Financial Sector Liberalization and Productivity Change in Uganda's Commercial Banking Sector

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Contents

List of tables

Abstract

The study employed quarterly data over a 13-year period from 1993 to 2005 to study the evolution of Total Factor Productivity (TFP) and its determinants among 11 banks in Uganda. Using a panel data set consisting of 484 observations (11 banks over 44 quarters), productivity was measured using the Malmquist index while the determinants of productivity were estimated using a two-way error components model. The results show that at the industry level there was a modest decline in TFP. However, at an individual level the experience is mixed. Six foreign-owned banks and one locally owned bank registered modest improvements while two foreign-owned and two locally owned banks registered declines. The declines recorded by the deteriorating banks more than offset the modest increase in TFP among improving banks. In addition, since the study covered a fairly long and non-homogeneous period (1993 to 2005) in terms of productivity change, it is rational to deduce that the major decline recorded in the first half of the period (1993 to 1999) more than offset the modest improvement in productivity that was recorded in the second period (2000 to 2005). Bank-level determinants of productivity were capital adequacy, which had a negative effect while increasing shareholders stake in banks, improvement in liquidity and earning power affected productivity positively. At the macro level, it was not possible to find a positive significant effect of financial liberalization on bank productivity.

Key words: *Financial Sector, Liberalization, Productivity, Efficiency, Commercial Banks and Uganda.*

Journal Classification: *I0, I2, I3, N3, O3*

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1. Introduction

Greater competition and efficiency in the banking system can lead to greater financial stability, product innovation and access of households and firms to financial services, which in turn affects economic growth. The importance of the banking sector motivates the concern that state-dominated monopolistic, inefficient and fragile banking systems in sub-Saharan Africa can be a major hindrance to development (Hauner and Peiris, 2005). In tune with most banking systems in Africa, the commercial banking sector used to be heavily regulated. The regulations affected market entry and exit, capital adequacy levels, reserve and liquidity requirements, deposit insurance and determination of interest rates on deposits and loans. The purported rationale for the regulations and restrictions was to aid the expansion of the reach of commercial banks, while preventing excessive competition for funds. The restrictions were expected to improve bank safety and soundness by increasing their profitability. However, this policy regime closed the banking system, rendering it immune to the disciplinary forces of competition. Rather than increase productivity, this policy regime also generated significant inefficiency in the use of resources in the banking sector.

More recently however, the financial sector has undergone reform and liberalization in tune with changes affecting banking systems around the world. Bonaccorsi di Patti and Hardy (2005) have summarized the reforms that have been implemented in a number of countries around the world. The reforms have affected the licensing of private local banks, the lifting of barriers to entry of foreign banks and the privatization of state banks. The reforms have also involved the introduction of market-based securities, the liberalization of interest rates, the removal of quantitative restriction, on lending and the tightening of prudential regulation. In a number of countries the financial sector has witnessed improved supervision and higher core capital requirements have been placed on financial institutions.

Financial sector reforms have had an impact on the financial sectors in a number of ways. First, the reforms have modified the environment under which banks operate. The reforms which have changed the operational environment include those deregulating interest rates, eliminating directed credits, liberalizing foreign currency holding and introducing market-based systems of monetary policy management. Second, the reforms have affected the productivity of financial institutions. The reforms include those that have led to changes in management and ownership, those leading to more intense competition, and those underpinning new regulations on treatment of non-performing loans and provisioning for loan recovery (Bonaccorsi di Patti and Hardy, 2005).

However, only few econometric studies have examined the effects of reforms on financial sectors in developing countries. The studies that have attempted to fill this void

include Leightner and Lovell (1998) and Bonaccorsi di Patti and Hardy (2005). Generally the results seem to suggest that public sector banks were least efficient (Berger et al., 2005). In addition, financial reform seems to enhance efficiency, while liberalization did not necessarily lead to a reduction in the dispersion of relative efficiency of commercial banks. The results also appear to suggest that banks with good management perform better under liberalization. Furthermore, countries with large shares of state ownership were associated with poor economic performance (Berger et al., 2004). The general view appears to be that privatization was followed by some performance improvements (Nakane and Weintraub, 2005; Beck and Hesse, 2006; Bonaccorsi di Patti and Hardy, 2005).

Over the last decade, internal and external pressure has altered the way banks operate, mainly through encouraging input saving and waste minimization. External pressure has come from liberalization of financial markets, while internal pressure has originated from investment in new technology. Product and territorial competition appears to have increased as the financial market opened up. Some commercial banks also took steps to reduce branches and personnel in order to eliminate unprofitable activities. It is the elimination of state ownership of banks and the improvement in communication and processing technology that seem to have reduced the need for extensive branch networks. Casual evidence indicates that the minimum efficient size of potential entrants into the market that is required to compete effectively with established banks could have been reduced. However, it appears that some costs could have increased following liberalization and may have encouraged banks to use resources more rationally or expand products and services more quickly. The key aspects of commercial bank restructuring in the recent past have therefore been aimed at increasing productivity (Bank of Uganda Supervision Report, 2003).

Efficiency and productivity indices have been employed to assess the impact of liberalization on the performance of banks in some developing countries (Leightner and Lovell, 1998; Khumbhakar et al., 2001, Isik and Hassan, 2003). However, despite the deep influence that the liberalization of the banking sector has had, its effects in terms of impact on productivity, technology and efficiency of the financial industry have not been adequately investigated. With a number of countries implementing financial sector reforms, examining actual experience would contribute to the existing body of information and provide interesting implications both for research and policy.

The quantification of the evolution of bank productivity is one way in which to assess the successes or failures of measures undertaken by policy makers in reforming the financial sector. More importantly, the results shed some light on the behaviour and reaction of different types of banks to policy change inducing policy makers to implement reforms in ways that help to strengthen financial systems. This study represents one of the initial attempts to measure productivity change in a young banking system. Employing a non-parametric Malmquist index approach, productivity is measured in banks between 1993 and 2005. Productivity growth is decomposed into technical and efficiency change. Efficiency change is further decomposed into pure and scale efficiency change in order to understand the impact of liberalization on different aspects of bank productivity and different groups of banks.

Statement of the problem

Some evidence is accumulating on the analysis of the aggregate performance of the financial sector at the macroeconomic level with regard to the assessments of changes in the structure and performance following reform (Bank of Uganda, Supervision Reports, 2002–2004). However, this analysis needs to be extended to the microeconomic level given the increasing availability of comparable bank level data sets. Extension to the micro level permits the observance of the performance of banks much more directly. The use of micro panel data sets is of particular significance because changes in the performance of individual institutions can then be related to changes in a number of bank-specific characteristics such as ownership and governance following liberalization (Bonaccorsi di Patti and Hardy, 2005).

Investigation of the impact of liberalization on commercial bank productivity in this context would be important given the continuing debate on this issue. Indeed, while Bhattacharya et al., (1997) and Wheelock and Wilson (1999) show the impact of liberalization to be positively associated with TFP growth in the banking sector, financial sector deregulation has also been shown to generate differential impacts on bank productivity (Isik and Hassan, 2003).

Despite this debate, few if any studies have investigated the evolution and the determinants of TFP in banks. The limited number of studies implies that information regarding the direction of impact of liberalization and deregulation remains debatable. This study attempts to close this gap by investigating the performance of Uganda's banks over the period 1993 to 2005. While the choice of the period for investigation was informed largely by data availability, the period covered was sufficient in as far as coverage of the key reforms in the financial sector is concerned. The study therefore is expected to help in understanding how liberalization and regulatory change affected productivity change. The other contribution of this study lies in the use of quarterly longitudinal data on banks, and employing panel data econometric techniques to analyse the problem.

Study objectives

Competitive pressure has forced banks to use resources more rationally leading to increased efficiency and productivity. An upward shift in the frontier is observed to have occurred due to technological investments and advances. In addition, the performance gap between the best and worst practice banks reduced owing to better resource management. Given this background, the study attempted to achieve the following objectives:

(i) To investigate the pattern of TFP in banks during the liberalization of the financial sector,
(ii) To investigate the determinants of TFP of banks,
(iii) To analyse the effect of liberalization on TFP.

Hypotheses

Given the objectives outlined above, this study specifically investigated the following hypotheses:

a) Banks TFP improved over the phase of financial sector liberalization,
b) Favourable bank-specific factors such as, bank size, bank expense structure, income structure, asset quality, capital adequacy, earning ratios, and liquidity ratios associated positively with the level of TFP.

The rest of the report is organized as follows. The state of commercial banks is reviewed in Section II, and literature relating to deregulation and bank productivity is provided in Section III. Section IV outlines the mechanism for generating empirical estimates of TFP, suggests the main bank-level determinants of productivity change in the banking sector and describes the data used. Section V presents and discusses the empirical results while section VI offers some concluding remarks.

2. Reforms and the banking sector

Financial sector reforms

The financial system in Uganda has undergone substantial legal, structural and institutional reforms over the last decade. Financial sector reforms were carried out with the objective of boosting efficiency and productivity of banks. The main mechanism for efficiency improvement was to allow competition by limiting state interventions and enhancing the role of the market. One of the initial reforms involved freeing of the mechanism of interest rate determination. In April 1992, the sale of treasury bills through periodic auctions for monetary policy purposes commenced. The liberalization of interest rates was followed almost immediately by changes that led to market-based determination of the external value of the shilling in 1993. Some of the complementary changes in the foreign exchange market included granting permission to residents and non-residents to hold foreign exchange deposits. To expand the financial sector, new types of financial institutions were allowed into the financial market and a premium was placed on the promotion of new types of financial products. However, to give impetus to market forces, new regulations in the operation of the inter-bank foreign exchange market were adopted.

As early as 1992, some of the directed credit programmes that operated at preferential interest rates were eliminated and in 1993, the inter-bank money market was established to improve the financial systems liquidity. For monetary policy purposes, emphasis increasingly shifted to the use of open market operations. Open market operations helped improve bank service portfolios, as these were enriched by trading in repurchase agreement (REPO) transactions, government bills and bonds. Furthermore, the introduction of the Uganda Securities Exchange (USE) in 1997 helped strengthen capital markets activity and provided more investment avenues for banks. In the area of bank supervision, unified accounting principles and standard reporting systems were adopted. Appendix A shows some of the key reforms affecting financial sector performance that have been undertaken since 1989.

The state of the banking sector

The banking sector comprises 15 banks (having declined from 20 in 1999 despite the increase from 14 in 1993) and is dominated by foreign owned institutions. In 1993, there were 8 foreign-owned banks, 6 local banks and one state-owned bank. In 1999 there were 11 foreign-owned banks, 8 local banks and one state-owned bank. By 2004, the number of foreign-owned banks remained 11 while locally owned banks significantly declined to four after the closure of International Credit Bank, Cooperative Bank and Greenland

Bank. The closure of locally owned banks was due to insolvency on account of large non-performing loan portfolios. During the same period two locally owned banks namely Orient Bank and TransAfrica Bank merged. In addition, this period was also marked by the closure of Trust Bank, a foreign owned bank and the licensing of Citibank in 2001 also foreign owned. Stanbic Bank, which is foreign owned acquired Uganda Commercial Bank (UCB) in 2002 through the privatization process. Since UCB had been the largest commercial bank in the country, its acquisition by Stanbic led to the subsequent transformation of Stanbic Bank into the largest commercial bank in the country.

Overall, the banking system is relatively small (even by African standards), underdeveloped and characterized by a large share of foreign ownership. Subsequently, the level of concentration is relatively high. In the same vein, the level of financial intermediation remains low. The branch network for commercial banks reduced from 169 in 1993 to 156 branches in 1999 and to 130 branches in 2004. The contraction in branch network was mainly due to the closure of Cooperative Bank and UCB. Cooperative Bank had the second largest branch network in the country comprising of 30 branches while UCB had 67 branches. Nonetheless, there was substantial expansion arising from branch networks of locally owned banks with Centenary Rural Development Bank doubling its branches from 10 in 1999 to 20 in 2004, and Orient Bank increasing from 2 branches to 6 branches. Registered banks between 1993 and 2004 are shown in Table 1.

