A
COMPARATIVE ANALYSIS
OF THE PERFORMANCE OF CANADIAN AND U.S. BANKS FROM 2005 TO 2013 USING THE STOCHASTIC FRONTIER APPROACH

by

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Abstract

To understand why the U.S. banking system collapsed but the Canadian one did not during 2007-08 financial crisis, I first review the history of U.S. and Canadian banking system regulations. The review suggests that the regulators in these two systems have two different perspectives on improving efficiency: U.S. policy has emphasized efficiency gains due to competition while Canadian policy has emphasized scale economies. Next, the Stochastic Frontier Approach was used to measure and compare the technical inefficiency of 12 U.S. banking holding companies with 6 Canadian banks from 2005 to 2013. The average technical inefficiency of Canadian and U.S. banks were almost the same during this period. This suggested that the respective performances are similar between, at least with respect to cost efficiency of those banks with similar assets. As such, this thesis provides support for the hypothesis that the cause of the different relative performances was not cost efficiency.

Key Words：U.S. banking system, Canadian banking system, history of banking regulations, technical inefficiency, financial crisis

List of Abbreviations and Symbols Used

BBT	Branch Banking &Trust Corporation
BHC	Bank Holding Company
BMO	Bank of Montreal
BNY	Bank of New York Mellon Corporation
CIBC	Canadian Imperial Bank of Commence
COF	Capital One Financial Corporation
CPI	Consumer Price Index
CSBC	Conference of State Bank Supervisors
DFA	Deterministic Frontier Analysis
DMU	Decision Making Unit
FDIC	Federal Deposit Insurance Corporation
FFIEC	Federal Financial Institutions Examination Council
FITB	Fifth Third Bancorp
FRB	Federal Reserve Board
IMF	International Monetary Fund
NBC	National Bank of Canada
NTRS	Northern Trust Corporation
OCC	Office of the Comptroller of the Currency
OSFI	Office of the Superintendent of Financial Institutions
PF	Price of Loanable Funds
PK	Price of Capital

PL	Price of Labour
PNC	PNC Financial Services Group, Inc.
RBC	Royal Bank of Canada
RF	Regions Financial Group, Inc.
ROA	Return on Asset
ROE	Return on Equity
Scotiabank	Bank of Nova Scotia
SCP	Structure-Conduct-Performance Framework
SFA	Stochastic Frontier Analysis
STI	SunTrust Banks, Inc.
STT	State Street Corporation
TD	TD Canada Trust
TL	Total Loans
TOFA	Total Other Earning Financial Assets
USB	U.S. Bancorp
TE	Technical Efficiency

Glossary

Chattel Mortgage: a type of loan contract, under which the purchasers borrow funds to buy movable assets from the lenders, such as vehicles.

Closely Held: shares of a company are distributed to only a limited number of shareholders.

Herfindal Index: also known as Herfindahl-Hirschman Index (HHI), is an index to measure of the size of firms in relation to the industry and an indicator of the amount of competition among them.

Inside Lending： a bank makes loans to its own subsidiaries.

Least Cost Resolution: FDIC chooses the resolution method in which the total amounts of short-term and long-term expenditures and liabilities incurred have the lowest cost to the deposit insurance fund.

Monetary Circuit: in monetary circuit theory, "money" is the by-product of transactions of buyers and sellers. In monetary circuit, money is always as a liability issued by banks, which has as counterpart a credit simultaneously granted to buyers of goods and services within an economy.

Money Market Deposit Account: a saving account with checking account characteristics. The interest rate is based on the current interest rate in the money markets.

Negotiable Order Of Withdrawal Account (NOW Account): an interest-earning deposit account to which the savers can write cheques against money held on deposit.

Non-Bank Bank: a financial institution, which does not offer both lending and depositing services. It does not have a full banking license or is not supervised by a banking

regulatory agency.

Prompt Corrective Action: FDIC should minimize the losses and address the banks problems while they are still manageable.

Super NOW Account: a negotiable order of withdrawal account from which savers can earn higher interest rates than from regular accounts.

Unit Banks System: a system of banking where the government puts restrictions and limitations on the banks' ability to open branch offices.

Widely Held: shares of a company are distributed over a large number of shareholders.

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Chapter 1 Introduction

In the autumn of 2008, the U.S. Economy experienced the greatest breadth of economic slowdown since the Great Depression of the 1930s. The financial turmoil spread across the world rapidly. After a bubble burst in the housing sector in 2007, an unexpected and huge loss was incurred by many holders of U.S. subprime mortgages and asset-backed commercial papers. This was to eventually trigger a string of failures of several prominent global financial institutions from 2007 to 2008. These included Lehman Brothers, Bear Stearns and Merrill Lynch.

In contrast, Canada did not experience an economic collapse similar to that of the U.S. Consistent with this, according to the Canadian Bankers Association survey of 2008, 70% of a random sample of adult Canadian respondents reported that they had a more positive impression of Canada's banks in comparison to U.S. and European banks. This majority believed that the stronger performance of Canadian banks relative to U.S. banks was due to: "1) higher requirements for deposit insurance; 2) better management of Canadian banks when compared to many U.S. banks; 3) a better government regulatory system; and 4) a long standing approach by Canada's banks to be cautious and conservative in their lending and investments" (Assessments of Canada's Banks-Fall 2008: An Update, 2008).

Similarly, the performance of Canadian banks has been given more credit from journalists, economists and financial analysts during this financial crisis than that of the U.S. banks. For example, the 2008 Financial System Stability Assessment report written by the International Monetary Fund (IMF) concluded that "Canada's financial system is mature,

sophisticated, and well-managed" and that "the stress tests show that the major banks can withstand sizable shocks" (Canada: Financial System Stability Assessment-Update, 2008).

In spite of such comparative reports, there have been a very limited number of papers, which use econometric methodologies to compare the performances of Canadian and U.S. banks statistically. For example, Allen, Engert and Liu (2006) used data from 1983 to 2003 to compare the cost-inefficiency of the "Big Six" Canadian banks and 12 U.S. samples of comparable BHCs. Based on their cost inefficiency measurement, they found that the Canadian banks were about 10 percent less efficient than a "best-practice" Canadian bank. In comparison, the mean of U.S. BHCs' inefficiency score was 16 percent (Allen, Engert and Liu, 2006). In another paper, Bordo, Redish and Rockoff (2011) compared the performance of U.S. banks and Canadian banks from a regulatory and historical perspective. They argued that the major reason for instability of U.S. banking industry is the fragmented banking system caused by a "dual banking system", which means that banks can be regulated at either the state or federal level. It greatly increases the regulatory complexity. At the same time, long-time restrictions on branch expansion led the commercial-banking dimension to become less developed while the investment-banking dimension became deeply developed with a high reliance on capital markets. High development in the investment-banking dimensions made the U.S. banks less vulnerable to financial panics (Bordo, Redish and Rockoff, 2011).

