Market Power and Efficiency in Banking: The Case of USA and Canada

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Abstract

The banking markets of USA and Canada have gone through the Global Financial Crisis (GFC) and many other changes during the period 2003-15. The USA banking market was severely impacted by the GFC, and several mergers occurred, while the extent of the GFC's impact on Canada was much less severe, and there was no major merger and acquisition activity. This study compares the impact of changing market concentration and power on the efficiency of the major banks in the both countries. A significant negative impact of the GFC is observed on bank efficiency. Overall, Canadian banks posted better efficiency scores than their US counterparts. We find that market power had a positive impact and market concentration a negative impact on profit efficiency however both have positive impact on cost efficiency. Market power has helped to lower the loan losses, interest margin, and increase profit from high-income client to achieve an optimal level of performance (from the banks' perspective). It has also played a role in improving bank stability. The paper contributes by integrating competition measures into the study of efficiency, demonstrating that inclusion of efficiency allows a more precise estimation of the frontier. The paper also has implications for the regulation of the banking sector, particularly with regard to competition.

Keywords: Market Power, Bank Efficiency, Global Financial Crisis, Lerner Index, Herfindahl-Hirschman Index.

JEL Classification: E58; E62; G01; G21; G32; O57

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1. Introduction

The widespread positive impact of market competition on industrial organizations persuaded the governments of many developed and developing countries to deregulate their financial sector to promote more competition. This started in the late 1970s and been a matter of concern among policymakers and academics due to the impact of changing banking market structure on its performance and stability. The objective of this deregulation was to promote competition among banks for fostering efficiency, service quality, and international competitiveness (Claessens & Laeven, 2004). However, most of the deregulated banking markets have become less competitive and more concentrated with time especially after the GFC. The debate on the good and bad impact of deregulation on banking sector is inconclusive so far. Many studies have been conducted on the outcomes of changing market concentration, power, and its relationship with bank efficiency and stability (Berger, 1995; De Guevara, Maudos, & Perez, 2005; Delis & Tsionas, 2009; Färe, Grosskopf, Maudos, & Tortosa-Ausina, 2015). The reported results of all these studies are mixed because of their different methodology, time frame, and geography. However, the assessment of banking market structure is very important for market participants and regulators for future policy guidelines. The banking sectors of USA and Canada are selected for this study to assess the impact of GFC, growing market concentration and power on bank efficiency.

Currently, the US banking system is based on thousands of banks regulated at federal and state level whereas Canadian banking system is based on few banks. However, about 58% of US banking assets are held by the six largest banks and 92% of Canadian banking assets by their big five banks (Mohsni & Otchere, 2017). Overall number of registered banks have declined in both countries during the study period. It is believed and supported by empirical evidence that concentrated markets tend to have lower deposit rates, and higher loan rates which imply a less competitive conduct by banks that may have negative effect on consumers (Dick, 2007). Therefore, increased banking concentration has prompted concerns among some observers over the market power of the banks in local banking systems. It is therefore desirable to explore the impact of changing banking market structure and power on the efficiency of the banks in the both countries. Moreover, it has been a sufficiently long period since the GFC to review its impact and consequences on the banking systems of USA and Canada. The findings of this study may be useful for regulatory environment, management practices, and overall bank supervision.

The Stochastic Frontier Analysis (SFA) employed in this study finds a significant impact of market power on most of the selected macroeconomic, risk, and banking structure variables. Overall,

market power has a positive influence on cost and profit efficiency but market concentration has a negative impact on profit efficiency, consistent with several previous studies (Belke, Haskamp, & Setzer, 2016; Fu, Lin, & Molyneux, 2014). We find that market power has helped banks to earn more profit from higher income clients, lower their interest margin, risk, and loan losses. Market power found more helpful for smaller banks to improve their efficiency relative to bigger banks. Granger-Causality results identified a positive and lagged role of market power in bank stability and efficiency. A significant and negative impact of the GFC is observed on market power, concentration, and bank efficiency. It seems to be the right time for regulators of both countries to intervene and further guide their banks to improve efficiency and avoid any future big crisis. The regulatory interventions and consequences have already been identified in some other developed countries but the appropriateness of those intervention still need to be investigated (Laeven, Ratnovski, & Tong, 2014; Scott, 2017).

This study makes several contributions and additions to existing literature. First, the methodological contribution of this study is to include the important role of market power in a one-stage SFA model to give more precise efficiency scores and show its contribution to bank efficiency. Second, to the best knowledge of the authors, it is the most recent bank efficiency comparison of USA and Canada which incorporates the effects of the GFC. The study also provides evidence of causality among bank efficiency, stability, and market power in US and Canadian banking sectors. Third, to the best knowledge of the authors, this study has for first time explored the impact of the GFC on the banking market structure of USA and Canada. Important policy implications are also identified at the end of the study.

The rest of the study proceeds as follows; the next section reviews the literature on the relationship between market concentration, power, and bank efficiency. Section 3 presents the methodology used to measure bank efficiency, market power, and modeling of their relationship. This section also describes the sources of data being used in estimation models. The empirical results of bank efficiency, market power, and their relationship are discussed in section 4. The last section concludes the results and discusses the possible implications of the study.

2. The Relationship between Market Concentration, Power and Bank Efficiency

The relationship of market concentration to bank efficiency and stability is widely debated but controversial among policymakers and academics. It is believed that the increase in banking market concentration is motivated by the prospective benefits of greater market power. The traditional structure-conduct-performance hypothesis (SCP) asserts that increasing concentration may result in imperfect competition in a market because of the absence of effective market supervision, which may

give power to banks to increase their net margin on their products and services (Berger, 1995; Färe et al., 2015). The exercise of market power may result in either a positive or negative relationship between market power and bank efficiency. The positive relationship posits that managers increase net margin to pursue the profit maximization objective of the firm and negative relationship indicates that managers increases the net margin to achieve objectives other than firm profits. Neither of these situations benefit the consumer or the economy because in either case, managers work for their own benefit without making sufficient efforts to improve firm performance (Koetter, Kolari, & Spierdijk, 2012). There is also an efficiency explanation of the positive relationship between firm performance, concentration, and market power. The efficient-structure-hypothesis (ESX) postulates that firms with superior management or production technology may lower their costs and increase the profits of the firm (Demsetz, 1973). There are more theories which have established the dimensions of the relationship between market concentration, power, and firm efficiency. For example, the quiet life hypothesis (QLH) explains the reasons for the negative relationship (Berger & Hannan, 1998) whereas, the relative-market power hypothesis (RMP) (Berger, 1995) and charter value hypothesis (Keeley, 1990) give various other reasons for a positive relationship.

