the country was found to have created positive effect on indigenous technological development of numerical computer controlled machine production (NCM). Second, OA reduced skill requirements for some office work necessitating labour redeployment, displacement or retraining. In the banking sector for example, he found that on-line information system greatly reduced manned window banking service and customer file management. Third, that though overall growth of business for factory automation (FA) and office automation (OA) accompanied their introduction, "in the particular production lines or offices where FA or OA equipment is introduced, such equipment had labour-saving effects" (pp.28). Trading firms and firms in the machinery and electronics industry, for instance, reduced office manpower by 8% and 5% respectively, using computers and other OA equipment. Of the 30 FA users, 17 or 57% had to deploy existing workers within the same division, e.g, a mechanic for conventional lathe for NC lathes, 12 firms or 40% had to set up a new work organization by transferring employees from different divisions, and 14 firms or

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[7] Office automation (OA) include computers, word processors, facsimile and photocopy machines. Factory automation (FA) on the other hand include numerically controlled machines (NC), Computer aided design (CAD) and computer aided manufacturing (CAM)-Robots.

47% had to hire new people. Introduction of IT clearly motivated re-organization of work and change in skill requirements. Fong Chan Onn (1989) conducted firm level case study of 44 Microelectronic (FA) and (OA) users in Singapore and Malaysia to investigate the impact of Microelectronic industry machinery on labour productivity and competitiveness of the innovating firms. He found the extent of labour displacement to be insignificant (See Fong Chann Onn Table 16 pp.28) but the extent of potential employment were greatly reduced by FA and OA. He argued that, "adoption of new technology may not cause a net decline in employment if economic growth can continue at a rapid rate" (pp.32), thus, to protect jobs from IT, employment created as result of productivity increase due to the diffusion of the technology must be able to offset the redundancy caused by it. Whether productivity gains from the technology in the third world countries would be able to spur the kind of growth required to protect jobs is doubtful. He also found IT to have a 'skill twisting' effect on labour and a change in the industrial structure implying a need for retraining of manpower. Leontieff and Duchin (1986) and Karunaratne (1986) from their independent input-output studies predict that the intensiveness of automation will make it possible to achieve over the next 20 years ever greater economies in labour relative to the production of the same bills of goods with the mix of technologies currently in use. In particular, automation of the office and the factory will continuously reduce the demand for the less skilled workers, i.e, by 8.5% to 11.7%

respectively of labour in a two scenario projection (see Leontief and Duchin, 1986). For most sectors, they found that increases in output are accompanied by reductions in employment under scenario 3 as compared to scenario 1, particularly for many of the metal-working sectors.[8]

Dickinson and Marsh (1978) investigating the impact of Robots on productivity in a Midland Car Factory found production to have doubled subsequent to the introduction of Spot-Welding Robots. Evans (1980) studying a Norwegian Insurance Company subsequent to the introduction of word processors found its productivity to have increased by about six times the original amount thus, strengthening the evidence by Dickinson and Marsh (1978), and Fong Chan Onn (1987) that IT improves competitive advantage of the innovating firms.

Nevertheless, Rada (1980), Jenkins and Sherman (1979), Nova and Minc(1980) and Arnold and Hugget et.al (1982) found the impact of IT on potential job protection or employment creation to be negative. Rada found that diffusion of IT reduced white-collar job occupations, with females in particular, having to suffer significant job losses, thus, reinforcing findings by Denny and Fuss (1983). For magnitude, Jenkins and Sherman (1979) discovered that information processing jobs suffered a 30% fall-off due to the diffusion of IT. Nova and Minc (1980) predicted from their study that a third of the jobs in the French financial sector could

[8] Scenario 3 implies more information technology intensity than in scenario 1 and 2.

vanish by 1990 as a result of IT implementation. Drucker (1989) in evaluating the potential changes in the corporate environment of the 1990's predicts that IT would reduce the levels of management and number by a similar amount as those reported by Nova and Minc (1980) and by that sustaining the belief that It is more of a destroyer of jobs than a creator or protector. Moreover, the impact of the technology influences quality of life and work content so that productivity from it has to be balanced against its social consequences. Cooley (1982) studied the impact of the technology on this social dimension. He conducted an extensive survey of the effects of automation on bank employees and discovered that bank-tellers who previously had some thinking to do had become little more than automatons as a result of IT diffusion in the sector. His findings were supported by Turoff and Hiltz (1972) who conducted a case study of 500 professional users of the so called electronic information systems (EIES) in the Brook street bureau. 44% of these people were found to be addicted to these gadgets and that those working with word processors and visual display Units (VDU) had various mental and physical illness. Lastly, on trade, Jussawalla and Chee-Wah Cheap argue that IT has introduced a technological dependence and a technology gap between countries that threatens to distort the existing pattern of international trade, obviously to make it worse for the developing countries. Information Technology therefore raises several economic and social issues that need to be assessed empirically for their continued rationalization.

2.3 Summary of Previous Studies

The standard Cobb -Douglas production process has been extended and modified to study the impact of technical progress on output. Substitutability of factors of production or the presence of economies[9] have greatly influenced the choice of methodology in this area. In the banking Sector, variable exponential substitution, scope as well as scale issues have been incorporated into modelling its production processes (Benston, Hanweck and Humprey 1982; Clerk 1984; Lindley and Sealy, 1987). A flexible generalized functional form has been found to be suitable in assessing the impact of technology on production processes and specific factor demand in the sector. No a priori structural form specification need to be imposed on the production structure if a Box-Cox transformation of the substitution parameters is allowed (Clerk, 1984; Lindley and Sealy, 1977; Colin, 1988; J. Burgess, 1984). Clark examined the sensitivity of the estimated output elasticity of cost to the selection of several alternative measures of output using generalized functional form methodology but found no change in response. (see also Sealy and Lindley, 1977). The formulation of a production structure in which a multi -product, many-input cost-minimizing firm is assumed completes the range of practical methodological issues addressed in empirical work. This study combines all the features of these evolutionary work (except it assumes a single-product, multi-input firm) and makes an

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[9] Breshnahan has identified two kinds of scale economies in the banking sector. See Breshnahan (1986) for details.

empirical country-specific application in an area which has not been properly assessed. The strength of this study lies in its ability to overcome potential manipulation of data inherent in descriptive techniques, particularly where the respondents have a motivation to cheat.

CHAPTER THREE

METHODOLOGY AND ESTIMATION

3.0 Introduction:

In this chapter, the framework of analysis for the study is discussed, the variables used are defined and the estimated model is presented. Statistical techniques employed are also discussed. The chapter is organized into 4 sections. The framework of analysis is covered in section 3.1. In section 3.2, we discuss and specify the estimated translog cost function and the labour demand function. Banking sector inputs, outputs and transformation processes are discussed in section 3.3. In section 3.4, we state the working hypotheses of the study. And finally, in section 3.5 we discuss the statistical procedure employed in data analysis.