Since there exists a very limited literature in comparing the performance of Canadian banks with U.S. banks, it is of interest to conduct further work on performance during the

period surrounding the financial crisis. In order to contribute to these comparisons, this study investigates the performance of the Canadian banks in comparison to the U.S. banks between 2005 and 2013. My approach in the following analysis is to firstly look at the regulatory development of these two countries, including a discussion of the related theoretical thoughts regarding the regulations and secondly, to use the Stochastic Frontier Approach (SFA) to determine the dispersion of the cost efficiency of Canadian versus U.S. banks. The aim of this thesis is to compare the comparative efficiency of U.S. versus Canadian banks in order to provide the above-mentioned performance assessments with a theoretical foundation.

From my review of the regulatory frameworks of the U.S. and Canadian banking systems, I found that the banking systems are very different with the U.S. financial system being market-based and the Canadian financial system being bank-based. These two systems not only represent two different financial systems: market-based and bank-based, but also demonstrate two different regulatory approaches, which reflect two different hypotheses on the degree to which competition versus scale are important for efficiency. To understand this, consider that the authorities in the U.S. put a long time restriction on banking expansion and cross-state entrance to prevent the increase of market power of banks in order to maintain competition among the financial institutions. As a result, U.S. securities markets have been at the center stage in terms of mobilizing savings to meet the needs of firms' investments, being responsible for corporate supervision and easing risk management, such that most of the giant banks have become highly involved in the securities markets. In contrast, in Canada, banks play an important role in transferring savings, allocating capital, scrutinizing the risks of loans, and knowing about the

investment decisions of borrowers. Banks are at the center of Canadian financial system, therefore, the Canadian authorities have historically preferred TO limit entry to those with enough capital to enter the banking industry, which has lead them to put a high standard on the institutions which qualify as banks. This has caused an oligopolistic banking market structure in the Canadian banking sector.

The hypothesis of this thesis is that these two regulatory methodologies could be the result of banking regulators holding two different hypotheses regarding regulatory approaches in the subject of Industrial Organization: the structure performance hypothesis (SP hypothesis) and the structure efficiency hypothesis (SE hypothesis). In the SP hypothesis, competition is encouraged because competition can increase the efficiency through stimulating the banks to minimize their costs or maximize their profits in order to survive in the banking industry. In the SE hypothesis, economies of scale are preferred to increase the efficiency of banks by minimizing the average cost in a long run. Also, a limited number of banks with adequate capital may have made the industry more stable and easier to supervise such that Canadian banks suffered less than U.S. banks during this financial crisis.

In support of this thesis, the first part of the paper argues that the banking systems in the U.S. and Canada provide good examples of these two different regulatory approaches based respectively on the structure performance and the structure efficiency hypothesis. In second part, I use the translog cost function under the Stochastic Frontier Approach (SFA) to test the dispersion of cost inefficiency of the Canadian and U.S. banks. This method will test the performance of the sample banks from these two countries. The time

frame of this test is from 2005 to 2013. The results suggest that there was no big difference between the U.S. banks' efficiency scores and those of the Canadian banks'. Based upon the SFA criterion, the performance of the U.S. and Canadian banks with similar assets and similar business division were almost the same. Therefore, I thought both competition and economies of scale could promote efficiency of banks. This result is consistent with Bordo et al's (2011) argument that the instability of U.S. banking system was not due to the performance of commercial banks.

Therefore, this thesis suggests that future studies could focus on other aspects of banking performance. These include: 1) which composition of bank assets makes U.S. banks more vulnerable to the financial stress than the Canadian banks; 2) whether the high standards that Canadian institutions must meet in order to be allowed to operate as banks is the reason why the Canadian banking system is stronger than the U.S. banking system at this time; 3) whether the fragmented banking regulatory body in U.S. is the reason why the U.S. banking system is less well-managed than the Canadian banking system.

Chapter 2 Overview of Banking Regulations in the U.S. and Canada

An important factor contributing to the current difference in the market structure of the U.S. versus Canadian banking sector and hence comparative performance is the set of legislations and regulations. For example, M. Bordo (1995) contended in his working paper that if one banking system is shown to be more efficient and stable than the other that this has resulted from differences in the regulatory system (Michael, 1995). Therefore, in order to understand the comparative performance of U.S. versus Canadian banks, I first investigate each country's regulatory structure from an historical perspective.

In Chapter 2, I will first look at the regulatory agencies in the U.S. followed by a look at Canada. Then, I review the banking regulations chronologically firstly for the U.S. and then for Canada.

2.1 Regulatory Agencies

In this section, I start out looking at the regulatory agencies in the U.S. followed by Canada.

2.1.1 United States of America

Historically, bank charters in the U.S. can be granted by two government-level regulators. One is federal-level regulator called the Office of the Comptroller of the Currency (OCC). The other is the state-level regulator in the states in which the business will operate. This pattern is called a "dual-banking system", which means that federal chartered banks and state chartered banks are chartered and supervised at different levels of governmental agencies. Further more, due to this dual system, the federal government does not have unambiguous power over those banks. To illustrate the power of the state-level regulators, consider that according to the 2013 Conference of State Bank Supervisors (CSBS) annual report, 75% banks operating in the U.S. were state-chartered although 91% of these state-level banks were smaller community banks. At the state level, 50 states and 4 territories all have their own banking departments, which grant state charters, and regulate and monitor insured and uninsured state banks. All together, almost 5,100 banks are regulated by the state-level (2013 CSBA Annual Report, 2014). At the federal level, in addition to the OCC, there are another two prudential bank regulators, the Federal Deposit Insurance Corporation (FDIC), which is in charge of government insured banks including national and state-level banks, and the Federal Reserve Board (FRB), which is in charge of nation-level banks and bank holding companies (Jickling and Murphy, 2010).

2.1.2 Canada

In comparison to the complex dual regulatory system in the U.S., the banking regulatory system in Canada is simple and hence more clearly delivered to the financial institutions and the public. The Office of the Superintendent of Financial Institutions (OSFI) is the

only governmental organization, which has the function to grant, supervise and regulate the individual financial institutions. In comparison with the FDIC and FRB, the Canada Deposit Insurance Corporation (CDIC) does not have a regulatory duty and the Bank of Canada does not supervise or regulate any individual financial institutions.

In Canada, the OSFI is the only institution that grants charters and is in charge of all banks. The OSFI is a federally-based independent agency with the assigned objective of providing oversight, ensuring that the banks are complying with their governing legislation, protecting depositors, and maintaining the stability of financial sectors. There is also a committee called the Financial Institutions Supervisory Committee, which supports the OFSI to address the issues and challenges facing the financial sectors. The committee includes the OSFI, the Bank of Canada, the Department of Finance, the CDIC and the Financial Consumer Agency of Canada (OSFI website).

Having introduced the regulatory bodies of U.S. and Canadian banking industry, I now look at their regulatory laws, which can be divided into two time phases. They are the pre-financialization phase, which is the time period before 1980, and the financialization phase, which commenced in 1980.