Table 1: Registered commercial banks

Name of institution	Ownership	Number of branches and agencies						
		1993	1999	2000	2001	2002	2003	2004
Uganda Commercial Bank	State	169	67	67	67	0	0	0
Cooperative Bank	Local	23	30	0	0	0	0	0
Gold Trust Bank Ltd.	Local		5	0	0	0	0	0
Nile Bank Ltd.	Foreign	1	3	3	3	3	4	6
Greenland Bank Ltd.	Local	3	5	0	0	0	0	0
Allied Bank International	Foreign	4	3	3	3	3	3	4
Centenary Rural Dev. Bank	Local	5	10	10	4	18	20	22
National Bank of Commerce	Foreign	1	2	2	2	2	2	2
Orient Bank Ltd.	Local	1	2	2	3	6	6	6
Barclays Bank (U) Ltd.	Foreign	5	2	2	2	2	5	5
Bank of Baroda (U) Ltd.	Foreign	6	7	7	7	6	6	6
Stanbic Bank	Foreign	1	1	1	2	68	65	68
Standard Chartered Bank	Foreign	1	1	1	5	6	6	6
Tropical Bank	Foreign	3	3	3	3	3	3	3
Crane Bank	Local		2	2	2	2	2	2
Cairo International Bank	Foreign		1	1	1	1	1	1
Diamond Trust Bank	Foreign		1	1	1	1	1	1
International Credit Bank	Local	1	2	0	0	0	0	0
TransAfrica Bank	Local		4	4	4	0	0	0
Trust Bank	Foreign		1	0	0	0	0	0
DFCU Bank	Local	3	3	3	4	4	5	7

Continued next page

Table 1: Continued

Name of institution	Ownership	Number of branches and agencies						
		1993	1999	2000	2001	2002	2003	2004
Citibank	Foreign		0	0	1	1	1	1
Total no. of branches and agencies		227	156	*156*	129	129	130	130
Total no. of active banks		15	20	*20*	17	15	15	15

Notes: As at end December of each year. International Credit Bank was closed in 1998; Cooperative Bank and Greenland Bank were closed in 1999. Purchase of UCB by Stanbic was completed in 2002 while Orient Bank merged operations with TransAfrica Bank Ltd.
Source: Bank of Uganda 2005

The health of the banking system has improved remarkably following the closure of several distressed banks, substantial improvements in supervision, the introduction of a risk-based approach and the privatization of the originally dominant state bank in 2002. The regulatory system has been modernized to international standards with the implementation of the Financial Institutions Act in 2004. The strengthening of supervision of commercial banks by Bank of Uganda (BoU) coupled with the restructuring of weak banks helped promote competition in the banking sector. Accordingly, the balance sheets of commercial banks improved with total assets growing from an average of UGS 668 billion in 1993–1996 to an average of UGS 1,228 billion in 1997–1999 and to UGS 3,315 billion in 2004. Over the period, treasury bills held by the banking sector increased since 1993 and more than tripled from an average of UGS 202 billion or 16 % of total assets in the period 1997–1999 to Ush 707 billion or 21% of total assets in 2004. Other assets such as loans and advances to customers and assets due from banks outside registered significant growth rising from a 1993–1996 average of Ush 280 billion and 129 billion to an average of UGS 419 billion and 240 billion in 1997–1999 and to UGS 977 billion and 682 billion in 2004. The liabilities equally grew mainly on account of increasing deposits which shot up from an average of UGS 346 billion (1993–1996) to an average of UGS 772 billion in 1997–1999; they more than doubled rising to UGS 2,438 billion in 2004. The data in Table 2 shows the aggregate assets and liabilities of commercial banks for the period 1993 to 2004.

The profit and loss statements of the commercial banks show increased profitability of the sector. In line with the growth in government securities held by the banking sector, interest earned on government securities rose from an average of UGS 6 billion in the 90's to UGS 128 billion in 2004. Similarly, interest on advances rose from the 1993–1996 average of UGS 37 billion to an average of UGS 39 billion between 1997 and 1999 and amounted to UGS158 billion in 2004. Although the 2004 value of interest on advances is fivefold the average for the 1997–1999 period, as a share of total income there has been a reduction from 42 % to about 33 %. The expenses also registered an increase from an average of UGS 113 billion in 1993–1996 to an average of UGS 349 billion in 2004. Salaries and other staff costs more than doubled while a reduction in the provision for bad debts was effected over the period. The rise in total expenses over the period was mainly due to a rise in non-interest expenses from the average of UGS 29 billion in the period 1993–96 to UGS 195 billion in 2004 on account of large investment outlays by banks in modern banking facilities to better cater for their clientele. The consolidated profit and loss statements of commercial banks are shown in Table 3.

Table 2: Commercial banks assets and liabilities (UGS billions)

	Average 1993 – 1996	Average 1997 – 1999	2000	2001	2002	2003	2004
Assets							
Cash and balances with BoU	78	125	196	238	218	233	345
Securities	38	202	332	514	839	886	707
Fixed assets	73	91	106	106	110	136	164
Due from banks outside Uganda	129	240	377	368	362	640	682
Loans & advances to customers	280	419	525	521	661	847	977
Investments	18	69	73	74	48	28	248
Other assets	53	82	236	217	218	220	192
Total assets	668	1,228	1,845	2,038	2,456	2,990	3,315
Liabilities							
Deposits	356	772	1,325	1,483	1,822	2,214	2,438
Due to deposit money banks	116	149	77	65	77	47	94
Provisions	88	66	63	58	50	47	87
Other liabilities	146	150	196	199	241	381	293
Capital (excl. profits)	-31	78	106	167	201	203	271
Profits	-7	14	78	66	65	98	132
Total liabilities and capital	**668**	**1,228**	**1,845**	**2,038**	**2,456**	**2,990**	**3,315**

Notes: As at end December of each year. The figures from closed banks are excluded from the data. Capital excludes end of year profits and does not consider end of reporting period for individual banks.
Source: Bank of Uganda

Table 3: Commercial banks comparative income statement (UGS billions)

Income	Average 1993 – 1996	Average 1997 – 1999	2000	2001	2002	2003	2004
Income							
Interest on advances	37	39	84	89	81	122	158
Interest on government securities	5	6	55	88	75	132	128
Other interest income	7	8	31	28	12	16	24
Total interest income	49	53	170	205	168	270	310
Total non interest income	38	41	78	86	93	123	171
Total income	86	94	248	291	261	393	481
Expenses							
Total interest expense	-16	-17	-40	-45	-28	-50	-54
Provision for bad debts	-37	-22	-14	-18	-3	-15	-14
Salaries & other staff costs	-31	-31	-50	-57	-64	-73	-86
Other non-interest expense	-29	-30	-69	-90	-101	-157	-195
Total expenses	-113	-100	-173	-210	-196	-295	-349
Net income	**-26**	**-6**	**75**	**81**	**65**	**98**	**132**

Notes: As at end December of each year. Excludes figures from closed banks.
Source: Bank of Uganda

These developments on the balance sheets and income statements of banks led to an improvement in the financial indicators of the banking sector particularly after 1999. The earnings of the sector at an aggregate level as depicted by the ratio of returns on assets (RoA) were quite low before 1999, amounting to a mere 1.0 %. However, following the closure of insolvent banks in 1999, the ratio improved to 4.2 %, the second highest

during the entire period, declining in the next two years (2001 and 2002) and then rising to about 4.3 % in 2004 as banks improved on their operational efficiency.

The capital adequacy indicators exhibited a big improvement over the period 1993 to 2004. Specifically, the ratio of core capital to risk-weighted assets rose from an average of –40.6 % in the period 1993–96 to an average of 8 % in 1997–99 and 18.8 % in 2004. The ratio was highest in 2001 at 20.5 % following the re-capitalization of operational banks after the closure of insolvent ones. This period coincided with the rise of minimum unimpaired paid up capital to UGS 2 billion. The decline in this ratio from 20.5 % in 2001 to 18.0 % in 2002 and further to 14.4 % in 2003 was due to the healthy growth in the total assets by about UGS 1 billion over the same period. These are indicated in Table 4.

Table 4: Key commercial bank financial ratios and indicators

Indicator	Average 1993 - 1996	Average 1997 - 1999	2000	2001	2002	2003	2004
Capital adequacy							
Core capital/risk weighted assets (%)	-40.6	8.0	17.4	20.5	18.0	14.4	18.8
Core capital (Ush billions)	-91.9	53.3	148.0	180.0	195.0	219.0	313.0
Paid-up capital (Ush billions)	29.0	82.2	67.0	84.0	86.0	86.0	95.0
Earning ratios							
Return on assets (%)	0.2	0.7	4.2	4.1	2.7	3.7	4.3
Return on equity (%)	-7.0	13.7	42.8	20.9	17.7	48.4	28.8
Liquidity							
Liquid assets to total deposits (%)	68.7	80.6	84.2	87.6	86.1	59.4	63.1
Total advances to total deposits (%)	70.2	54.6	39.0	35.3	36.4	35.3	37.4
Liquid assets (UGS billions)	247.2	616.5	1,106.0	1,292.0	1,564.0	1,314.0	1,538.0
Asset quality							
Loans and advances (UGS billions)	279.8	419.4	525.0	521.0	661.0	847.0	977.0
Non-Performing Advances (NPA – UGS billions)	97.7	163.9	52.0	34.0	20.0	61.0	21.0
Provisions for NPA (UGS billions)	12.3	20.3	32.0	24.0	16.0	47.0	21.0
Specific provision (UGS billions)	68.5	45.2	26.0	21.0	10.0	39.0	10.0
NPA to total advances (%)	36.1	39.4	9.8	6.5	3.0	7.2	2.2
Specific provisions to NPA (%)	68.2	34.9	50.5	61.2	53.2	62.9	45.1

Notes: As at end December of each year. The figures from closed banks are excluded from the data. Capital excludes end of year profits and does not consider end of reporting period for individual banks.
Source: Bank of Uganda

Trends in indicators of asset quality were largely shaped by the developments in the sector in the period between 1993 and 1999. During this period, the ratio of non-performing assets to total advances of about 38% was much higher than the internationally accepted standard of 10%. Hyuha and Ddumba-Ssentamu (1994) attributed the high level to political interference in the determination of loan sizes and interest rates especially among state-owned banks. This was exacerbated by incidents of insider lending prevalent in private banks at the time. This ratio however declined in 2000 to 9.8 % over the 1999

ratio of 60.9%; by 2002 the ratio was 3.0%. This downward trend reversed in 2003 when the ratio rose to 7.2 % before reverting to 2.2 % in 2004. The temporary reversal in the downward trend in 2003 was partly due to the large exposure of some banks to a specific export sector, which faced shocks after international prices collapsed.

The banking sector generally maintained high liquidity with the ratio of liquid assets to deposits averaging at about 68.7 % between 1993 and 1996, increasing to 80 % between 1997 and 1999 and peaking at 87.6 % in 2001. This level is way above the ideal 17.5 % which is indicative of the low provision of intermediation services by the sector. This however, can be attributed to the banks' high appetite for investment in short-term government securities as opposed to the extension of credit services to the private sector. Trends in the key financial indicators are depicted in Table 4.

3. Literature review

Deregulation and bank total factor productivity

The rationale for financial sector liberalization arises from the view that relaxation of barriers to competition and the resulting increase in competitive pressures drive banking institutions to become more efficient, and increase productivity in the long-term. Even from the theory of the firm, it is argued that managers operate efficiently to maximize profits and shareholder wealth. This implies that competition forces banks to raise productivity at least cost (Buer et al., 1993). In a free market environment, the capital market acts to penalize the under-performing bank by reducing its share price leading to its eventual take over. In addition, in a free market environment, banks that are inefficient are either acquired or driven out of the market. However, in the absence of competition, inefficient banks tend to survive because of barriers to entry or weak regulation (Isik and Hassan, 2003). Indeed, the market discipline hypothesis suggests that lack of competitive pressure induces deviations from the profit maximization goal as managers discover they do not require to operate efficiently to stay in business, and that they only need to maximize their own wealth (Evanoff and Israilevich, 1991).

