EMPIRICAL APPROACH TO FINANCIAL RATIOS OF COMMERCIAL BANKS: A DATA ENVELOPMENT ANALYSIS

Nobinkhor Kundu *
Asaduzzaman Sikdar **
Dr. Helal Uddin Ahmed ***

Abstract

This paper explores the phenomenon of identifying the efficiency of bank performance and challenges faced by financial ratios in their attempt to achieve corporate efficiency. The paper empirically investigates - the comparative analysis of bank performance efficiency between Canada and the United Kingdom. The secondary data were collected from the datastream during the period from 2016 to 2017. Using the time series data to an analysed growth rate of financial ratios and generate graphs for best financial ratios and also use Data Envelopment Analysis (DEA). The results show that the efficiency score obtained by 7 commercial banks are one, with 6 commercial banks more than 90%, and one is about 85%. But $Bank_7$ from selected fifteen's obtained efficiency score is moderate, 65%. This study finds analysis suggests that those who efficiency value is high compared to other banks and achieved the best corporate be performance.

Keywords: Financial Ratios, Data Envelopment Analysis, Bank Performance, Efficiency

1. Introduction

Over the last decades, commercial banks had affected the global financial crisis (GFC) in the whole world specially developed country. The global financial crisis demonstrated that there is a strong interdependence between economic activities and banking transactions. In the era of globalisation international banking transactions have affected due to the global financial crisis of 2007-2008. In this regard, it should be pointed out that the commercial bank of Canada and United Kingdom (U.K.) seems to face challenges regarding the financial ratios of the bank. Recently most banks in the world are offering very similar services and have a no different product. After the global financial crisis, the banking industry has changed dramatically, remained financial intermediary for the operation of banks.

Overviews of the country banks have more emphasis on improving their efficiency in the recent global financial crisis. During this crisis, some commercial banks did face a great liquidity crisis because individuals and companies moving from weaker banks to stronger banks. Generally, considered that both the Canadian and UK banking systems were not affected much on global financial crisis except for significant loss of depositors and investors confidence. Xiang, Shamsuddin and

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*   Associate Professor, Department of Economics, Comilla University
**   Assistant Professor, Department of Economics, Comilla University
*** Professor, Green Business School, Green University

Worthington (2015) considered the two-stage approach to estimate the efficiency of the banking sector cross country like Australia, Canada and the UK during the global financial crisis. They found from the first stage to positively affect efficiency include loans-assets and loans-deposits ratios and the second stage to negatively affect efficiency include bank size, provisions of loan, and financial leverage.

We concentrate on how the individual commercial bank in the region of Canada and UK changed after the global financial crisis. International banking transactions have been affected by the financial crisis in the UK and USA. These countries are major recipients of international bank lending and borrowing from the perspective of banks (Batten and Szilagyi, 2012). Moreover, credit supply to small and medium enterprises (SMEs) with banks has stronger financial conditions in the UK during the GFCs (Degryse, Matthews and Zhao, 2018). Actually, we focus on their actual positions of banks of financial ratios positions, net interest margin, return on equity, loans to total assets, non-performing loan to total loans, leverage, etc after the global financial crisis. More interestingly, Canada and UK banking positions tend to be more balanced. The analysis of their net positions of financial intermediaries is stable and risk-averse behaviour in the post-GFC.

After the global financial crisis, most of the banks have followed Basel-III measures to strengthen the regulation, supervision and risk management of banks. According to Vazquez and Federico (2015), Basel-III regulations depend on structural liquidity and leverage. Moreover, they pointed out bank failure whiten also depends on macroeconomic and monetary conditions. United Kingdom is exit from the European Union during the June 23, 2016 referendum, which referred to as Brexit. Most importantly, the impact of post-Brexit what will happen the banking performance in the UK.

Charnes, Cooper and Rhodes (1978) were the first introducers of Data Envelopment Analysis (DEA). DEA is non-parametric linear programming which linear combination of decision-making units (DMUs) for an input-output model. Financial ratios analysis based on data envelopment analysis (DEA) and estimated to financial ratios for measures efficiency of bank performance. Slacks based measures of DEA was approaches with two profitability models are tested for super efficiency (Avkiran, 2011). In financial ratios analysis correlations are low and production inefficiency. LaPlante and Paradi (2015) demonstrated that Data Envelopment Analysis (DEA) used successfully for bank branch performance analysis and findings production and profitability of banks. Here with the mention that they focused on Canada's top five commercial banks within the top 75 banks worldwide respect to assets size. This bank has a network of more than one thousand branches and employees numbered over forty thousand. They suggested the efficiency scores of DEA model to find potential growth efficiency of each bank branch.

The objective of the present study is:

i) *How to identify the best financial indicators between Canada and the United Kingdom commercial bank?*
ii) *Examine how to measures the efficiency of bank performance between Canada and the United Kingdom commercial bank?*

The organization of the rest of the paper is as follows. Section 2 reviews the existence of literature on the current study. Section 3 presents the empirical analysis based on financial ratios in comparison among the banks and growth rate of ratios. Section 4 describes the analysis of the results of financial ratios using DEA for the efficiency of bank performance. Summary of the results is discussed in the last section.

2. Review of Literature

Sherman and Gold (1985) considered four traditional financial inputs as well as interest paid, fixed assets, capital expenditure and operating expenses for thirty branches of Iranian commercial bank. They used data envelopment analysis model for measuring the relative operating efficiency of bank branches. We found from the results that all units are the desirable level of efficiency. Salim, Arjomandi and Dakpo (2017) investigated non-performing loans for the period of 1998 to 2012 and used DEA for the efficiency of Iranian banks and credit risk management. They found their analysis credit quality have been government monitored more actively across Iranian banks due to the efficiency and stability of the banking sector.

