

Change In The Composition Of Bank Income And Its Effect On The Changes In The Efficiency Of Bank Regions

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ABSTRACT

Over the past five years, banks experienced a change in the composition of bank income earning more in service fees compared to interest income. The effect of this change on the efficiency of bank regions is investigated. Data Envelopment Analysis (DEA) and the TFP (Total Factor Productivity) index decomposition methodology were used to estimate efficiency and to decompose productivity change into its different components. Two models were specified – one for the ‘traditional function’ of a bank and one for the ‘non-traditional function’ of a bank. It appears that some bank regions experienced improvement in efficiency under the “non-traditional” model, meaning that the change in the composition of bank income can result in improved efficiency.

Keywords: Bank Income; Total Factor Productivity; Technical Efficiency; Scale Efficiency; Technical Change; Productivity Change

INTRODUCTION

Over the past decade, and especially over the last five years, there has been a gradual change in the composition of bank income. In comparison to interest income, banks, on average, earn more non-interest income than before. According to the DI 200 and BA 120 Reports (Department of Bank Supervision), the amount of non-interest income matches that of interest income and, in some cases, even exceeds it. In order to maintain profitability and to ensure an acceptable return to shareholders, banks have diversified their services with various types of cross-selling, resulting in an increase in non-interest income.

Banks, as managers of the various risks facing them, are attempting to maximise profits and thereby maximising the wealth of shareholders. In order to maximise profits, bank management should invest in assets that generate the highest gross yield and keep costs down. Risk-taking is a normal behaviour of financial institutions, given that risk and expected return are so tightly interrelated (Bessis, 2002:27). One of the fundamental risks faced by all banks is the interest rate risk.

Banks act as intermediaries between lenders (surplus economic units) and borrowers (deficit economic units) in the economy; therefore, banks exist because of the conflict between the requirements of lenders and borrowers in terms of risk, return, and term to maturity. According to Faure (1999:6), banks facilitate the flow of funds from surplus economic units to deficit economic units by issuing financial liabilities that are acceptable as assets to the lenders and they use the funds obtained to acquire claims that reflect the requirements of the borrowers. In the economy, banks therefore borrow money from the surplus units (lenders) and lend money to the deficit units (borrowers).

The profitability of a bank is thus determined, *inter alia*, by the amount of interest income generated by that bank. The difference between the borrowing rate and the lending rate is known as the interest rate gap. The interest rate gap is a standard measure of the exposure to interest rate risk and, according to Bessis (2010:290), the interest

rate gap for a given period is defined as either the difference between fixed-rate assets and fixed-rate liabilities or the difference between interest-sensitive assets and interest-sensitive liabilities.

Over the last decade, the banking scene experienced considerable changes. During this time, banks saw the first substantial rewrite of the Banks Act and Regulations since 1990, following the adoption of the international guidelines called Basel II which took effect on 1 January, 2008 (Booyesen, 2008:6). Banks also saw the introduction of the National Credit Act, as well as the financial sector charter. All these changes had the effect that banks experienced pressure on their lending activities and thus on their profitability. Further reasons include increased competition because of, *inter alia*, foreign banks entering the South African banking scene, financial services delivered by various companies, and the introduction of new banking products. There have been a number of changes in respect of the regulatory environment, product offerings, and number of participants resulting in a greater level of competition on the market from smaller banks, such as Capitec Bank and African Bank, which have targeted the low income and the previously unbanked market. The SA banking industry is currently made up of 19 registered banks, two mutual banks, 13 local branches of foreign banks, and 43 foreign banks with approved local representative offices (Anon, 2010).

These changes forced banks to rethink their marketing strategies in order to increase income and thus the wealth of shareholders. This was made possible with the introduction of new banking products that contributed toward an increase in service fees. Banks thus saw a shift in the composition of income moving from interest income to non-interest income.

The question this paper attempts to answer is whether this shift in the composition of bank income has any effect on the efficiency of a bank. In order to do this, the DPIN Version 1.1, which uses the Data Envelopment analysis (DEA) programs developed by O'Donnell (2010b) to compute and decompose Hicks-Moorsteen TFP indexes, was used to estimate the efficiency and changes of a large South African bank at the regional level. Two models were used to distinguish between the effects of the two different outputs.

Various studies have previously used DEA to study the performance of banks at both the firm/corporate level (e.g. Drake, 2001; Devaney & Weber, 2000; Berger & Humphrey, 1997; Mendes & Rebello, 1999; Resti, 1997; van der Westhuizen & Oberholzer, 2003; van der Westhuizen, 2008; van der Westhuizen and Oberholzer, 2009; and van der Westhuizen, 2011) and at the branch level (e.g. Sherman & Ladino, 1995; Sherman & Gold, 1985; Vassiloglou & Giokas, 1990; Oral & Yolalan, 1990, O'Donnell & van der Westhuizen, 2002; Oberholzer & van der Westhuizen, 2004; van der Westhuizen, 2005; and van der Westhuizen, 2010).

The contributions of this paper are two-fold: 1) It is the first to apply the program for Decomposing Productivity Index Numbers (DPIN) to study the efficiency and total factor productivity of a large South African bank and 2) it is the first to use this methodology to investigate the components of productivity change this bank experienced.

Total Factor Productivity

Managers, as is the case with bank managers, are all interested in the productivity (efficiency) levels within the organisation as high productivity usually results in higher profits. Knowledge about productivity is important in formulating business strategy and policy-making. In many cases, the productivity that is available is only partial, e.g. labour productivity. Effective economic and business policy-making requires the accurate measurement of total factor productivity (TFP) change and its components (O'Donnell, 2008:1). For this purpose, numerous measures are available; but for the purpose of this paper, the TFP index decomposition methodology developed by O'Donnell (2008) and the DEA programs for implementing the methodology, also developed by O'Donnell (2010b), is utilised.

The framework proposed by O'Donnell (2008:1) is both conceptually and mathematically simple, where the simplicity is achieved by defining index numbers in terms of aggregate quantities and prices. According to O'Donnell (2008:2), there are essentially two main approaches to decomposing TFP growth and he combines the main features of both approaches and calculates TFP index numbers that are said to be complete. In the bottom-up approach, researchers define generic measures of efficiency and technical change and then combine them to form a

TFP index. In the top-down approach, they start with a recognizable index and then attempt to decompose it in a meaningful way.

Total factor productivity (TFP) can be defined as the ratio of an aggregate output to an aggregate input which means that index numbers that measure changes in TFP can be expressed as the ratio of an output quantity index to an input quantity index; i.e., a measure of output growth divided by a measure of input growth (O'Donnell, 2010b:528). As the total factor productivity (TFP) of a multiple-output multiple-input firm is commonly defined as the ratio of an aggregate output to an aggregate input, this means that if Q_{nt} and X_{nt} denote the aggregate output and input of firm n in period t , the TFP of the firm in that period is simply (O'Donnell, 2008:7)

$$TFP_{nt} = \frac{Q_{nt}}{X_{nt}} \tag{1}$$

The associated index number that measures the TFP of firm n in period t relative to its TFP in period 0 is

$$TFP_{n0,nt} = \frac{TFP_{nt}}{TFP_{n0}} = \frac{Q_{nt}/X_{nt}}{Q_{n0}/X_{n0}} = \frac{Q_{n0,nt}}{X_{n0,nt}} \tag{2}$$

where $Q_{n0,nt} = Q_{nt}/Q_{n0}$ is an output quantity index and $X_{n0,nt} = X_{nt}/X_{n0}$ is an input quantity index. This means that TFP growth can be viewed as a measure of output growth divided by a measure of input growth (O'Donnell, 2010c:1).