The focus of this study is on the dynamics of the relationship between market concentration, power, and bank efficiency. The study also aims to assess the impact of market power on other determinants of bank efficiency which may help to identify the channels and objectives of exercising market power in banks. Although several significant papers have tested the relationship between market concentration, power, and bank efficiency, it is difficult to draw a conclusion from a review of recent literature because of the differing results of these studies. Many studies have supported the earlier results of Berger and Hannan (1998) who reported a negative relationship between bank efficiency and market concentration (Akins, Li, Ng, & Rusticus, 2016; Fu et al., 2014; Pruteanu-Podpiera, Weill, & Schobert, 2008; Restrepo-Tobón & Kumbhakar, 2014). These studies also reported the negative impact of market concentration and bank power on banks' financial stability. The study by Akins et al. (2016) found that the banks facing less competition are more likely to engage in risky activities, face more regulatory interventions, have higher loan losses, and are more likely to fail. In contrast, the papers of Maudos & de Guevara (2007), Casu & Girardone (2009), and Koetter et al. (2012) reported a positive relationship between market power and bank efficiency. Similar results are reported by later studies looking at banks of developed and developing countries (Färe et al., 2015; Kasman & Carvallo, 2014; Schaeck & Cihák, 2014).

Many previous studies on market concentration, power, and bank efficiency have included macroeconomic variables which may affect the efficiency of the banks and some firm-level variables

related to bank efficiency which may be influenced by market power. The variables of bank size, interest rate, net margin, GDP per capita, and level of capital may help in improvement of bank efficiency (Berger & Humphrey, 1997; Maudos & de Guevara, 2007; Xiang, Shamsuddin, & Worthington, 2015). The impact of bank risk, loan losses, loans to assets ratio, liquidity, market concentration, and power depends on the market structure, bank characteristics, the regulatory and institutional framework, and effectiveness of supervision (Beck, De Jonghe, & Schepens, 2013; Fu et al., 2014). All these variables are included in this study to achieve our multiple objectives. First, this may help us to get a more precise estimation of bank efficiency. Second, their relationship with bank efficiency can be interpreted. Third, the influence of market power can be observed on these variables to identify the channels for exerting market power.

3. Methodology

3.1 Measurement of Bank Efficiency

In previous research, frontier analysis is recognized as the most sophisticated way to compare the relative performance of production units (Berger & Humphrey, 1997). There are two major paradigms to construct frontier for benchmarking the relative efficiency of selected units with best practice. One is based on mathematical programming and other employs econometric techniques. These techniques are used in the form of the two-stage model, two-stage mixed model, and one-stage model in different studies (Berger & Mester, 1997; Casu & Girardone, 2009; Xiang et al., 2015). However, the problems of correlation, biased estimators, and data-generating process with two-stage models are well documented in the literature (McDonald, 2009; Simar & Wilson, 2007; Wang & Schmidt, 2002).The Stochastic Frontier Approach (SFA) used in this study, is one of the most frequently used parametric approach in prior studies to estimate the bank efficiency in a single stage. SFA provides a single value for bank efficiency and its relationship with variables of market power in presence of other environmental variables. There are four benefits of including the market power and other environmental variables in a one-stage SFA approach. First, this approach will give us more robust efficiency score in presence of these variables. Second, it will solve the statistical problems of the two-stage approach (Wang & Schmidt, 2002). Third, it will help to identify the impact of other variables on efficiency as per industry structure. Finally, it will give us the magnitude of their relationship with bank efficiency. The variables of HHI and Lerner Index are used as proxies for market concentration and power in the present study. The variable of HHI or concentration has previously been used in one-stage SFA approach (Belke et al., 2016; Casu & Ferrari, 2015; Xiang et al., 2015); however, the use of Lerner index is not frequent in SFA models. It is recommended in prior studies to select relatively homogenous economies for cross-countries bank efficiency studies,

therefore the economies of the USA and Canada are selected for this study and remaining banking market differences are controlled with inclusion of the control variables in estimation models (Berger & Mester, 1997; Xiang et al., 2015).

The cost function for this study in translog form can be specified as follows:

$$\ln TC_{it} = \alpha_o + \sum_{n=1}^{3} \alpha_n \, lny_{nit} \; + \frac{1}{2} \sum_{k=1}^{3} \sum_{n=1}^{3} \alpha_{nk} \, lny_{nit} lny_{kit} \; + \; \sum_{j=1}^{2} \beta_j \; lnw_{jit} + \frac{1}{2} \sum_{m=1}^{2} \sum_{j=1}^{2} \beta_{jm} \, lw_{jit} lw_{mit} \; + \sum_{j=1}^{2} \sum_{n=1}^{3} \varepsilon_{nj} \; ly_{nit} lw_{jit} \; + \; \gamma_t t + \frac{1}{2} \, kt^2 + v_{it} + \mu_{it} \quad (3.1)$$

Where TC_{it} is the total cost of i-th bank in each year t. y_{it} is vector of outputs and w_{it} is vector of input prices. v_{it} are normally distributed random error terms and independent of inefficiency error terms. μ_{it} are truncated normal positive inefficiency error terms and independent of random error terms.

$$\mu_{it} = \; \delta z_{it} + \omega_{it} \qquad (3.2)$$

The inefficiency errors are based on z vector of environmental variables which may contribute to bank inefficiency.

$$\ln PBT_{it} = \alpha_o + \sum_{n=1}^{3} \alpha_n \, lny_{nit} \; + \frac{1}{2} \sum_{k=1}^{3} \sum_{n=1}^{3} \alpha_{nk} \, lny_{nit} lny_{kit} \; + \; \sum_{j=1}^{2} \beta_j \; lnw_{jit} + \frac{1}{2} \sum_{m=1}^{2} \sum_{j=1}^{2} \beta_{jm} \, lw_{jit} lw_{mit} \; + \sum_{j=1}^{2} \sum_{n=1}^{3} \varepsilon_{nj} \; ly_{nit} lw_{jit} \; + \; \gamma_t t + \frac{1}{2} \, kt^2 + v_{it} - \mu_{it} \quad (3.3)$$