Barr, Seiford and Siems (1993) evaluated quantitatively the measures of managerial efficiency and quality of banks in the US banking industry. They used nine hundred and thirty banks over five years period for data envelopment analysis (DEA) model described by six inputs and three outputs for management quality. This result is crucially important for managerial decision-making units (DMUs) and simultaneously management role in allocation and production efficiency. Figueira, Nellis and Parker (2009) pointed out that the role of ownership state and private and foreign and domestic on the banks' performance across Latin America. They used financial and economic ratios of cross-sectional data for 2001 in a final sample of 204 banks in 20 different Latin American countries on productivity, efficiency or cost of production. They employed data envelopment analysis (DEA) and found a significant difference in bank performance between state-owned and private-owned banks and between foreign and domestically-owned banks in different Latin American countries.

Dyson et al. (2001) considered the application of data envelopment analysis (DEA) and measures of selected input-output variables and weights. Under the assumptions of homogeneity of units, DEA analysed pitfalls and protocol. Isik and Hassan (2002) discussed the technical, scale and allocative efficiencies of Turkish

banking industry. They employed the non-parametric approach and used data from the period of time 1988 to 1996. These results suggested that the heterogeneous characteristics of banks have significant impact on the technical, scale and allocative efficiency. They also emphasized on financial reform packages and asked the government to improve managerial efficiency as an incentive scheme. Halkos and Salamouris (2004) investigated financial ratios and data envelopment analysis (DEA) approaches for efficiency measurement of the Greek banking sector. They used financial ratios for the three consecutive periods of time from 1997 to 1999 and comparing the inefficient banks with efficient ones. Analysis of the results showed that higher the size of total assets, higher the efficiency of banks as well as compared to financial ratios analysis in terms of performance.

Lin, Hsu and Hsiao (2007) examined relative efficiency of management and managerial efficiency in Taiwan commercial bank. They used 37 domestic commercial banks and data envelopment analysis (DEA) to estimate the efficiency of domestic commercial banks in Taiwan through the Malmquist index. The empirical results showed that the mean relative efficiency value of 0.59 and a standard deviation of 0.23, managerial efficiency value of six banks has 1 and the rest of those banks have been improving. Kao and Liu (2009) explored the efficiency of Taiwan commercial bank for measuring the efficiency of decision-making units (DMUs). They used forty-eight commercial banks and covering five consecutive years from 1997 to 2001 for data envelopment analysis for measuring the efficiency of decision-making units as well as simulation. These results showed that four simulations from 150 stochastic observations, small sample size found a good estimation of true efficiency, moderate sample size recommended producing reliable efficiency and large sample size indicated that good estimations of distribution efficiency of the Taiwan commercial banks.

Paradi and Schaffnit (2004) conducted the two production models in the country-wide evaluation. They used 66 Canadian commercial banks, 14 Domestic and 42 foreign bank subsidiaries and data envelopment analysis (DEA). One model is most useful to the bank branch manager and another model is incorporating financial results towards senior management. The study suggested that the cost-minimisation for efficiency performance of individual branches. Paradi, Rouatt and Zhu (2011) also explored the two-stage Data Envelopment Analysis (DEA) approach and used the data from 816 branches of the top five Canadian commercial banks. This analysis focused on three important dimensions as well as production, profitability and intermediation for the performance of operating units. This dimensional performance evaluation depends on geographical location and market size of the bank. This result suggested that small and medium branches are more efficient in production and profitability dimensions and large branches reveal best performance means of intermediation efficiency.

Paradi, Zhu and Edelstein (2012) demonstrated data envelopment analysis and used one thousand branches of Canadian commercial bank including domestic banks, foreign subsidiary and full-service bank for efficiency improvement possibility. The results of this analysis have found different managerial capabilities. Data Envelopment Analysis (DEA) model satisfied the criterion of Pareto dominance and comparisons of branch performance which exhibited significantly stronger operational types of branches. Havranek and Irsova (2013) analyzed bank efficiency and compared the results of Central Europe and United States commercial banks. They used the banks' balance sheet and income statement data from 1995 to 2006 for data envelopment analysis (DEA) model. They found their analysis foreign-owned banks are more efficient than domestic banks. In general estimation of cost, revenue and profit efficiency, United States banks are more efficient.

It is mentioned earlier, most of the empirical studies are corporate with the efficiency of bank branches and managerial performance analysis used the data envelopment analysis (DEA) approaches. But they have not found empirical tests for financial ratios of commercial banks between the economies of Canada and United Kingdom with Data Envelopment Analysis (DEA). The focal point of this research paper is that financial-banking efficiency ratios are used as variables to evaluate efficiency, instead of the typically used input-output variables in almost all banking applications.

3. Empirical Analysis of Financial Ratios

The empirical analysis is to explore the influencing financial ratios of bank efficiency performance that ensure overall banking efficiency in two countries, Canada and the United Kingdom. To estimate the data envelopment analysis (DEA), models financial ratios are used which are of the top fifteen commercial banks in Canada and the United Kingdom. This paper uses the financial ratios data from Datastream during the period 2016–2018 to investigate the financial ratios efficiency of bank performance. The data on net interest margin, return on equity (ROE), return on assets (ROA), cost to income ratio, cost to asset ratio, interest cost ratio, property, plant and equipment to total assets, loans to total assets, net interest to asset, non-performing loan to total loans, leverage and capital adequacy ratios are obtained from the datastream, Thomson One Wealth, 2019 and shown in Appendix A.1. We estimate the financial ratios of the bank and estimated ratios can be expressed as the following equation:

3.1 Profitability

The net interest margin measures the percentage of the net interest income (total expenses subtracted from total income) as a share of total loans. The higher the firm's net interest margin the better it is. Figure (i) is provided depicting the financial ratios in graphical format. The profitability ratios as net interest margin of Toronto-Dominion bank and other banks are around 3 percent indicates that during 2017

Toronto-Dominion bank earned 3 cents on each dollar of total loans. According to the figure, rest of the banks net interest margin are closed to around 2.