2.2 Regulatory Laws

As mentioned previously, Bordo contends that the regulatory system has an important influence on banks' performance. Therefore, I believe that it is necessary to review the

banking regulations in the U.S. and Canada in order to compare the performance of U.S. and Canadian banks.

2.2.1 Pre-financialization Phase (Before 1980)

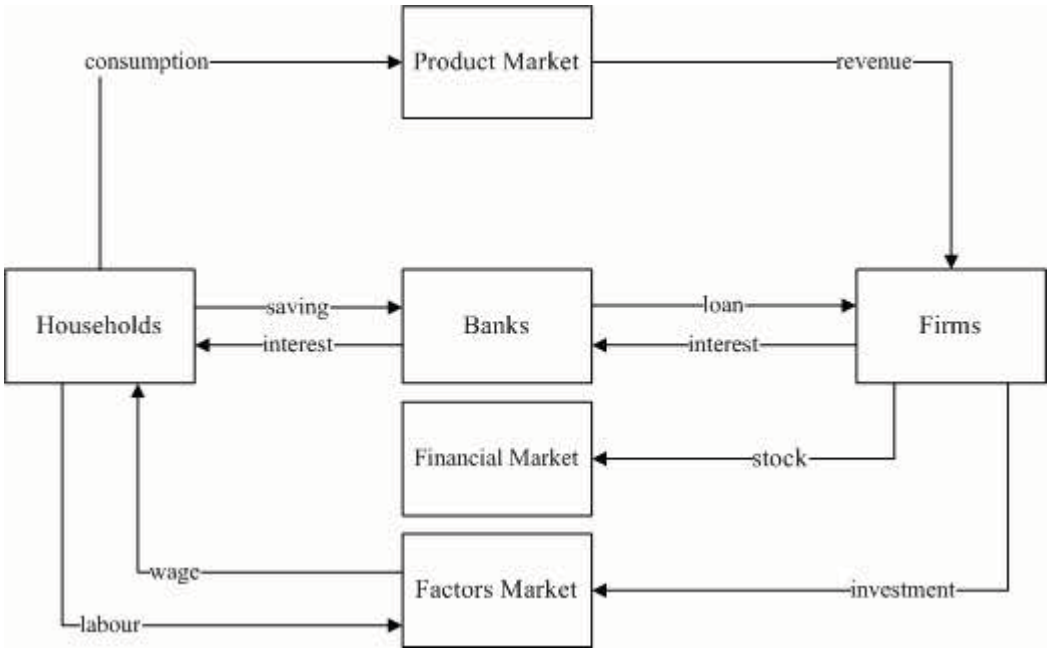
Firstly, I review the role of a bank in the economy circuit in the pre-financialization phase, which refers to the period before 1980. Secondly, I discuss the first banks, which were established in U.S. Thirdly, I review the U.S. banking regulations chronologically in the pre-financialization phase. Fourthly, I discuss the first banks in Canada. The last part of this section reviews the Canadian banking regulations in the pre-financialization phase.

2.2.1.1The Role of Banks in the Monetary Circuit Before the Financialization Phase

The banking system has historically been acknowledged to be crucial for the transmission of funds from people who save to people who have productive investment opportunities. Schumpeter (1934) pointed out the remarkable correlation between commercial banks and entrepreneurial activities. In his book, "The Theory of Economic Development", commercial banks are described as "the suppliers of credits that grant purchasing power to entrepreneurs." This credit enables them to purchase production factors such as private property and sufficient labour, in advance, to carry out their new production opportunities. Schumpeter argues that this essential function of banks is needed to promote industrial development and sustain overall economic growth (Schumpeter, 1934).

In the pre-financialization phases, prior to 1980, the banks were the only creator of credit to finance productive activities. At that time, banks and firms were at the center of monetary circuit and as such were an essential engine of economy growth. Next, I will explain how banks worked in the monetary circuit and this procedure is illustrated in Figure 1 as well.

Figure 1 Bank Role in the Pre-financialization Phase



In the first stage of monetary circuit, when firms want to acquire new productive factors, they are granted credit by the banks. Banks then use the newly-held deposits of savers (S) to backup this credit (L). The deposits are liabilities in the banks' balance sheets, and the credit to firms is in the form of loans to be put as assets in the balance sheets of banks. Meanwhile, as the counterpart of banks, firms write their liabilities as the same amount of "newly-created money" in the form of loans plus interest (rL), and this total amount (L+rL) is paid back at a pre-determined date. In addition to borrowing from banks, firms

also can go to the financial capital markets to issue stocks to finance their long-term growth goals. At the same time, households can buy the stocks from financial markets.

In the second stage of monetary circuit, firms use the money they borrowed from banks and the financial capital market to hire people, buy land and other production factors to launch a new round of productive activities. Households receive wages (W) as reimbursement for their labor. Part of reimbursement (W-C), where C represents consumption expenditure, will be the newly-held deposited money, which, in turn, enters the first stage of the next round of monetary circuit.

In the third stage of monetary circuit, firms receive money from households' consumption expenditure (C) by selling the products that were generated by their investments in the second stage and then pay back their principle amount of loans plus interest to banks. When banks receive the amount paid back from firms, they then set part of this money on reserve to cover the deposit withdrawal of households and the rest of the money is put into the next round of monetary circuit. The assets and liabilities in the banks' balance sheets are reduced at the same time (Seccareccia, 2012).

In the pre-1980 phase, just as Fetter (1904) said "A bank is a business whose income is derived chiefly from lending its promises to pay". Before 1980, banks' revenues primarily came from the net interest incomes, which were the products of the interest rate spread, multiplied by the outstanding loans. Therefore, the profits of banks were heavily dependent upon the growth of entrepreneurial activities with liquidity being dependent on

household saving habits. Since banks were seldom involved in the investment business, the only market risk faced by the banks was the interest rate risk.

Now that I have illustrated the functional form of a bank in the monetary circuit, I investigate the establishment and regulatory history of the U.S. and Canadian banking system in the pre-financialization phase.

2.2.2 The First Establishment of U.S. Banks in the Pre-Financialization Phase

The first U.S. bank was proposed by Lieutenant Colonel Alexander Hamilton in 1779-1780 in order to provide currency in payment for the supplies needed by the Army. However, the value of the issued currency depreciated quickly as a result of a weak government issuing more and more continental and state bills. Therefore, someone proposed that the bills' value should depend on the promise of a private institute with credits and assets and that this kind of institute would be "instituted by authority of Congress, for ten years, under the denomination of the Bank of the United States". Subsequently, the first chartered bank was accordingly established in Philadelphia in 1781 and was named "Bank of North America". It commenced business on Jan. 7, 1782. The major role of this private bank was to help finance the Revolutionary War (Hammond, 1957; Barth, 2010).

2.2.3 The U.S. Banking Regulation in Pre-Financialization Phase

After reviewing the function of a bank in a monetary circuit and the first establishment of U.S. bank, now, I will chronologically review the U.S. banking regulations in the pre-financialization phase.