In equation 3.3, the independent variables are same as equation 3.1 but dependent variable is the amount of profit before tax plus constant of Θ (Berger & Mester, 1997) to estimate alternative profit efficiency, where Θ is the absolute value of minimum normalized profit before tax plus 1[4]. In standard profit efficiency, the price of output is given, so a bank changes the quantity of output and input to get optimal revenue for maximum profit. However, when measuring alternative profit efficiency, the quantity of output is given so the bank can charge different prices to get optimal revenue for maximum profit (Berger & Mester, 1997). The impact of market power will be more applicable to the alternative profit efficiency model compared to the traditional profit efficiency model. The inefficiency errors are similar to equation 3.1 with a negative sign because inefficiency will lower the profit efficiency of bank. The variables of the total cost (TC), profit before tax (PBT), and two input prices (w_1, w_3) are normalized by the price of funds (w_2) to impose linear homogeneity on all models. Furthermore, total cost (TC), profit before tax (PBT), and output amounts are normalized by total equity to minimize the size bias.

[4] This allows us to avoid having any negative values for which we cannot apply logarithms.

The question about causation among bank efficiency, stability, and market power has been discussed in prior studies under different hypotheses (Akins et al., 2016; Allen & Gale, 2004; Berger, 1995; Keeley, 1990). Various hypotheses which explain relationship between bank efficiency and market power are discussed in previous section of this paper. Several prior studies have explored the trade-off relationship between banking market power/competition and financial stability of the banks. As per traditional competition-fragility view, more banking market competition reduce market power, decrease profit margin which encourage banks to take more risk for better returns. Higher level of risk and lower returns can bring more fragility in banking market. The counter-argument is known as competition-stability view which believes that competition will promote efficient utilization of resources to reduce cost as compared to competitors. The reduced cost will help bank to offer lower interest rate on loans to attract more business and there will be lower chances of loan default which can result in more financial stability (Allen & Gale, 2004; Beck et al., 2013; Berger, Klapper, & Turk-Ariss, 2009).

The relationship among banking market power, stability, and efficiency remains widely debated and controversial issue among researchers and policy makers. Various prior studies found that efficient banks are more stable or stable banks are more efficient (Assaf, Berger, Roman, & Tsionas, 2017; Yildirim & Philippatos, 2007). Similarly, few other studies reported that higher banking market power may result in more efficient and stable banking system or stable and efficient banks have more market power relative to peers (Casu & Girardone, 2009; Mohsni & Otchere, 2017; Schaeck & Cihák, 2014). Therefore, this paper has examined the causation relationship among market power, efficiency, and bank stability in following the Granger-causality framework:

$$\text{Stability}_{it} = f_1\,(\text{Stability}_{i,lag}, \text{Market Power}_{i,lag}, \text{Efficiency}_{i,lag}) + \varepsilon_{1it} \quad (3.4)$$

$$\text{Market Power}_{it} = f_2\,(\text{Market Power}_{i,lag}, \text{Stability}_{i,lag}, \text{Efficiency}_{i,lag}) + \varepsilon_{2it} \quad (3.5)$$

$$\text{Efficiency}_{it} = f_3\,(\text{Efficiency}_{i,lag}, \text{Stability}_{i,lag}, \text{Market Power}_{i,lag}) + \varepsilon_{3it} \quad (3.6)$$

As mentioned earlier that bank stability is measured with Z-Score, market power/competition with the Lerner Index, and bank efficiency is estimated with equations 3.1 & 3.3. The Granger-causality test is run among selected three variables for lag up to 4 years.

3.2 Measurement of Market Power and Modelling

There are quite a few indicators which may measure the market power and competition in the banking industry including HHI, Panzar-Rosse Statistic, Lerner index, Tobin's q, and Boone Indicator. Each of these indicators has its own strengths and weaknesses, with some more inclined toward measuring market concentration and others market power. The present study has selected the

Lerner index as proxy for market power, and the Herfindahl-Hirschman Index (HHI) for market concentration or competition (Akins et al., 2016; Casu & Girardone, 2009).

The HHI is the sum of the squared market share of each bank in the system. The present study has calculated market share of each selected bank in given country based on assets held at end of its financial year. A lower value of the HHI represents lower concentration in a banking industry and a higher HHI is a sign of higher market concentration. It is a measurement of changes in the relative market share besides market concentration, which is its superiority on traditional concentration ratio (Corvoisier & Gropp, 2002). The HHI is sector level variable and most frequently used by the public authorities to evaluate the competition conditions of the market (De Guevara & Maudos, 2007). It is superior than traditional measure of market concentration because it measures both market concentration and shifts in share of market participants. The Lerner Index is a firm level variable and identifies the power of an institution to set prices of its inputs and outputs (Färe et al., 2015). The Lerner index is considered to be a superior measure of industry structure as it measures actual firm-level competitive effects as compared to other measures used in prior studies (Maudos & de Guevara, 2007). Therefore, it is used as a measure of market power in the structure of banking sector in each country. The Lerner index represents the markup of price over the marginal cost a bank may charge to its customers which is the indicator of market power. It is calculated as:

$$Lerner_{it} = (P_{TAit} - MC_{TAit}) / P_{TAit} \qquad (3.7)$$

Where P_{TAit} is the price of total assets proxies by the ratio of total revenue to total assets by bank *i* at time *t*, and MC_{TAit} is the marginal cost of the total assets for bank *i* at time *t*. The resulting $Lerner_{it}$ is annual average for all bank in each study year. The MC_{TAit} is derived using the following translog cost function:

$$\ln TC_{it} = \beta_0 + \beta_1 \ln Q_{it} + \beta_2 \frac{1}{2} \ln Q^2_{it} + \sum_{j=1}^{2} \alpha_{jt} \ln w_{jit} + \frac{1}{2} \sum_{k=1}^{2} \sum_{j=1}^{2} \alpha_{jk} \ln w_{kit} \ln w_{jit} + \sum_{j=1}^{2} \delta_j \ln Q_{it} \ln w_{jit} + \gamma_t t + \varepsilon_{it} \qquad (3.8)$$