The return on equity measures the profit before tax of firm on the total shareholders' equity in the firm. Generally, if this return is higher, the owners are better off. It is categorically seen from the figure (ii) that ROE of Onesavings bank 28.41 percent indicates that during 2017 Onesavings bank returned 28.1 cents on each dollar of total equity. On the contrary, ROE of Barclays bank -2.71 percent indicates that during 2017 Barclays bank return was -2.71 cents on each dollar of total equity.

The return on total assets often callesd for the return on investment (ROI), which measures the overall effectiveness of management in generating profits before tax with its available total assets. The higher the firm's return on total assets the better it is. The figure (iii) shows that return on assets compared among the fifteen banks. Selected nine banks among the fifteen banks return on total assets is close to 0.90 percent indicates that during 2017 return was 0.009 cents on each dollar of total assets on all ranks except Onesavings bank. But ROA of Barclays bank -0.14 percent indicates that during 2017 Barclays bank return -0.0014 cents on each dollar of total assets. However, four banks have not founded data during the year 2017.

3.2 Cost to Efficiency Ratios

The definition of cost-to-income ratio, simply divides the organization's operating expenses by its operating income for the specific year. Operating expenses in this context comprise of all the costs of running the business such as fixed costs (rent, mortgage, insurance, utilities, property taxes and so on) and Revenue includes sales receipts, fee income and interest earned on loans. Analysis of cost-income ratio in figure (iv) of the bank of Scotland shows that the highest total operating expenses in respect to operating income among the selected banks.

The cost-assets ratio measures the operating expenses of the firm with total assets over the period. From the figure (v), the cost-assets ratio of Lloyds banking is highest which is 4.32 percent and indicates that during 2017 Lloyds banking 4.32 cents on each dollar of total assets over the period. Rest of commercial bank of Canada and the United Kingdom is closed around 3 percent.

The definition of interest-cost ratio simply divides the organization's interest expenses by its interest income for the specific year. The figure (vi) shows that return on assets compared among the fifteen banks. Selected six banks among the fifteen banks return on total assets is close to 0.90 percent which indicates that during 2017 return 0.009 cents on each dollar of total assets.

3.3 Asset Quality to Risk

Property, plant and equipment (PPE) to total assets ratio represents property, plant and equipment of the firm with the total assets over the period. From the figure (vii) PPE-total assets ratio of most of the commercial banks is less than 1 percent during 2017 except Lloyds and Standard Chartered Bank. This ratio of Lloyds which is 1.11 percent indicates that during 2017, property, plant and equipment costed 1.11 cents on each dollar of total assets.

Loans-assets ratio measures how much loans to the business of the firm to the total assets over the period. This figure (viii) shows Loans-assets ratio of the Western bank is 116.41 percent which indicates that Western bank had 116.41 percent loans to the business of the firm in respect to the total assets during 2017.

Net interest to asset ratio measures net interest income of the firm in respect to the total assets over the period. From the figure (ix), net interest to asset ratio of the Western bank is highest which is 3.14 percent and of indicates that Western bank net interest income 3.14 cents on each dollar of total assets during 2017. This ratio of Onesavings bank 2.82 is the second highest among the selected commercial banks in the UK.

Non-performing loans ratio measures non-performing loans (NPL) to the total loans over the period. This figure (x) shows non-performing loans to the total loans of Standard Chartered bank is 2.78 percent which indicates that 2.78 cents on each dollar of total loans during 2017 than those that are in default. This ratio bank of Scotland 2.59 is second highest among the selected commercial banks in the UK.

3.4 Capital Ratio

Leverage measures the proportion of total equity as a share of the firm's total assets. The higher this ratio, the greater the financial leverage, the greater the potential risk and return. From the figure (xi), the proportion of total equity as a share of the firm's total assets of Versa bank, and the western bank is the highest around 8 percent during 2017.

Capital Adequacy Ratio (CAR) is a measure of total equity expressed as a percentage of a bank's risk-weighted assets, this ratio is also known as capital to risk-weighted assets ratio. This ratio used to by the protected depositors and to ensure stability and efficiency of the financial markets in the world. We have analysed from the figure (xii), capital adequacy ratio of Lloyds bank, Bank of Scotland and HSBC bank are of the highest value around 25 percent in the selected fifteen banks during 2017.

3.5 Growth of Financial Ratios

The financial ratios of net interest margin, return on equity (ROE), cost to income ratio, cost to asset ratio, interest cost ratio, property, plant and equipment to total assets, loans to total assets, net interest to asset, non-performing loan to total loans,

leverage and capital adequency ratios during 2017 shown in Appendix A.2. The growth of financial ratios of the fifteen banks shows an unstable improvement during the period 2016–2018.

3.6 Descriptive Statistics

Table-1 provides a summary of the descriptive statistics for the financial ratios as the increase of net interest margin, return on equity (ROE), cost to income ratio, cost to asset ratio, interest cost ratio, property, plant and equipment to total assets, loans to total assets, net interest to asset, non-performing loan to total loans, leverage and capital adequency ratios during 2017. One can observe that the variables have high standard deviations and the median values in almost are smaller than their mean values, indicating that the data are skewed to the right.