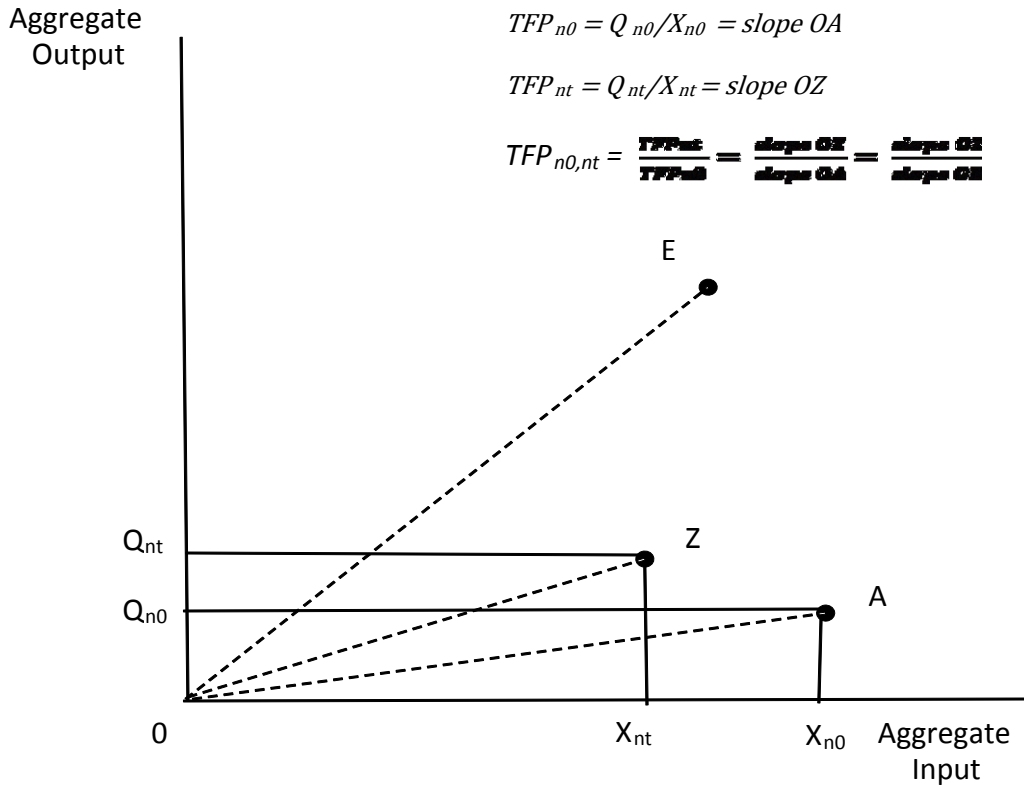
O'Donnell (2010c:2) refers to TFP indexes that can be expressed in terms of aggregate quantities, as in equation (2), as being multiplicatively-complete. In evaluating productivity growth, it is imperative to identify the components of productivity change. According to O'Donnell (2011:1), there are at least two reasons for wanting to identify the drivers of productivity change: 1) All other things being equal, productivity growth that is driven by technical progress and/pr increases in technical efficiency will always be associated with higher net returns and 2) different policies will generally have different effects on the various components of productivity change.

The Components Of Productivity Change

According to O'Donnell (2010c:2), all multiplicatively-complete TFP indexes can be decomposed into a measure of technical change and several measures of efficiency change. Completeness is a sufficient condition for decomposing a TFP index into measures of technical change, technical efficiency change, scale efficiency change, and mix efficiency change (O'Donnell, 2008:10). Figure 1 illustrates the basic idea in aggregate quantity space (O'Donnell 2010a:3). In this figure, the TFP of firm n in period 0 is given by the slope of the ray passing through the origin and point A, while TFP in period t is given by the slope of the ray passing the origin and point Z. It follows that the TFP index that measures the change in TFP between the two periods is $TFP_{n0,nt} = \text{slope OZ}/\text{slope OA}$. It is clear from Figure 1 that the change in the TFP of the firm between periods 0 and t can be decomposed with reference to a point E as $TFP_{n0,nt} = (\text{slope OZ}/\text{slope OE}) \times (\text{slope OE}/\text{slope OA})$ (O'Donnell, 2010a:3).

Within this framework, a potentially infinite number of points E can be used to effect a decomposition of a multiplicatively-complete TFP index (O'Donnell, 2010a:2). According to O'Donnell (2010c:9), among the efficiency change components are input- and output-oriented measures of technical, scale, and mix efficiency change.

Figure 1: Measuring and Decomposing TFP Change

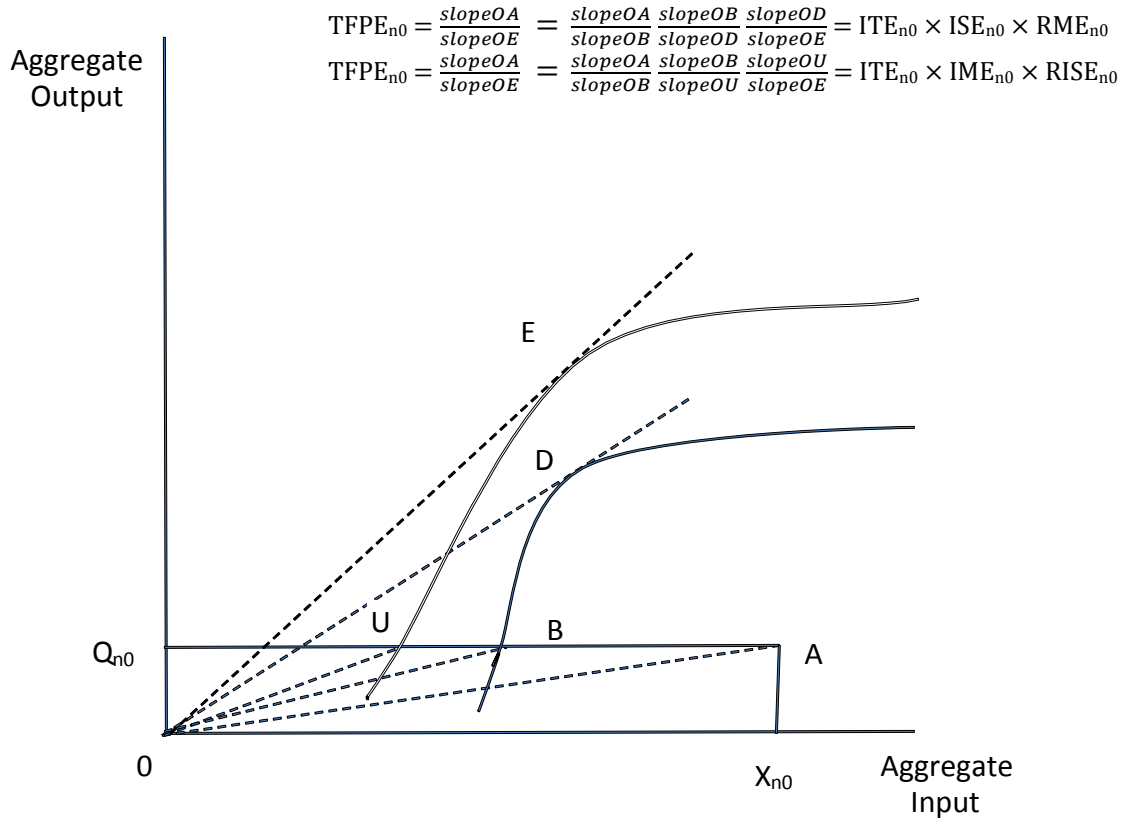


Source: O'Donnell, 2010a:3

According to O'Donnell (2010:2-5), the efficiency measures that feature prominently in input-oriented decompositions of TFP change are:

- Input-oriented Technical Efficiency (ITE), which measures the difference between observed TFP and the maximum TFP that is possible while holding the input mix, output mix and output level fixed. In Figure 2, the curve passing through points B and D is the frontier of a “mix-restricted” production possibilities set. ITE is a ratio measure of the horizontal distance from point A to point B. Equivalently, it is a measure of the difference in TFP at points A and B: $ITE_{n0} = \text{slope } OA/\text{slope } OB$.
- Input-oriented Scale Efficiency (ISE), which measures the difference between TFP at a technically-efficient point and the maximum TFP that is possible while holding the input and output mixes fixed (but allowing the levels to vary). This measure of efficiency is represented in Figure 2 as a movement from point B to point D: $ISE_{n0} = \text{slope } OB/\text{slope } OD$. O'Donnell (2010b:9) refers to point D as the point of *mix-invariant optimal scale* (MIOS).
- Residual Mix Efficiency (RME), which measures the difference between the maximum TFP possible on a mix restricted frontier and the maximum TFP possible when input and output mixes (and levels) can vary. This measure of efficiency is represented in Figure 2 as a movement from point D to point E: $RME_{n0} = \text{slope } OD / \text{slope } OE$.

Figure 2: Two Input-Oriented Decompositions of TFP Efficiency



Source: O'Donnell, 2010a:3.

- Input-oriented Mix Efficiency (IME), which measures the difference between TFP at a technically-efficient point on the mix-restricted frontier and the maximum TFP that is possible while holding the output level fixed. This measure of efficiency is represented in Figure 2 as a movement from point B to point U: $IME_{n0} = \text{slope } OB/\text{slope } OU$.
- Residual Input-oriented Scale Efficiency (RISE), which measures the difference between TFP at a technically and mix-efficient point and TFP at the point of maximum productivity. According to O'Donnell (2010:4), any improvement in TFP is essentially a scale effect and may also contain a residual mix effect. This measure of efficiency is represented in Figure 2 as a movement from point U to point E: $RISE_{n0} = \text{slope } OU/\text{slope } OE$.
- TFP Efficiency (TFPE), which measures the difference between observed TFP and the maximum TFP possible using the available technology. This measure of efficiency is represented in Figure 2 as a movement all the way from point A to point E: $TFPE_{n0} = TFP_{n0}/TFP_0^*$ where TFP_0^* denotes the maximum TFP possible using the technology available in period 0.

Figure 2 illustrates just two of the many pathways from point A to point E and therefore two of the many decompositions of TFP efficiency:

$$TFPE_{n0} = \frac{TFP_{n0}}{TFP_0^*} = ITE_{n0} \times ISE_{n0} \times RME_{n0} \tag{3}$$

$$TFPE_{n0} = \frac{TFP_{n0}}{TFP_0} = ITE_{n0} \cdot IME_{n0} \cdot RISE_{n0} \quad (4)$$

O'Donnell (2010c:4) also presents several output-oriented decompositions of TFP efficiency in terms of pathways from point A to point E. Such decompositions provide a basis for an output or input-oriented decompositions of any multiplicatively-complete TFP index.

DATA AND MODEL

Monthly data covering the 24 months sample period for the 37 regions of one of the largest banks in South Africa were obtained. Some of the descriptive statistics are presented in Table 1.

Table 1: Descriptive Statistics (Monthly Values in Rand)

Variable	Mean	Std dev.	MMin.	Max.
Total deposits (R'000)	1914	971	643	5851
Total loans (R'000)	355	153	51	875
Interest income (R'000)	6387	2959	1933	19959
Non-interest income (R'000)	25527	10118	8660	57253
Operating expenditure (R'000)	1423	550	515	10111
Staff costs (R'000)	3100	794	1543	6907

Two models were specified in order to capture the 'traditional', as well as the 'non-traditional', functions of a bank. Model 1 was specified to estimate the efficiency of the bank under the 'traditional' function; namely, to lend money in return for interest paid to the bank. Model 2 was specified to estimate the efficiency of the bank under the 'non-traditional' function of a bank; namely, to lend money, and in the process, render a large number of services in return for service fees (non-interest income).

Outputs: Model 1:
 y_1 = value of loans (rand)
 y_2 = value of interest income (rand)

Outputs: Model 2
 y_1 = rand value of loans (rand)
 y_2 = rand value of non-interest income (rand)

Inputs: Models 1 and 2:
 x_1 = rand value of deposits
 x_2 = rand value of total operating expenditure (excluding staff costs, interest paid and depreciation)
 x_3 = rand value of staff costs.

According to Sathye (2001), there are two main approaches to defining the outputs and inputs of banks - the production and intermediation approaches. The production approach views banks as firms which "produce" different types of deposits (e.g. savings, term and demand deposits) and loans (e.g. commercial, housing and personal loans) using inputs such as capital, labour and materials (Berger *et al.*, 1987). Under this approach, numbers of deposit accounts, loan accounts, and transactions processed are used as measures of bank outputs. Input costs are measured as operating costs excluding interest paid.

The intermediation approach views banks as intermediaries that facilitate the transfer of funds from holders of surplus funds to economic agents who are in need of funds – they 'intermediate' surplus funds into loans and other assets. Under this approach, the dollar volumes (i.e., values) of loans and deposits are used to measure bank outputs while input costs are measured as operating costs including interest paid.

Favero and Papi (1995) identify three more approaches to defining bank outputs and inputs: 1) The asset approach is a variant of the intermediation approach in which outputs are strictly defined by assets; 2) In the user-

cost approach, outputs are chosen on the basis of net contributions to bank revenue; and 3) In the value-added approach, outputs are chosen on the basis of share of value added. Neither the user-cost nor the value-added approaches appear to adequately account for all the functions carried out by banks.

According to Resti (1997), a pivotal issue throughout the whole literature, based on stock measures of banking products, is the role of deposits. On the one hand, it is argued that they are an input in the production of loans (intermediation or asset approach); yet, other lines of reasoning (value-added or user-cost approach) suggest that deposits themselves are an output, involving the creation of value added and for which the customers bear an opportunity-cost.

In this paper, the intermediation approach is adopted. The main reason for using this approach is because the production approach requires the number of accounts and transactions processed (output measures under the production approach) that are not readily available. Measuring scale and technical efficiency using DEA requires data on output and input quantities, while measuring allocative and cost efficiency also requires data on input prices.

The inputs used in both models are, to some extent, similar to those used by Sherman and Gold (1985), Rangan *et al.* (1988), Aly *et al.* (1990), Elyasiani and Mehdiian (1990 and 1992), Chen (1998), and Berger and Humphrey (1991). The outputs for Model 1 correspond to some of the outputs used by Charnes *et al.* (1990) and Yue (1992). The outputs for Model 2 are a modified mixture of those used by Favero and Papi (1995) and Yue (1992). According to Favero and Papi (1995:390), non-interest income (y_2 in Model 2) can be regarded as a proxy for various services provided by banks, which are usually neglected by a strict acceptance of the intermediation or asset approach.

The inputs used for both models are very much similar to those used by Stavarek (2002), Chen (1998), Charnes *et al.* (1990), and Olivei (1992). The outputs for both models are a modified mixture of those used by Charnes *et al.* (1990), Chen (1998), and Yue (1992).

RESULTS

All computations were performed using the DPIN software developed by O'Donnell (2110a). The program uses the conceptual framework developed by O'Donnell (2010c) and the data envelopment analysis (DEA) programs developed by O'Donnell (2010b).