The supervision of banks helps to ensure well functioning market and competitive viability, soundness and security (Wheelock and Wilson, 1995). In order to survive, banks must run efficiently. Improved bank productivity results from better resource allocation, improved profitability, greater amounts of funds intermediated at better prices and improvements in service quality to consumers (Isik and Hassan, 2003). Financial liberalization affects the environment with which banks have to operate through increased competition from non-bank rivals, removal of interest rate ceilings on deposits and revisions to capital requirements. To improve productivity banks have had to introduce innovations in financial engineering and apply new information-processing technologies to cut costs and reduce input waste (Berger and Mester, 1997).

While financial sector liberalization has been implemented in both developed and developing financial sectors, empirical investigations of productivity change have mainly been conducted in industrialized countries that offer large sample populations. Three things are therefore important. First, it is vital to measure changes in efficiency and productivity of banks in developing countries using methodological and analytical approaches that address the specific issues of banking systems of small countries at various stages of development (Dogan and Fausten, 2002). Second, while there have been some attempts to study aggregate financial sector performance (Hauner and Peiris, 2005) more effort is required in measuring productivity change at the micro level.

Third, it is argued that deregulatory policies aim at increasing competition and boosting efficiency and productivity by disciplining resource managers (Shyu, 1998). Managers are disciplined by placing them in a situation in which success depends on ability to operate efficiently within a liberal environment. While the success of commercial banks in most countries has been found to depend largely on ability to operate efficiently, for most countries, the empirical results of the impact of liberalization have been mixed. For example, in India liberalization led to higher efficiencies in the entire system (Bhattacharya et al., 1992). Conversely, in the case of Norway, Berg et al. (1992) reported a productivity decline following deregulation. In Turkey, improvement in commercial bank productivity following liberalization is reported in Isik and Hassan (2003). Shyu (1998) also reported improved efficiency in Taiwanese banks after deregulation. However, Grifell-Tatje and Lovell (1997) and Khumbakar et al. (2001) found that efficiency declined in Spain just as Wheelock and Wilson (1999) reported a decline in productivity in the USA. These results suggest that the short-run impact of deregulation may be discouraging. Even in a liberalized financial sector banks profits could arise from market power (Denizer, 1997) or from other market or regulatory distortions (Isik and Hassan, 2002). In addition, the requirements for a fast growing economy can create abundant profit opportunities for banks and this can offset increases in banking costs and hence reduce the impact of competitive pressure on banks to improve productivity. However, efficiency and productivity studies have not kept pace with significant financial changes taking place especially in Sub-Saharan Africa (Berger et al., 1993; Berger and Humphrey, 1992) because most of the productivity studies are related to developments in industrial countries.

In view of differences in the evolution of productivity following financial sector liberalization and the dearth of studies on productivity in sub-Saharan Africa, this study investigated how productivity evolved in banks in response to deregulation. Indeed, apart from Mpuga (2002), Kasekende and Atingi-Ego (2003) and Hauner and Peiris (2005) no sufficient empirical work has examined issues of productivity, technology and efficiency change in banks. Mpuga (2002) found that new capital requirements introduced in 1996 had a positive effect on bank performance at the aggregate level in terms of accumulation of deposit, assets and growth in advances, liquid assets, paid up capital, core capital and total capital, and net profits. In addition, liberalization was observed to have introduced some competition in the banking sector particularly for large banks, which also happen to be foreign owned (Birungi, 2006). However, at an individual level, local banks suffered massive declines in performance compared to foreign-owned banks as their profitability declined and non-performing loans grew. The poor performance was attributed to weak management and supervisory inputs among the local banks. Kasekende and Atingi-Ego (2003) obtained similar survey results indicating that commercial banks' overall assessment of the effects of financial sector liberalization was positive. They linked the observed growth in private sector credit to efficiency gains at the aggregate level from pursuing financial sector reforms and interest rate deregulation.

The approach favoured in this research report to investigate productivity relied on using a non-parametric Malmquist index to determine the sources of input waste in banks. Bank level data were used mainly to facilitate policy conclusions. A stochastic frontier model was not warranted, as it would have required a rather large sample size to generate reliable estimates of productivity measures. The index approach, which is less data demanding and works well with small samples in addition to the possibility of applying it without having knowledge about the proper functional form of the frontier, error distribution or the inefficiency

structure (Evanoff and Israilevich, 1991; Wheelock and Wilson, 1999) was considered appropriate for the study. While the index approach was considered appropriate, banking technology is subject to shifts from factors such as experience, increased knowledge, new innovations and better production techniques and heightened competition (Hunter and Timme, 1986; Berger and Mester, 1997). In addition, improvements in information-processing and applied finance can enable banks to make more profitable investments at lower cost. Moreover, productivity could be sensitive to regulatory changes that affect costs, such as the deregulation of interest rates and the relaxation of entry barriers. Furthermore, the location of the best-practice bank depends on competitive conditions; since even managers have been shown to reduce effort or pursue goals other than cost minimization if competition is lax. In addition to assessing productivity change, these considerations merit investigating its determinants.

Determinants of bank total factor productivity

Overall the type of macroeconomic and policy environment determines the level of Total Factor Productivity (TPF) in banks. The deregulation of the financial sector should therefore improve bank productivity. Mishkin (1991) indicated that the productivity of banks is likely to be affected by factors in the economic environment such as slow gross domestic product (GDP) growth, volatility of interest rates, unexpected domestic currency depreciation, price level volatility, uncertainty, high share of non-performing credit to the private sector and adverse terms of trade movement. Unfavourable developments in these aggregates can worsen adverse selection and moral hazard problems (Dermirguc-Kunt and Detragiache, 1997). TFP for banks in countries with weak macroeconomic environment is likely to be low.

However, productivity change is also associated with bank specific factors such as bank size, bank expense structure, income structure, asset quality, capital adequacy, earning ratios, liquidity ratios and corporate governance structure. According to De Young et al. (1998) the management quality score in CAMEL analysis from regulatory bodies is associated with higher productivity, as is asset quality. TFP is likely to differ across banks depending on adverse selection and moral hazard problems that affect channelling of funds to productive activities in the economy (Isik and Hassan, 2003). The financial market is subject to asymmetric information: when making decisions, one party may know more about a transaction than the other party. Asymmetric information creates a problem in two ways. First, through adverse selection, which occurs before a transaction is entered into. Second, through moral hazard which arises after a transaction is agreed to. Asymmetric information affects the quality of loan originations yet loans are a critical output of banking institutions. Kwan and Eisenbeis (1994) and Resti (1997) reported that problem loans are negatively related to efficiency even in non-failing banks. It is the effect of these issues on Ugandan banks that this study seeks to establish.

4. Methodology for measuring bank productivity

Measurement of commercial banks total factor productivity

Following Fare et al. (1994), Leightner and Lovell (1998), Wheelock and Wilson (1999) and Isik and Hassan (2003), a non-parametric Malmquist measure is considered appropriate to measure bank performance, especially because liberalization has forced banks to control costs. The approach should help to determine the sources of input waste in banks and facilitate making policy conclusions. Stochastic models, however, require large sample sizes to generate reliable estimates of productivity measures. The index approach is less data demanding and works well with small samples and does not need knowledge of the proper functional form of the frontier, error and inefficiency structure (Evanoff and Israilevich, 1991, Wheelock and Wilson, 1999). Although our sample contains all banks, the number of banks is relatively small (15 in 2004), further motivating our use of a non-parametric technique in this study.

A number of productivity indices have been developed such as those by Fisher (1922), Tornqvist (1936) and Malmquist (1953). While the calculation of the Malmquist index is quantity based, the derivation of the Fisher and Tornqvist indices requires information on prices. This provides the Malmquist index with an advantage in cases where price information is lacking or cannot be relied upon. To formalize these concepts, consider S banks producing *M* outputs by using *K* inputs. Let $x^{i,t} = (x_1^{i,t}, ..., x_K^{i,t}) \in \Re_+^K$ and $y^{i,t} = (y_1^{i,t}, ..., y_M^{i,t}) \in \Re_+^M$ denote input and output vectors respectively of bank i=1,…S in time period t=1,….T. The production possibilities set at time *t* is assumed to be available to any bank is given by:

$$P^t = \{(x,y) | \ x \text{ can produce } y \text{ at time } t\} \quad (1)$$

It is assumed that the technology, which is the upper boundary of P^t, satisfies a number of axioms. To start with, P^t is convex, closed and bounded for all $X \in \Re^K$. In addition, to produce non-zero output levels, some inputs must be used. Furthermore, both inputs and outputs are strongly disposable, that is, a bank can dispose its unwanted inputs or outputs without cost. Finally, zero output levels are possible. The Shepard output distance function for bank *i* at time *t* for given period *t* technology (as indicated by the superscript t: attached to D) can be defined as:

$$D^t(x^{i,t}, y^{i,t}) = inf \{\delta^{i,t} > 0 \ / \ y^{i,t} / \delta^{ii,t} \in P^t (x^{i,t))}\} \quad (2)$$

The Malmquist index is the geometric mean of two productivity indices that use output distance functions for alternative base periods t and $(t + 1)$ as provided by the D–superscripts:

$$M = \left[\frac{D_0^t(x^{i,t+1}, y^{i,t+1}) D_0^{t+1}(x^{i,t+1}, y^{i,t+1})}{D_0^t(x^{i,t}, y^{it}) \quad D_0^{t+1}(x^{i,t}, y^{i,t})} \right]^{1/2} \tag{3}$$

The starting index relates the input-output combinations observed in two time periods t and $(t + 1)$ to the period t technology frontier, and the second index relates the same input– output combinations to the period $(t + 1)$ technology frontier. The numerator terms define the inputs employed and the outputs generated by banks i in period $t + 1$ and the denominator terms represent the corresponding quantities observed for period t. The frontiers are not static but are subject to change due to innovation, shocks from financial crises, changes in market structure and financial deregulation. In line with the distance functions of Farrel (1957) and the definition of productivity by Fare et al. (1994), a Malmquist TFP change index (*tfpch*) can be specified. *tfpch* is a product of the index of efficiency change and the index of technical change (*techch*). Following Fare et al. (1994), manipulation of the Malmquist index enables a distinction to be made between efficiency changes and technical changes as:

$$tfpch = \frac{D_0^{t+1}(x^{i,t+1}, y^{i,t+1})}{D_0^t(x^{i,t}, y^{i,t})} \left[\frac{D_0^t(x^{i,t+1}, y^{i,t+1}) \quad D_0^t(x^{i,t}, y^{i,t})}{D_0^{t+1}(x^{i,t+1}, y^{i,t+1}) D_0^{t+1}(x^{i,t}, y^{i,t})} \right] \tag{4}$$

which can be rewritten in a simplified form as:

$$tfpch = effch * techch \tag{5}$$

Efficiency change refers to how much closer a bank gets to the efficiency frontier. It measures the catching-up or falling behind effect. Technical change (*techch*), however, is how much the benchmark production frontier shifts at each bank observed input mix (technical innovation or shock).

Fare et al. (1994) further decompose the first ratio on the right hand side of Equation 4 (which measures change in efficiency) by rewriting the equation as:

$$tfpch = \frac{D_v^{t+1}(x^{i,t+1}, y^{i,t+1})}{D_v^t(x^{i,t}, y^{i,t})} * \frac{D_0^{t+1}(x^{i,t+1}, y^{i,t+1}) \quad D_v^t(x^{i,t+1}, y^{i,t+1})}{D_0^t(x^{i,t}, y^{i,t}) D_v^t(x^{i,t}, y^{i,t})}$$

$$\left[\frac{D_0^t(x^{i,t+1}, y^{i,t+1}) \quad D_0^t(x^{i,t0}, y^{i,t0})}{D_0^{t+1}(x^{i,t+1}, y^{i,t+1}) D_v^{t+1}(x^{i,t}, y^{i,t})} \right]^{1/2} \tag{6}$$

Equation 6 can be rewritten in a simplified form as:

$$tfpch = pech * sedh * techch \tag{7}$$

In this simplified form of Equation 7 the product of the first two terms on the right hand side is the efficiency change. Fare et al. (1994) refer to the first term on the right hand side *(pech)* as a measure of pure efficiency change reflecting improvements in

management practices, and to the second *(sech)* as a measure of change in scale efficiency, which indicates improvements towards the optimal scale in terms of cost control (Isik and Hassan, 2003).