Table 1: Summary of the Descriptive Statistics: 2017

Financial Ratios	Mean	Maximum	Minimum	Std. Dev.
Return on Equity	11.17133	28.41000	-2.71	7.953832
Interest Margin	2.492402	3.122870	1.282442	0.565955
Interest to Asset	1.709706	3.135578	0.780261	0.703473
Cost-Income	385.6245	774.9015	93.22229	199.0180
Cost-Asset	2.944438	4.320440	1.870121	0.743989
Interest-Cost	266971.4	4004093.	18.55175	1033843.
PPE-Asset	0.423012	1.114809	0.075495	0.296719
Loans-Assets	68.62469	116.4119	42.14545	21.99995
NPL-Loans	1.344394	2.782596	0.000000	0.829542
LEVERAGE	7.293151	12.26285	4.996167	2.231074
Capital Adeq.	17.25849	24.05674	11.43233	3.790625

(Authors' Calculations)
Sources: Data from Datastream, Thomson One Wealth, 2019

4. Empirical Analysis of DEA

DEA has become one of the most widely used approaches to measuring the efficiency of financial institutions. We show that the proposed DEA model can be used as a complement/substitute for simple ratio analysis. This can be partially attributed to the difference in data availability. Assume n banks decision-making units (DMUs) which are appraised on r financial ratios $y_{rj}\left(r = 1,\ldots,s\right)$ are the observed r financial ratios of jth DMUs $\left(j = 1,\ldots,n\right)$. The efficiency of firm 0 is given by $1/zo$. According to Charnes, Cooper and Rhodes (1978), the mathematical formulation of the DEA model:

$$\max \varphi$$

$$\text{Subject to } \sum_{j=1}^{n} \lambda_j \, y_{rj} \geq \varphi y_{ro}$$

$$\sum_{j=1}^{n} \lambda_j = 1 \, ; \, \lambda_j \geq 0$$

The task of this study is to examine the efficiency of the commercial banking system during the period 2017 and the relative efficiency of the banks of Canadian and United Kingdom. We employ both ratio analysis and data envelopment analysis techniques (DEA) for the measurement of the efficiency with the use of financial ratios which are frequently applied in the banking sector. Specifically, the efficiency of a bank is measured by using ratios such as return on equity (ROE), net interest margin, net interest assets ratio, leverage, and capital adequency ratios. Their use of financial ratios can make the identification of and comparison to top performers very difficult. The efficiency results calculated from data envelopment analysis (DEA) by *Microsoft-Excel* are presented in Table 2.

Table 2: DEA Analysis of Financial Ratios

Bank	Return on Equity	Output Target	Output Slack	Output Slack %	Net Interest Margin	Output Target	Output Slack	Output Slack %
Bank 6	14.83	14.83	0	0	3.12287	3.12287	0	0
Bank 9	1.55	1.55	0	0	2.618193	2.618193	0	0
Bank 14	6.46	6.46	0	0	1.314929	1.314929	0	0
Bank 4	10.03	10.03	0	0	2.69352	2.69352	0	0
Bank 11	28.41	28.41	0	0	2.838587	2.838587	0	0
Bank 12	5.89	5.89	0	0	2.767054	2.767054	0	0
Bank 15	10.29	10.29	0	0	2.898439	2.898439	0	0
Bank 5	18.24	18.51127	0.271268	1.487214	2.50211	2.539321	0.037212	1.487214
Bank 8	16.9	17.35228	0.452283	2.676229	2.968284	3.047722	0.079438	2.676229
Bank 2	14.57	15.19962	0.629617	4.321324	2.682264	2.798173	0.115909	4.321324
Bank 13	1.54	1.615632	0.075632	4.911146	2.737661	2.872112	0.134451	4.911146
Bank 1	13.14	13.84748	0.707477	5.384149	2.704631	2.850253	0.145621	5.384149
Bank 3	17.97	19.30357	1.333572	7.4211	2.432369	2.612878	0.180509	7.4211
Bank 10	-2.71	-3.17821	-0.46821	17.27707	1.282442	1.50401	0.221568	17.27707
Bank 7	10.46	16.06719	5.607193	53.60605	1.822683	2.799752	0.977069	53.60605

(Continued...)

Bank	Net Interest to Assets	Output Target	Output Slack	Output Slack %	Leverage	Output Target	Output Slack	Output Slack %
Bank 6	1.63314	1.63314	0	0	5.813327	5.813327	0	0
Bank 9	1.220536	1.220536	0	0	6.563758	6.563758	0	0
Bank 14	0.780261	0.780261	0	0	6.039083	6.039083	0	0
Bank 4	3.135578	3.135578	0	0	12.01264	12.01264	0	0
Bank 11	2.815704	2.815704	0	0	5.787512	5.787512	0	0
Bank 12	1.166187	1.166187	0	0	7.558316	7.558316	0	0
Bank 15	2.586336	2.586336	0	0	12.26285	12.26285	0	0
Bank 5	1.316749	1.336332	0.019583	1.487214	5.194477	5.27173	0.077253	1.487214
Bank 8	1.415218	1.453092	0.037874	2.676229	6.095923	6.259064	0.163141	2.676229
Bank 2	2.121371	2.213042	0.091671	4.321324	8.470386	8.836419	0.366033	4.321324
Bank 13	1.289225	1.352541	0.063316	4.911146	7.770517	8.152139	0.381621	4.911146
Bank 1	1.825197	1.923469	0.098271	5.384149	8.089817	8.525385	0.435568	5.384149
Bank 3	2.049694	2.201804	0.15211	7.4211	7.086137	7.612007	0.525869	7.4211
Bank 10	0.875649	1.026935	0.151286	17.27707	5.656356	6.633609	0.977253	17.27707
Bank 7	1.414747	2.173137	0.75839	53.60605	4.996167	7.674415	2.678248	53.60605

(Continued ...)