3.1 Theoretical Framework

Production theory and the related duality theorem provides the relevant analytical context for evaluating productivity change due to technical progress. The subject is adequately covered in Fuss and McFadden (1976). Within this framework, a firm is assumed to be a rational, consistent maximiser (minimiser) of output (cost) from a set of physical technological possibilities. Assuming technology to be exogenous, the maximum amount of output, Q, which can be produced from any given set of inputs (x_1, ..., X_n) is

described by:

(1) $Q = f(X, Z, T)$, where Q = output, X is a vector of factor inputs, Z is a vector of states of nature and T is time. This function is single- valued, i.e. there will be a maximum (minimum) output (cost) for each set of inputs. The choice making behaviour of a firm is thus guided by two alternative principles:

(i) Given the level of final output, Q, and factor prices, W, choose the optimal mix of inputs. The optimal mix of inputs is thus given by:

(2a) $X_i^* = f_i(W_1, \ldots, W_n, Q)$

(ii) Alternatively, the output by a firm reflects a cost minimising behaviour. From the behaviourial axioms stated above, the firm seeks to produce output Q with the least (optimal) cost possible and as in the case of optimal input mix, the optimal (minimal) cost level is -

(2b) $C^* = W_i X_i^* = f(W_1, \ldots\ldots, W_n, Q)$.

The duality theorem maintains that differentiating equation (2b) with respect to factor prices yield the optimal input combination in equation (2a), i.e,

(3) $d C^* / d W_i = X_i^*$

under some general simplifying assumptions, e.g, perfect competition in output and factor input markets, a well behaved or input-regular cost function (ex post transformation process) contains the same information as its primal (ex ante production function). The partial derivative of equation (3) with respect to input prices (w) yields the corresponding input demand functions,

and the sum of the values of the input demands X_i's equals cost:

(4) $dC^*/dW_i * W_i/C^* = W_i X_i^*/C_i$ or $d\ln C^*/dW_i = W_i X_i^*/C^* = S_i$, where

S_i is interpreted as the cost share of the ith factor in the total cost of producing output Q. The cost share equations are a reduced form of the cost function proper, C^*, because they contain the same argument. The estimated parameters of a cost share equation can be used to approximate the cost function relationships.

The next step in this theoretical formulation allowing for productivity change measurement builds on the following observation: for a cost minimising firm, given factor price - output configurations and other state of nature constraints, technical progress would permit the firm to produce the same level of output but at a lower cost, i.e.,

(5) $SFT_c = d\ln C^*/T|_{Q,\ W,\ Z}$

Where SFT_c is a measure of technical change (productivity growth), C refers to the total cost, and T is an indicator of technical change. The impact of this change is reflected by the changes in cost share equations or in the factor proportions (X_i/X_j) In the respective sub periods. symbolically:

(6) $SFT_b = dS_i/dT|_{Q,\ W,\ Z}$

A combination of this choice theoretic formulation and empirical econometric considerations would determine the exact nature of the estimated model for productivity growth. For instance, technical progress can be proxied by time and thus introduced directly into the cost function (Nadiri, 1982) or it may be proxied by expenditures on technology- embodied capital goods.

Increases in the proxy represent improvements in the technology ($T = e^{A}$), where e is the natural logarithm of technical change and (A) is the proxy (probably expenditures on R & D)

In empirical modelling, a number of issues to be addressed in addition to those discussed in section 3.1 above include the exact functional relationships between cost, factor prices and output. As pointed out by Christensen and Greene (1976), it is essential to distinguish economies of scale from decrease in cost resulting from technical change. Furthermore, productivity change due to the time trend (movement) should be differentiated from productivity change due to a structural change (shift). Secondly, any a priori restrictions on substitution possibilities should be justified theoretically. Lastly, in order to correspond to a well behaved production function, a cost function must be homogenous of degree one in prices. There is extensive literature on empirical modelling of production functions and their duals. Among these, flexible functional forms are popular for obvious reasons (see chapter two of this study).

3.2 Empirical Model Specification

The basic proposition of this model is that process innovations embodied in computer technology lowers the cost of banking sector operations and improves the quality of banking products. A translog cost function for a cost - minimising commercial bank is specified. Factor inputs: computer rentals, deposits and labour wages are transformed into loans and

investments in money market instruments and long-term securities such as Treasury bonds, Treasury bills, Municipal Council securities, and central bank borrowing instruments. These activities are considered to be the most important output of commercial banking and non-banking financial services by financial intermediation theorists (Gilbey, 1982; McKinnon-Shaw, 1984). Our empirical model specification below assumes that these firms compete each other both for inputs and outputs. Competition among these depository institutions is, however, within confined limits of lending and borrowing rates of interest set by the Central Bank (between 11% to 15%)[1]. The estimated cost elasticity of output model builds on the duality theorem explored in section 3.1 above. We further assume jointedness in the production of rather homogenous financial intermediation products in the sector.

Letting C = total expenses, Q = total output and W_i = the price of input i, where i = computing, labour and cost of deposits respectively, the translog cost function can be expressed as:

(1) $\ln C=\alpha_0+\alpha_i \ln W_i+\frac{1}{2}\Sigma_i\Sigma_j\beta_{ij}\ln W_i \ln W_j+\delta_0 \ln Q+\beta_1(\ln Q)^2+\Sigma_i\beta_i \ln Q \ln W_i$, for i= 1, 2, 3.

Differentiating (1) logarithmically with respect to the price of each factor yields three equations for the elasticity of total cost with respect to each input price:

(2) $d\ln C/d\ln W_i =\alpha_i+\Sigma_i\beta_{ij}\ln W_j+\delta_i \ln Q$, for i=cp, av, and lf -our

[1] These rates have recently been revised by the central bank. The borrowing and usury rates now range between 12% to 18% for commercial banking firms. Competition is thus likely to intensify as excess liquidity forces these institutions to compete for treasury and central bank financial instruments and for potential borrowers.

shorthand for computing, labour and loanable funds. Also as seen in section 3.1 above:

(3) $dC/d\ln W_i = dC/dW_i * W_i/C$, and

(4) $dC/dW_i = X_i^*$

Substituting (4) into (3) and (3) into (2):

(5) $W_i X_i^*/C = \alpha_i + \sum_j \beta_{ij} \ln W_j + \delta_i \ln Q$, and

from equation (5) the three estimated share equations are derived:

(6a) $P_{cp} * Q_{cp}/C = \alpha_{cp} + \beta_{cpcp} \ln(P_{cp}/P_{lf}) + \beta_{cpsv} \ln (P_{sv}/P_{lf}) + \delta_{cp} \ln Q$[2*]

(6b) $P_{sv} * Q_{sv}/C = \alpha_{sv} + \beta_{cpsv} \ln (P_{cp}/P_{lf}) + \beta_{svsv} \ln (P_{sv}/P_{lf}) + \delta_{sv} \ln Q$

(6c) $P_{lf} * Q_{lf}/C = \alpha_{lf} + \beta_{cplf} \ln (P_{cp}/P_{lf}) + \beta_{svlf} \ln (P_{sv}/P_{lf}) + \delta_{lf} \ln Q$

Allen elasticities of substitution of factors can be constructed from equations 6(a), 6(b) and 6(c) as follows:

7(a) $e_{ii} = (\beta_{ii} + (P_i * Q_i/C)^2 - (P_i * Q_i/C)) / P_i * Q_i/C^2$, for own price elasticity and as:

7(b) $e_{ij} = (\beta_{ij} + (P_i * Q_i)(P_j * Q_j)/C) / ((P_i * Q_i/C)(P_j * Q_j/C))$, for the cross price elasticities of substitution.