The *tfpch* index can attain a value greater than, equal to, or less than unity depending on whether the bank experiences productivity growth, stagnation or productivity decline respectively, between periods *t* and *t + 1*. The *effch* index takes a value greater than 1 for an efficiency increase 0 for no efficiency change or less than 1 for an efficiency decrease. Similarly *techch* index attains a value greater than 1 for technological progress, 0 for technological stagnation, or less than 1 for technical regress. However, efficiency by itself can bias the measurement of a bank's performance especially during periods of technical change, and therefore studies based on cross-sectional data may not contribute to explaining productivity growth in banks (Berg et al., 1992). A technological advance that is adopted by only a few banks, but not the average bank, could expand the estimated production frontier. A bank that fails to take advantage of technological improvements will increasingly be inefficient relative to banks taking on new technology. This is because productivity growth does not always imply an efficiency increase (Wheelock and Wilson, 1999; Isik and Hassan, 2003).

Determinants of total factor productivity

The study adopts a two-way error components model for the determinants of TFP for the banking sector specified as:

$$tfpchit = \beta_0 + (\beta_1)' macro_t + (\beta_2)' bank_{it} + \varepsilon_{it} \quad (8)$$

Where *macro* captures the role of macroeconomic factors, *bank* consists of bank-specific characteristics[1] and the two way error component ε_{it} is given as

$$\varepsilon_{it} = \mu_i + \lambda_t + v_{it} \quad (9)$$

where *i* denotes the individual bank classification and *t* is the time period from 1993 to 2005. The symbol μ_i denotes the unobservable bank-specific effect, while λ_t denotes the time-specific effect and v_{it} is the remainder assumed to be a white noise stochastic error term. $\propto$ is a constant and β is a (K * 1) vector of the coefficients on K explanatory variables.

Specifically, a fixed effects model is adopted after carrying out a test for the fixed effects where μ_i and λ_t are assumed to be fixed parameters to be estimated and the remainder disturbances stochastic which is IID (0, g_v^2).

The macroeconomic variables included the real interest rate and the real effective exchange rate. A number of empirical studies of financial liberalization have used the real interest rate as a proxy for financial liberalization (Bandiera et al., 1997; Fry, 1997; Hermes et al., 1998). In this study, the real interest rate is similarly used to indicate an increase in the level of financial liberalization since real negative rates are often indicative of financial repression while positive real rates reflect movement towards less financial

repression. The other reason why the real interest rate is used as a measurement for financial liberalization is because many of the domestic financial reforms undertaken during the period (see Appendix A) fed into real interest rates. As such real interest rates are deemed to reflect the wider picture of the domestic financial reform process. The real effective exchange rate is intended to capture developments in the economy that may affect bank performance especially through the level of non-performing loans. More importantly, the liberalization of interest rates and exchange rates are arguably some of the major milestones that were achieved during the early stages of financial liberalization.

A period dummy is included to capture the effect of the first half of the period (1994 to 1999) during which the banking sector experienced a crisis. Also included is the share of foreign banks assets to total bank assets to measure the effect of foreign penetration on productivity.

Bank data for productivity measurement

A number of alternative approaches are available for the specification of inputs and outputs that are relevant to bank production (Dogan and Fausten, 2002). The more common approach which views banks as financial intermediaries is referred to as the intermediation approach. There are several variants of this approach. Berger and Humphrey (1997) used the value added approach which views banks as production units that produce loans and deposits using labour and capital. In this approach, both liabilities and assets have some output characteristics. Nonetheless, only those categories that have substantial value addition are treated as outputs while others are treated as either inputs or intermediate products depending on the individual attributes of each category. Another approach found in the literature is referred to as the user-cost approach. This approach described by Hancock (1991) uses the simple rule that the net revenue generated by a particular asset or liability item determines whether the financial product is an input or an output. This approach emphasizes the profitability of a bank in relation to various expenditures. Oral and Yolalan (1990) used this approach to measure the relative profitability efficiency of a set of bank branches using their interest and non-interest incomes as outputs, and interest paid on deposits and expenses incurred by personnel, administration and depreciation generated by the operation of bank premises as inputs. While their details differ, empirically the value added and user-cost approaches tend to suggest similar classification of bank inputs and outputs with the principal exception being the classification of demand deposits as an output in most user-cost studies and as both an input and output when the value added approach is taken (Wheelock and Wilson, 1999).

The second method, the asset approach, measures inputs by the volume of deposits and other liabilities, and output by the volume of loans and other assets. This approach considers banks as financial intermediaries between liability holders and fund beneficiaries (i.e. debtors). Grigorian and Manole (2002) argued that this approach is appropriate for large banks that purchase their funds in big chunks from other banks and large institutional depositors. They also argue that for smaller banks, this approach fails to account for transaction services delivered to depositors underestimating the overall value added by the banking system.

The activity-based production approach is the third variant, which treats the number of accounts and transactions processed as outputs produced with the application of labour and capital. In particular, studies that have adopted this approach have defined bank outputs

as the number of accounts, various transactions measured in number, number of loan applications and customer service survey ratings. Bank inputs have been defined as rent, capital and operating costs, number of online terminals, marketing conditions or activity ranking and labour measured in number or as monetary expenses.

Following the bank closures starting around 1997, bank management in individual banks shifted emphasis towards making sound lending decisions. That is credit managers increasingly focused their attention on credit analysis to determine the ability of borrowers to repay loans, along with collateral evaluations to protect banks' financial profits and deposit payments due. The emerging pattern of both a reduction in non-performing assets and an increase in private sector credit post-1999 confirms the emphasis on improving both the volume and quality of loans extended. This role is closer to the view followed in the intermediation approach. The analysis therefore adopts the intermediation approach and adopts a model for each of the two approaches found in the literature (value added and user-cost) to derive two sets of estimates for TFP and its components over the period 1993 to 2005.

Input and output data

Data on commercial banks is obtained from returns submitted to the Bank of Uganda. The sample contains data on all banks during the period 1993 to 2005. Observations included are for banks, where all inputs and outputs are reported during the review period. Therefore, banks that were closed between 1993 and 2005 and those that were licensed during the same period were omitted to retain a continuous set of variables for the remaining banks over the review period. Subsequently, out of a total of 15 banks, the sample was reduced to 11 banks. In addition, data for the periods 1994, 1997 and 1998 were missing for all banks and are not included in the data set. The panel therefore consists of 484 observations (11 banks over 44 quarters).

Three key inputs are employed in the value-added approach. The first is the labour input defined as the monetary expenses on wages and salaries of full-time employees on the payroll. The second is physical capital, which is measured as the book value of premises, staff houses, furniture and equipment, and motor vehicles and other fixed assets. The third is the purchased funds, which is the sum of time deposits, savings deposits and borrowings from Bank of Uganda. The outputs employed are loans, overdrafts, discounts, government securities and demand deposits. The information in Table 5 shows the descriptive statistics of the variables for the value-added approach.

Table 5: Descriptive statistics of inputs and outputs in model 1– (UGS)

Variable	Mean	Standard deviation	Median	Minimum	Maximum
Loans	17,146,756	30,213,536	4,856,161	0	179,961,624
Overdrafts	15,399,700	18,154,842	8,145,826	12,071	110,740,990
Discounts	215,650	589,475	0	0	8,929,053
Government Securities	26,884,536	64,019,086	6,970,000	0	453,199,959
Demand deposits	50,716,826	108,173,723	14,172,649	61,330	607,704,204
Physical capital	5,782,800	7,664,435	3,826,503	29,622	55,517,856
Purchased funds	28,922,114	37,963,599	12,175,027	68,361	211,564,981

Labor	558,862	1,055,448	240,477	2,690	11,457,741

Notes: The zeros reflect nil loans, discounts and government securities for one bank which begun operations around the start of the study period and had not started providing all of the licensed banking activities
Source: Bank of Uganda

In the second model based on the user cost approach, the procedure followed by Yeh (1996) in a study of banks in Taiwan was adopted, where outputs are defined as interest income, non-interest income and total loans. Interest income includes interest on loans and securities. Non-interest income includes service charges on loans and transactions, commissions and other operating income. Total loans comprise of loans and drafts. Inputs are defined as interest expenses, non-interest expenses and total deposits. This model is of particular relevance to the banking industry given that it takes into account receipts from off-balance sheet activities, which form a substantial portion of transactions in banks. Specifically, the commissions and fees included in the non-interest income and the income from transactions involving foreign exchange reported in the interest income section of the profit and loss accounts of banks are inclusive of receipts from related off-balance sheet activities. Interest expenses include expenses for deposits and other borrowed money. Non-interest expenses include service charges and commissions, expenses associated with fixed assets and general management affairs, salaries and other expenses. Total deposits are deposits and purchased funds for bank operations and the sources of loanable funds for investment. The descriptive statistics of the variables for the user cost approach are shown in Table 6.

The distance function in Equation 2 is independent of units of measurement in the inputs and outputs. However, since the Malmquist indices involve comparisons across time, all the shilling values are converted to 2000 prices using the consumer price index.

Table 6: Descriptive statistics of inputs and outputs in model 2– (UGS)

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
Interest income	2,683,995	1,171,609	50,481,984	1,685	4,481,897
Non-interest income	1,379,024	724,250	19,010,644	-73,204	2,133,191
Total loans	32,762,106	13,656,485	234,682,886	97,816	44,520,833
Interest expenses	559,313	290,850	3,946,063	387	675,308
Non-interest expenses	1,919,024	1,003,708	35,222,058	16,461	3,388,857
Deposits	79,078,103	28,679,325	792,424,399	136,135	141,463,447

Source: Bank of Uganda

Data for productivity determinants

Bank specific factors such as bank size, income structure, asset quality, capital adequacy, earning ratios and liquidity ratios are selected to assess how they affect productivity and are obtained from Bank of Uganda. Some descriptive statistics of these factors and the TFP estimates derived are provided in Table 7.

Table 7: Summary of descriptive statistics for all variables

Variable	Description	Mean	Median	Max	Min	Std. Dev.
TFP1	TFP change (model 1)	1.033	0.991	3.843	0.239	0.310
TFP2	TFP change (model 2)	1.029	1.003	2.881	0.025	0.248
ASTAR	Ratio of assets to total assets	5.870	2.954	31.191	0.058	6.723
CCRWA	Ratio of core capital to risk-weighted assets	20.583	16.057	244.230	-77.232	33.791
EQTA	Ratio of equity to total assets	11.232	4.646	77.866	0.021	16.296
NPTA	Ratio of non-performing advances to total advances	19.815	6.836	366.095	0.000	33.149
RTOA	Return on assets	0.630	1.118	5.858	-21.361	2.160
TATD	Ratio of total assets to total deposits	54.063	52.987	146.620	0.000	22.420
REER	Real effective exchange rate	97.860	95.250	124.290	82.190	11.992
INTR	Real interest rate	1.194	1.200	1.290	1.090	0.039
EXP	Ratio of assets for all foreign banks to total bank assets	86.952	86.857	93.806	82.944	2.730

Source: Author's calculations

5. Empirical results

Aggregate banking sector efficiency dynamics

In order to estimate technical efficiency, the linear programming equations represented in Equation 6 were solved for each bank in each time period. Detailed quarterly results on productivity change are reported in Tables 8 and 9. These tables show productivity change for all banks in the sample based on the value added and user cost approaches respectively. Entries in the tables show changes between quarters while the means are derived as geometric means over the entire sub-period for each of the two sub-periods. The overall mean is the geometric mean of the entire period while percentage changes are derived as the difference between the component of productivity change and 1 expressed as a percentage.