The results are presented in a way that may make it possible to determine which model generates the highest productivity and to investigate the contributions of the components of efficiency change. Because of the large number of regions, it is impossible to report on all the regions; therefore, a number of regions will be selected to report on.

The regions selected were 14, 17, 22 and 27. (The reason for selecting a specific region is explained during the discussion of the components of efficiency change for the relevant region.)

The average efficiency scores for all regions are reported in Table 2. It is evident from the results that Region 4 was the most efficient region, being fully efficient under both models and on all the components of the efficiency scores.

Regions 17 and 26 were fully output-oriented as well as input-oriented technical efficient under Model 1. These two regions were unable to repeat its efficiency scores in the case of Model 2. Regions 21, 25 and 37 were fully output-oriented, as well as input-oriented technical efficient, under both models. Seventeen regions were able to improve both its OTE and ITE while one region experienced an improvement in only OTE.

Region 14 exhibits the highest average improvement in OTE and ITE, moving from Model 1 to Model 2, where Region 14 was fully output- and input-oriented technically efficient. The TFP experience of Region 14 under Model 1 is summarised in Figure 3.

Table 2: Average Efficiency Scores for All Regions

Region	Model 1 - Loans and interest income						Model 2 - Loans and noninterest income					
	OTE	OSE	OME	ITE	ISE	IME	OTE	OSE	OME	ITE	ISE	IME
1	0.8480	0.9323	0.6245	0.8189	0.9655	0.9120	0.9652	0.9317	0.6533	0.9473	0.9504	0.9396
2	0.8683	0.9372	0.9065	0.8366	0.9728	0.9553	0.9863	0.9186	0.8719	0.9771	0.9279	0.8727
3	0.8948	0.9926	0.3031	0.9093	0.9757	0.7369	1.0000	1.0000	0.4451	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8716	0.9849	0.8505	0.8859	0.9689	0.9681	0.9819	0.9948	0.8943	0.9827	0.9940	0.9385
6	0.8046	0.9732	0.6591	0.7921	0.9886	0.9621	0.8725	0.9888	0.7055	0.8669	0.9952	0.8879
7	0.9712	0.9458	0.5476	0.9639	0.9530	0.9373	0.9845	0.8704	0.6448	0.9644	0.8895	0.9770
8	0.9534	0.9692	0.4796	0.9451	0.9778	0.9452	0.9059	0.9519	0.6065	0.8749	0.9858	0.9040
9	0.9967	0.9982	0.5651	0.9965	0.9985	0.9741	0.7991	0.9880	0.7578	0.8453	0.9339	0.8029
10	0.9969	0.9963	0.6330	0.9966	0.9966	0.9247	0.9477	0.9742	0.7102	0.9579	0.9628	0.9317
11	0.8701	0.9903	0.4360	0.8741	0.9859	0.9368	0.7424	0.9875	0.5760	0.8008	0.9168	0.8439
12	0.9388	0.9679	0.5437	0.9327	0.9743	0.8873	0.9343	0.9799	0.6328	0.9325	0.9814	0.9737
13	0.9032	0.9857	0.4633	0.8995	0.9899	0.8927	0.8789	0.9761	0.5495	0.8906	0.9637	0.9019
14	0.8376	0.9273	0.4401	0.9408	0.8194	0.9215	1.0000	0.8568	0.7945	1.0000	0.8568	0.9856
15	0.9111	0.9768	0.8676	0.9974	0.9767	0.9319	0.9871	0.9172	0.8950	0.9922	0.9123	0.8566
16	0.9355	0.9913	0.8200	0.9334	0.9936	0.9463	0.9820	0.9315	0.8525	0.9711	0.9419	0.8643
17	1.0000	1.0000	0.8669	1.0000	1.0000	1.0000	0.9997	0.9767	0.9244	0.9962	0.9802	0.9899
18	0.8440	0.9842	0.4427	0.8637	0.9624	0.8224	0.9894	0.9801	0.4930	0.9924	0.9771	0.8864
19	0.9896	0.9932	0.4971	0.9886	0.9942	0.9422	0.9042	0.9841	0.6238	0.9065	0.9820	0.8732
20	0.9141	0.9852	0.6806	0.9089	0.9910	0.9226	0.9825	0.9809	0.7309	0.9769	0.9866	0.8797
21	1.0000	0.9741	0.9455	1.0000	0.9741	0.9637	1.0000	0.9582	0.9800	1.0000	0.9582	1.0000
22	0.8550	0.9820	0.4592	0.8467	0.9916	0.8936	0.8831	0.9881	0.5488	0.8896	0.9809	0.9289
23	0.9741	0.9951	0.9263	0.9747	0.9944	0.9592	0.9827	0.9977	0.9347	0.9838	0.9966	0.9515
24	0.8802	0.9587	0.5632	0.8663	0.9743	0.8531	0.9588	0.9831	0.6145	0.9533	0.9889	0.9595
25	1.0000	0.8694	1.0000	1.0000	0.8694	0.9985	1.0000	0.9761	1.0000	1.0000	0.9761	1.0000
26	1.0000	0.9703	1.0000	1.0000	0.9703	0.9993	0.9932	0.9395	0.9850	0.9982	0.9350	0.9845
27	0.9612	0.9928	0.7305	0.9589	0.9953	0.9598	0.9378	0.9503	0.8182	0.9154	0.9741	0.8084
28	0.9873	0.9684	0.6370	0.9848	0.9710	0.8960	0.9994	0.9884	0.7398	0.9993	0.9885	0.9968
29	0.8714	0.9868	0.4302	0.8709	0.9876	0.8464	0.9754	0.9882	0.4894	0.9768	0.9867	0.9198
30	0.9440	0.9887	0.5717	0.9412	0.9917	0.9029	0.9908	0.9955	0.6526	0.9888	0.9977	0.9128
31	0.9956	0.9954	0.6734	0.9942	0.9968	0.9164	0.9955	0.9948	0.7562	0.9939	0.9963	0.8990
32	0.9459	0.9862	0.6039	0.9452	0.9870	0.9290	0.9364	0.9708	0.7082	0.9253	0.9826	0.8185
33	0.9925	0.9871	0.8330	0.9936	0.9859	0.8564	0.9278	0.9777	0.9072	0.9437	0.9614	0.6894
34	0.9570	0.9851	0.5792	0.9633	0.9786	0.7934	0.7432	0.9936	0.7745	0.8150	0.9075	0.6936
35	0.9748	0.9928	0.5087	0.9754	0.9921	0.9582	0.8557	0.9780	0.6637	0.8655	0.9673	0.7536
36	0.8954	0.9765	0.5889	0.8861	0.9869	0.8612	0.9940	0.9905	0.6406	0.9910	0.9936	0.9843
37	1.0000	0.9598	1.0000	1.0000	0.9598	0.9822	1.0000	0.9824	1.0000	1.0000	0.9824	0.9680

This figure reveals that the productivity of Region 14 (under Model 1) has been steadily increasing over the sample period and that the rate of productivity growth has outpaced the rate of technical progress. This growth is supported by the output-oriented measure of technical efficiency (OTE) and the residual output-oriented scale efficiency (ROSE), while the output-oriented mix efficiency (OME) deteriorated during the sample period. The productivity growth appears to have been primarily due to technical progress and changes in both mix and scale.

The TFP experience of Region 14 under Model 2 is summarised in Figure 4. This figure reveals that the rate of productivity growth of Region 14 under Model 2 remained relatively unchanged during the sample period, despite a moderate rate of technical progress. The output-oriented technical efficiency (OTE) remained unchanged during the sample period with the residual output-oriented scale efficiency (ROSE) exhibiting an increase over the sample period, particularly during the latter third of the sample period. It appears that the contrasting movements of ROSE and OME during the latter third of the sample period, as well as the low rate of technical change, contributed to the lack of productivity growth.