3.3 Definition of Banking Inputs and Outputs

Recent marketing theory has generated a number of concepts relating to utility which are highly applicable to the banking sector activities. These include ideas like "place utility" produced by distributors and " Quantity utility" created by retailers (Stanton, 1987). The basic proposition is that for a

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[2*] By exploiting Shephards' lemma, the following restrictions can be immposed on the number of estimated parameters. These are;
(1) $\alpha_i = 1$, (2) $\beta_{ij} = \Sigma_i \beta_{ij} = \Sigma_i \Sigma_j \beta_{ij} = 0$, (3) $\delta_i = 0$, and (4) $\beta_{ij} = \beta_{ji}$. Hence, it is sufficient to estimate just the first two equations.

good or service to satisfy the needs of a consumer, it has to be accessible. Accessibility denotes both time, place and quantity among other things. A distributor, thus, creates additional utility by making the product accessible to the consumers.

In the banking business, depositors and borrowers enjoy the "convenience" supplied by the depository institutions through its intermediation. A depository institution produces convenience by screening potential borrowers so that loanable funds are distributed to the most profitable investment projects and it provides security to depositors funds besides the interests earned by the assets to the savers. Convenience is also produced to depositors by the institutions through payment arrangements carried out on their behalf, e.g, standing orders, trust activities, e.t.c. Convenience is, therefore, the corner -stone of banking business.[3] The economy as a whole benefits from this prudent banking behaviour. By accepting deposits from savers and by extending loans or advances to most efficient borrowers, a depository institution produces a set of unique services to the economy .

To provide the services, a firm in the industry requires loanable funds, labour and other factor inputs like premises and office equipments which have to be acquired at some cost. For instance, banks acquire deposits with the intention of loaning them

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[3] In the industrialized economies, "convenience" has become an important factor in the measurement of productivity growth. The proliferation of convenience products such as plastic money, electronic funds transfer systems and point-of-sale billing have certainly enhanced the operation of the market exchange mechanisms. In a recent empirical productivity growth measurement of the American economy, Bailey constructed some divisia index for these convenience services. See Bailey (1989).

out at higher interest rates to borrowers or for investing them in more profitable investment projects. Thus, loanable funds acquired from the depositors at some interest cost - the borrowing rate, are subsequently transformed into outputs like investments, loans and advances to the needy entrepreneurs. A banking firm is in this way very much like a manufacturing one.

In short, three main areas of activity characterize commercial banking input transformation process. Transactions involving demand and time deposits and lending to corporate or retail clients are by far the greatest. Other activities include money market operations for the bank's own portfolio, maintaining safe deposit boxes, management of standing orders, issuing letters of credit , and giving investment advice. The largest volume of a commercial bank' activities, however, relates to processing the transactions made with demand deposits and processing loans. These activities are highly information based so that potential application of information technology is high. The rapid diffusion of IT -based convenience products such as the " money -link" or automatic teller machines (ATM) in the Kenyan banking sector reflect these opportunities. Since a major component of a banks' transformation process involves data processing, the convenience of these new products should be treated as input in the production of banking services. The following variables are used in our study to represent banking inputs and outputs:

LNS= loans outstanding and include real estate loans made and serviced, consumer, construction, agricultural and other loans

measured in Kenya shillings.

INVE= investments and includes short-term money market instruments and long-term securities held measured in Kenya shillings. Input prices comprise prices of labour, loanable funds and computing services. i.e.

DEP= total deposits including demand deposits and the time deposits or certificates of deposits measured in Kenya shillings.

CODEP= interest cost of available funds, measured by dividing interest costs incurred on deposits and borrowing during the year by the average amount outstanding, measured in Kenya shillings.

AVAWAG= average wages per employee (including officers but not directors), calculated by dividing the aggregate wages paid during the year by the average number of officers and employees on the payroll during the year, measured in Kenya shillings.

CPTNG= average annual computer rental per CPU hour at prime times rates provided by taking the banks estimate of the current equivalent market monthly rental price for its on-premise mainframe computer multiplied by twelve divided by the reported average weekly number of CPU hours multiplied by 52. For the firms without an on-premise CPU component, the figures obtained from firms of similar asset or liability size with on-premise CPU units are used as proxy, also measured in Kenya shillings. Loanable funds are, however, the most significant input of the sector.

By summary, the estimated variables are: (1) the two outputs - investments and loans[4], and (2) the three input prices - interest cost on loanable funds, wages and computer rental costs.

Following the adjustment (dynamic) production or cost function models, we treat the value of the input variables as flows, thus computing expenses are regarded as a true approximation of imputed value derived from the software and hardware components. A capital (physical) user cost for other equipments and premises are excluded because, both historical and book values are not an adequate proxy for their service flow values (physical capital costs) and also because differences in accounting policies across firms regarding depreciation write offs - further distorts the inclusion of depreciation into the user cost[5].

3.4 Working Hypotheses of the Study

We hypothesize that:

(1) **automation of commercial banking services has not changed the output elasticity of employment in the sector,**

(2) **that it has not led to any productivity change, and**

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[4] Greenbaum (1967a) and Kalish and Gilbert (1973) used a weighted sum of total bank inputs as a measure of banking output. They obtained the weights by regressing bank revenue from interest earning assets against total banking revenue and then applied the index to the various assets to get a weighted sum of the output. This approach recognises the multiproduct nature of banking services and the existence of interbank differences in the prices of bank output.

[5] Book value distort true rental costs if banks own the buildings and equipment at different points of time. The adjustment production or their implied dual cost functions recognise rightfully that excess capacity, which is ubiquitous im many economies or sectors or firms , may render the empirical results form studies assuming instantaneous short-run equilibrium postulation to be biased. Factor input price shocks, such as the oil shocks of the 1970s or stock exchange crashes can influence production processes importantly.

(3) that it has not changed work organization in the sector.