Where Q_{it} is a proxy for bank output or total assets for bank *i* at time *t*, w_{jit} is a vector of three input prices which indicate the price of labor, borrowed funds, and fixed assets respectively. The prices of labor are the ratio of total personnel expenses to total number of employees, prices of borrowed funds are the ratio of total interest expenses to total liabilities, and prices of fixed assets are the ratio of operating expenses except personal expenses to net fixed assets. The variables of the total cost (TC), and two inputs (w_1, w_3) are normalized by the price of funds (w_2) to impose linear homogeneity on

the model. Furthermore, the variables of TC and Q are normalized with total equity to reduce the bias of bank size. Marginal cost (MC) is then computed using the following equation:

$$MC_{TAit} = Cost_{it}/Q_{it} [\beta_1 + \beta_2 \ln Q_{it} + \sum_{j=1}^{2} \delta_j \ln w_{jit}] \qquad (3.9)$$

The marginal cost from equation 3.9 is used in equation 3.7 to calculate Lerner index for year *t* for all banks which is used in equation 3.2 to test its association with bank inefficiency. The higher score for the Lerner index indicates higher market power for the bank in setting the prices on its products and services. A higher market power is the likelihood of lower competition in the given banking industry of the country. The Lerner index is calculated for each bank-year observation and the annual average is then calculated for each country over the study period[5].

The marginal cost (MC) and efficiency scores are estimated with similar translog equations which may give rise to the problem of simultaneity (Koetter et al., 2012). Although the variables and estimation process are different for both outcomes still there are chances of simultaneity problem due to similar functional form and similarity of few variables. Therefore for robustness, Tobin's q is used as an alternative measure of market power (Keeley, 1990). The available alternatives to calculate the adjusted Lerner index may not work with current banking data because proposed measures are not able to estimate bank power for off-balance sheet activities and non-interest income. The impact of market power variable on efficiency and other variables of SFA equation is assessed under two different models of each efficiency estimate. First, equation 3.1 is estimated in presence of Lerner Index as Model 1, then the same equation is used without the Lerner Index to record its impact on inefficiency and other variables as Model 2.

3.3 Data

Panel data for 14 banks for the period 2003-15 is collected from DataStream with data on environmental variables collected from IMF, Central Banks, and World Bank reports. The list of selected banks is given in Appendix 2. Banks are selected on the basis of their asset size, and together represent about more than half of the banking sector in the selected countries. At least five banks are selected from each country to maintain sufficient observations for recommended measurement techniques. Both countries share a common inheritance of Anglo-Saxon banking system in their banking operations, structure, and regulations (Leigh, 2009; Mitchell, Muysken, & Van Veen, 2006). The remaining variation in their economic environment is minimized by introducing control variables

[5] It is not possible to use the Lerner Index for each bank-year in the SFA model due to some negative index values.

in the measurement model. The selection of input, output, and dependent variables is based on intermediation role of banks as discussed in the prior studies (Sealey & Lindley, 1977; Xiang et al., 2015). In this case, banks convert their own and borrowed capital into loans, investments, and other services while using labor and office fixtures. The given set of control variables has been used by different cross-country studies in past (Carbó-Valverde, Humphrey, & del Paso, 2007; Mergaerts & Vander Vennet, 2016; Xiang et al., 2015). A significant impact of these variables is expected on the efficient frontier over the period to minimize the cross-country variation in a banking environment.

Symbol	**Definitions**
Dependent Variables	
TC	Total cost includes interest expenses and operating expenses. It is used to calculate cost efficiency.
PBT	Profit before tax plus a constant Θ. The constant is the absolute value of minimum profit of a bank over the profit of all banks plus 1. It is dependent variable for alternative profit efficiency.
Variable Input Prices	
w_1	Price of labor is personnel expenses per employee.
w_2	Price of funds is interest expenses dividing by total borrowed funds including deposits and other borrowings.
w_3	Price of physical capital is operating expenses minus personnel expenses dividing by net value of buildings & equipment.
Variable Output Quantities	
y_1	Total amount of loans, advances, and other receivables.
y_2	All investments assets and securities.
y_3	Commission, fees, and other operating income.
Environmental Variables	
GDC (Z_1)	Annual average GDP per capita of each country which is a measure of market size available to the banks of each country.
EQ (Z_2)	It is equity to total assets ratio. It is taken as measure of risk-level.
IR(Z_3)	Annual average five-year bond rate of each country. It is a measure of potential profitability in given banking system.
NIM(Z_4)	Annual average net margin of all banks in each country. It is a combination of market power and cost efficiency of the banking system in a country. Higher net margin means either bank is able to charge higher prices for their services or banks have controlled their cost and vice versa.
TA(Z_5)	Bank size is measured by the total assets of each bank for a selected year.
LOS(Z_6)	This is the ratio of loan loss expenses from the income statement to average net loans for year t and t-1.
Z-Score(Z_7)	Z-score of each bank as a measure of bank stability. It is calculated with following formula; $\frac{\text{ROA+ (Equity/Asset)}}{\sigma(\text{ROA})}$. Where ROA and equity to asset ratio is calculated for each bank in each financial year but standard deviation of ROA is computed using rolling window of 4 years.
LAT(Z_8)	Loans to total assets ratio is proxy for liquidity and lending portfolio.
HHI (Z_9)	The Herfindahl-Hirschman Index is calculated on the basis of bank assets and is a proxy for concentration.
Lerner(Z_{10})	Lerner Index is a proxy for market power of banks in each selected country.

4. Empirical Results

As discussed in the previous section, the inputs and outputs for the stochastic frontier approach are selected on the basis of the intermediation approach (Sealey & Lindley, 1977) for the banks in both economies. The descriptive statistics for the data variables are given in Table 4.1, for each country. There is ample variation in values of each data variable across both countries. The variation in data is mostly due to the different size of banks and economy of each country, but there is not much difference in macroeconomic variables. Selected environmental variables are not highly correlated with each other as reported in Appendix 1. There is one case of medium correlation which is the negative correlation of HHI with net interest margin and equity ratio. This correlation was expected because in concentrated banking markets banks keep lower equity due to lower competition which may result in lower net interest margin (Berger et al., 2009; Schaeck, Cihak, & Wolfe, 2009).