2.2.3.1 National Banking Act 1863 and 1864

After the first several decades since the first bank was established, there were no federal-level banking regulations or governmental agencies to rule these banks. Instead, most banks were managed by the state governments. However, when the Civil War broke out, the Federal government had to raise the money to finance the supplies to fight with the Southern States. To facilitate this, the National Banking Acts of 1863 and 1864 were passed in the Senate. The acts provided the chance to establish the OCC, an independent bureau under the Treasury Department, which was given the authority to grant charters and to supervise all national banks. However, due to the state governments still having the power to grant charters and supervise the state banks, a unique "dual banking system" came into being and the number of banking establishments in U.S. was to rapidly grow. By 1870, there were 1638 national banks operating businesses in U.S. (Flaherty, no date).

2.2.3.2 Federal Reserve Act of 1913

From 1870 to 1907, a series of financial panics happened after the National Banking Act was passed, the most severe of which was the "1907 Bankers' Panic", which raised concerns among researchers and bankers, each of whom agreed that there should be a central bank in the U.S. to address financial panics and to manage the currency system.

As a result, by the end of 1913, the Congress passed the Federal Reserve Act (also known as Owen-Glass Act or Currency Act) and created the Federal Reserve System to serve as the central banking system of the United States (Flaherty, no date).

2.2.3.3 McFadden Act of 1927

In 1927, the McFadden Act was passed to encourage federal banks to compete with state banks. This act let national banks' branches enter state markets within state limitations. However, this act at the time didn't promote the development of U.S. banking industry given the Great Crash of 1929 and the ensuring Great Depression. The collapse began with the collapse of the U.S. stock market and lasted until 1939 with the economy reaching its bottom in 1933. During this period, 11,000 out of 25,000 U.S. banks failed (Federal Reserve Board website).

2.2.3.4 Glass-Steagall Act of 1933

In 1933, in an attempt to prevent further bank collapses, a series of substantial reforms of the banking system were brought about by the Glass-Steagall Act, which was also known as the four provisions of the Banking Act of 1933. The first important provision was the establishment of the Federal Deposit Insurance Corporation (FDIC), which insured the deposits and supervised the member financial institutions for their soundness to protect consumers and keep public confidence in the U.S. banking system so as to prevent bank runs. The fund was made up by premiums from member institutions. This, however, introduced a moral hazard problem since banks now had increased incentives to make excessively risky loans. To reduce this risk, the other crucial change introduced was that

investment banks were separated from commercial banks. Commercial banks, the banks that take deposits and make loans, were now no longer permitted to underwrite and deal with securities. Meanwhile, investment banks were to specialize in the underwriting and dealing of securities and were not allowed to connect closely with the commercial banks.

Additionally, Regulation Q was introduced in the same year to keep banks away from excessive competition. Regulation Q prohibits interest payments on checking accounts and puts interest rate ceilings on saving accounts and other deposits in order to prevent excessive competition for attracting deposits, which might drive down the spreads of lending rates and borrowing rates (Barth, Li and Lu, 2010; Federal Reserve Board website).

2.2.3.5 Bank Holding Company Act of 1956

In 1956, in order to prevent "unfair" competition between the large city banks and the small town banks, the Bank Holding Company Act was signed into law. Before the act, a holding company could establish independent banks in different states to avoid varieties of restrictions on cross-state branches by different state laws. They could also use the deposits from their affiliated banks to make loans to their non-bank firms. The act also gave a clear definition of a "bank holding company", which is a holding company that holds 25% or more of the shares of two or more banks. Moreover, it granted power to the Federal Reserve Board to regulate the bank holding companies. The bank holding companies were required to register and be supervised by the FRB, and needed to apply

to the FRB when they wanted to expand their businesses across states (Federal Reserve Board website).

2.2.3.6 Bank Merger Act of 1960 and 1966

In 1959, a bill was proposed to address the problem that unrestricted mergers and consolidations might erode competition in the banking industry and increase market power. In 1960, the Bank Merger Act was enacted and it required the Board of Governors of the Federal Reserve System, the Comptroller of the Currency, and the Federal Deposit Insurance Corporation to scrutinize all merger and consolidation applications no matter whether the bank was a national bank, a state member bank or a non-member insured bank. However, the scrutiny may not have been very intense given that only thirty-one out of nine hundred applications were denied. Conflict arose between the Bank Merger Act and the United States Antitrust Law. The Department of Justices didn't fully agree with the decision of these three agencies about the merger decisions. To prevent these kinds of conflicts, the Bank Merger Act of 1960 was amended in 1966 to accommodate the banking industry into United States Antitrust Law. The Department of Justices can advise that they are against the bank mergers within 30 days under the antitrust law after the mergers were approved by the OCC, the FDIC or the FRB (Guy, 2010).

2.2.3.7 Bank Holding Company Amendment of 1970

In 1970, the Bank Holding Act of 1956 was amended again with another definition of a "bank holding company". This was to prevent some large national banks from taking advantage of loopholes in the definition of "bank holding company" as defined in the

1956 Banking Holding Company Act, which allowed holding companies holding only one bank to avoid supervision by the FRB. After 1970, the bank holding company was defined as an entity, which controls one or more banks such that the FRB could now supervise all holding companies, even if they only owned one bank (Hayes, 1971; Barth te.al, 2010).

2.2.3.8 International Banking Act of 1978

In 1978, the International Banking Act of 1978 was passed with the stated purpose of promoting fair competition between foreign and domestic banks. Accompanying economic globalization, banks had expanded their business across the borders and as a result, many foreign banks opened their businesses in the U.S. As a result, by April 1978, there were 122 foreign banks or their subsidiaries running business in the U.S., 63 of them operating in more that one state and 31 of them operating in three or more states. Non-uniformed restrictions on foreign banks and domestic banks drew the attention of the authorities. After the act passed, all foreign-owned banks were under the control federal regulatory agencies and restrictions on those banks were the same as those on the domestic banks. (Barth te.al 2010; Segala, 1979)

After reviewing the changes of U.S. banking regulations in the pre-financialization phase, it is apparent that the governors of U.S. banking industry were likely to be problem-solvers. The banking regulators kept changing the bank policies to deal with the problems that happened in the market. In contrast, the most obvious characteristic of the

Bank Act is that it includes a "sunset" clause, which meant the Bank Act had to be periodically reassessed.

In the next section, I move on to review how the Canadian regulators supervise the Canadian banking regulations.

2.2.4 The Canadian Banking Regulation in the Pre-Financialization Phase

In Canada, the pre-financialization phase regulations on the banking industry came mainly from the Bank Act with an obvious divergence in banking regulations from the U.S.'s. I review several revisions, which are considered to have had a significant influence on current banking system.