3.5 Estimation Procedure

The optimal procedure in estimation is to jointly estimate the cost function (equation 2) and the share equations (6a and 6b) as a multivariate regression system. As is the case in a Zellner approach for estimating seemingly unrelated regression (SUR) equations, the results, however, become sensitive to the omitted factor share equation and positive serial correlation may also be detected by the Durbin -watson test statistic.[6] From the cost share equations, productivity growth is evaluated as the negative of the partial derivative of the cost function with respect to the shift variable -which in our case is computing services (evaluated at mean output). The alternative to this procedure (which we followed) includes the construction of an interactive dummy variable to the defined output by assigning the value of 1 to the period when automation became very pronounced - in our case 1985-1989 period - and then comparing the output elasticities of cost coefficients for the two periods. The relevant productivity growth coefficient is interprated as a reduction in the cost of producing the same level of output in period two as in the earlier one. The Chow test for a structural break can also be used to assess the change in productivity growth in the sector, the interpration is

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[6] Because the disturbances on the share equations must sum to zero for each firm, one must expect nonzero contemporaneous covariances between disturbances in different equations. Thus, Zellner's (1962) requirement is singular.

essentially the same. We opted for the dummy variable analysis for its convenience.

Secondly, the impact of computerized commercial banking on employment in the sector is assessed by constructing output elasticity of employment coefficients based on banking sector input and output variables defined and used in our estimation (see section 3.3 above). The procedure involves constructing a labour demand function for the depository institutions including a dummy variable interaction with the outputs to test for changes in output elasticity of employment. The relevant coefficient for measuring changes in employment is interprated as the change in employment for the same level of output in period two as compared to the earlier one. The estimated stochastic semi-log labour demand function takes the form below:

(8) $EMPL = \alpha_0 + \alpha_1 \ln Q + \alpha_2 \ln (D_1 * Q) + \alpha_3 \ln DEP + \alpha_4 \ln AVAW + e_t$,

where EMPL is the demand for labour, and D_1 is the dummy variable appropriately interacted with the output of the sector. Deposits are included in this equation because loanable funds and labour are complementary in the transformation of the outputs.

And lastly, the impact of IT on work organization was explored by administering a questionnaire to the 10 largest commercial banks which had automated their operations using computer technology (See appendix 2 for the questionnaire). The questionairre results are analysed by measures of central tendencies.

SUR method was preferred in estimating the output elasticity of cost model because it has all the properties of generalized

least squares (GLS). Besides, it is convenient when one or more of the omitted variables in the empirical model specification are common to firms in the same industry leading to specification error. A specification error is reflected in the error disturbance term and the residual will be correlated cross-sectionally between firms in the same industry (see Sundaram 1982). The technique is also suitable in estimating cost elasticity of a multiproduct firm because of jointedness in the production of certain banking services, e.g. the production of loans and investments in money market instruments depends on the size and portfolio of its deposits[7] which in turn is an intermediate product itself. Again, when nonallocable factor inputs such as interest cost on deposits are used in the production process of a firm, SUR method gives much superior estimates than the alternatives. Pooled data also yield better, more robust statistical results when they are obtained by SUR methods as compared to OLS regression methods. Because SUR has properties of generalized least squares, heteroscedasticity and autocorrelation are both systematically checked as the best, robust statistical results are obtained. A simple OLS technique is applied to employment and output data to obtain output elasticity of employment coefficients for the period under study. And lastly, simple social science measures of central tendency are computed to analyse the information on diffusion of IT in banking sector and its impact on work organization.

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[7] There is considerable controversy in the literature regarding the treatment of deposits as banking input. See Sealy Jr. and Lindley, 1977 and Jeffrey A. Clark, 1984.

CHAPTER FOUR

DATA ANALYSIS AND EMPIRICAL RESULTS

4.0 Introduction:

The data on the sectors inputs and outputs are analysed and the main findings reported in this chapter. The chapter is in four sections. The data on the sectors inputs and output, their sources and limitations are described in section 4.1. In section 4.2, the estimation results for output elasticity of cost share equations are reported and analysed. Estimation results for the labour demand equation are reported and analysed in section 4.3. And lastly, the impact of IT on work organization are reported and analysed in section 4.4.

4.1 Data Type, Sources and limitations

Pooled cross- section and time- series[1] secondary data were obtained from the 10 largest[2] commercial banks' records and from their financial statements for the last decade. The decade is chosen because computer application became pronounced then.

Data was readily available on the two bank outputs, i.e loans (LNS) and investments (INVE) and on deposits (DEP). Nearly all the

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[1] See Biorn (1981) for the theoretical foundations and procedure for pooling cross-section and time series data.

[2] The size of a bank is measured by the number of current and/ or savings accounts held, the branch networking, average loan size given, and deposit size,e.t.c

banks studied presented data on these variables in the same form which also happened to be consistent with the operational definition of the variables. One bank, however, recorded part of its investments (1-3 months treasury bills) under short-term cash and money at short call. The two were then added- up to make its total investment series.

Data on the number of employees, total wages paid, computer rental, and total interest cost on deposits were, however, difficult to obtain. For interest rates, an average was computed from the Central Banks' quarterly economic review figures on the four deposit portfolios, i.e 1-3 months, 3-6 months, and 6-9 months for time deposits and savings. The computed average rate of interest was then applied to the average outstanding deposits during the year to obtain the interest cost on deposits (CODEP). Computer costs (CPS) were obtained by dividing the recognized computer usage of own computer mainframe or PCs and software services for the whole year by 12 months to obtain the monthly (average computer costs) divided by the reported weekly number of CPU hours multiplied by 4. Computing costs are treated as administrative overhead by most of the banks surveyed because it is a service activity to all other operations.

The number of employees (MAN) and average wage bill (AVAWAG) were obtained from staff establishment and payroll records respectively. In general, factor input prices were difficult to obtain from the banks and a lot of estimation had to done,

especially for computer costs.[3] The data obtained was then pooled by treating each yearly observation for a vector of banking sector input-output variables as independent observations. This generated 36 observations, thus, allowing for 26 degrees of freedom for tests of significance for the 10 estimated parameters.

4.2.1 Estimation Results for Productivity Growth

Productivity growth is interprated as a negative change in the output elasticity of cost coefficient relating to the dummy variable interaction with the sector's output (see section 3.5, chapter 3 above). The estimated output elasticity of cost coefficients are positive and statistically different from zero for many of the input variables at the 5% level of confidence as expected (see Table 4, below). The output elasticity of fixed costs (represented by the intercept of equation 1) to changes in the computing service cost share equation are found to be inelastic and statistically insignificant. On the other hand, the output elasticity of variable costs to changes in computing services is statistically significant and big by a magnitude of 1.958. Similarly, the output elasticity of variable costs to changes in the relative price between computing service and labour is statistically significant but small by a magnitude of 0.272.

[3] Our estimation rested on weekly consumption of cassette tapes, computer stationary, floppy disks/diskettes, magnetic disks, paper tapes, the weekly number of hours use of mainframe and PCs and their respective market prices.