Figure 3: Components of Total Factor Productivity Change under Model 1 - Region 14

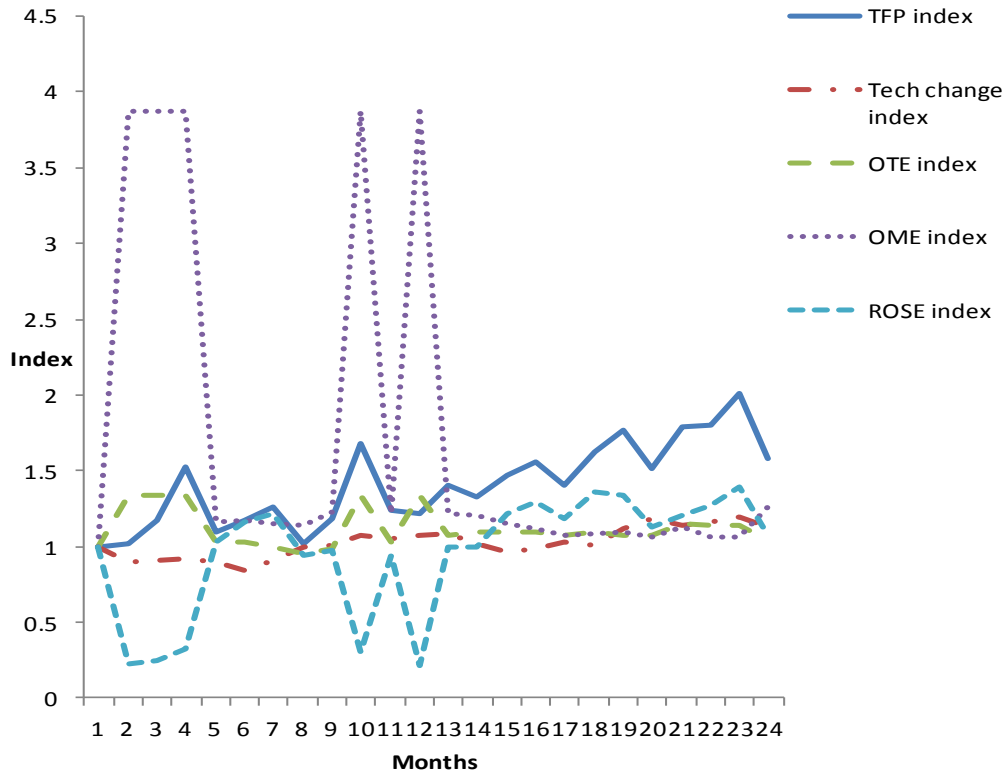
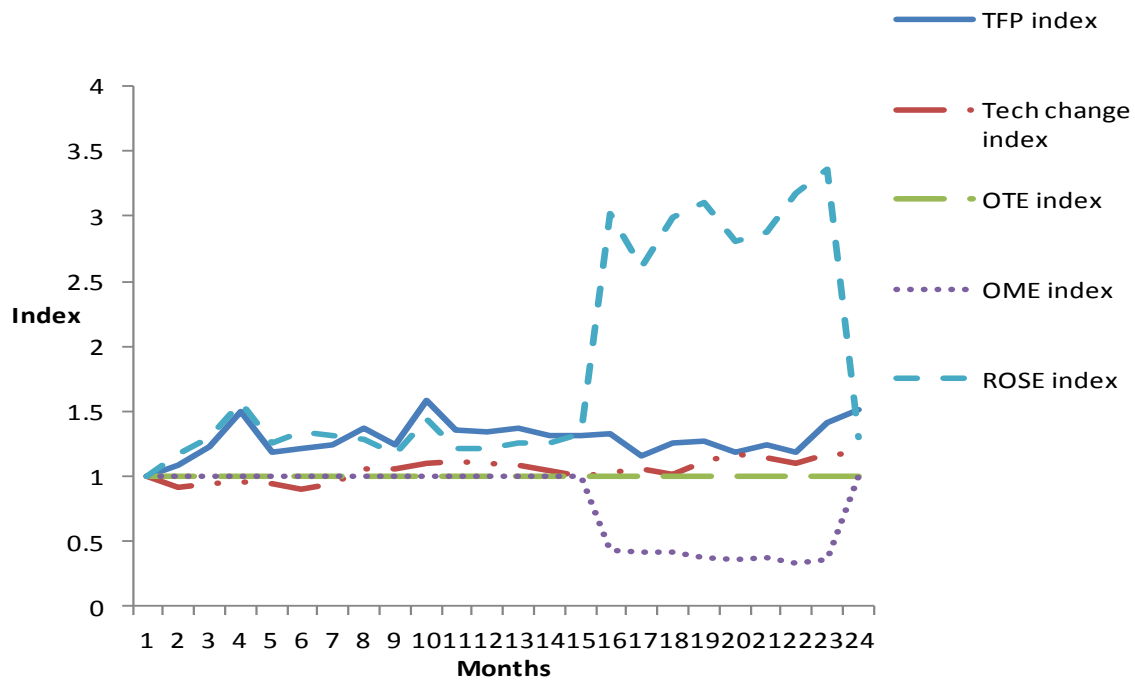


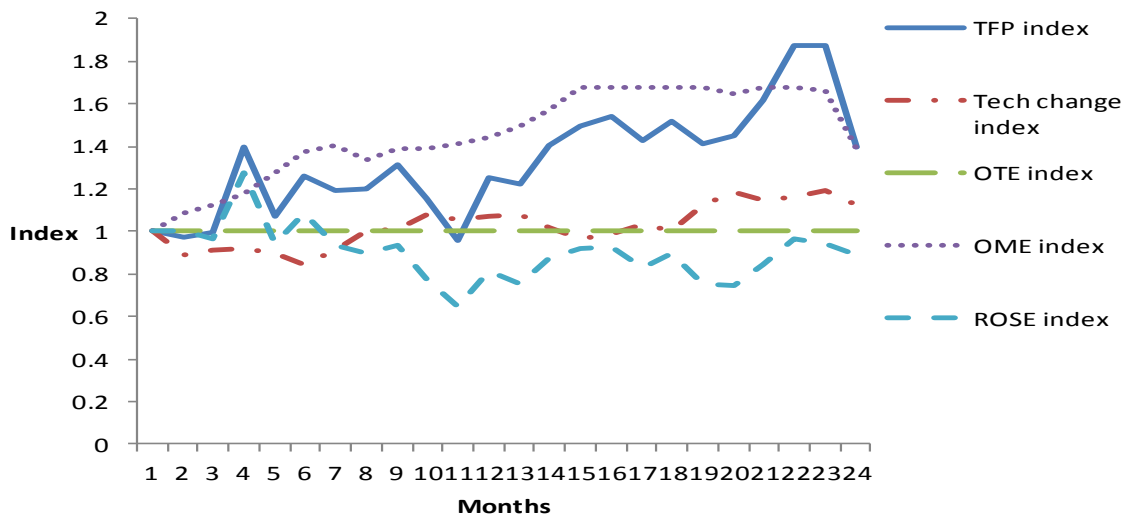
Figure 4: Components of Total Factor Productivity Change under Model 2 - Region 14



The TFP experience of Region 17 under Model 1 is summarised in Figure 5. Region 17 is selected as a region where, under Model 1, the region was fully output- as well input-oriented technically efficient, but it did not repeat the performance moving to Model2. This region experienced mixed results in scale efficiency moving from Model 1 to Model 2.