2.2.4.1 The First Establishment of Canadian Banks in the Pre-Financialization Phase

The earliest reference to banks in Canada was in 1792 in Montreal. At that time, Montreal was one of six trading centers in Canada at which several gentlemen, who, after seeing that the U.S. banks were providing valuable support to the trade business, had become interested in establishing credit institutions. As a result, in March 1792, three firms: Phyn, Ellice and Inglis based in London; Todd, McGill and Co. and Forsyth; and Richardson and Co. based in Montreal, signed to establish a bank in Montreal, called Canada Banking Company. The business of this institution would be "to receive deposits of cash, to issue notes in exchange for such deposits, to discount bills and notes of hand, and to facilitate

business by keeping cash accounts with those who chose to employ the medium of the bank in their receipts and payments." However, Canada Banking Company didn't get a bank charter at that time. The legislature committee stated that the bank "would encourage a spirit of gambling and speculation founded on false capital". According to Morton (1895), "Capricious political impediments and conservative character" were to delay the founding of the private banks such that the first Canadian bank, the Bank of Montreal, was not established until 1817. It was not until 1822, that it would receive a grant from the Legislature of Lower Canada (Breckenridge, 1895).

2.2.4.2 The First Bank Act of 1857

Because of the frequency of Canadian bank failures during the first half of the nineteenth century, such as the first bank crisis in 1837 and the second in 1857, the Bank Act, "An Act respecting Banks and Banking", was first introduced in 1871. It repealed all provincial acts, which might conflict with the federal regulation and established the fundamental pattern of the Canadian banking system. It defined the "bank", set up the reserve requirements (banks should keep their one-third cash reserve in the form of Dominion notes), and defined a minimum denomination in circulation as $4 and required a decennial review process (Marianopolis website).

2.2.4.3 The Amendment of 1881

In the first "decennial review" from 1870-1880, a few changes were made to the Bank Act in the Amendment of 1881. The main change was to propose that a failed bank had a prior lien on its assets, which relaxed the restriction on banks dealing in shares of their

capital stock. The amendment of 1879 disallowed banks from making loans based upon shares in other chartered banks, which means that banks could not count risky stocks as assets to make more loans (Curtis, 1947).

2.2.4.4 The Amendment of 1890

In the next "decennial review" from 1881-1890, the 1890 Revision of the Bank Act increased the paid-up capital requirements of new banks from $100,000 to $250,000 and required another $100,000 of paid-up capital within 2 years after starting the business. This requirement restricted the entrance of new banks. Due to the high standards to open a new bank and no restrictions on the branch establishments, the most obvious difference between the Canadian and U.S. banking system came into being: a nation-wide branch banking network system in Canada and a huge unit-bank banking system in the U.S. Meanwhile, in Canada, the Bank Circulation Redemption Fund was formed. This made the banks mutually guarantee to provide the payment of the notes of any failed bank (Johnson, 1910).

2.2.4.5 The Amendment of 1900

In the Bank Act Revision of 1900, the most significant event was the establishment of the Canadian Banker's Association (CBA) by a special act of the Parliament. The CBA worked as a corporation and was granted the duty to oversee its member banks. It was also involved in creating and destroying bank notes. It played important roles in ensuring the stability and efficiency of the Canadian banking industry. Another important event

was simplifying the merger and acquisitions procedures, which could now be approved by the Governor of Canada in a short process (Marianopolis website).

2.2.4.6 The Amendment of 1914

In 1914, the amendment of the Bank Act made the bank loans more flexible such that banks could legally accept collateral as credit to lend loans. The act also came up with a rigid auditing process to inspect banks and their branches in order to protect the shareholders and the public. At the same time, the Financial Act, "An Act to Conserve the Commercial and Financial Interests of Canada", granted power to the Government to issue new Dominion notes and the Finance Department was given the power to lend to the chartered banks at their request. Hence, the Finance Department became the lender of last resort, which is the main duty of the central bank today (Curtis, 1947).

2.2.4.7 The Amendment of 1935

In 1935, the Bank of Canada Act was passed to establish the Bank of Canada (the Bank). Although the Bank of Canada was a privately owned institution at that time, its establishment opened a "new era of the Canadian banking system". During the same year, the Bank Act changed some provisions due to the establishment of the Bank of Canada. The act required that the reserve requirements of the banks must be held within the Bank of Canada and it also required the Bank of Canada to keep a reserve in gold equal to 25 % of its liability. After the Bank became publically owned in 1938, it also became responsible for the management of public debts. At the same time, due to the participation of the Bank, several limitations were placed on private issue notes, which were

subsequently banned in 1945. The Bank was responsible for the redemption of these notes (Bank of Canada website; Shearer and Clark, 1984).

2.2.4.8 The Amendment of 1954

In the 1954 Amendment of the Bank Act, an open money market was established for commercial banks, large corporations and provincial governments. This market made the money supply more flexible and sensitive though this also lessened the monetary management by the Bank. Most trading instruments in this market were short-term government securities and Treasury bills. During the same year, the National Housing Act was revised to allow commercial banks to offer insured mortgage loans to residents and the banks were also allowed to take chattel mortgages on real or moveable property, which were the pledges for mortgages (Freedman, 1997).

2.2.4.9 The Amendment of 1967

In 1967, the Bank Act was amended with three important changes. The first was the removal of the 6-percent interest rate ceiling on lending rates. The second was the removal of limitations on bank lending for mortgages. These two changes would strengthen the competence of banks with other near-bank financial institutions. Now, the banks could increase consumer loans, including mortgage and credit cards loans. These two changes both encouraged banks to take riskier loans, especially, given the third change, which was the introduction of deposit insurance through the establishment of the Canadian Deposit Insurance Corporation (CDIC). Although deposit insurance system can protects the depositors of member institutions from the panics and contagions, which

arise due to the banking failures, it also raises the moral hazard problem, which banks might take too much risk. (Freedman, 1997; Finance Canada)