Table 4 Systems Regression Results Using SUR Technique

coef.	C	β_2	β_3	β_4	β_5
EQ1	1.504	1.958	0.272	-0.291	0.008
$T-_{stat.}$	(0.41)	(3.71)	(1.53)	(-1.88)	(0.66)
EQ1 D.W	0.556				
S.E	0.721				
$F_{.stat}$	4.979				
R^2	0.380				

coef	C	β_7	β_8	β_9	β_{10}
EQ2	7.062	-0.480	0.928	0.174	0.023
$T-_{stat.}$	(3.55)	(-1.67)	(9.60)	(2.07)	(3.38)
S.E	0.392				
D.W	1.114				
$F_{.stat}$	31.285				
R^2	0.801				

changes in the level of output (loans plus investments) influences total variable cost outlays for the sector. The elasticity of variable costs to changes in loans and investments is statistically significant by a magnitude of 0.295. Firms in the sector are, therefore, likely to be sensitive to changes in the relative price of deposits and usury ceilings (which are controlled by the Central Bank). And lastly, our test for productivity growth measured as a negative change in fixed and variable costs for the same level of output in period two as compared to the earlier one

is not statistically different from zero at the 5% level of significance. The output elasticity of the costs to changes in computing is a small 0.008 change which is again not statistically different from zero at the 5% level of significance.

Our second equation, (equation 2), describes the output elasticity of cost to changes in the cost share of loanable funds in the industry. Both R^2 and the magnitude of estimated output elasticities of cost parameters indicate a large responsiveness to changes in the relative prices of loanable funds to other factor inputs. The output elasticity of fixed costs to changes in loanable funds share equation is , for instance, 7.062 indicating that a 1% increase in loanable funds and investments would increase fixed costs by 7.062%. This is not surprising because, the banking sector regulatory framework imposes significant fixed cost structure on the sector. For example, the Central bank demands all depository institutions to retain 20% of their total deposit holding in liquid assets (reserve ratio). Besides, the banks are expected to keep special non-interest earning deposits with the Central Bank as well as to lend or invest no more than some fixed proportion of their authorised and fully paid-up capital. The recent introduction of deposit protection fund and the reduction in the proportion of loanable deposits to authorised and fully paid-up share capital proportion not exceeding 18.5% by the new banking Act 1989 would increase these costs substantially.

In equation 2, the output elasticity of variable costs to changes in the relative prices of computing services and labour is

large, 0.92, but statistically insignificant. on the other hand, the relative price between loanable funds and labour suggest statistically significant changes in costs. For example, the output elasticity of variable costs to changes in their relative prices is 0.92. Again, as in equation 1 above, the output elasticity of variable costs to changes in the size of a banks' output is statistically significant but small (i.e., the marginal effect of a change in output on variable cost is 0.17). Lastly, in the loanable funds cost share equation, (equation 2), the output elasticity of variable costs to changes in expenditures for computing services is statistically significant but small in magnitude (i.e., the marginal effect of a change in computing services on total variable costs is 0.02). Information technology in the sector has, therefore, not led to any cost -savings as expected.

4.2.2 Estimation Results for the Labour Demand function

The estimated semi- log labour demand function is as below:

$$\underset{\quad}{EMPL} = \underset{(-2.961)}{-10.563} - \underset{(-1.793)}{6.686}\ln Q - \underset{(-0.674)}{0.006}SFT + \underset{(13.397)}{1.015}\ln DEP - \underset{(-1.353)}{0.460}\ln AVAW$$

R^2=0.882, F=58.019, D.W=1.238

where Q is a sum of investments and loans, DEP refers to deposits, AVAW refers to average wage and SFT is the shift variable given by the log of an interaction between Q and the dummy variable. The R^2 for this equation was 0.882, i.e, high suggesting that variations in the demand for labour in the sector were adequately explained

by the model. All the estimated parameters were found to be statistically significant, except for wages. The regression results from this equation indicate that information technology is labour- saving and capital -using with the magnitude of substitution between labour and capital being -0.006 (i.e., the output elasticity of employment with respect to changes in information technology expenditures is negative 0.006). The coefficient is small but statistically significant at the 95% level of confidence. Estimated parameter values for banking sector outputs and deposits reveal that they are important determinants of employment in the sector. The output (input) elasticity of employment is -6.686 and 1.015 for outputs and deposits respectively. Similarly, the marginal effect of a change in deposits on employment in the sector is positive. As expected for normal goods, this study found the relationship between wages and employment to be negative. The output elasticity of employment to changes in wages is negative 0.460. The parameter was, however, statistically insignificant at the 95% level of confidence suggesting that wages are not important in the hiring decision of banking firms. Thus, increased diffusion of information technology and services in the sector would lead to significant decreases in manpower, probably being more pronounced for low skilled workers for which the technology is a substitute (see our findings in section 4.2.3 below). In chapter five we discuss some of the implications suggested by these findings.

4.2.3 Impact of IT on Work Organization

The most fundamental change in banking procedures and control systems relates to payment approval. Computer-based checking system has reduced the span of referral and authorization of payment instructions almost by two thirds.[4] The expansion in responsibility has helped reduce the levels and style of supervision from direct worker/supervisor relationship to a post facto based supervision and control system, i.e., automation has eliminated the passing clerk in the checking system and caused his deployment to back office banking work. Back office work include checking of in-house vouchers, bills and foreign exchange instruments, stamping and micro-filming. The passing clerk has also been redeployed to deal with clearing house checks and to analyzing the daily computer reports.

In the previous practice, a correctly drawn payment instruction is presented to the cashier who confirms whether the documents are in order, initialises and then passes it over to the referral clerk who in turn passes it to the B-signer(passing clerk) to confirm adequacy of the funds. The B-signer initialises the payment instructions and passes it over to the A-signer for final authority for payment. The referral clerk then collects all the authorized payments to the paying cashiers. The payment cashier then records the transaction and pays the cash to the order. At

[4] The reduction in span of control and referral is measured by the volume of transactions which are completely dealt with at the point of contact between the customer and the bank officers as a fraction of the previous volume referred before automation.

the end of the day, the cashier balances all cash payments ("waste") and cash receipts for accounting purposes. The cashier's records are eventually used to adjust client accounts. It is important to note here that this process consumed a substantial time of the officers mentioned above.

Computer-based banking system has eliminated some of these procedures. Computerized client account records and a built-in software controlled checking system has simplified work and eliminated cash balancing ("waste") which was previously done manually.[5] The cashier now maintains a box of specimen signatures for clients and a computer report of balances (in the case of back office automation) and has been allowed a cashiers' limit. This is the authority to pay cash to certain pre-established limits which vary from bank to bank, but mostly up to kshs 10,000. Within this limit, the cashier does not refer the payment instruction to any other officer in the bank, all the procedures end up at the cashier's table. Information on client account balances, identity and history are retrieved at the touch of a button (in the case of front office automation). If the cashier is satisfied with the payment instructions and account holder balances, she authorises the payment. The transaction is automatically entered into the computer, thus eliminating the need for manual balancing of the "waste at the end of the day. Bank Book-Keeping and financial

[5]As a result of the elimination of manual "waste" balancing, the banks have realized substantial cost savings of "overtime" which was quite an important component of banking labour costs.

reports are readily obtained each working day enabling decision making to be faster and more accurate than before. In this way, automation has completely eliminated the function of the referral and passing clerks and shortened the distance travelled by checks in the once a five stage operation.