Towards the end of the first half of the period (1993 to 1999) the banking sector was in a crisis. This culminated in the restructuring of weak banks and closure of insolvent banks. The period after 1999 was marked by improved regulation and supervision in addition to adoption of new technology such as the use of automatic teller machines (ATMs) and developments in the payments system. The Central Banks regulatory and supervisory roles were also strengthened by the new Financial Institutions Act 2002, which deterred insider lending and equity concentration among other things. The introduction of a risk-based approach following the passing of this Act and subsequent recruitment and training of new staff in the supervision department were key developments in the post-1999 period. However, the efficiency measures show that there were both improvements and deterioration over the entire period. This could possibly be explained by the bank's failure to consolidate the productivity gains that occurred particularly in the second sub-period. The only exception is in scale efficiency change towards the last three to four years, which was more stable, compared to the other components of TFP. As seen in Tables 8 and 9 none of the components of the TFP change index exhibited a steady trend during the entire period.

Table 8: Malmquist index summary of quarterly means for all banks – Model 1

Period	techch	% ch	pech	% ch	sech	% ch	TFPch	% ch
1994Q1/1993Q4	1.251	25.1	1.005	0.5	0.994	-0.6	1.250	25.0
1994Q2/1994Q1	1.071	7.1	0.993	-0.7	0.986	-1.4	1.048	4.8
1994Q3/1994Q2	0.959	-4.1	1.017	1.7	0.973	-2.7	0.949	-5.1
1995Q1/1994Q3	1.162	16.2	0.984	-1.6	0.997	-0.3	1.141	14.1
1995Q2/1995Q1	0.899	-10.1	0.983	-1.7	1.012	1.2	0.894	-10.6
1995Q3/1995Q2	0.941	-5.9	0.991	-0.9	0.917	-8.3	0.854	-14.6

1995Q4/1995Q3	0.906	-9.4	1.051	5.1	0.985	-1.5	0.938	-6.2
1996Q1/1995Q4	1.035	3.5	0.971	-2.9	1.116	11.6	1.121	12.1
1996Q2/1996Q1	1.019	1.9	0.965	-3.5	1.020	2.0	1.002	0.2
1996Q3/1996Q2	0.967	-3.3	1.016	1.6	0.892	-10.8	0.876	-12.4
1996Q4/1996Q3	0.906	-9.4	1.051	5.1	0.985	-1.5	0.938	-6.2
1997Q1/1996Q4	1.038	3.8	0.970	-3.0	1.001	0.1	1.009	0.9
1997Q3/1997Q1	1.127	12.7	1.012	1.2	1.092	9.2	1.246	24.6
1997Q4/1997Q3	0.893	-10.7	0.980	-2.0	1.003	0.3	0.877	-12.3
1998Q1/1997Q4	0.913	-8.7	0.993	-0.7	0.972	-2.8	0.881	-11.9
1998Q2/1998Q1	1.001	0.1	0.991	-0.9	0.976	-2.4	0.968	-3.2
1998Q4/1998Q2	0.882	-11.8	1.058	5.8	1.042	4.2	0.972	-2.8
1999Q1/1998Q4	1.127	12.7	0.960	-4.0	0.973	-2.7	1.054	5.4
1999Q2/1999Q1	0.917	-8.3	0.976	-2.4	1.026	2.6	0.918	-8.2
1999Q3/1999Q2	0.927	-7.3	1.015	1.5	1.034	3.4	0.974	-2.6
1999Q4/1999Q3	1.013	1.3	0.938	-6.2	1.006	0.6	0.957	-4.3
Mean	0.993	-0.7	0.996	-0.4	0.999	-0.1	0.988	-1.2
2000Q1/1999Q4	1.042	4.2	1.026	2.6	1.025	2.5	1.096	9.6
2000Q2/2000Q1	1.086	8.6	0.995	-0.5	0.947	-5.3	1.023	2.3
2000Q3/2000Q2	1.016	1.6	0.967	-3.3	1.010	1.0	0.992	-0.8
2000Q4/2000Q3	0.954	-4.6	1.075	7.5	1.028	2.8	1.054	5.4
2001Q1/2000Q4	0.978	-2.2	1.048	4.8	0.925	-7.5	0.947	-5.3
2001Q2/2001Q1	1.064	6.4	0.972	-2.8	1.063	6.3	1.098	9.8
2001Q3/2001Q2	1.026	2.6	1.027	2.7	1.006	0.6	1.061	6.1
2001Q4/2001Q3	0.960	-4.0	1.009	0.9	1.033	3.3	1.000	0.0
2002Q1/2001Q4	1.132	13.2	0.993	-0.7	0.996	-0.4	1.119	11.9
2002Q2/2002Q1	0.930	-7.0	1.007	0.7	1.003	0.3	0.939	-6.1
2002Q3/2002Q2	1.048	4.8	0.988	-1.2	0.995	-0.5	1.030	3.0
2002Q4/2002Q3	1.042	4.2	0.994	-0.6	0.989	-1.1	1.025	2.5
2003Q1/2002Q4	1.067	6.7	1.018	1.8	1.003	0.3	1.090	9.0
2003Q2/2003Q1	0.891	-10.9	1.001	0.1	1.008	0.8	0.899	-10.1
2003Q3/2003Q2	0.950	-5.0	0.954	-4.6	1.000	0.0	0.906	-9.4
2003Q4/2003Q3	1.067	6.7	1.011	1.1	0.997	-0.3	1.075	7.5
2004Q1/2003Q4	0.912	-8.8	1.003	0.3	1.006	0.6	0.920	-8.0
2004Q2/2004Q1	0.878	-12.2	1.001	0.1	0.999	-0.1	0.878	-12.2
2004Q3/2004Q2	1.092	9.2	1.011	1.1	0.985	-1.5	1.088	8.8
2004Q4/2004Q3	0.982	-1.8	1.016	1.6	0.985	-1.5	0.982	-1.8
2005Q1/2004Q4	1.090	9.0	0.960	-4.0	1.013	1.3	1.059	5.9
2005Q2/2005Q1	0.891	-10.9	0.952	-4.8	0.973	-2.7	0.826	-17.4
Mean	1.000	0.0	1.000	0.0	0.998	-0.2	0.997	-0.3
Overall Mean	**0.997**	**-0.3**	**0.998**	**-0.2**	**0.999**	**-0.1**	**0.995**	**-0.5**

Source: Author's calculations

Table 9: Malmquist index summary of quarterly means for all banks – Model 2

Period	techch	% ch.	pech	% ch.	sech	% ch.	TFPch	% ch.
1994Q1/1993Q4	0.864	-13.6	0.969	-3.1	0.995	-0.5	0.832	-16.8
1994Q2/1994Q1	0.843	-15.7	1.034	3.4	1.001	0.1	0.872	-12.8
1994Q3/1994Q2	1.028	2.8	0.985	-1.5	0.974	-2.6	0.987	-1.3
1995Q1/1994Q3	1.086	8.6	0.995	-0.5	0.999	-0.1	1.080	8.0
1995Q2/1995Q1	1.146	14.6	0.980	-2.0	1.023	2.3	1.149	14.9
1995Q3/1995Q2	0.972	-2.8	1.044	4.4	0.978	-2.2	0.992	-0.8
1995Q4/1995Q3	1.010	1.0	0.981	-1.9	0.990	-1.0	0.982	-1.8
1996Q1/1995Q4	0.918	-8.2	0.978	-2.2	1.016	1.6	0.911	-8.9
1996Q2/1996Q1	1.155	15.5	1.012	1.2	1.030	3.0	1.203	20.3
1996Q3/1996Q2	0.963	-3.7	1.030	3.0	0.965	-3.5	0.957	-4.3

1996Q4/1996Q3	1.010	1.0	0.981	-1.9	0.990	-1.0	0.982	-1.8
1997Q1/1996Q4	1.099	9.9	1.028	2.8	1.017	1.7	1.148	14.8
1997Q3/1997Q1	1.166	16.6	0.992	-0.8	0.982	-1.8	1.135	13.5
1997Q4/1997Q3	0.858	-14.2	0.983	-1.7	1.040	4.0	0.877	-12.3
1998Q1/1997Q4	0.907	-9.3	0.949	-5.1	1.006	0.6	0.866	-13.4
1998Q2/1998Q1	0.964	-3.6	1.050	5.0	0.998	-0.2	1.011	1.1
1998Q4/1998Q2	1.074	7.4	0.995	-0.5	0.987	-1.3	1.054	5.4
1999Q1/1998Q4	0.932	-6.8	1.022	2.2	0.967	-3.3	0.921	-7.9
1999Q2/1999Q1	1.053	5.3	0.989	-1.1	1.046	4.6	1.090	9.0
1999Q3/1999Q2	0.861	-13.9	1.015	1.5	1.007	0.7	0.881	-11.9
1999Q4/1999Q3	0.995	-0.5	0.955	-4.5	0.988	-1.2	0.939	-6.1
Mean	0.991	-0.9	0.998	-0.2	1.000	0.0	0.988	-1.2
2000Q1/1999Q4	1.013	1.3	1.023	2.3	1.006	0.6	1.042	4.2
2000Q2/2000Q1	1.049	4.9	1.003	0.3	1.002	0.2	1.054	5.4
2000Q3/2000Q2	1.019	1.9	1.026	2.6	0.992	-0.8	1.036	3.6
2000Q4/2000Q3	1.092	9.2	0.948	-5.2	0.985	-1.5	1.020	2.0
2001Q1/2000Q4	1.090	9.0	1.011	1.1	0.982	-1.8	1.082	8.2
2001Q2/2001Q1	0.909	-9.1	1.020	2.0	1.035	3.5	0.960	-4.0
2001Q3/2001Q2	0.999	-0.1	1.012	1.2	1.007	0.7	1.018	1.8
2001Q4/2001Q3	0.878	-12.2	1.001	0.1	0.999	-0.1	0.878	-12.2
2002Q1/2001Q4	1.102	10.2	0.991	-0.9	0.989	-1.1	1.079	7.9
2002Q2/2002Q1	0.993	-0.7	0.972	-2.8	1.016	1.6	0.980	-2.0
2002Q3/2002Q2	0.984	-1.6	1.041	4.1	0.999	-0.1	1.023	2.3
2002Q4/2002Q3	1.035	3.5	0.964	-3.6	0.962	-3.8	0.960	-4.0
2003Q1/2002Q4	1.069	6.9	1.037	3.7	1.012	1.2	1.121	12.1
2003Q2/2003Q1	0.980	-2.0	0.984	-1.6	1.023	2.3	0.987	-1.3
2003Q3/2003Q2	1.032	3.2	0.998	-0.2	0.995	-0.5	1.025	2.5
2003Q4/2003Q3	0.950	-5.0	0.994	-0.6	1.006	0.6	0.950	-5.0
2004Q1/2003Q4	0.960	-4.0	1.007	0.7	0.996	-0.4	0.964	-3.6
2004Q2/2004Q1	1.070	7.0	0.992	-0.8	0.993	-0.7	1.054	5.4
2004Q3/2004Q2	0.986	-1.4	1.003	0.3	0.994	-0.6	0.983	-1.7
2004Q4/2004Q3	0.964	-3.6	1.013	1.3	1.007	0.7	0.984	-1.6
2005Q1/2004Q4	0.920	-8.0	1.004	0.4	1.010	1.0	0.933	-6.7
2005Q2/2005Q1	1.050	5.0	1.007	0.7	0.995	-0.5	1.053	5.3
Mean	1.004	0.4	1.001	0.1	1.000	0.0	1.005	0.5
Overall Mean	**0.998**	**-0.2**	**1.000**	**0.0**	**1.000**	**0.0**	**0.998**	**-0.2**

Source: Author's calculations

Nonetheless, a comparison of the two sub-periods using means shows that in the first model there was a decline of 0.7 % and 0.4 % for technical and pure efficiency changes respectively in the first sub-period compared to no changes in the second sub-periods while in the second model there were improvements of 0.4 % and 0.1 % in the second sub-period compared with declines of 0.9 % and 0.2 % in the first sub-period for both technical and pure efficiency changes respectively. The overall mean shows results for the entire banking sector for the two models; the results suggest that the sector became less efficient over the 44 quarters by 0.5 % in model 1 and 0.2 % in model 2. However, the declines in TFP change over the entire period are on account of the deteriorations that occurred during the first sub-period despite some offsetting improvements over the second period. The two models show conflicting results for scale efficiency change with model 1 showing an overall decline of 0.2 % and model 2 showing no change over the entire period. It is possible that the role of off-balance sheet activities, which have grown in both size and sophistication over the review period partly, explain the better results for scale efficiency in the second model.