Bank	Capital Adeque. Ratio	Output Target	Output Slack	Output Slack %	Efficiency Score	Peers	Rank
Bank 6	17.02972	17.02972	0	0	1	6,11,12,15	1
Bank 9	24.05674	24.05674	0	0	1	11,12,15	2
Bank 14	23.1871	23.1871	0	0	1	11,12,15	3
Bank 4	11.67359	11.67359	0	0	1	15	4
Bank 11	14.83649	14.83649	0	0	1	9,11,14	5
Bank 12	21.83426	21.83426	0	0	1	11,12,15	6
Bank 15	14.68313	14.68313	0	0	1	9,11,12,15	7
Bank 5	18.09768	18.36684	0.269151	1.487214	0.9853458	6,11,15	8
Bank 8	15.56005	15.97647	0.416423	2.676229	0.9739353	15	9
Bank 2	15.95015	16.6394	0.689258	4.321324	0.9585768	9,15	10
Bank 13	18.39727	19.30079	0.903517	4.911146	0.9531876	6	11
Bank 1	16.45996	17.34619	0.886229	5.384149	0.9489093	6,9,11,15	12
Bank 3	15.26404	16.3968	1.13276	7.4211	0.9309158	6,12,15	13
Bank 10	20.41478	23.94186	3.527077	17.27707	0.8526816	9,12	14
Bank 7	11.43233	17.56075	6.12842	53.60605	0.651016	11	15

(Authors' Calculation)
Sources: Data from Datastream, Thomson One Wealth, 2019

Analysis (DEA) was found to be one of the most versatile approaches used in the banking industry. It makes each DMU look as favourable as possible to its peers by allowing each DMU to choose its variable weights/multipliers. However, the

majority of DEA banking studies have focused on banks at an institutional level, rather than at the branch level (Halkos and Salamouris, 2004). DEA also can identify reference units for each DMU, which proves to be a very useful managerial tool as it aids in determining the potential causes and remedies for the identified inefficiencies.

Two sets of results based on average DEA efficiency scores for banks in 15 of the 2 countries in our analysis. These two countries are the top number of banks for which we have data. From an examination of the results within each of the two countries, we can interpret that there are no significant differences between banks which are majority state-owned, privately-owned and foreign banks. The study is an analysis of financial ratios performance across the countries, Canada and the United Kingdom. Table 2 presents the efficiency score, output target, output slack, output slack percentages, and peers of each bank.

Based on table 3, the most efficient bank is Bank 6 (Tor-Dominion bank). The result shows that return on equity ratio (10.46), net interest margin ratio (1.82), net interest assets ratio (1.41), leverage ratio (4.99), and capital adequacy ratio (11.43), which measures the bank efficiency is one by indicating 'best' financial ratios (outputs) amongst the selected fifteen banks in Canada and U.K. On the contrary, the least efficient bank is Bank 7 (Laurentian Bank). The result shows that return on equity ratio (14.83), net interest margin ratio (3.12), net interest assets ratio (1.63), leverage ratio (5.81), and capital adequacy ratio (17.02), which measures the bank efficiency as 0.65 by indicating 'moderate' financial ratios (outputs) amongst the selected fifteen banks in the Canada and U.K.

To measure bank efficiency with respect to financial ratios, we use DEA to estimate the bank's efficiency. The efficiency scores obtained 1 (or 100 percent) of Tor-Dominion, Bank of Scotland, Lloyds Banking, Western Bank, Onesavings Bank, HSBC Holdings, and Versabank. These banks output slack percentage is zero. On the contrary, efficiency scores obtained more than 90 percent of National Bank, Royal Bank, Nova Scotia, Standard Chartered, Bank of Montreal, and Canadian Imperial bank. These banks output slack percentage is a single digit. Moreover, efficiency scores of Barclays Bank obtained 85.26 percent and output slack percentage is 17.27. But efficiency scores of Laurentian Bank obtained 65.10 percent and output slack percentage is 53.60. It implies that if DMU_7 (Laurentian Bank) is to be efficient; it should increase its output by 53.60% for the same level of inputs. The efficiency scores obtained by used DEA and to identify peers of the banks. It can be seen in Table 3 most of the peers shows bank 11, and bank 12 and bank 15. Thus Bank 11 (Onesavings bank) return on equity is lower than the peer bank (0.26). Thus, bank 11 might need to use its' return on equity more effectively to improve its efficiency.

5. Summary of Results

The aforementioned analysis points to the fact that empirically tests for financial ratios of commercial banks between Canada and the United Kingdom economies. This research paper investigates Data Envelopment Analysis (DEA) that findings efficiency of bank performance by using cross-section data from Datastream. We compare the twelve financial ratios among the fifteen banks in Canada and the UK. The growth of financial ratios of the fifteen banks show an unstable improvement during the period 2016–2018. Moreover, we observe that the variables have high standard deviations and the median values in almost are smaller than their mean values, indicating that the data are skewed to the right. The results of DEA has predicted that financial ratios of some banks are relatively better off rather than other banks of both counties (Avkiran, 2011; Halkos and Salamouris, 2004). The results show that efficiencies for the 7 commercial banks are one, with 6 commercial banks obtained efficiency of more than 90%, and one is about 85%. But only one bank from selected fifteen has obtained efficiency score is moderate, 65%.