Again, where banking is computerized, worker supervision is post facto through the `transaction exception report'. This report gives detailed computer records of transactions which exceeded the cashiers' limits or which exceeded the built -in control systems. Supervisors now just analyses this group of transactions to appraise the work of the cashiers and for decision making.

Thus, the B-Signer and A-Signer responsibility have been shifted to more tasks requiring more discretion than before. Control and supervision of branches is based on daily computer data which has to be received balanced on the daily batch control sheets from the branches. Decision making on them (branches) is thus improved.

The impact of automated banking on skill requirements has not been experienced in Kenya. 9 out of the 10 respondents stated that only those working in their data processing (DP) or information systems (IS) department were required to have specific computer skills (see table 5(b) below). These banks, however, had organized some elementary training for all their staff on computer technology to increase their appreciation of the technology. 60% of the respondents stated that older staff were far much less inclined to learning the new technology than the younger ones.

Table 5(a) Areas of Computer Application in the Banks

Banking Activity	Automated				To Automate			
	Front		Back		Front		Back	
	No.	%	No.	%	No.	%	No.	%
1 Client Accounts	6	60	4	40				
2. Bank bookkeeping	6	60	44	0				
3. Check Clearing	7	70	3	30				
4. Bill & Forex	5	50	0	0	1	10		
5. Cash Records	6	60						
6. Loans Processing	3	30			1	10		
7. Staff Records	7	70						
8. Payroll	7	70						
9. Others	1	10						

Table 5(b) Effect of Computerization on Work Organization

Banking Activity	Affected		Not-affected		Impact
	No	%	No	%	
1. Cash/Check Processing	8	80	2	20	f
2. Skills Requirement	0	0	0	0	nl
3. Control systems	9	90	1	10	pf
4. Work Supervision	9	90	1	10	imp idr mrsp btr clsr wkc
5. Bookkeeping system	10	100			macc f mcmp
6. Employment	0	0	0		depl

*f=faster, nl=nil, pf=post factor, depl=deployment, imp=improved, idr=indirect, mrsp=more responsibility, btr=better, clsr=closer, wkc=work centred, macc=more accurate, mcmp=more comprehensive.

Table 5(c) Motives for and Capacity Utilization of Computers

1. MOTIVES						2. UTILIZATION	
1. Speed		Accuracy		Save Costs		bandwagon	
No.	%	No.	%	No.	%	No.	%
10	100	10	100	1	10	0	0
2. Large		Big		Medium		Small	
No.	%	No.	%	No.	%	No.	%
0	0	3	30	7	70	0	0

Table 5(d) Effect of Computerized Banking on Work Environment

	Affected	Not-Affected	Impact
1. Worker-to-worker			
Respondents	8	2	f*
Percentage	80	20	macc
2. Worker-to-Supervisor			
Respondents	7	3	p
Percentage	70	30	r
			idr
3. Worker-to-Machine			
Respondents	6	4	bu
Percentage	60	40	me
4. Work Effort			
Respondents	6	4	imp
Percentage	60	40	

*f=faster, m=more accurate, imp=improved, r=relaxed, idr=indirect, me=more efficient, mp=more productive, btru=better use

One respondent maintained that although skills had not been "twisting", new job entrants with computer literacy were increasingly having ahigherprobability of being hired compared to those who do not have any. All the banks surveyed had automated their client account records, and bank bookkeeping systems, 70% had

automated clearing of cheques, staff/personnel records and payroll, respectively while 50% of them had automated their bills and foreign exchange transactions. One bank reported that records of its fixed assets and budgeting were also automated besides those above. In the case of partially locally owned banks, the software packages were customized by the parent company e.g, Barclay's Bank uses a package known as BIAS developed by Barclay's Bank International. Fully owned local banks, however, rely on local suppliers of software, and to a small extent on their information systems staff for their software needs. All the banks surveyed relied on maintenance contracts with computer service firms for installation and maintenance services. Two forms of automation are in practice, namely front office and back office automation. Front office automation installed by National bank, Grindlays, ABN, AMBANK and Bank of Credit and Commerce appear to have had the greatest impact on the quality of banking services as compared to back office automation practised by the Standard Chartered and Barclay's bank of Kenya. Although 70% of the respondents stated that they have not computerised their loan processing system, they acknowledged that computer-based client account information system had reduced loan processing time by almost three working days. Most of these banks indicated their plans to computerise credit approval system. In all, computer-based banking in kenya has been justified because it speeds the turnaround time, it increases accuracy, improves control and supervision of staff and branches and improves the quality of decision making. Besides, automated

banking has improved the working environment in the industry. For instance, 80% of the respondents stated that as a result of the new technology, workers are more relaxed mentally, i.e, automatic reconciliation of bank records and preparation of financial reports on a daily basis has reduced the fear of failing to meet deadlines. Again, increased responsibility, especially to cashiers, has removed their direct control by supervisors, by that making them more relaxed mentally. 70% of the respondents stated that less tension and the shift of emphasis from routine to non -routine tasks has increased the social interaction between staff and customers and the appreciation between staff of the interdependence of their work. Two respondents added that, automated banking has enhanced team spirit and that reliability between staff has increased.

Software built-in control systems and post facto supervision rather than direct supervisor/manual control system has allowed workers to feel independent and the supervisor to be work rather than staff centred. Both work effort and attitude to work were reported to have been greatly improved by 60% of the respondents as a result of the change in feeling.

Reliance of the banks on software-based supervision places high demands on the quality of these products if they have to deliver. Unfortunately, consumers of off - the - self software packages in the industry may not be aware of sales - pitch assertions which lead to the acquisition of unsuitable software programmes. Incompatibility of hardware and software programmes

through uninformed acquisition by some the banks surveyed has led to premature replacement of these resources often at substantial costs to the firms. In the words of a critic, "application has often been geared to using what has been obtained rather than obtaining what a firm needs." In an oligopolistic vertically integrated informatics market, the degree of risk in wrong software acquisition is serious. The potential for costly complications and waste due to an inefficient search for package software and, more so, the selection of the wrong system is relatively high for the ignorant. Under -utilization of existing programmes in the banks may also reflect the unsuitability of the acquired programmes, again reinforcing the demands for high quality of these products.