The overall index shows deterioration in productivity during the first sub-period of 1.2 % followed by a smaller deterioration in the second sub-period of 0.3 % in the first model. The deterioration in the first sub-period is dominated by deterioration in technical efficiency while in the second sub-period; the deterioration in scale efficiency accounts for the decline in total productivity. In the second model, productivity change improvements in the second sub-periods are more than offset by deteriorations during the first sub-period. However, as in the first model, the second model's deterioration in the first sub-period is dominated by technological deterioration. The developments in the regulatory regime which improved considerably post-1999 in addition to the significant strides that were taken by government to liberalize the banking sector particularly support the results observed in the second sub-period. Other developments such as the introduction of ATMs, electronic banking and improvements in the payments system such as the introduction of an electronic funds transfer system and real time gross settlement scheme in the post-1999 period have equally contributed to the overall improvement in productivity during this period.

The biggest changes in TFP at the aggregate bank level were deteriorations that occurred in 1997 and 1998 and improvements occurring in the years 1995, 1996 and 2002. The large deteriorations in productivity in 1997–1998 coincided with the closure of the first bank on the grounds of insolvency and insider lending. It is therefore intuitive that the closure of this bank may have had a negative impact on other banks. In fact the subsequent closure of other banks, which had similar problems in 1999, reaffirms the deteriorations in productivity in this period. The reduction of government intervention in credit allocation and the positive gains that may have resulted from the completion of the liberalization of interest rates and exchange rates in the two years before 1995/96 could have contributed to the improvement in productivity in the period. The resolution to privatize UCB in 2002 also coincides with improvements that occurred in the banking sector in the same year. This suggests that the privatization of the commercial bank may have positively affected productivity of the entire sector.

Individual bank efficiency dynamics

At the individual bank level, measures for changes in TFP in model 1 show improvements among four foreign banks and one local bank over the entire period, explained entirely by technological improvements. There were no changes in pure and scale efficiency for the majority of banks. However, three foreign banks had a decline in pure efficiency compared to one local bank. The same local bank also had a decline in scale efficiency although the gains in technological efficiency were more than enough to offset the decline in efficiency change. One foreign bank was also able to increase its scale efficiency in addition to increasing its technical efficiency. The combined improvements in both scale and technical change more than offset the decline in pure efficiency resulting in increased TFP for the bank. The results in Table 10 show the efficiency change measures by bank obtained from model 1.

Table 10: Individual bank efficiency change measures – model 1

Bank	Ownership	Efficiency change index	Technical change index	Pure efficiency change index	Scale efficiency change index	TFP change index
1	Foreign	0.997	1.009	0.996	1.001	1.006
2	Foreign	1.000	1.013	1.000	1.000	1.013
3	Foreign	1.000	0.982	1.000	1.000	0.982
4	Local	0.985	1.021	0.992	0.993	1.006
5	Local	1.000	0.974	1.000	1.000	0.974
6	Foreign	1.000	0.999	1.000	1.000	0.999
7	Foreign	0.994	1.011	0.996	0.999	1.005
8	Local	1.000	0.984	1.000	1.000	0.984
9	Foreign	1.000	0.975	1.000	1.000	0.975
10	Foreign	1.000	1.025	1.000	1.000	1.025
11	Foreign	0.994	0.980	0.998	0.996	0.974
Mean		0.997	0.997	0.998	0.999	0.995

Source: Author's calculations

In the second model, individual bank measures for changes in efficiency show technical change improvements among seven banks compared to only four shown in the first model. Among the seven banks that had technological improvements over the period, six were foreign owned while one was locally owned (the same bank that had technological improvement in the first model). Only one foreign bank and one local bank were able to increase their efficiency over the period. The increase in efficiency in the case of the foreign bank resulted from an improvement in scale efficiency while an increase in pure efficiency accounted for the efficiency change in the case of the local bank. The driving force therefore explaining the improvements in TFP for the seven banks during the period was technological improvement. All banks that registered improvements in model 1 also showed improvements in model 2. It is therefore reasonable to assume that model 2 performs better than model 1. The efficiency change measures by bank are shown in Table 11.

Nonetheless, the apparent overall decline in total productivity for all banks, especially for local banks need not necessarily reflect a decline in average productivity. This is because a favourable increase in production possibilities stemming from regulatory changes and from improvements in production inputs or methods could account for the decline. The fact that there were no significant deteriorations in both pure efficiency and scale efficiency among most banks in both models lends support to this argument. Subsequently, banks that were not able to adopt any new technological advances became increasingly inefficient relative to banks that adopted the new technology during the same period.

Table 11: Individual bank efficiency change measures – model 2

Bank	Ownership	Efficiency change index	Technical change index	Pure efficiency change index	Scale efficiency change index	TFP change index
1	Foreign	0.998	1.004	1.000	0.999	1.002
2	Foreign	1.000	1.025	1.000	1.000	1.025
3	Foreign	1.000	1.022	1.000	1.000	1.022

4	Local	1.002	1.015	1.002	1.000	1.017
5	Local	1.001	0.989	1.000	1.000	0.990
6	Foreign	1.000	0.922	1.000	1.000	0.922
7	Foreign	1.001	1.017	1.000	1.001	1.018
8	Local	0.999	0.976	1.000	0.999	0.975
9	Foreign	1.000	1.005	1.000	1.000	1.005
10	Foreign	1.000	1.012	1.000	1.000	1.012
11	Foreign	1.000	0.993	1.000	1.000	0.993
Mean		1.000	0.998	1.000	1.000	0.998

Source: Author's calculations

It is therefore implied that only those banks that experienced a decline in output relative to input usage became less productive during the period. Thus it is conceivable that the productivity change deteriorated for most of the local banks, which are usually slower than foreign banks in adopting technological improvement. Moreover, local banks have had a history of large non-performing loans due to inadequate screening of borrowers and massive insider lending. In addition, these banks employ personnel with lower skills than those employed in foreign banks. Hyuha and Ddumba-Ssentamu (1994) noted that local banks especially the state-owned banks were susceptible to government interference; this is not the case for foreign banks. Government interference in local banks was generally observed in the determination of loan sizes, interest rates and other charges, bank clients, management and staff recruitment and credit allocation. Subsequently, local banks were more prone to having large non-performing loans as well as inefficient manpower.

Regression results on determinants of productivity change

Regression equations were estimated for the micro and macro level determinants of TFP in banks over the period 1993 to 2005. The indices of TFP change derived from the two models specified for the different input–output combination components were used as the dependent variables. In the specification, the change in TFP was modelled as a function of the ratios of assets to total bank assets (ASTAR), equity to total assets (EQTA), core capital to risk-weighted assets (CCRWA), non-performing advances to total advances (NPTA), total assets to total deposits (TATD), return on assets (RTOA), real effective exchange rate (REER), real interest rate (INTR), and the level of foreign penetration (EXP). The choice of variables used was intended to assess the influences of market concentration, share holders stake in banks, capital adequacy, asset quality, liquidity, and earnings respectively on TFP change in the banking sector and the effects of selected macro variables during the period.

Before estimating the equations, an examination of the properties of the underlying data was effected. Testing for stationarity of the time series was done to ensure that the variables used in the regressions were not subject to spurious correlation. For the variables on change in TFP (TFP1 and TFP2), the results indicated no presence of unit roots. The test statistics of the Levin-Lin-Chu (LLC), Breitung test, Im-Pesaran-Shin (IPS), and both Fisher tests rejected the null of a unit root. Similarly, the Hadri test statistic, which tests the null of no unit root, failed to reject the absence of unit roots.

Table B1 in Appendix B shows the test results.

The unit root test results on the variable for bank size (ratio of individual bank assets to total bank assets) indicated the presence of a unit root. The LLC, Breitung, IPS, and the ADF Fisher tests failed to reject the null of a unit root while the Hadri test statistic, strongly rejects the null of no unit root. However, the PP Fisher test rejected the null of a unit root at a 10 % level of significance (see Table B2 in Appendix B). Going by the results from most of the tests we concluded that there was a unit root and detrended the ratio of assets to total bank assets by regressing it on a constant, time trend and its own significant lag. The unit root test for the detrended variable is shown in Table B2 and all tests with the null of a unit root reject the null while the Hadri test accepts the null of a no unit root. As in the case of the index of TFP change, all unit root tests on the remaining variables (CCRWA, EQTA, NPTA, RTOA and TATD) with the exception of the Breitung test for the ratio of CCRWA and the Hadri test for CCRWA, NPTA, RTOA and TATD rejected the presence of unit roots. Since most of the tests confirmed that the variables were I (0), contradicting results from the Breitung test for CCRWA and the Hadri test for CCRWA, NPTA, RTOA and TATD were ignored. Table B3 in Appendix B provides the test results. Variables for the real effective exchange rate and the level of foreign penetration had unit roots while the real interest rate did not have a unit root.

Having established the order of integration, estimation was effected using a two-way fixed effects error component model. In addition to the fixed effects model, estimates for a one-way error components model with period random effects and two-way error components model with cross section fixed effects and period random effects were made. A fourth equation was estimated for all variables including the macro variables under the assumption of common coefficients for all banks. The fifth equation had all variables although the assumptions were changed to specific coefficients for banks in respect of bank level variables. For the fixed effects model, the significance of the unobservable individual effects of each bank and the unobservable time effects was determined using the redundant fixed effects test. The test confirmed the joint significance of cross section and time fixed effects. The test results are shown in Table B4 in Appendix B and the results for the estimated regression equations are shown in Table 12.

The regression estimates based on a balanced panel for the two TFP change estimates were estimated using the error components model. The estimates for TFP2 as the dependent variable on the respective bank specific variables provided more noteworthy results with more significant variables compared to the equation with TFP1 as the dependent variable. In addition, the regression for the determinants of TFP2 provided a better fit. Bank size did not have a significant effect on productivity although Berger et al. (1993) noted that large banks operated at levels closer to the efficiency frontier than smaller banks.

Capital adequacy was negatively associated with TFP and statistically significant at a level of 5 %. The result suggests that banks can raise their productivity by reducing the capital ratio. This is particularly the case if the current capital ratios are compared with the mandatory levels prescribed in the regulations. The average capital ratio for banks in the sample is 20.5 % (see Table 7) compared to the minimum required level of 8 % in the regulations. This suggests that banks have not optimally utilized the available capital.