Although the research has indicated important findings, yet it suffers from some limitations which can be addressed in future studies. There are many factors that require ensuring the efficiency of financial ratios in Canada and the UK.

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Appendices

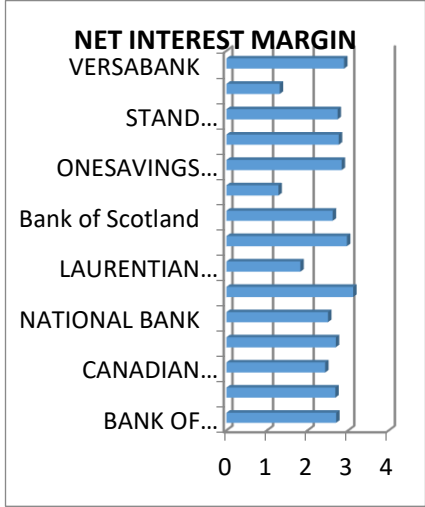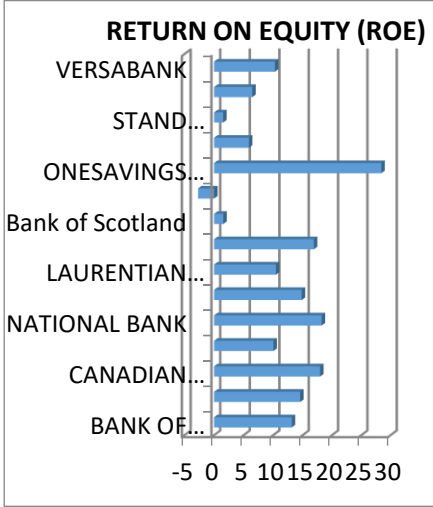### A.1 Figure of Financial Ratios

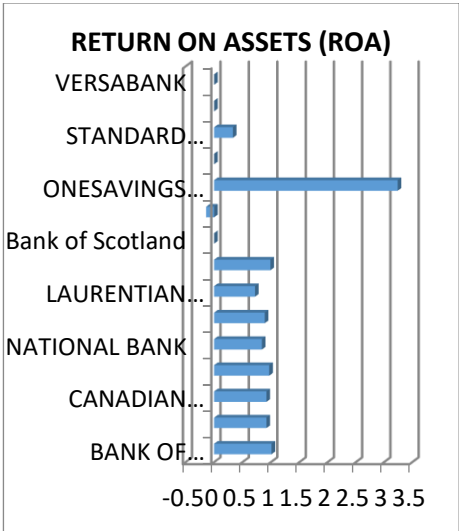

Figure-(i): Net Interest Margin

Figure-(ii): Return on Equity
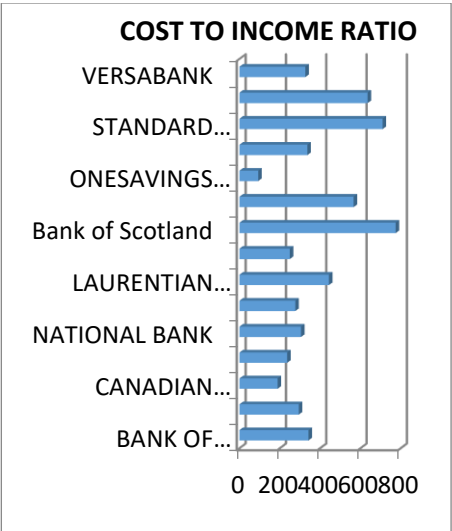
Figure-(iii): Return on Assets