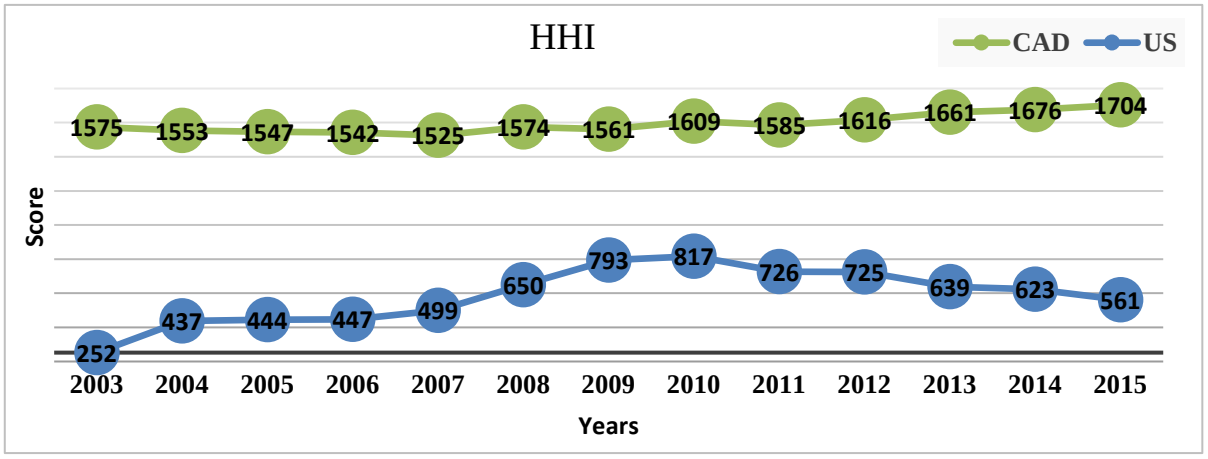
Table 4.1 Descriptive Statistics of Variables

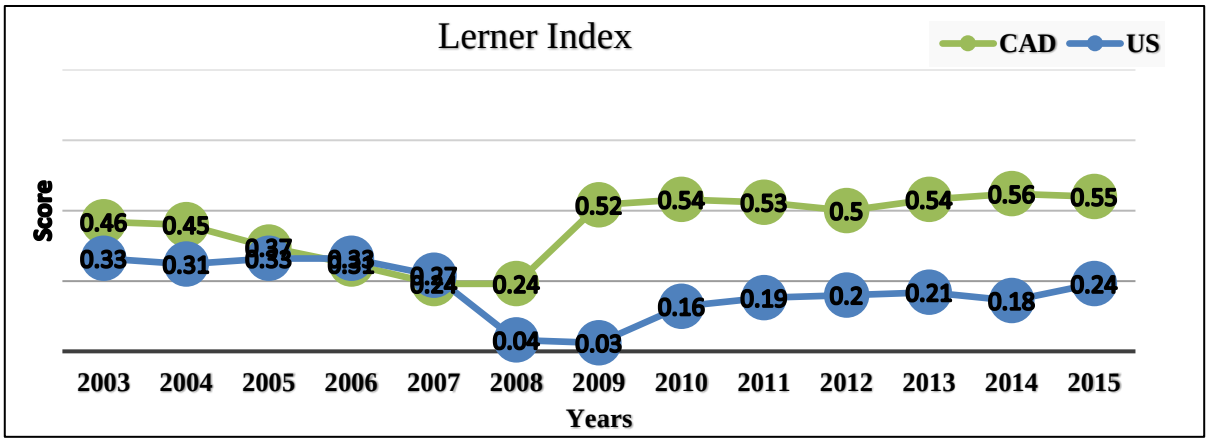
Variables	**US Banks (US$M)**				**CAD Banks (US$M)**			
Dependent Variable	**Mean**	**Max**	**Min**	**SD**	**Mean**	**Max**	**Min**	**SD**
Total Cost (TC)	43278	157045	4152	40259	14350	34253	2559	7091
Profit Before Tax (PBT)	10304	37014	-51289	12384	4038	10443	-3594	2657
Input Variables								
Price of Labour (w_1)	0.092	0.154	0.036	0.023	0.09	0.13	0.05	0.02
Price of Funds (w_2)	0.014	0.037	0.002	0.009	0.017	0.036	0.006	0.008
Price of Physical Capital (w_3)	1.66	3.75	0.69	0.65	2.20	4.62	0.81	0.88
Output Variables								
Net Loans (y_1)	388080	910805	33448	295653	210726	466139	34131	118001
Total Investment (y_2)	390643	1565281	17646	425686	168265	379298	22797	98781
Non-interest Income (y_3)	20198	65356	0	18083	6769	17684	1926	4268
Environmental Variables								
GDP per Capita (z_1)	49038	55836	39677	4533	43310	52495	25026	8135
Equity Ratio.(z_2)	0.10	0.13	0.05	0.02	0.05	0.07	0.04	0.01
Interest Rate (z_3)	2.56	4.74	0.72	1.27	2.73	4.20	0.94	1.11
Net Interest Margin (z_4)	3.41	3.76	2.98	0.23	2.27	4.14	1.60	0.75
Total Assets (z_5)	918463	2573126	68168	818313	413217	843296	62103	222643
Loan Losses (z_6)	6733	37390	129	8481	876	2528	0	570
Loans to Assets (z_7)	0.52	0.72	0.28	0.14	0.51	0.65	0.41	0.07
Z-Score (z_8)	44.47	140.45	5.53	33.31	38.02	111.79	5.21	20.17

As mentioned in the methodology section, ten environmental variables are included in inefficiency errors terms of the frontier equation to record their influence on efficiency scores as well as their relationship with bank efficiency. The most important variables related to the present study are the Herfindahl-Hirschman Index (HHI) and Lerner Index. The calculated values of both variables

are presented below in Figure 4.1. It is evident from the graphs of Figure 4.1 that the Canadian banking sector is more concentrated and has more power to set the price of the products and services for its customers compared to the US counterpart. The score for the Lerner Index and HHI for Canada is higher than many developed economies especially in recent years (Weill, 2013). The HHI has increased over the study period in USA but market power has reduced. The market power of banks in both countries reduced significantly during the Global Financial Crisis due to lower demand for banking products and services. Canadian banks got more market power immediately after the GFC but US banks have gained their market power gradually. The concentration (HHI) of both banking sector increased during the crisis due to some mergers and acquisitions. The correlation test is not able to find a significant relationship between the Lerner Index and the HHI over the study period which is consistent with prior studies (Maudos & de Guevara, 2007).