Table 12: Summary of the regression estimates of TFP determinants

Variable	1	2	3	4	5
Constant (C)	0.9432***	0.9212***	0.9017***	0.5071	
	(0.0358)	(0.0422)	(0.0520)	(0.3456)	
Bank size (ASTAR)	-0.0085	-0.0066	-0.0122	-0.0072	
	(0.0118)	(0.0121)	(0.0125)	(0.0071)	
Capital adequacy (CCRWA)	-0.0013***	-0.0014***	-0.0015***	-0.001382*	
	(0.0005)	(0.0005)	(0.0006)	(0.0008)	
Ownership stake (EQTA)	0.0025**	0.0032*	0.0037*	0.0029*	
	(0.0010)	(0.0018)	(0.0019)	(0.0016)	
Liquidity (TATD)	0.0011*	0.0014**	0.0015*	0.0011*	
	(0.0006)	(0.0006)	(0.0008)	(0.0006)	
Assets quality (NPTA)	0.0004	0.0003	0.0006	0.0003	
	(0.0004)	(0.0004)	(0.0005)	(0.0003)	
Return on assets (RTOA)	0.0294***	0.0299***	0.0301***	0.0265**	
	(0.0067)	(0.0073)	(0.0075)	(0.0111)	
Change in the REER				0.00577**	
0.0058**					
				(0.0028)	(0.0027)
Real interest rate				0.3669	0.29044
				(0.2932)	(0.3645)
Foreign bank penetration				0.6477	1.2989
				(0.9990)	(1.1955)
Period Dummy				-0.0099	-0.0034
				(0.0237)	(0.0334)
R-squared	0.0561	0.0673	0.1808	0.0681	0.2477
Adjusted R-squared	0.0437	0.0338	0.0652	0.0469	0.0851
Durbin-Watson stat	2.437	2.4535	2.4814	2.4933	2.4781

Notes: The dependent variable is TFP2. 1 refers to estimates with random period effects, 2 refers to estimates with fixed cross section and random period effects while 3 refers to estimates with fixed cross section and period effects. Equation 4 provides estimates based on the assumption that banks have common coefficients for all regressors. Equation 5 provides estimates based on the assumption that banks have common coefficients for all macro variables but specific coefficients for bank-specific regressors. Coefficients for bank specific regressors are not shown in the table due to space constraints. Figures in parentheses are standard errors. *, ** and *** refer to significant variables at 10, 5 and 1 % level.
Source: Author's calculations

Increase in shareholders stake is positively associated with banks performance and is statistically significant at a 10 % level. This result suggests that banks, whose shareholders have a large stake, are likely to perform better possibly due to increased interest of shareholders in bank performance. Bank liquidity bears a positive and statistically significant effect on performance. This suggests that from a bank perspective, it is rational to hold high liquidity levels. This is however, detrimental to social efficiency in the sense of provision of credit to the non-bank sector.

Private lending is only around 5% of GDP—a third of the sub-Saharan African average and significantly below the low-income countries average (IMF 2006). Moreover, the agricultural sector, which accounts for over a third of GDP, only receives about 10 % of private sector lending (IMF 2006).

Asset quality has a positive effect on bank performance confirming that bad loans affect bank profitability and efficiency. This result, however, is not statistically significant at conventional levels of significance although, a related result is that bank profitability bears a positive and highly significant effect on bank productivity. A possible explanation for this finding is that profitable banks are able to reinvest some of the earnings to enhance productivity.

The real effective exchange rate is positively associated with bank productivity and statistically significant at a level of 5 %. This suggests that bank performance is vulnerable to a depreciation of the real effective exchange. A possible explanation for this result is that bank lending is concentrated among importers whose activity and profitability, and therefore ability to pay their loan obligations, are boosted by exchange rate appreciation. The real interest rate has a positive sign although it is not significant. It is therefore not possible to conclude that liberalization has had a positive effect on bank productivity at the aggregate level. A similar result is obtained when the real Treasury bill rate is used instead of the real interest rate. The interest rate spread, which is another potential variable for determining how liberalization has affected productivity, was not used in the regression because it did not show a declining trend over the liberalization period. On the contrary it was found to be stable over the period oscillating between 8 and 14 percentage points. A possible explanation for this behaviour is that the risk and administrative cost associated with bank lending to the private sector has not come down as expected over the review period. The period dummy, suggests that the first half of the period 1994 to 1999 was negatively associated with productivity, although the effect was not significant. The level of foreign penetration is positively related to productivity although its effect is not statistically significant.

Robustness

The general finding is that TFP change declined over the period 1993 to 2005. In addition, the regression results for the determinants of TFP change from the second model suggest that capital adequacy negatively affected TFP while increases in the shareholders stake in bank assets, bank liquidity and performance in terms of earnings affected productivity positively. Some tests on the robustness of these results are carried out. First TFP change derived using the second model is re-estimated using reduced samples. The first sample excludes the largest bank while the second sample excludes the smallest bank. The results are compared with those derived for the entire sample comprised of 11 banks (see Table 13 for the results).

Table 13: Robustness test for estimates of TFP change and its components

Bank	Efficiency change	Technical change	Pure efficiency change	Scale efficiency change	TFP change
All 11 Banks	1.000	0.998	1.000	1.000	0.998
Excludes largest bank	1.001	0.993	1.000	1.001	0.993
Excludes smallest bank	1.001	0.991	1.000	1.001	0.992

Source: Author's calculations

Whether the largest or smallest bank is excluded from the sample, change in TFP shows a decline. This conforms to the results when the total sample of 11 banks is used. Nonetheless, the decline in the TFP change excluding the largest bank is smaller than when the smallest bank is excluded. Moreover, the estimates for TFP change excluding the smallest and largest banks are smaller than estimates derived for the entire sample of 11 banks. The differences in the estimates for the three samples appear to be driven by developments in technical change. Other TFP change components appear to be the same irrespective of exclusion of the largest or smallest bank. A test was conducted to determine whether the difference between the estimates from the whole sample of 11 banks and the smaller samples excluding the largest and smallest bank respectively was significant. A paired sample t-test for the difference in means was carried out. The results of the test for estimates of TFP change and its components are shown in Table 14.

Table 14: Paired sample t-test for the difference between means for the entire sample and means for the reduced sample

Variable	Paired difference means	t-statistic	df	Sig. (2 -tailed)
Efficiency change	All 11 banks and excl largest bank	0.36	42.00	0.72
	All 11 banks and excl smallest bank	0.31	42.00	0.76
Technical efficiency change	All 11 banks and excl largest bank	0.86	42.00	0.40
	All 11 banks and excl smallest bank	0.78	42.00	0.44
Pure efficiency change	All 11 banks and excl largest bank	0.21	42.00	0.84
	All 11 banks and excl smallest bank	0.15	42.00	0.88
Scale efficiency change	All 11 banks and excl largest bank	0.36	42.00	0.72
	All 11 banks and excl smallest bank	0.30	42.00	0.77
TFP change	All 11 banks and excl largest bank	0.84	42.00	0.41
	All 11 banks and excl smallest bank	0.76	42.00	0.45

Source: Author's calculations

In all cases the test suggests that the estimates for the entire sample are not significantly different from those derived using the reduced samples which exclude the largest and smallest bank respectively. Secondly, estimates from the two reduced samples were used to run the model for the determinants of TFP change. A summary of the results is given in Table 15.

Table 15: Summary of the regression estimates of TFP determinants from the reduced samples

	1	2	3	1	2	3
Variable	Sample excluding largest bank			Sample excluding smallest bank		
Constant (C)	0.9411***	0.9152***	0.9013***	1.0341***	1.0201***	1.0011***
	(0.0389)	(0.0460)	(0.0561)	(0.0422)	(0.0464)	(0.0547)
Bank size (ASTAR)	-0.0115	-0.0089	-0.0152	-0.0024	0.0005	-0.0055
	(0.0133)	(0.0137)	(0.0143)	(0.0110)	(0.0113)	

(0.0117)					
Capital adequacy (CCRWA)	-0.0012**	-0.0013**	-0.0013**	-0.0038***	-0.0042*** -0.0047***
	(0.0005)	(0.0005)	(0.0006)	(0.0010)	(0.0011) (0.0012)
Ownership stake (EQTA)	0.0023**	0.0032*	0.0037*	0.0034**	0.0051** 0.0062***
	(0.0010)	(0.0019)	(0.0020)	(0.0014)	(0.0020) (0.0022)
Liquidity (TATD)	0.0011*	0.0014**	0.0014*	0.0001	0.0003 0.0006
	(0.0006)	(0.0007)	(0.0008)	(0.0006)	(0.0007) (0.0008)
Assets quality (NPTA)	0.0004	0.0003	0.0007	-0.0002	-0.0003 -0.0002
	(0.0005)	(0.0005)	(0.0006)	(0.0004)	(0.0004) (0.0005)
Return on assets (RTOA)	0.0285***	0.0288***	0.0287***	0.0316***	0.0321*** 0.0324***
	(0.0069)	(0.0075)	(0.0078)	(0.0068)	(0.0074) (0.0076)
R-squared	0.0561	0.0680	0.1931	0.0693	0.0824 0.1917
Adjusted R-squared	0.0424	0.0333	0.0686	0.0558	0.0483 0.0670
Durbin-Watson stat	2.4327	2.4502	2.4841	2.5396	2.5595 0.0114

Notes: The dependent variable is TFP2. 1 refers to estimates with random period effects, 2 refers to estimates with fixed cross section and random period effects while 3 refers to estimates with fixed cross section and period effects. The numbers in parentheses are standard errors. *, ** and *** refer to significant variables at 10%, 5% and 1 % level.
Source: Author's calculations

The regression estimates from the reduced samples support estimates derived for the whole sample. In both cases, capital adequacy negatively affected TFP while increases in the shareholders stake in the banks' assets, bank liquidity and performance in terms of earnings affected productivity positively. The positive effect of return on assets on productivity change is stronger when the smallest bank is removed from the sample and smaller when the largest bank is removed from the sample. This suggests that while large banks may not be more efficient than small banks, they are able to use their size to mobilize higher returns. This justifies the continued operation of many branches among the large banks. From these results it is possible to conclude that the results are to a large extent not driven by the heterogeneity of the banking sector in respect to size.

6. Conclusion

In summary, the banking system has undergone significant reform. Public confidence in the banking system has improved following the banking crisis between 1997 and 1999. Indeed, government intervention in the banking system meant that banks, which were riddled with non-performing loans and were insolvent by the end of the 1990s, were removed. Part of the reform process involved the setting up of the Non-Performing Assets Recovery Trust (NPART) in 1995 to recover the bulk of the unpaid loans. In 1998 and 1999 banking supervision improved significantly; interventions in four banks led to their closure. The branch network continued to expand after the privatization of UCB, the closure of distressed banks and the strengthening of supervision. In addition, bank asset quality and profitability improved substantially. Risk portfolio also improved with nonperforming loans falling from 29% of the portfolio in 1998 to 12 % at end September 2004 (Bank of Uganda 2005; Hauner and Peiris, 2005). Overall, the 0.5% increase in TFP during the period after 1999 compared to a deterioration of 1.2% confirms the positive developments in the sector.

The results of the study also provide evidence of improvement in productivity of foreign banks largely explained by technical change. Out of the 11 banks (seven foreign and four local) included in the study, there were improvements in seven banks (six foreign banks and one local) over the period. The average improvement in productivity among the seven banks is estimated at 1.4%. This suggests that foreign banks have had a positive impact on the banking sector's productivity especially in the period after 1999. Nonetheless, caution needs to be exercised when opening up for new foreign banks to ensure that the liberal environment does not create foreign entities, which due to concentration become too-big-to-fail or too-big-to-discipline. It is therefore important to carefully determine commitments to bind in the financial services agreement under the GATTS and how to progressively liberalize the sector further.

In terms of factors determining productivity, capital adequacy bears a negative significant effect on productivity suggesting that banks can raise their productivity by reducing the capital ratio. Moreover, it is evident that banks have maintained levels of capital adequacy that exceed the minimum required level as per the regulations. It can therefore be argued that they have not optimally utilized the available capital. Results indicate that increasing the ownership stake in bank assets positively affects productivity suggests that shareholders take a keener interest in the affairs of their banks as their stake increases. Bank liquidity and bank profitability were found to bear positively on bank performance. However, that banks prefer lending to government suggesting that while some banks especially the foreign banks may have realised improved TFP over the period, they shied away from performing the role of credit allocation. Therefore, it may not be

possible to conclude that the observed improved TFP for the seven banks translated into social efficiency in terms of fulfilling savings mobilisation and credit extension.

Consequently, second generation policies are required to improve efficiency of banks in terms of fulfilling their financial intermediation role. An important emerging area of policy should focus on addressing major impediments to lending such as insufficient enforcement of already weak creditor rights, lack of information about borrowers, and administrative barriers to using assets as collateral. This should be augmented by policies aimed at resolving structural bottlenecks that include addressing infrastructure bottlenecks relating to production of electric power, transport, communication and other public utilities. The high costs of these utilities undermine the competitiveness of Ugandan banks. The Central Bank will also need to embrace the increased use of foreign exchange sales whenever market conditions permit for sterilizing external aid financing. This will reduce bank reliance on treasury securities for investment opportunities, which has been associated with crowding out of credit to the private sector.