2.3 Financialization Phase (1980-)

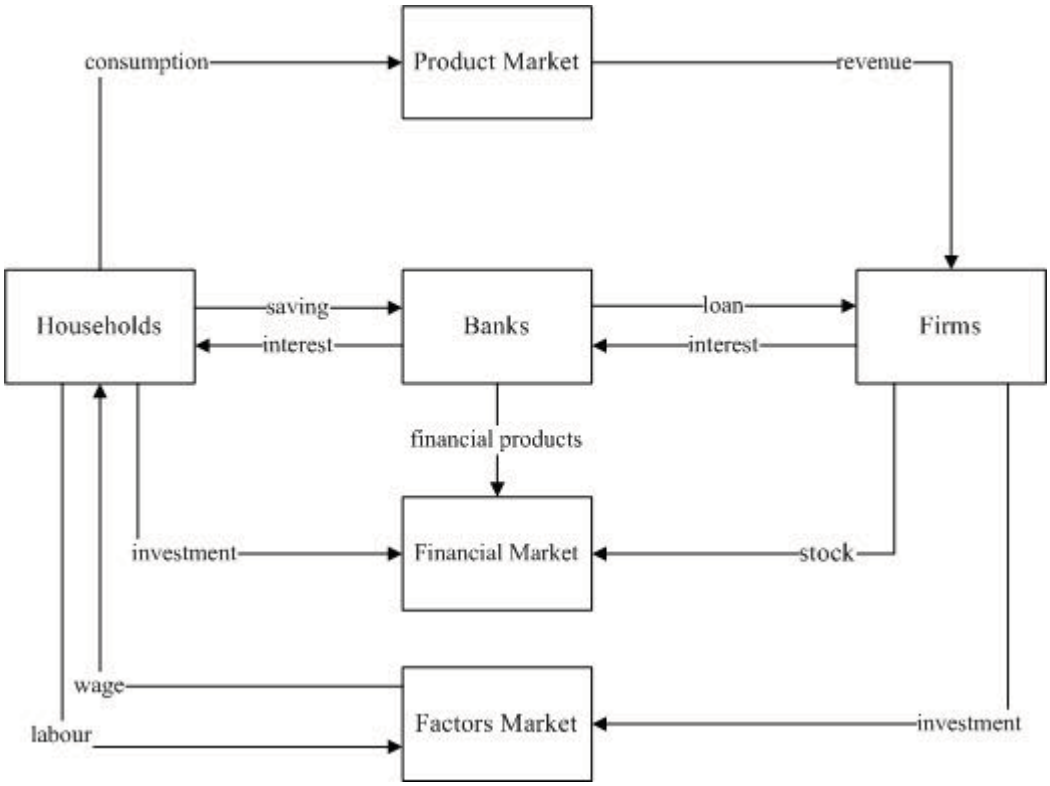
Now that I have discussed the history of regulation in the pre-financialization phase, I move on to discuss the U.S. and Canadian banking regulatory system in the financialization phase. Firstly, I discuss the function of banks in the monetary circuit in the financialization phase. Secondly, I discuss the market structure of the U.S. banking industry and banking regulations in the financialization phase. Thirdly, I look at the market structure of Canadian banking industry and banking regulations in the financialization phase.

2.3.1 The Role of Bank in Monetary Circuit in the Financialization Phase

Currently, with the development of financialization on the capital accumulation, the banking model has changed from "originate and hold" into "originate and distribute". "Originate and hold" means banks will not write down the loans they issue on their own balance sheet until they are paid. It means banks have to scrutinize the credit records of borrowers to ensure that they present acceptable default risk level. However, "originate and distribute" means banks can package their issuing loans via a securitization process and sell them to financial capital markets (as shown in the Figure 2). Those sold loans will no longer stay on the balance sheets of the banks, which means the banks do not undertake the full credit risks of borrowers. Meanwhile, a confluence of financialization, globalization and deregulation has diversified the resources of funds and the users of

funds. The banks are no longer the only intermediaries between savers and investors. Financial capital markets have become important channels via investment banks and equity markets to intermediate financial funds to support the capital needs of enterprises and to provide more structured financial products to meet the investment desires of savers. Moreover, since the banks are also highly involved in this market due to seeking lucrative investment opportunities by layering their assets, their primary incomes are no longer just coming from the interest rate spreads between lending and deposit rates. Also, administrative and custodial fees, commissions, and investments have become major components of banks' incomes. Therefore, the kinds of market risks to banks have increased. These include interest rate risk, foreign exchange risk, equity risk and commodity risk (Seccareccia, 2012).

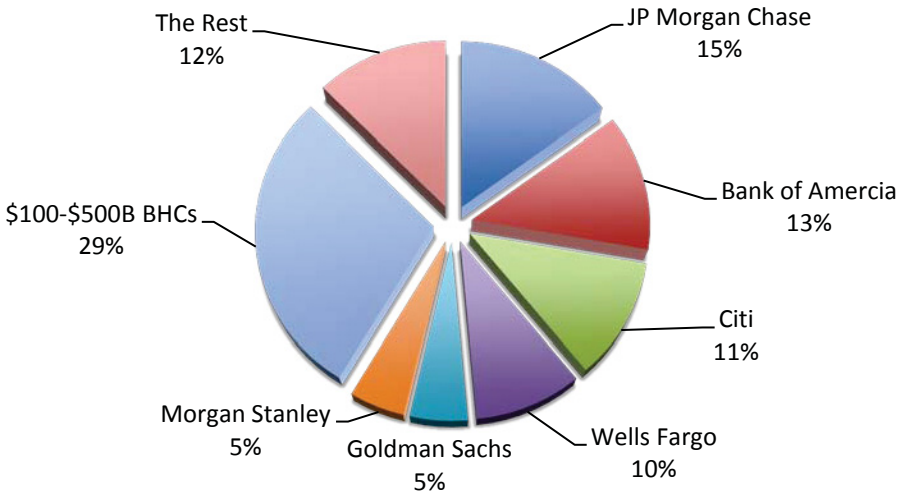
Figure 2 Bank Roles in the Financialization Phase



2.3.2 The Current Market Structure of U.S. Banking Industry

A Conference of State Bank Supervisors (CSBS) reported that in 2013, there were total of 6821 domestic and foreign institutions (CSBS, 2013). Banks in United States could register at the levels of either federal or state government. The six largest bank holding companies in U.S. today are JP Morgan Chase and Co., Bank of America Corporation, Citigroup INC., Wells Fargo and Company, Golden Sachs Group, INC. and Morgan Stanley. Each holds more than $800 billion in total assets and accounts for almost 58.5% of total industry assets on June 30, 2014. Additionally, there were 23 banks, which held assets between $100 billion and $500 billion and made up 29 percent of total industry assets in the U.S. The rest of the bank holding companies only held 12% as of this date. The concentration ratio of largest six bank holding companies in U.S. was almost 58% and the Herfindahl Index is 705, which is considered to BE a low level of concentration. Figure 3 below shows the percentages of market shares of U.S. banking holding companies.

Figure 3 Total Assets among U.S. BHCs



Source: FFIEC 2014

2.3.3 The U.S. Banking Regulation in Financialization Phase

Since I have now given a brief picture of current market structure of the U.S. banking industry, I will next look at banking regulations in financialization phase in the U.S.

2.3.3.1 Depository Institutions Deregulation and Monetary Control Act of 1980

On March 31th, 1980, an act of a far-reaching influence was passed and signed by President Jimmy Carter. This was the Depository Institutions Deregulation and Monetary Control Act, which called off several regulations on banks and made a fundamental change to the U.S.banking system. First, all depository institutions were now under the FRB's regulations and were forced to meet reserve requirements according to the relevant standards. Second, over a 6-year period, restrictions (including State restrictions) on interest rate ceilings on deposit accounts were gradually eliminated. Also, the restriction on the State mortgage usury ceiling was removed. Meanwhile, NOW (negotiable order of withdrawal) accounts could be offered nation-wide, and the banks were allowed to pay interest on personal transactions accounts. Third, deposit insurance was increased from $40,000 to $100,000. The act improved the banks' abilities to compete with other kinds of financial institutions and encouraged residents to save more money. This deregulation was allowed, as it was believed that competition among the different financial institutions would increase efficiency, and, stability issues were not considered to be as great of a concern as before (Thomas, 2006).