Lastly, on-line, off-premise inter-branch transfer of checks and payment instructions has reduced clearing time by almost 3 working days. Two respondents for example, stated that as a result of automated inter-branch clearing system, inter -branch credit/debit position is determined each day via on-line computer interfacing as opposed to the manual process which relied on telecommunications and took four working days. Convenience to customers is thus increased as their billing and payment system is improved. At the time of the survey, one bank disclosed that a plan to establish an electronic clearing house (EFTs) was at the committee stage-under the code name SWIFT-society for worldwide inter-bank financial telecommunications system. Also debated is the creation of an electronic magnetic ink character recognition system to facilitate the former. An electronic clearing house

would clearly have implications for the current paper based money market payment system, the courier industry and labour market for low level banking workers. From the discussion above, automated banking in Kenya has necessitated changes in work organization and working environment.[6]

[6]Most of the banks surveyed had automated just a few banking operations for less than six years. Moreover the software applications used are old restricted programmes. Many banks are already changing both hardware and software packages (for example Bank of Credit and Commerce Intern. and Kenya Commercial Bank Ltd.). The impact of the technology is going to be much greater as the remaining banks innovate and new superior technologies become perverse.

CHAPTER FIVE

SUMMARY AND POLICY IMPLICATIONS

5.0 Introduction:

This chapter summarises the main aspects of the study and their policy implications. It is in four sections. The major aspects of the study are summarised in section 5.1 while the policy implications of the study for innovators and entrepreneurs in information technology are presented in section 5.2. In sections 5.3 and 5.4 respectively, we describe the limitations of the study and suggest areas for future research.

5.1 Summary of the Study

In the study, the history, nature and extent of diffusion of IT in Kenya was examined. Computers were found to be dominant among the information technologies. Many firms, especially service institutions like banks and the government had automated many of their operations using the technology. The affects of IT on organization of work, employment and productivity of factors in Kenya's banking sector was assessed to provide policy data to guide IT development policy.

The methodology for assessing the impact of IT on employment, work organization and productivity growth in the existing literature is descriptive. Empirical evidence based on the methodology especially from NICs is controversial and non-conclusive. Some of the evidence indicated that IT was responsible

for greater employment opportunities while others found it was responsible for re-organization of work, job losses and/or redeployment of existing labour, especially for the low skilled workers. These studies, however, agree that the technology leads to productivity growth and therefore, competitiveness for the innovating firms. This result is strongly supported by the few analytical studies. The theoretical framework for the analytical studies is based on the production theory and the duality theorem. The translog cost function is very popular among these studies because it allows for scope and scale economies to be tested for and it does not impose any a priori restrictions on the substitution possibilities between factors of production. Seemingly unrelated regression method (SUR) has been widely accepted as being most appropriate for estimating the specified flexible functional form cost functions. The technique has the properties of generalized least squares (GLS) and also yields more robust statistical results when there is jointedness in the production of output for a multi-product firm or when a model specification omits a common variable to many of the firms in the same industry.

In this study, a hybrid of descriptive and analytic methodology was used to assess the impact of the technology on employment, work organization and productivity growth in Kenya. The framework of analysis was the duality theorem in which a translog cost function and a dummy variable test for a structural break was specified for a single-output, multi-input commercial banking firm. Pooled cross-section and time- series data on the

sectors inputs and outputs for the last decade was analyzed using SUR technique developed by Zellner (1961). The results of the study indicated that the IT was labour-saving and capital using, (i.e the output elasticity of employment was found to -6.686). On the other hand, cost-savings realized from the application of the technology were found to be small and not statistically different from zero at the 5% level of significance (i.e the output elasticity of variable costs to changes in computing service share equation was 0.008). The results further indicated that the IT necessitated changes in work organization leading to redeployment of certain categories of manpower, namely, the passing clerk and in expanding the responsibility of some others, namely, the cashiers. Apart from the direct labour -saving effects of the new IT-based commercial banking products such as the "money link" and electronic funds transfer systems, the existing banking operations have changed in ways which reduce the levels of labour utilization. For instance, the number of cheques processed per hour per employee in the bank had increased tremendously. At the same time, computer-based banking has increased convenience to customers and improved the payment system in ways which enhances labour efficiency and productivity. Thus, even though the sector has not been an important consumer of manpower[1], employment in the sector would worsen in the future despite it being one of the growth sectors of the economy. Improved capacity utilization of installed

[1]Finance,insurance, real estate and business advisory services employed just 3.2% of total labour force in the economy in 1986. Of this number, 30.9% were secretaries and clerks, client oriented clerks accounted for 11.3% and 0.1% were machine operators and assemblers. See the National Manpower Survey, 1989.

components by the innovating banks will further aggravate potential job creation in the sector.

The mode of automation chosen by many of the innovating firms (both front and back office) were found to be under-utilized due to wrong hardware and software acquisitions and/or user attitudes. A number of banks surveyed had replaced or indicated their intentions to acquire new computers or software programs, probably suggesting lapses in the acquisition of previous ones. This presented additional costs to the innovating firms or under-utilization of the information systems and probably explains the statistical insignificance of the output elasticity of cost coefficient for productivity growth in the computing cost share equation. Similarly, centralized data processing departments (as in the case of Kenya Commercial Bank or Standard Chartered) or disintegrated distributed information management systems (as in the case of the National Bank of Kenya) were found to impose additional costs on the firms and therefore reduced potential cost-savings.

5.2 Policy Implications of the Study

IT was found to be labour-saving and capital using in this study. The national policy for employment creation, however, favors intermediate, labour-intensive technology. This suggests two courses of policy action on IT; either to limit its use to a few areas of application or to establish export-oriented domestic production of the technology so that additional demands for it creates jobs domestically.

The first option calls for a number of policy instruments

peripherals are particularly attractive because they do not impose such high capital, engineering or technical requirements as the computer components proper. Peripherals such as printers, terminals, diskettes, monitors, e.t.c could easily be set up at the Kenya Posts and Telecommunications' equipment manufacturing plant in Gilgil. Both Zimbabwe and Algeria in Africa are already manufacturing the technology on a joint venture basis between the government parastatal, local investors and some foreign entrepreneurs.

Domestic software "housing" is the most promising area of investment because evidence indicate that its costs are rising compared to the costs of hardware and because there already exists a corpus of local computer programmers and analysts working for multinational firms who could be supported to start the software writing business of their own.[2] The success of this strategy, however, depends on whether the local investors could be competitive enough to penetrate the largely vertically integrated oligopolistic informatics market. Some time- bound government protection of the local investors through anti-trust legislation and credit programmes may help in eliminating some of the barriers to entry into the market and in setting up local production.