An important caveat regarding the results is the imposed data restriction resulting in a sample of only surviving banks during the period of study. Subsequently, all failed banks and new banks during the period 1993 to 2005 were excluded from the analysis. This sample restriction is largely a result of lack of reliable data on failed banks and insufficient data on new banks. The findings should therefore be used with this consideration. Nonetheless, the findings provide an important contribution towards understanding the progress that has been made thus far in improving productivity among banks in Uganda.

Notes

1. Comments received during the AERC review mechanism and the anonymous reviewers are gratefully acknowledged.

2. The principal aims of the reform processes have been to raise the level and efficiency of the allocation of investment and to enhance the provision of financial services to all sectors of the economy. Liberalization and reform were meant to boost efficiency and productivity by enhancing the role of the market and limiting state involvement.

3. Bank ownership is measured in terms of the majority shareholder (50 % or more). Banks whose majority shareholders are Ugandans are classified as locally owned banks while those whose majority shareholders are non-Ugandans are classified as foreign-owned banks. Going by this classification procedure, there has been little if any change in the ownership structure of banks with the exception of the largest state-owned bank, which was privatized through the sale of its shares to an existing foreign-owned bank. The state-owned bank is however, excluded from the banks whose TFP is measured.

4. The reforms have been protracted. They go back to 1993 when a new Financial Institutions bill and the Bank of Uganda Charter were enacted clarifying the role of BoU as a regulator and supervisor.

5. For inputs the formal definition is: if y can be produced from x then y can be produced from any $x^* \geq \in x$ · For outputs it is: if $y \in P(x)$ and $y^* \leq y$ then $y^* \in P(x)$.

6. See Fare et al. (1994); Wheelock and Wilson (1995) and Isik and Hassan (2003 for a detailed description of efficiency and productivity indices.

7. Technical change may indicate a technical progress in case the production frontier, which depicts the maximum performance possible by banks, shifts upward or technical regress if the frontier shifts downward. The former results from financial innovation or increased competition while the latter may stem from financial sector fragility (Isik and Hassan (2003).

8. Macroeconomic factors could include headline inflation, Treasury bill rates, degree of financial liberalization measured by the spread between lending and deposit rates or exchange rate depreciation.

9. Candidates for bank specific factors include ownership, size, concentration, non-performing portfolio, total assets, cost of funds, cost of fixed assets and administrative expenses.

10 Dummy variables may help to understand the behaviour of foreign banks, small banks, local banks and the post liberalization phase.

11. Kasekende and Atingi-Ego (2003) highlight the significance of interest rate and exchange rate liberalization to the financial sector.

12. Section 27 of the Financial Institutions Act 2004 requires banks to maintain a core capital ratio of 8 %.

13. On average, 50 % of the loan portfolio of banks is shared equally among manufacturers and traders. The largest share of loans provided to manufacturers is for imported inputs while most of the loans for trade are accessed by wholesalers for importation (See Bank of Uganda Bank Supervision annual reports 1999 to 2005).

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Domestic financial liberalization

Appendix A

Interest rates

- 1988: Removal of credit ceilings and raising of interest rates by 10%
- 1989: Adopted adjustment of interest rates with inflation rate changes to deliver positive real interest rates.
- 1992: Adopted an auction-based Treasury bill market with key interest rates linked to the weighted average of the t-bill rate marking the beginning of the decontrol of interest rates.
- 1994: Full liberalization of interest rates
- 2003: Licensed primary dealers authorized to trade in government securities in the secondary market leading to the discontinuation of the rediscount facility.
- 2004: Introduced a government treasury bond whose primary role was to ease pressure on the lower end of the market although served also as a reference for pricing long term secondary market instruments.

Pre-competition measures

- 1991: Lowering of entry barriers.
- 1993: Introduction of the shilling inter-bank money market, introduction of the rediscount facility and removal of restrictions on Treasury bill holdings.
- 1996: Institution of a two (2) year moratorium on licensing of new Banks
- 1997: Extension of the two (2) year moratorium on licensing of new Banks
- 2005: Lifting of moratorium on licensing of new Banks

Reserve requirements

- 2000: Increase of Commercial Bank minimum paid up capital

Directed credit and credit ceilings

- 1988: New credit scheme for rural farmers
- 1989: Removal of directed credit facilities towards crop finance
- 1991: Reinstitution of directed credit to coffee farmers through banks.

Banks ownership

- 1998: Privatization of Uganda Commercial Bank
- 1999: Withdrawal of management of UCB from buyers and placement of its

management under Bank of Uganda.
- 2002: Sale of government shares in Bank of Baroda on the securities exchange.
- 2002: Second privatization of UCB

Prudential regulation

- 1993: Enactment of the Bank of Uganda Statute 1993 and the Financial Institutions Statute 1993 enhancing Bank of Uganda's monetary and supervisory authority.
- 1994: Introduction of penalties to banks for late or non-submission of returns
- 1999: Imposition of strict penalties by defiant bank owners on default in regard to bank law.
- 2003: Review of the Financial Institutions Bill and strengthening of prudential regulations
- 2003: Enactment of the Micro Finance Deposit taking Institutions Act

Securities market

- 1995: Presentation of the Capital Market Authority Bill to parliament providing a framework for a private sector securities market.
- 1996: Establishment of a board of the Capital Markets Authority
- 1997: Licensing of the Uganda Securities Exchange.

International financial liberalization

- 1986: Adoption of a dual exchange rate system from a fixed exchange rate system
- 1990: Legalization of the parallel foreign exchange market
- 1992: Introduction of a foreign exchange auction system marking the transition from a fixed exchange rate regime towards a market based exchange rate system.
- 1993: Introduction of an inter-bank foreign exchange market
- 1993: Current account liberalization.
- 1997: Liberalization of capital account transactions

Appendix B

Table B1: Summary of Unit Root tests on TFP change

Variable	Method	Statistic	Prob.**	Cross-sections	Obs	Lags (Selected automatically by the SIC)
TFP1	Null: Unit root (assumes common unit root process)					
	Levin, Lin & Chu t*	-23.2173	0.0000	11	457	0 to 2
	Breitung t-stat	-11.6651	0.0000	11	446	
	Null: Unit root (assumes individual unit root process)					
	Im, Pesaran and Shin W-stat	-21.8674	0.0000	11	457	
	ADF - Fisher Chi-square	339.3800	0.0000	11	457	
	PP - Fisher Chi-square	391.3450	0.0000	11	462	
	Null: No unit root (assumes common unit root process)					
	Hadri Z-stat	0.4769	0.3167	11	473	
TFP2	Null: Unit root (assumes common unit root process)					
	Levin, Lin & Chu t*	-26.7182	0.0000	11	457	0 to 3
	Breitung t-stat	-8.4803	0.0000	11	446	
	Null: Unit root (assumes individual unit root process)					
	Im, Pesaran and Shin W-stat	-25.7881	0.0000	11	457	
	ADF - Fisher Chi-square	383.5030	0.0000	11	457	
	PP - Fisher Chi-square	359.1280	0.0000	11	462	
	Null: No unit root (assumes common unit root process)					
	Hadri Z-stat	0.1342	0.4466	11	473	

Source: Author's calculations

Table B2: Summary of Unit Root tests on ASTA

Variable	Method	Statistic	Prob.**	Cross-sections	Obs	Lags (Selected automatically by the SIC)
ASTA	Null: Unit root (assumes common unit root process)					
	Levin, Lin & Chu t*	-0.4081	0.3416	11	460	0 to 1
	Breitung t-stat	-0.1243	0.4505	11	449	
	Null: Unit root (assumes individual unit root process)					
	Im, Pesaran and Shin W-stat	0.2660	0.6049	11	460	
	ADF - Fisher Chi-square	27.5203	0.1921	11	460	
	PP - Fisher Chi-square	31.7502	0.0818	11	462	
	Null: No unit root (assumes common unit root process)					
	Hadri Z-stat	11.6183	0.0000	11	473	

ASTAR	Null: Unit root (assumes common unit root process)					
	Levin, Lin & Chu t*	-21.3062	0.0000	11	450	0 to 1
	Breitung t-stat	-9.8914	0.0000	11	439	
	Null: Unit root (assumes individual unit root process)					
	Im, Pesaran and Shin W-stat	-20.5753	0.0000	11	450	
	ADF - Fisher Chi-square	311.0720	0.0000	11	450	
	PP - Fisher Chi-square	329.6900	0.0000	11	451	
	Null: No unit root (assumes common unit root process)					
	Hadri Z-stat	-1.1829	0.8816	11	462	

Source: Author's calculations

Table B3: Summary of Unit Root tests on CCRWA, EQTA, NPTA, RTOA and TATD

Variable	Method	Statistic	Prob.**	Cross-sections	Obs	Lags (Selected automatically by the SIC)
CCRWA	Levin, Lin & Chu t*	-2.4992	0.0062	11	462	0
	Breitung t-stat	-0.2857	0.3875	11	451	
	Im, Pesaran and Shin W-stat	-2.1922	0.0142	11	462	
	ADF - Fisher Chi-square	38.5342	0.0159	11	462	
	PP - Fisher Chi-square	39.5074	0.0123	11	462	
	Hadri Z-stat	8.7740	0.0000	11	473	
EQTA	Levin, Lin & Chu t*	-3.7810	0.0001	11	462	0
	Breitung t-stat	-0.8434	0.1995	11	451	
	Im, Pesaran and Shin W-stat	-4.5603	0.0000	11	462	
	ADF - Fisher Chi-square	66.2969	0.0000	11	462	
	PP - Fisher Chi-square	59.5722	0.0000	11	462	
	Hadri Z-stat	0.0751	0.4701	11	473	
Variable	**Method**	**Statistic**	**Prob.****	**Cross-sections**	**Obs**	**Lags (Selected automatically by the SIC)**
NPTA	Levin, Lin & Chu t*	-7.6825	0.0000	11	445	0 to 8
	Breitung t-stat	-6.2030	0.0000	11	434	
	Im, Pesaran and Shin W-stat	-10.6478	0.0000	11	445	
	ADF - Fisher Chi-square	167.1510	0.0000	11	445	
	PP - Fisher Chi-square	173.2480	0.0000	11	462	
	Hadri Z-stat	5.5637	0.0000	11	473	
RTOA	Levin, Lin & Chu t*	-11.0847	0.0000	11	451	0 to 9
	Breitung t-stat	-4.1715	0.0000	11	440	
	Im, Pesaran and Shin W-stat	-12.6948	0.0000	11	451	
	ADF - Fisher Chi-square	182.9300	0.0000	11	451	
	PP - Fisher Chi-square	202.0720	0.0000	11	462	
	Hadri Z-stat	7.5905	0.0000	11	473	
TATD	Levin, Lin & Chu t*	-4.0827	0.0000	11	460	0 to 1
	Breitung t-stat	-2.1945	0.0141	11	449	
	Im, Pesaran and Shin W-stat	-3.8624	0.0001	11	460	
	ADF - Fisher Chi-square	56.7078	0.0001	11	460	
	PP - Fisher Chi-square	63.7853	0.0000	11	462	
	Hadri Z-stat	9.2530	0.0000	11	473	

Notes: The null of the Levin, Lin & Chu t and the Breitun t-stat tests assumes a common unit root process, while the null for the Im, Pesaran and Shin W-stat assumes individual unit root process. The null for the Hadri Z-stat assumes no common unit root process.
Source: Author's calculations

Table B4: Summary of redundant fixed effects test

	Equation 1		Equation 2	
Effects Test	**Statistic**	**Prob.**	**Statistic**	**Prob.**
Model 1				
Cross-section F	0.4556	0.9177	0.8005	0.6284
Cross-section Chi-square	5.1678	0.8797	9.0420	0.5281
Period F	1.3125	0.1006	1.3317	0.0892
Period Chi-square	57.6382	0.0440	58.4287	0.0379
Cross-Section/Period F	1.1288	0.2614	1.2362	0.1380
Cross-Section/Period Chi-square	61.4046	0.1509	66.8403	0.0675

Source: Author's calculations

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