Figure 5 reveals that the productivity of Region 17 has been steadily increasing over the sample period and that the rate of productivity growth has outpaced the rate of technical progress, particularly during the latter half of the sample period. The residual output-oriented scale efficiency (ROSE) exhibits a decline with the output-oriented technical efficiency (OTE) remaining unchanged during the sample period. The productivity growth (under Model 1) appears to have been primarily due to technical progress and change in mix.

Figure 5: Components of Total Factor Productivity Change under Model 1 - Region 17



The TFP experience of Region 17 under Model 2 is summarised in Figure 6.

Figure 6 reveals that under Model 2, the productivity of Region 17 has been steadily increasing over the sample period and that the rate of productivity growth has outpaced the rate of technical progress. The growth in productivity seems to have been primarily due to technical progress and output-oriented mix efficiency (OME). This is similar to the situation under Model 1, where the main contributor to the improvement in productivity is due to technical progress and the change in mix.

The TFP experience of Region 22 under Model 1 is summarised in Figure 7. Region 22 is random selected as one of the regions that were never fully efficient, either under Model 1 or under Model 2. However, these regions experienced a reduction in output and input-oriented technical efficiency and mixed changes in scale efficiency moving from Model 1 to Model 2.

Figure 7 reveals that, under Model 1, the productivity of Region 22 has been steadily increasing over the sample period, but on a number of occasions, the rate of technical progress has outpaced the rate of productivity growth. The output-oriented technical efficiency (OTE) exhibits a gradual decline over the sample period. The productivity growth appears to have been primarily due to technical progress and the output-oriented mix efficiency (OME).

Figure 6: Components of Total Factor Productivity Change under Model 2 - Region 17

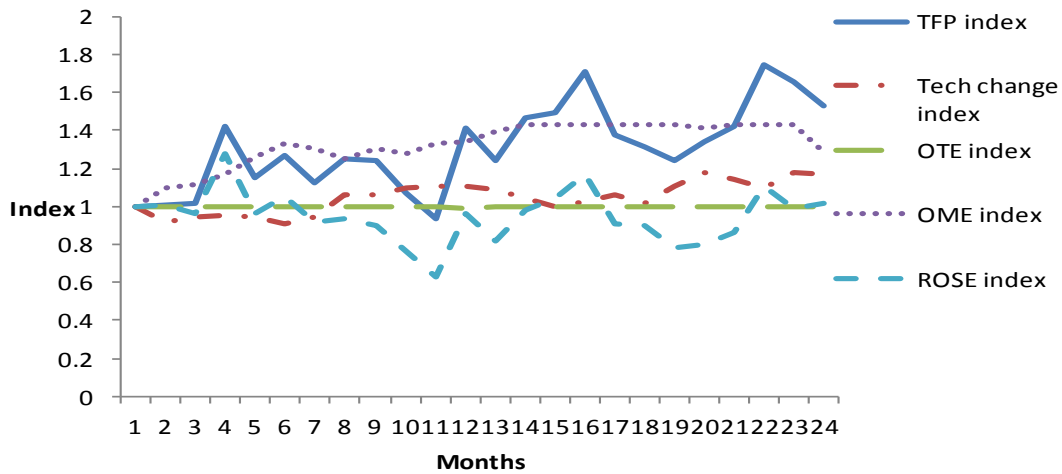


Figure 7: Components of Total Factor Productivity Change under Model 1 - Region 22

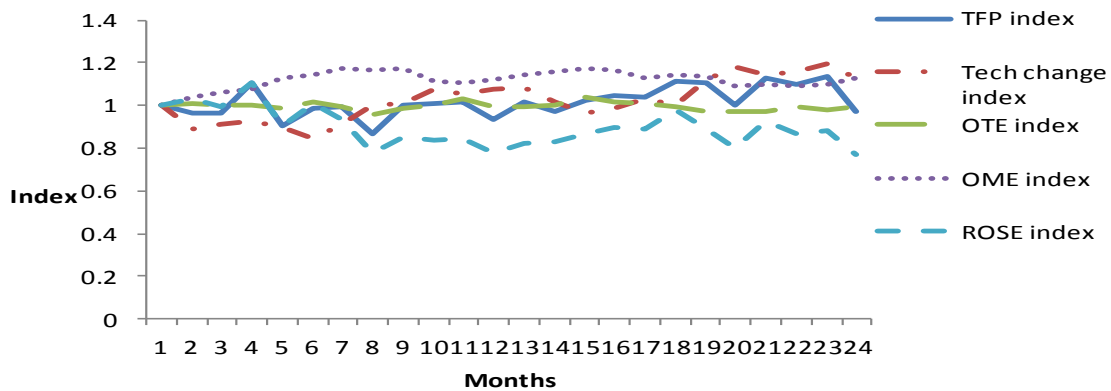
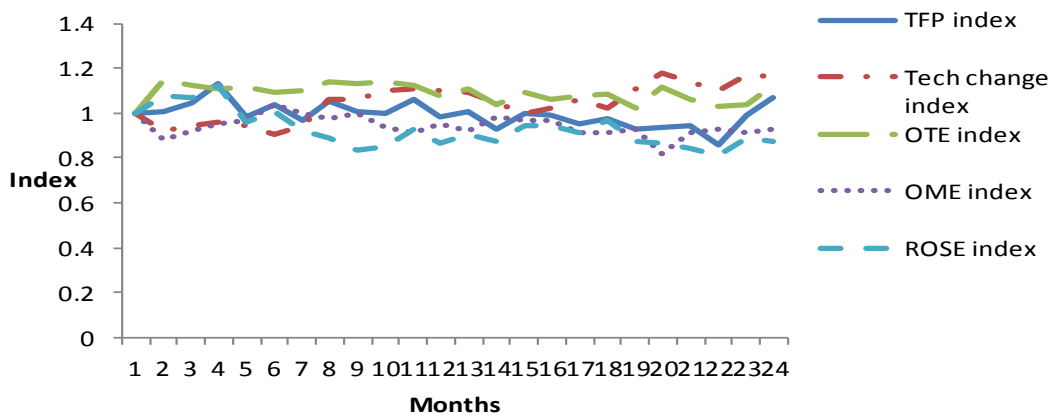


Figure 8: Components of Total Factor Productivity Change under Model 2 - Region 22