Subsequently, the Garn-St Germain Depository Institutions Act granted the authority to banks to offer the new money market deposit account (MMDA) for households and the Super NOW accounts for business and government agencies. It also allowed banks to make alternative loans (contrary to fix-rate and fix-term mortgages).

2.3.3.2 Competitive Equality Act of 1987

In 1987, the Competitive Equality Act amended the definition of the "bank" to be any bank insured by the FDIC or an institution, which accepts deposits and makes commercial loans. The act also limited non-bank bank activities. Non-bank banks were not allowed to "engage in any activity that the bank was not lawfully engaged in" nor could they engage in both deposit-taking and commercial lending activities.

2.3.3.3 Federal Deposit Insurance Corporation Improvement Act of 1991

In 1991, the Federal Deposit Insurance Corporation Improvement Act was passed to solve the undercapitalization problem of the FDIC. Since almost 1,300 commercial banks were bankrupted or required assistance from the FDIC from 1934 to 1991, this agency became undercapitalized in 1991. The act required the FDIC to "prompt corrective action" and "least cost resolution" to ensure the soundness and safety of banking system. The insurance premium of member institutions should be risk-based now and the FDIC was now allowed to borrow $30 million instead of $5 million from the Treasury Department (Thomas, 2006; Federal Reserve Board website).

2.3.3.4 The Riegle-Neal Interstate Banking and Branching Efficiency Act of 1995

In 1995, a crucial bank reform happened as a result of the passing of the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 (the "Riegle-Neal Act"). Adequately capitalized bank holding companies were permitted to acquire banks across state lines and to merge the banks, which were located in different states into branch networks. The Riegle-Neal Act repealed the McFadden Act of 1927, which prohibited interstate branch banking. Since no state opted out the act, the act removed the barrier, which had prevented of BHC geographic expansion and had been in place for seventy years. It was argued that this act would improve the efficiency of the banks via reducing overhead costs, diversifying assets and liabilities, and meeting consumers' mobility needs (Federal Reserve Board website).

2.3.3.5 The Gramm-Leach-Bliley Act of 1997

Subsequently, the deregulation of banking industry continued at a rapid pace. New strategic opportunities were created by the new acts, which had allowed the banks to realize geographic and product diversification.

In 1997, Regulation Y listed the permissible non-bank activities, which holding companies were permitted to engage in, and loosened the anti-tying restrictions on bank holding companies and their nonbanking subsidiaries. This allowed the bank holding companies and their nonbanking subsidiaries to enter into tie-in arrangements. In 1999, the Gramm-Leach-Bliley Act (GLBA), also known as Financial Services Modernization

Act of 1999, eliminated the barriers for banks to enter different financial sectors. The new Act repealed the Glass-Steagall Act of 1933, which prohibited commercial banks from transacting other financial services, including investment banking and insurance. The GLBA promoted the integration of financial industry to introduce "financial holding companies", which could own different kinds of financial institutions, including commercial banks, investment banks and insurance companies. Also, the FHCs were put under the supervision of the FRB. The Riegle-Neal Act and the GLBA were the two important acts, which accelerated the deregulation of the U.S. banking system, generated the complex banking organizations and diversified the banking activities. The traditional banking activities, deposit-taking and lending, were shifted to pursue lucrative investments, such as securities and derivatives. These two acts were also judged to affect the 2007-2008 financial crisis (Federal Reserve Board website; Sherman, 2009).

2.3.3.6 Financial Service Regulatory Relief Act of 2006

Just one year before 2007-08 financial crises, regulatory burdens on depository institutions were being reduced again.

The Financial Service Regulatory Relief Act of 2006 extended the examination cycles of depository institutions with more than $250 million and community banks with more than $500 million in assets to 18 months up from an annual basis. The act also allowed banks to engage in cross-marketing activities as long as the arrangement didn't violate anti-tying restrictions and had been approved by the FRB. It also reduced the reporting requirements for inside lending (Philadelphia Fed website).

One year later, the bursting of the U.S. housing market bubble led to a great loss in mortgage-related financial products, and then the U.S. economy entered the recession.

2.3.3.7 Emergency Economic Stabilization Act of 2008

During this financial crisis, several acts were imposed on the banking system in an effort to rescue the economy from this turmoil. The first one was the Emergency Economic Stabilization Act of 2008.The act was a bailout of financial institutions; it authorized the Secretary of the Treasury to spend up to $700 billion to purchase “trouble assets” including residential and commercial mortgages and mortgage-related assets as well as any asset, which contributed to the financial instability. As such, this act didn't require the financial institutions to repair the problems by themselves (Federal Reserve Board website).

2.3.3.8 Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010

In 2010, a crucial legislative change to financial supervision was brought about by the Dodd-Frank Wall Street Reform and Consumer Protection Act. This act had significant effects on all financial institutions. The act created several new agencies: the Financial Stability Overnight Council (the Council) and the Orderly Liquidation Authority, the role of which is to monitor the financial system. The act also imposed stringent standards on banks’ risk management, including the “Volcker Rule”, which prohibits insured depository institutions from dealing in derivatives for their own accounts (Federal Reserve Board website).

From reviewing of all the important changes in U.S. banking regulations in the financialization phase, we found that these regulations reversed the acts, which had been put into place during the pre-financialization phase. These deregulations returned the U.S. banking industry to the conditions, which had preceded the "Great Depression" and it happened again.

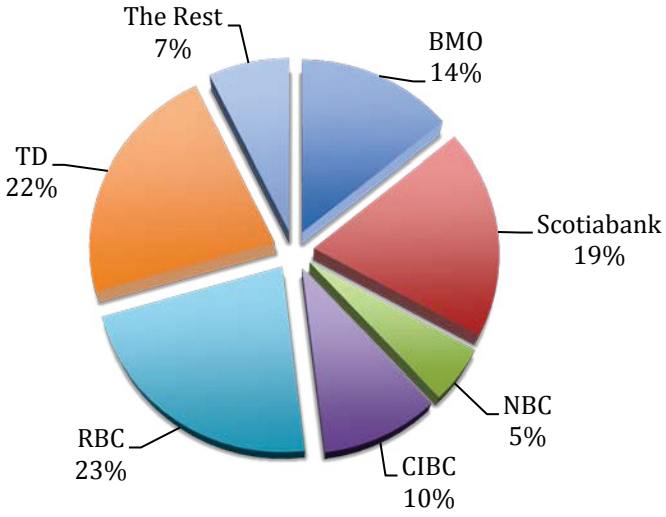
Now, I move on to discuss the market structure of the Canadian banking industry and go through the changes in the Canadian banking regulations in the financialization phase. First, I begin with the market structure of Canadian banking industry. Then, I move on to review the changes in the Canadian banking regulations in the financialization phase.