Figure 4.1





The estimators of cost and alternative profit efficiency models are reported in Table 4.2. Both models are based on two inputs and three output variables which result in 22 independent variables in the translog form and 10 environmental variables in inefficiency error terms. The relationship of

main input and output variables are reported in Table 4.2. The results for environmental variables are reported in Table 4.3 and efficiency score in Figure 4.2. Total Cost and profit before tax have decreased significantly for selected banks over the study period. The costs of banks have increased due to labor cost, high amount of loans, and noninterest income. Total investments and operational cost have helped banks to lower their total cost. The profitability of banks has declined over the time due to higher cost of labor and investment losses. The higher dependency of US and Canadian banks on investment activities is not helping much to improve their efficiency. In contrast, increased non-interest income, amount of loans, and lower operational expenses are the major escalators of their profitability. The relationship of input and output variables didn't change significantly in absence of market power variable of the Lerner index which means banks may not able to use their power for more efficient utilization inputs to achieve optimal level of output. The value of γ is between zero and 1, which justifies the use of the stochastic efficiency model for selected data. The significant likelihood ratio (LR) is proved to be the best fit of selected models.

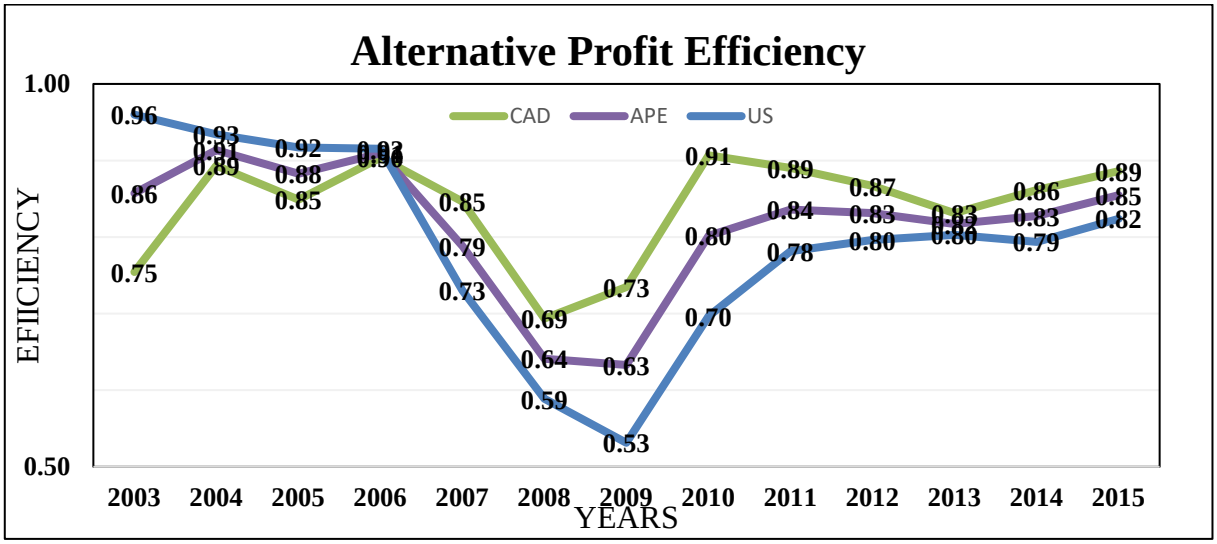
Table 4.2. Estimates of Cost, Alternative Profit, and Profit Efficiency Models

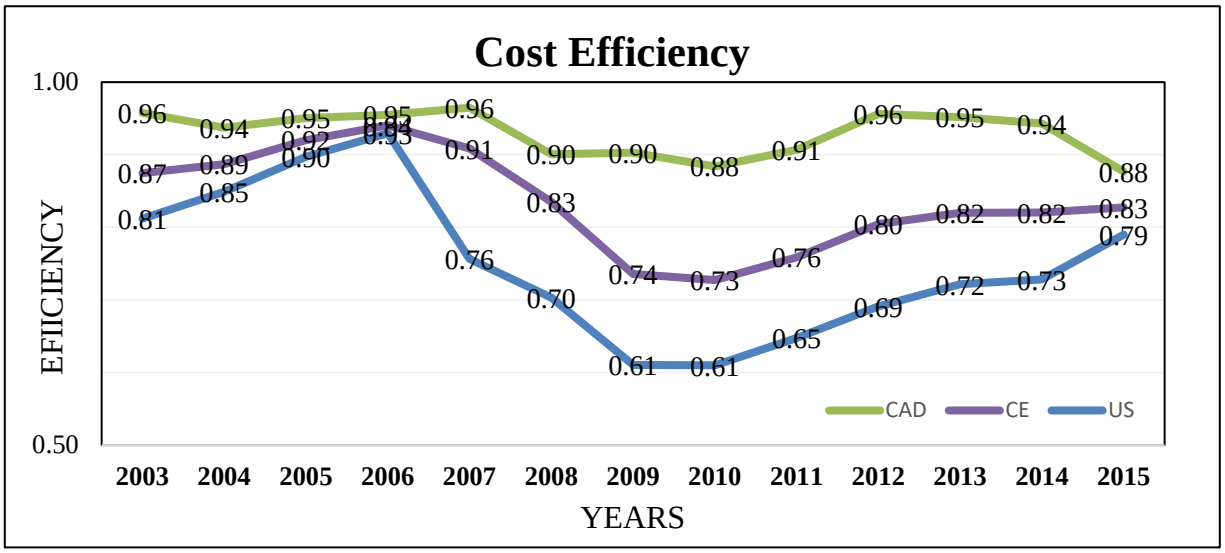
Variables	**Cost Efficiency**		**Alternative Profit Efficiency**	
	Coeff.	**t Ratio**	**Coeff.**	**t Ratio**
Constant	0.14	0.16	-0.70***	-4.03
Ln $w_{1/} w_2$ (Price of Labour)	1.19***	3.13	-0.36***	-6.51
Ln $w_{3/} w_2$ (Price of Capital)	-0.028	-0.078	1.57***	19.05
Ln $y_{1/} w_2$ (Net Loans)	0.60*	1.30	0.63***	9.90
Ln $y_{2/} w_2$ (Total Investments)	-0.47*	-1.40	-1.38***	-20.11
Ln $y_{3/} w_2$ (Non-interest Income)	5.26***	6.02	5.62***	39.37
Time	-0.051***	-4.58	-0.052***	-26.02
No. of Observations	182		182	
Sigma-squared	0.014***	7.25	0.30***	19.04
Gamma (γ)	0.99		0.99	
Log-likelihood	226		114	
LR	143		165	