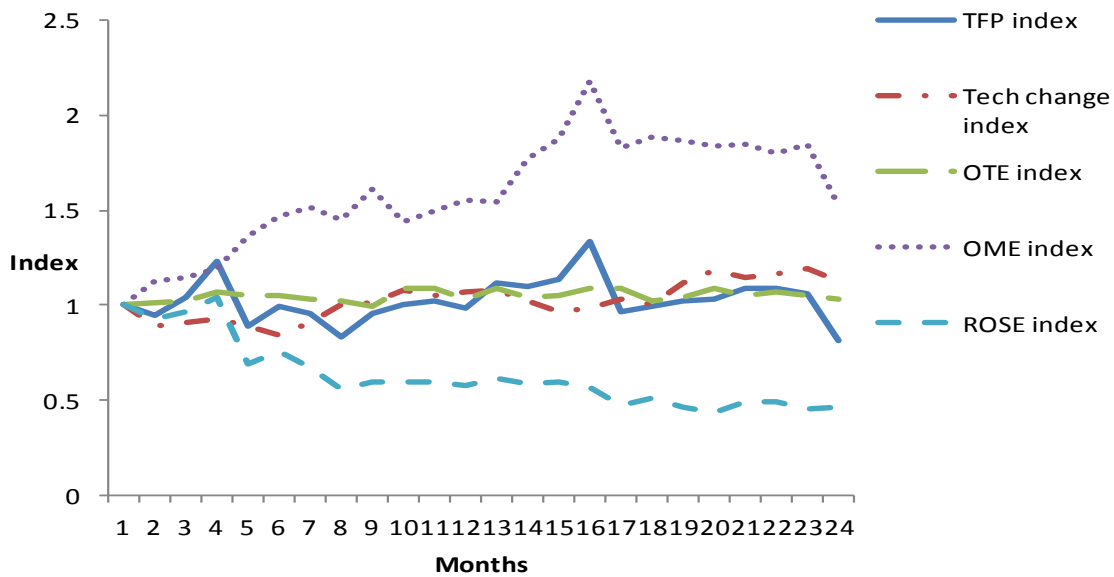


The TFP experience of Region 22 under Model 2 is summarised in Figure 8. This figure reveals that over the sample period, there has been a steady decline in the rate of productivity despite an increase in the rate of technical progress. The decline in productivity appears to be primarily due to a decline in the output-oriented technical efficiency (OTE), output-oriented mix efficiency (OME), as well as residual output-oriented scale efficiency (ROSE).

The TFP experience of Region 27 under Model 1 is summarised in Figure 9. Region 27 is random selected as one of the regions that experienced no improvement in output- or input-oriented technical efficiency with mixed changes in scale efficiency moving from Model 1 to Model 2.

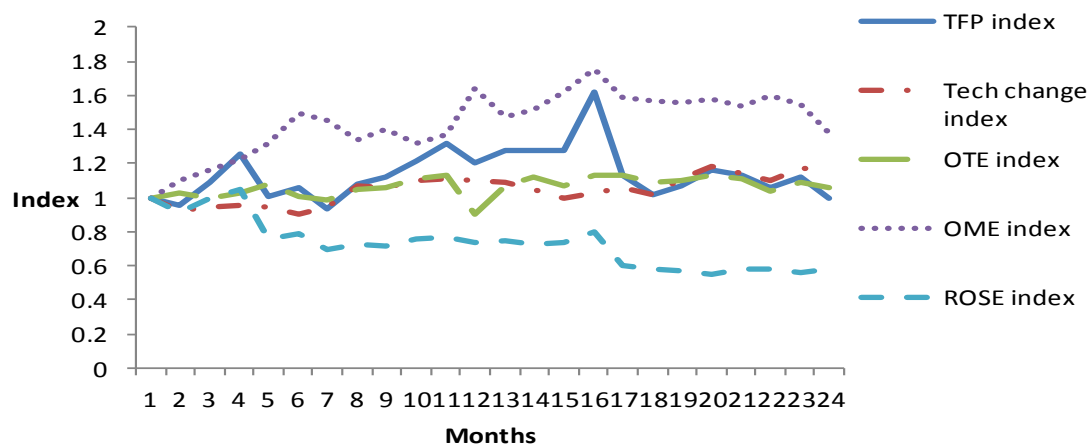
Figure 9 reveals that during the first half of the sample period, the productivity of Region 27 has been steadily increasing and that the rate of productivity growth outpaced the rate of technical progress, but during the latter half of the period, the situation was reversed. The output-oriented mix efficiency (OME) exhibits a steep increase with the residual output-oriented scale efficiency (ROSE) a steep decline. The productivity growth appears to have been primarily due to technical progress and change in mix.

Figure 9: Components of Total Factor Productivity Change under Model 1 - Region 27



The TFP experience of Region 27 under Model 2 is summarised in Figure 10. This figure reveals that the productivity of the region has remained low and that the rate of productivity growth and the rate of technical progress converged at the end of the sample period. The output-oriented mix efficiency exhibits a steep increase with the residual output-oriented scale efficiency a steep decline. Productivity growth appears to have been primarily due to change in mix.

Figure 10: Components of Total Factor Productivity Change under Model 2 - Region 27



CONCLUSION

The banking scene has been experiencing considerable change over the past five years. Pressures on the profitability of banks are forcing banks to rethink their marketing strategies, which has led to a situation where banks rely more on service fees as a source of income.

DPIN Version 1.1 by O'Donnell (2010a) was used to compute and decompose productivity index numbers in order to determine how this change in the composition of bank income affects the efficiency of bank regions. Two models were formulated – one to estimate efficiency in the case of interest income and one in the case of non-interest income as the “main” source of income.

Region 4 was the most efficient region being fully efficient under both models and on all the components of the efficiency scores. Regions 17 and 26 were fully output-oriented as well as input-oriented technical efficient under Model 1. Regions 21, 25 and 37 were fully output-oriented as well as input-oriented technical efficient under both models. Seventeen regions were able to improve OTE and ITE while one region experienced an improvement in only OTE. Region 14 exhibits the highest average improvement in OTE and ITE, moving from Model 1 to Model 2 where Region 14 was fully output- and input-oriented technically efficient. Seventeen regions experienced an improvement in both OTE and ITE, moving from Model 1 to Model 2.

Four regions were selected for analysis of the components of productivity change. Productivity of Region 14 (under Model 1) has been steadily increasing over the sample period. The rate of productivity growth has outpaced the rate of technical progress. The productivity growth appears to have been primarily due to technical progress and changes in both mix and scale. The rate of productivity growth of Region 14 (under Model 2) remained relatively unchanged during the sample period, despite a moderate rate of technical progress. It appears that the contrasting movements of ROSE and OME during the latter third of the sample period, as well as the low rate of technical change, contributed to the lack of productivity growth.

The productivity of Region 17 (under Model 1) has been steadily increasing over the sample period and the rate of productivity growth has outpaced the rate of technical progress, particularly during the latter half of the sample period. The productivity growth appears to have been primarily due to technical progress and change in mix. Under Model 2, the productivity of Region 17 has been steadily increasing over the sample period and the rate of productivity growth has outpaced the rate of technical progress. The growth in productivity seems to have been primarily due to technical progress and output-oriented mix efficiency (OME). This is similar to the situation under Model 1 where the main contributor to the improvement in productivity is due to technical progress and the change in mix.

Under Model 1, the productivity of Region 22 has been steadily increasing over the sample period; but on a number of occasions, the rate of technical progress has outpaced the rate of productivity growth. The productivity growth appears to have been primarily due to technical progress and the output-oriented mix efficiency (OME). Under Model 2, the region experienced a steady decline in the rate of productivity despite an increase in the rate of technical progress. The decline in productivity appears to be primarily due to a decline in the output-oriented technical efficiency (OTE), output-oriented mix efficiency (OME), as well as residual output-oriented scale efficiency (ROSE).

During the first half of the sample period, the productivity of Region 27, under Model 1, has been steadily increasing and the rate of productivity growth outpaced the rate of technical progress; but during the latter half of the period, the situation was reversed. The productivity growth appears to have been primarily due to technical progress and change in mix. Region 27, under Model 2, experienced low productivity growth with the rate of productivity growth and the rate of technical progress converging at the end of the sample period. Productivity growth appears to have been primarily due to change in mix.

It is evident that there are, on average, productivity gains due to the change in composition of bank income.