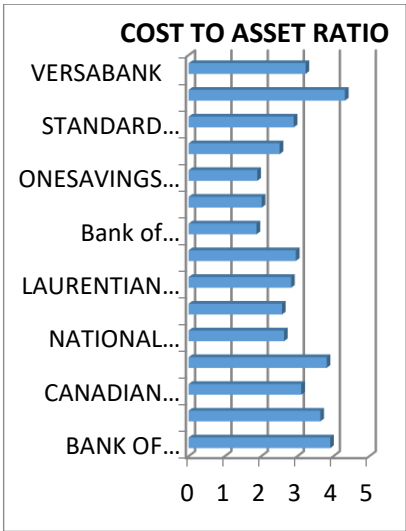**Figure-(iv): Cost-Income Ratio**

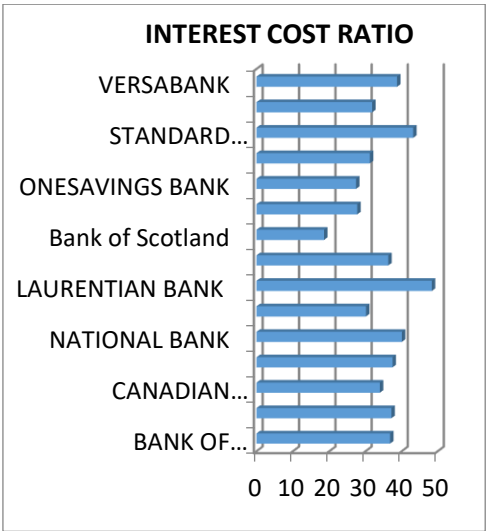**Figure-(v): Cost Asset Ratio**

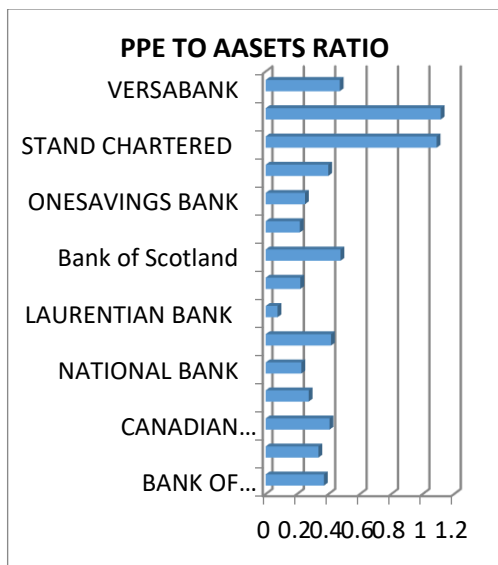
Figure-(vi): Interest Cost Ratio
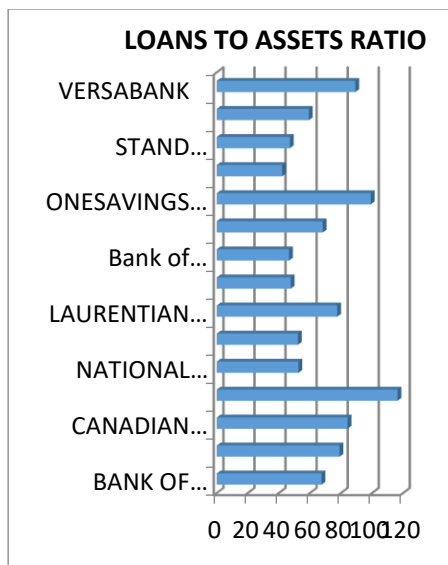
Figure-(vii): PPE-Total Assets

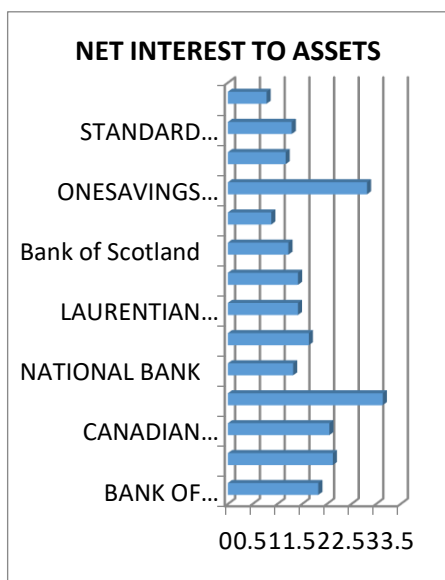
Figure-(viii): Loans-Total Assets

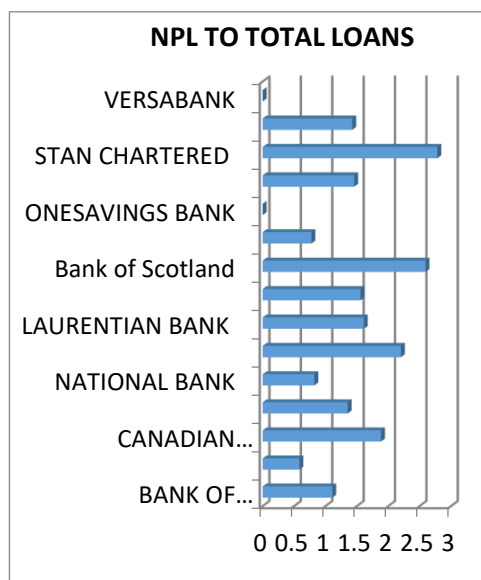**Figure-(ix): Net Interest to Asset**

Figure-(x): NPL to Total Loans

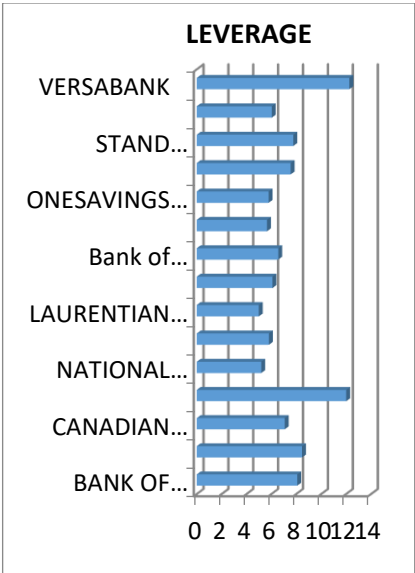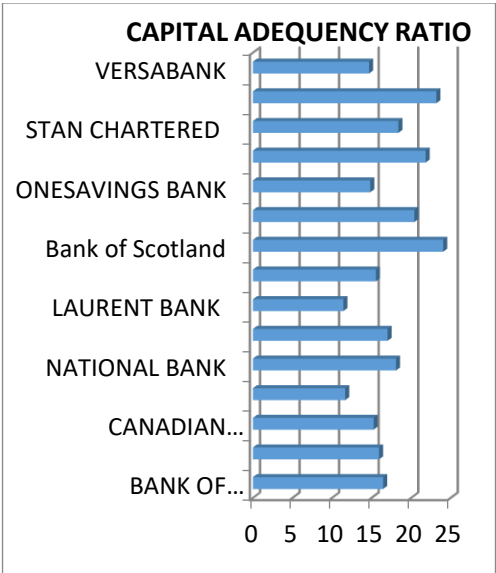**Figure-(xi): Leverage**