Figures 4.2 show the average annual efficiency of banks. The impact of GFC on the bank efficiency was first observed in the year 2007 and efficiency worsen in the following two years in both countries. The impact was more prolonged on cost efficiency and stronger on US banks during the GFC. The profit efficiency of US banks was better than Canadian banks before GFC but it is vice-versa in the post-GFC era. Similarly, the market power of US banks was close to Canadian counterparts before GFC but opposite after the GFC. The superiority of Canadian banks in cost efficiency is visible during the whole study period. The efficiency score improved by one point in

presence of market power in Model 1 but is not significant. It may be concluded that higher market power is associated with higher bank efficiency which is not the case in many other developed and developing economies (Akins et al., 2016). However, the advantage of Canadian banking market is strong supervisory power and the market restrictions (Mohsni & Otchere, 2017) to restrain the scope of market power. Although, the efficiency score changes in presence of different environmental variables, but the trend proved to be similar under different models. The relationship of environmental variables with bank efficiency is reported Table 4.3.

Figure 4.2: Average Efficiency Score Graph





The macroeconomic variables are introduced to control the difference in the economic environment of both selected countries. As per results of Table 4.3, these variables have contributed to bank efficiency too. The environmental variables are considered as uncontrollable variables for bank management in the literature (Xiang et al., 2015) but banks may use these variables in favor of

their institution with suitable strategies. It is evident from results that the role of some macroeconomic variables changes in presence of market power. Bank management may get more benefit from high-income customers while using market power. The level of the interest rate has helped banks to improve their cost efficiency during the study period and is consistent in both cost efficiency models. Theory suggests that a low-interest rate environment brings down the net bank margin and information asymmetries, and as a result banks react by lowering their lending standards to search for higher yield (Delis & Kouretas, 2011). The search for high yield may lead to higher level of risk assets, credit expansion, and intensify the competition (Dell'Ariccia & Marquez, 2006) which may result in lower the bank efficiency. The impact of interest rate is negative on profit efficiency in presence of market power which means banks can use market power more effectively in lower interest rate environment for profitability. Conversely in high-interest rate environment, banks already have good margin so don't need to use market power. The role of net margin in lowering cost efficiency becomes more prominent when banks have more power which is consistent with agency theory (Jensen & Meckling, 1976). Similarly, the positive relationship of net margin disappears with profit efficiency in presence of market power which means bank management spend net margin under moral hazard and lower profit efficiency.

The higher level of capital can help reduce bank risk and provide a stable source of funding (Vazquez & Federico, 2015).The positive relationship of equity with cost efficiency asserts that current level of equity plays a positive role in the improvement of cost efficiency and the market power helped in better utilization of the equity (Pessarossi & Weill, 2015). The negative relationship of equity ratio with profit efficiency is consistent with efficiency-risk hypothesis which postulates that more efficient firms tend to keep relatively low equity ratio (Berger & Di Patti, 2006; Lozano-Vivas, Pastor, & Pastor, 2002). The higher expected returns from the greater profit efficiency substitute to some extent for the equity capital in protecting the firm against any financial distress. The relationship between loans to assets ratio and profit efficiency changed to be negative and loan losses to loans positive in market power model. Similarly, the relationship of loan losses to loans become less negative. It means banks cannot get benefit from more loans while using market power however it may help to reduce the loan losses which is another positive impact of market power. The relationship of stability variables with profit efficiency has changed to positive in the presence of market power. It may be concluded from results that market power makes banks more stable and both variables are helping banks to be more profit efficient.

Table 4.3 Market Power and Profit Efficiency

Variables	Alt. Profit Model 1		Alt. Profit Model 2	
	Coeff.	t Ratio	Coeff.	t Ratio
Macroeconomic Variables				
Interest Rate	-0.56***	-2.78	0.016	0.092
GDP Per Capita	0.48***	4.30	0.52	0.52
Net Margin	0.36	1.03	0.79***	2.33
Risk Variables				
Equity Ratio	-2.54***	-9.35	-3.90***	-6.49
Loans to Assets Ratio	-2.05***	-2.62	0.15	0.30
Loan Losses to Loans	0.12	0.64	-0.86***	-6.49
Z-Score	0.67***	8.00	0.026	0.34
Structure Variables				
Total Assets	-0.22***	-3.58	0.057	1.10
HHI	-1.89***	-14.29	-0.40***	-3.45
Market Power Variable				
Lerner	5.84***	9.57	NA	NA

Variables	Cost Model 1		Cost Model 2	
	Coeff.	t Ratio	Coeff.	t Ratio
Macroeconomic Variables				
Interest Rate	0.37***	4.80	0.28***	3.92
GDP Per Capita	0.17	0.17	-0.44	-0.44
Net Margin	-0.42**	-2.00	-0.21*	-1.28
Risk Variables				
Equity Ratio	2.70***	2.72	-0.21	-0.18
Loans to Assets Ratio	-0.32	-0.51	-0.43	-1.02
Loan Losses to Loans	-0.15*	-1.41	-0.32***	-4.90
Z-Score	0.091	0.20	-0.043	-0.012
Structure Variables				
Total Assets	0.042	0.14	0.027	1.06
HHI	0.90*	1.55	0.078*	1.52
Market Power Variable				
Lerner	1.03***	3.75	NA	NA