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REFERENCES

1. Aly, H.Y., Grabowsky, R., Pasurka, C. and Rangan, N. (1990): "Technical, scale and allocative efficiencies in US banking: an empirical investigation", *The Review of Economics and Statistics*, May, 211-218.
2. Anon. (2010): *South African Banking Sector Overview*. Park Town: The Banking Association South Africa.
3. Balk, B.M. (2001): "Scale efficiency and productivity change", *Journal of Productivity Analysis*, 15, 159-183.
4. Berger, A.N. and Humphrey, D.B. (1991): "The dominance of inefficiencies over scale and product mix economies in banking", *Journal of Monetary Economics*, 28, 117-148.
5. Berger, A.N. and Humphrey, D.B. (1997): "Efficiency of Financial Institutions: International Survey and Directions for Further Research", *European Journal of Operational Research*, 98, 175-212.
6. Bessis, J. (2002): *Risk Management in Banking*. New York: Wiley.
7. Bessis, J. (2010): *Risk Management in Banking*. Chichester: Wiley.
8. Booysen, S. (2008): *Annual Review 2008*. Park Town: The Banking Association South Africa.
9. Caves, D. W., L. R. Christensen and W. E. Diewert (1982): "The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity." *Econometrica* 50(6): 1393-1414.
10. Charnes, A., Cooper, W.W. and Haung, Z.M. (1990): "Polyhedral cone-ratio DEA models with an illustrative application to large commercial banks", *Journal of Econometrics*, 46, 213-227.
11. Chen, T. (1998): "A study of bank efficiency and ownership in Taiwan", *Applied Economic Letters*, 5(10), 613-617.
12. Department of Bank Supervision. (2002): "Annual report". Pretoria: South African Reserve Bank.
13. Department of Bank Supervision. (Various years): "DI 200 Reports and BA 120 Reports", www.resbank.co.za/sarbddata/ifdata/periods.asp?type=DI200
14. Devaney, M. and Weber, W.L. (2000): "Productivity growth, market structure, and technological change: evidence from the rural banking sector", *Applied Financial Economics*, 10, 587-595.

15. Drake, L. (2001): "Efficiency and productivity change in UK banking", *Applied Financial Economics*, 11, 557-571
16. Elyasiani, E. and Mehdiian, S.M. (1990): "A non-parametric approach to measurement of efficiency and technological change: The case of large US commercial banks", *Journal of Financial Services Research*, July, 157-168.
17. Elyasiani, E. and Mehdiian, S.M. (1992): "Productive efficiency performance of minority and non-minority owned banks: a non-parametric approach", *Journal of banking and finance*, 17, 349-366.
18. Faure, A.P. (1999): Elements of the South African Financial System. (In Fourie, L.J., Falkena, H.B. and Kok, W.J., eds. *Student Guide to South African Financial System*. Johannesburg: Thomson Publishing.
19. Favero, C.A. and Papi, L. (1995): "Technical Efficiency and Scale Efficiency in the Italian Banking Sector: a non-parametric approach", *Applied Economics*, 27, 385-395.
20. Mendes, V. and Rebelo, J. (1999): "Productive Efficiency, technological change and Productivity in Portuguese Banking", *Applied Financial Economics*, 9(5), 513-521.
21. Oberholzer, M. and Van der Westhuizen, G. (2004): "An empirical study on measuring profitability and efficiency of bank regions", *Meditari (Accounting Research)*. Volume 12. 165-178.
22. O'Donnell, C.J. and van der Westhuizen, G. (2002): "Regional comparisons of banking performance in South Africa", *The South African Journal of Economics*, 70(3), 485-518.
23. O'Donnell, C. J. (2008). "An Aggregate Quantity-Price Framework for Measuring and Decomposing Productivity and Profitability Change." Centre for Efficiency and Productivity Analysis Working Papers WP07/2008. University of Queensland. <http://www.uq.edu.au/economics/cepa/docs/WP/WP072008.pdf>.
24. O'Donnell, C. J. (2010a). DPIN Version 1.0: A Program for Decomposing Productivity Index Numbers. Centre for Efficiency and Productivity Analysis Working Papers WP01/2010, University of Queensland.
25. O'Donnell, C. J. (2010b). "Measuring and Decomposing Agricultural Productivity and Profitability Change." *Australian Journal of Agricultural and Resource Economics*, 54(4), 527-560.
26. O'Donnell, C. J. (2010c). Nonparametric Estimates of the Components of Productivity and Profitability Change in U.S. Agriculture. Centre for Efficiency and Productivity Analysis Working Papers WP02/2010, University of Queensland.
27. O'Donnell, C. J. (2011). "The Sources of Productivity Change in the Manufacturing Sectors of the U.S. Economy." Centre for Efficiency and Productivity Analysis Working Papers WP07/2011. University of Queensland. <http://www.uq.edu.au/economics/cepa/docs/WP/WP072011.pdf>.
28. Olivei G. (1992): Efficiencia tecnica ed efficienza di scala nel settore Italiano: un approccio non-parametrico, *Quaderni del Centro Baffi di Economia Monetaria e Finanziaria*, pp. 67.
29. Oral, M. and Yolalan, R. (1990): "An Empirical Study on Measuring Operating Efficiency and Profitability of Bank Branches", *European Journal of Operational Research*, 46, 282-294.
30. Rangan, N., Grabowsky, R., Aly, H.Y. and Pasurka, C. (1988): "The technical efficiency of US banks", *Economics letters*, 28, 169-175.
31. Resti, A. (1997): "Evaluating the cost-efficiency of the Italian Banking System: What can be learned from joint application of parametric and non-parametric techniques", *Journal of Banking and Finance*, 21, 221-250.
32. Sathye, M. (2001): X-efficiency in Australian Banking: an empirical investigation, *Journal of Banking and Finance*, 25, 613-630.
33. Sherman, H.D. and Gold, F. (1985): "Bank Branch Operating Efficiency. Evaluation with Data Envelopment Analysis", *Journal of Banking and Finance*, 9, 297-315.
34. Sherman, H.D. and Ladino, G. (1995): "Managing Bank Productivity Using Data Envelopment Analysis (DEA)", *Interfaces*, 25, 60-73.
35. Stavarek, D. (2002): "Comparison of the relative efficiency of banks in European transition economies", Proceedings of the D.A. Tsenov Academy of Economics 50th Anniversary Financial Conference, Svishtov, Bulgaria, April, 955-971.
36. Van der Westhuizen, G. and Oberholzer, M. (2003): "A model to compare bank size and the performance of banks by using financial statement analysis and data envelopment analysis", *Management Dynamics: Contemporary Research*, 12(4), 18-26.
37. Van der Westhuizen, G. (2005): "The relative efficiency of bank branches in lending and borrowing: An application of data envelopment analysis", *South African Journal of Economic and Management Science*, 8(3), 363-376.

38. Van der Westhuizen, G. (2008): “Estimating technical and scale efficiency and sources of efficiency change in banks using balance sheet data: A South African study”, *Journal for studies in Economics and Econometrics*, 32(1), 23-45.
39. Van der Westhuizen G. and Oberholzer M. (2009) The role of interest income and non-interest income on the performance of four large South African banks, *Studia Universitatis Babes Bolyai Oeconomica*, 54(2), 100 -114.
40. Van der Westhuizen G. (2010) The role of interest income and non-interest income on the relative efficiency of bank regions: The case of a large South African bank, *Studia Universitatis Babes Bolyai Oeconomica*, 55(2), 3 -23.
41. Van der Westhuizen G. (2011). The relative efficiency of banks in lending and borrowing: Evidence from data envelopment analysis, *Studia Universitatis Babes Bolyai Oeconomica*, 56(3), 42-57.
42. Vassiloglou, M. and Giokas, D. (1990): “A Study of the Relative Efficiency of Bank Branches: An Application of Data Envelopment Analysis”, *Journal of the Operational Research Society*, 41, (7), 591-597.
43. Yue, P. (1992): “Data Envelopment Analysis and Commercial Bank Performance: A Primer with applications to Missouri Banks”, Federal Reserve Bank of St. Louis. January/February, 31 -45.

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