Secondly, computerized banking was found to lead to only small, even statistically insignificant, cost-savings to the innovators. This was most likely due to underutilization of the

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[2]Sullivan and Frost (1986) reports that the software content of small systems accounted for approximately 22% of the value of an entire system in 1982. It increased to nearly 37% in 1990. In medium systems, this ratio was expected to be about 50% in 1990, and in large systems, it was projected to increase from 25% in 1981 to 33% in 1990. See Sullivan (1986) for details.

technology by the banks or due to wrong software acquisitions. Potential benefits from It depends on how far the innovators are willing to exploit the technology in their operations. It also depends on the way the information management system is organized. Front office automation in the sector appears to be more effective in improving service quality. Back office computerization of banking processes leads to reductions in turnaround time too but is less faster or satisfying psychologically compared to front office because, the latter allows customers to interact easily with the cashiers and obtain any necessary information about their accounts. Decentralization of computing services was also found to be more effective in information system management than a centralized one. For instance, the National Bank of Kenya instals one mainframe and a system of terminals in each branch and therefore information is processed at the point of event. Any changes are easily corrected for at the branches. In a centralized system as done by Barclays Bank, the Standard Chartered Bank and the Kenya Commercial Bank, diskettes containing information from all the branches have to be collected each day for processing in Nairobi and then back again to the branches for use in the next business day. This process has to be highly synchronized to avoid delays. Kenya Commercial Bank, for example depend on chartered flight to collect these diskettes from the branches. A part from being expensive, a change in weather conditions could badly compromise this operation. In fact, Barclays bank still experiences delays in processing the data from the branches because those which have not been automated delay in sending in their data

and yet data from all the branches have to be processed in a batch. Delays in receiving the data inconvenience the customers as they cannot withdraw without this information. The policy implication to the banks is that to realize cost -savings from the technology, they should decentralize their information systems. Instead of a single corporate-wide data base, many small integrated data bases which can be consolidated upwards through the functional and operational levels are likely to yield superior results. Customized software packages that takes local end-user specific needs would furthur improve potential gains from the technology.

Lastly, as computer and other information technologies increase in the country, employment opportunities are going to be linked to computer literacy. Those intending to make investments in human capital should consider investing in these skills, especially those in highly information based activities like clerical work, quality control supervision, secretarial and many operations in the printing industry.

5.3 Limitations of the Study

This study covers a short period of computer application in the country and some of its impact may not have been fully experienced. Two, the study focused only on the banking sector, limiting generalization of the evidence to other sectors of the economy. The exclusion of physical capital user cost from our study further limits the value of our empirical evidence since the coefficients are likely to be biased upwards.

5.4 Areas for Future Research

As the information sector continues to expand, measures of multi-factor productivity growth (MFP) which do not take this sectors' contribution into account are likely to be biased. Unfortunately, the National Income Account tables for Kenya do not provide statistics for this sector. Information technology also alters existing input-output relationships between other sectors importantly. A study which measures the growth and productivity of the sector at the aggregate level would provide the information required to bridge the knowledge gap. A purpose of studying differential productivity change is to improve our knowledge of the effects of IT on overall economic growth.

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APPENDIX 2

CONFIDENTIAL

QUESTIONNAIRE

(Put a tick in the right space)

Name of the firm ----------
Designation of Officer Responding ----------
Date ..... Month ...../1990 .....

A: HISTORY OF COMPUTER USE IN THE FIRM

(1) Have you computerized any of your operations?
Yes ---------- [ ] No ---------- [ ]
(2) If yes, since when? ----------
(3) What kind of computer(s) were installed then?
Describe ----------

---
(4) If your answer to (1) above is yes, what was the mode of computerization?

(a) Decentralized [ ]
(b) Centralized [ ]
(c) Front Office [ ]
(d) Back office [ ]
(e) Other, specify

---

(5) Has there been any changes in equipments installed since then?
Yes ---------- [ ] No ---------- [ ]
(6) If your answer to (5) above is yes, what were the changes?
Describe ----------

---
(7) If your answer to (5) above is yes, what reasons prompted the changes?
(a) ----------

(b)----------

(c)----------

(d)----------
---
(8) If your answer to question (5) above is no, do you consider making any changes in your computer equipments?
Yes ---------- [ ] No ---------- [ ]

(9) If your answer to (8) above is yes, describe the intended changes

---

B: AREAS OF COMPUTER APPLICATION IN THE FIRM

(1) If your answer to question (1), section A above is yes, which areas of your operations have been computerized?

(a) client account records [ ]
(b) bank bookkeeping records [ ]
(c) clearing of cheques [ ]
(d) bills and foreign exchange records [ ]
(e) cash records [ ]
(f) loan/advance application processing [ ]
(g) staff/personnel records [ ]
(h) payroll [ ]
(i) other (s), specify

---

(3) If your answer to (1) above is no, do you consider computerizing your operations?

Yes ---------- [ ] No ---------- [ ]

If yes, which areas of your operations do you intend to computerize?

(a) (as in 2(a) above) ----------[ ]
(b) (as in 2(b) above) ----------[ ]
(c) (as in 2(c) above) ----------[ ]
(d) (as in 2(d) above) ----------[ ]
(e) (as in 2(e) above) ----------[ ]
(f) (as in 2(f) above) ----------[ ]
(g) (as in 2(g) above) ----------[ ]
(h) (as in 2(h) above) ----------[ ]
(i) (as in 2(i) above) ----------[ ]

(4) If your answer to (1) and (2) above was yes, what were or will be the consequences on:

(a) work organization?

(b) skills requirement(s)?

(c) Payment approval or depositing procedures?

(d) control systems?

(e) loan/advance application processing procedures?

(f) employee/work supervision?

(g) book-keeping systems?

(h) job requirements?

(i) others? specify

C: MOTIVES FOR AND CAPACITY UTILIZATION OF INSTALLED COMPUTER EQUIPMENTS

(5) Do you think computer usage in your organization is justified?
YES ---------- [ ] NO ---------- [ ]

(6) If your answer to (5) above is yes, what are some of these reasons (in order of merit)

(a) ---

(b) ---

(c) ---

(d) ---

---

(7) To what extent has your organization been able to exploit installed computer capacity (in terms of CPU hours per day) ?

(a) Small - ---- [ ] (b) Medium ---- [ ] (c) Big ----- [ ]
(d) Large ----- [ ]

(8) Do you think a change in the degree of current computer usage would make a difference on your organization's operations?
YES ---------- [ ] NO ---------- [ ]

(9) If yes, what changes in operations do you anticipate?

(a)---

(b)---

(c)----------

(d)----------

D: EFFECT OF COMPUTERS ON THE WORKING ENVIRONMENT

(10) DO you think computer application in your operations has had an effect on:
(a) worker to worker relationship?
Yes -------- [ ] No ---------- [ ]

If yes, describe?

(b) worker to supervisor relationship?
Yes ---- [ ] No ----- [ ]

If yes, describe?

(c) worker attitudes to machines?
Yes --------- [ ] No ---------- [ ]
If yes,describe?

(d) employee work effort?
Yes -------- [ ] No ---------- [ ]

If yes, describe?

(e) worker attitude to his work?

Yes-------[ ] No ---------- [ ]

If yes, describe?

THANK YOU VERY MUCH FOR YOUR CO-OPERATION