Figure-(xii): Capital Adequency Ratio

Sources: Data from Datastream, Thomson One Wealth, 2019

Year	Bank	ROE	Interest Margin	Interest to Asset	Cost-Income	Cost-Asset	Interest-Cost	PPE-Asset	Loans-Assets	Leverage	Capital Adeq.	NPL - Loans
					Table-A.1: Growth of Financial Ratios of the Fifteen Banks[1]: 2016–2018							
2017	Bank 1	9.682805	0.027517	-5.58088	-4.16736	-0.07324	15.25351	-11.8004	-5.60685	-2.34094	7.995931	-11.4615
2018	Bank 1	-1.67428	-3.4348	-3.75563	-0.16809	7.871762	27.67385	-8.77033	-0.33224	-3.72043	-4.07334	-7.25893
2017	Bank 2	6.11799	-1.60548	-1.0194	-5.65524	-2.49429	4.259315	-11.1007	0.595635	0.415195	3.466829	-13.1129
2018	Bank 2	-1.50995	-1.07168	0.711588	8.411541	7.216574	13.85785	5.422259	1.802585	1.613923	2.019752	3.20125
2017	Bank 3	-9.15066	-7.02772	-8.54239	-5.08765	-6.71091	10.20613	-19.9315	-1.62916	12.6959	10.29297	-5.963
2018	Bank 3	-6.95604	7.104525	8.252859	13.12314	21.66449	25.1585	-2.79918	1.072162	8.708939	5.756972	-6.72476
2017	Bank 4	9.021739	5.65442	0.648693	-18.4676	-6.89971	-4.33564	-10.2512	-4.73783	-3.64889	1.489613	-12.767
2018	Bank 4	10.06979	2.109751	4.931493	2.102078	9.718871	8.979187	-2.08112	2.76344	-2.31229	-5.68756	3.317906
2017	Bank 5	56.56652	2.0126	3.257	-43.531	-3.49567	-15.3695	-60.615	1.219849	6.633066	9.982061	-13.2291
2018	Bank 5	0.657895	-3.41081	-2.02265	0.924686	15.32292	40.69162	0.847172	1.437187	2.635159	4.804705	-6.13176
2017	Bank 6	11.84012	0.826396	-3.69179	-3.51922	-0.41493	20.52911	-10.7979	-4.48115	-5.87648	-4.7543	-9.79796
2018	Bank 6	3.84356	4.623643	2.225192	6.057572	14.18294	29.29109	-3.97496	-2.29246	2.076733	6.479044	5.868646
2017	Bank 7	13.20346	-3.52484	-1.93581	-12.6706	-2.71784	0.251589	-1.66353	1.647084	8.710549	3.506802	-5.81396
2018	Bank 7	-5.06692	15.22155	11.88475	18.99561	18.68137	7.462883	133.7945	-2.89598	8.923395	7.725376	6.193431
2017	Bank 8	1.440576	-0.93929	0.799789	-1.00414	5.145358	12.03283	-8.47221	1.755567	1.067749	-1.46669	-15.8236
2018	Bank 8	1.715976	-0.54452	-3.59074	5.928724	5.634457	23.74852	-3.64927	-3.06289	-1.73909	3.380934	-11.6994
2017	Bank 9	-111.372	3.656151	11.68897	-261.745	-26.1687	-18.0958	8.655112	7.749489	7.600449	12.93689	-13.2588
2018	Bank 9	122.5806	3.953544	2.36334	-37.3044	2.403185	16.74408	31.77944	-1.52973	0.573445	0.751013	-100
2017	Bank 10	-196.441	-46.4093	0.332731	-8.51125	3.794629	0.569279	-4.27939	87.22026	5.3494	15.0655	-47.2511
2018	Bank 10	-193.358	90.13402	-17.8569	-29.6733	-3.06373	45.52592	2.88076	-56.7973	-2.08183	-1.75536	161.5109
2017	Bank 11	-15.897	-10.4948	-8.49659	-26.7993	-29.3395	-20.9577	25.75878	2.232457	-3.96731	2.665244	
2018	Bank 11	-100										
2017	Bank 12	645.5696	-3.41038	0.712656	-53.5929	-9.44374	5.214992	0.675873	4.268611	2.085191	6.712703	-23.3997
2018	Bank 12	27.33447	-0.33578	-1.61086	3.80831	-1.54433	23.38705	-1.10801	-1.27938	-3.50323	-1.41995	-47.683
2017	Bank 13	-255.556	9.412808	15.63215	-70.5391	9.219149	8.151217	-3.10646	5.684293	3.752327	2.551936	-17.3911

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[1] Bank of Montreal = Bank 1, Nova Scotia= Bank 2, Canadian Imperial= Bank 3, Western Bank= Bank 4, National Bank= Bank 5, Toronto-Dominion= Bank 6, Laurentian Bank = Bank 7, Royal Bank= Bank 8, Bank of Scotland= Bank 9, Barclays Bank= Bank 10, Onesavings Bank= Bank 11, HSBC Holdings= Bank 12, Standard Chartered = Bank 13, Lloyds Banking= Bank 14, Versa Bank= Bank 15

2018	Bank 13	-22.0779	-4.36106	-4.65376	24.44407	2.574441	13.45026	-13.3215	-0.30605	-6.28756	5.385985	-22.9308
2017	Bank 14	46.48526	9.58989	8.979583	-37.3742	-20.0578	-27.9961	-1.31775	-0.5569	1.754577	3.309736	-13.6075
2018	Bank 14	24.4582	2.065057	6.824473	-52.7527	-42.8127	-43.246	-3.77181	4.66312	3.96826	4.335833	30.53972
2017	Bank 15	171.504	17.82678	14.35278	-27.6768	-5.71834	-13.7249	84.93742	-2.9484	12.01799	12.57544	
2018	Bank 15	-17.3955	9.213664	11.1946	-30.8966	-2.88661	-6.09378	-0.6524	1.813821	1.808963	1.335205	

(Authors' Calculations)

Sources: Data from Datastream, Thomson One Wealth, 2019