The impact of market concentration is negative on profit and positive on cost efficiency in both models and do not change with market power. It seems banks show weak scale economies however smaller banks are more profitable relative to bigger banks. It is further supported by the negative relationship of banks size with profit efficiency. Overall, the market power of banks has helped to improve bank efficiency. The efficiency scores of profit and cost efficiency increase by about 1 point but is not statistically significant. However, the level of market concentration may hinder the future improvement in bank efficiency. It is consistent with common practice of many regulators to assess the level of concentration in given market before approval of any merger to avoid abuse of market power (De Guevara & Maudos, 2007). Market power seems more beneficial for

smaller banks relative to bigger banks which can be used by regulators to improve competition in their banking markets. The negative consequences of the bank size and concentration are already noticed by some developed economies and have introduced market interventions to restrain it (Laeven et al., 2014; Scott, 2017; U-Din, Tripe, & Kabir, 2017). Regulators of both countries would work to boost bank market power beside controlling the concentration and the bank size. Determinants of market power are already well documented in prior studies (Efthyvoulou & Yildirim, 2014). The next question is whether market power made banks stable and efficient or vice versa?

Table 4.4. Granger Causality Results

	Z-Score	Lerner Index	Alt. Profit Efficiency	Cost Efficiency
Z-Score t-1	9.68***	2.08**	1.68***	2.65***
Z-Score t-2	-3.30***	-2.04**	-2.48***	-2.16**
Z-Score t-4	-3.95***	-1.50*	-0.86	-1.61*
Lerner t-1	-0.19	4.98***	1.74*	-0.40
Lerner t-2	1.58*	-0.75	-0.34	0.48
Lerner t-4	2.28**	0.54	0.15	-0.47
APE t-1	-0.28	-2.01**	2.89***	NA
APE t-2	-0.72	-0.66	-0.85	NA
APE t-4	0.04	-0.17	0.03	NA
CE t-1	-2.16**	-2.16**	NA	3.59***
CE t-2	0.01	1.00	NA	0.30
CE t-4	-0.45	0.92	NA	0.59

The causal relationships between market power, bank stability, and efficiency are reported in Table 4.4. These results further strengthen the positive role of market power in bank stability and profit efficiency. The impact of market power in bank stability is more significant for longer period of time but bank efficiency didn't play any role in improvement of bank stability. Bank efficiency have not played positive role in gaining more market power however market power has positive role in improvement of profit efficiency. The impact of one year lagged variables is positive on current year but negative for two and four years lag which means past performance of banks can impact their near future but cannot guarantee for longer period. It may be concluded from the results of Table 4.4 that the market power makes banks more stable and profit efficient. Results seem to be consistent with Structure-conduct hypothesis (SCP) which asserts that banks achieve superior efficiency through their market power in less competitive market.

5. Conclusion and Implications

Canadian banks are found to be more efficient than US banks. The Canadian banking sector has more market power and concentration compared the US counterparts. The use of market power

by banks has helped to achieve better efficiency. Analysis of the results found the influence of market power on most of the macroeconomic, risk, and market structure variables of the banking industry. Market power has helped banks to achieve more efficiency through high income customers, lower loan losses, and bank stability. Bank size, higher loan assets, and net margin lowered the efficiency of banks in presence of more market power. It may be concluded that more market power and smaller size of banks may help to improve bank stability and efficiency. Many prior studies concluded that concentrated banking sectors are more stable (Beck et al., 2013) which was challenged by later studies due selection of unsuitable proxy of concentration (Claessens & Laeven, 2004). This study supports the argument that greater market power allows banks to be more stable and protect their franchise value (Allen & Gale, 2004).

This conclusion has three major implications for regulators and banks. First, the concerns of many national and international regulators about higher loan portfolio of banks is valid. It justifies the introduction of existing macroprudential regulations and recommend further in future to regulate lending sector of each country. Second, recently the regulators of USA have imposed the restrictions and Australians imposed levy on the size of banks. Canadian banking market is very concentrated and its regulators may need to introduce some initiative to limit the size of banks, as has already done a in few other developed economies. It may make banking market more competitive and lower the negative impact of market concentration on profit efficiency. Third, the increase in market power of the US banks can further help smaller banks to grow their market share. The findings of this study are equally applicable in Europe and other developed economies where bank size and market concentration have increased in the post-GFC era (Schoenmaker, 2017). The existence of SCP is identified in both countries which may turned to be QLH in near future. Therefore, bankers should find innovative ways to use market power for better management and optimal utilization of resources.

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Appendix 1: Correlation among Environmental Variables

	Interest Rate	GDP	NIM	Equity Ratio	Size	LAT	Loan Losses	Z-Score	HHI	Lerner Index
Interest Rate	1									
GDP	-0.52	1								
NIM	0.02	0.27	1							
Equity Ratio	-0.33	0.49	0.64	1						
Size	-0.28	0.34	0.14	0.09	1					
LAT	-0.01	0.01	-0.03	0.23	-0.61	1				
Loan Losses	-0.21	0.20	0.58	0.47	0.49	-0.31	1			
Z-Score	0.28	-0.11	-0.07	0.09	-0.29	0.32	-0.48	1		
HHI	-0.14	-0.24	-0.71	-0.72	-0.11	-0.05	-0.40	-0.24	1	
Lerner Index	0.04	-0.27	-0.43	-0.62	-0.20	0.01	-0.64	0.22	0.51	1

Appendix 2: List of Selected Banks

Sr.	Name of Bank	Country
1.	TD Canada Trust	Canada
2.	Royal Bank of Canada	Canada
3.	Bank of Nova Scotia	Canada
4.	Canadian Imperial Bank of Commerce	Canada
5.	Bank of Montreal	Canada
6.	National Bank Canada	Canada
7.	J.P. Morgan Chase	USA
8.	Bank of America	USA
9.	Wells Fargo	USA
10.	Citigroup	USA
11.	US Bancorp	USA
12.	PNC Financial Services	USA
13.	SunTrust Bank	USA
14.	BB & T	USA