2.3.4 The Current Market Structure of Canadian Banking Industry

Today, there are a total of 83 banks or their subsidiaries operating in Canada. Those include 29 domestic banks, 24 foreign bank subsidiaries, 27 full-service foreign bank branches and three foreign bank lending branches (Canadian Bankers' Association website). Those banks are divided into three categories, Schedule I, Schedule II and Schedule III. Banks in schedule I are those domestic banks authorized to accept deposits by Federal Bank Act. According to the data of the Office Superintendent of Financial Institutions, in Aug.31, 2014, the six largest banks ("Big Six"), which consist of Bank of Montreal (BMO), National Bank of Canada (NBC), Royal Bank of Canada (RBC), Bank of Nova Scotia (Scotiabank), Canadian Imperial Bank of Commence (CIBC) and Toronto Dominion Canada Trust (TD), owned approximate 92.7 percent of the total assets among

Canadian banks, including domestic banks and international banks. These market shares are illustrated in the Figure 4 (OFSI website). The "Big Six" also contributed almost 92 percent of the credit to loan markets. Meanwhile, due to their multi-business lines, including trading, wealth management, investment banking, insurance and brokerage they play important non-traditional bank roles in Canadian financial system. The concentration ratio of six Canadian banks was 92.7 % and the Herfindahl Index was 1679, which is considered to be a moderately concentrated market structure. Schedule II banks are bank subsidiaries of foreign institutions, which also can take deposits and are regulated by the Federal Bank Act. These banks can be closely held and/or wholly owned by non-residents. However, parents of those foreign institutions must be widely held. The last category, Schedule III banks are bank branches owned by foreign institutions. There are several restrictions on their business, including that they are not allowed to accept deposits under $150,000 and they are required to focus on commercial banking and broader lending activities (Minister of Finance website; Canadian Banker Associate website). Figure 4 illustrates the market structure of the Canadian banking industry based upon their total assets.

Figure 4 Total Assets among Canadian Banks



Source: OFSI 2014

2.3.5 The Canadian Banking Regulations in the Financialization Phase

Now that I have reviewed the Canadian bank market structure, in the next section I look at the changes of the Bank Act in the financialization phase.

2.3.5.1 The Amendment of 1981 and 1991

After the Amendment of 1981, the Canadian bank system was to follow the speed of deregulation of the U.S. banking system. In the 1981 and 1991 Amendments of the Bank Act, the segment of business domains of the traditional four pillars of financial institutions (commercial banks, insurance companies, trust companies and investment dealers) was broken down. Banks were allowed to expand their businesses into different areas, including financial leasing, data-processing services, owning subsidiaries of venture capital companies, mortgage loan companies and discount brokerage firms.

Banks could now provide several “in-house services” such as portfolio management and investment consulting services. Moreover, the reserve requirement of chartered banks was phased out, which increased the bank assets substantially.

Meanwhile, several restrictions and newly created agencies were developed to deal with this deregulation situation. The Canadian Payment Association was created under Canadian Payment Act of 1980 to be responsible for the cheque-clearing system, and the Office of the Superintendent of Financial Institution was founded in 1987 to oversee the Canadian banking system and to ensure its soundness and compliance with the laws. Meanwhile, new rules, relating to ownership required that the chartered banks must still be widely held (maximum 10% of voting shares) in order to prevent the concentration of ownership and the significant upstream commercial-bank links in order to avoid giant corporations manipulating the Canadian financial institutions. Certainly, there were still limitations on banks involvement in owning non-financial businesses, which restrict the strong downstream links between banks and commercial companies. Additionally, the Bank Act still has to be reviewed every five years since the 1992 amendment. (Daniel, 2002-03)

2.3.5.2 The Amendment of 2001

The main change of the 2001 Bank Act Amendment was the relaxation of limitations on bank ownership. Now, the “widely held” limitation was only put on the large banks (greater than $5 billion in equity), and the limitation was increased from 10% to 20% of voting shares and 30% non-voting. Medium and small size banks were no longer subject

to this restriction. At the same time, the holding company regime was introduced to the banks for the first time but this didn't change the range of businesses the banks could operate. It did, however, give banks some flexibility to arrange their organization structure (Daniel, 2003).

2.3.5.3 The Amendment of 2007 and 2012

Since the banks' problems in Canada have been due to the global liquidity constraints rather than domestic market weakness, the Bank Act Amendments of 2007 and 2012 were not heavily modified to solve the problems of financial crisis 2007-08. However, similar to the U.S. case, since the Canadian banks had issued mortgage-backed securities, several policies and programs were introduced to address the problems with the mortgage market and the financial structure products. To solve the mortgage problems, the government expanded the Canada Mortgage Bond program to include 10-year maturities and introduced a new temporary insured mortgage purchase program, which can purchase up to $125 billion in National Housing Act Mortgage-backed Securities from Canadian financial institutions to help address the liquidity crisis. To solve the financial products problem, the governments modified existing mortgage insurance rules to enhance the governance on mortgages and required banks to clearly state the disclosures for deposit-type investment products and deposit-type registered plans. The stated aim was to help consumers to distinguish and compare those products.

The comparative reviews of the banking regulations of the U.S. and Canada supports the hypothesis that U.S. banking regulators have preferred to keep the banks under a fair

competitive environment. This led them to set several restrictions on “big players” and this opened the “doors” for different institutions to be banks. Also, they separated the business dimensions of banks to prevent them from becoming too big. To contrast, throughout the history of the Canadian banking, regulators have preferred that banks be “big players” in order to keep this industry stable. Therefore, in Canada, regulators didn't prevent banks entering every place in Canadian markets and acquiring different kinds of financial institutions.

The two different approaches of the U.S. and Canadian banking regulators might reflect two different hypotheses in industrial organization. The approach of the U.S. banking regulators can represent the structure-performance hypothesis. The other approach called the efficiency structure hypothesis might be represented by the idea of Canadian banking regulators. In Chapter 3, I explain these two hypotheses in detail.

Chapter 3 Theoretical Foundation of the Study

The comparison of U.S. and Canadian banking regulations discussed in Chapter 2 suggested that U.S. regulators have been more likely to protect competition among all those banks. Regulations have kept "big players" out of occupying small markets to restrict them from sharing integrated resources from conglomeration. State governments in the U.S. have been concerned about the monopoly power of "big players" encroaching on the living space of small businesses and manipulating the price in local markets. Therefore, the state governments have historically restricted the big banks from big cities from entering the local markets, and the federal government has also restricted the competitive abilities of big banks. To contrast, Canadian banking regulations have emphasized the capital and the scale of the institutions preferring relatively large and adequately capitalized banking. At the same time, Canadian regulators have not intervened closely to encourage competition among the banks and other financial institutions. Since there have been a limited numbers of banks and an integrated regulatory system, these have permitted the government to supervise the system effectively and promptly. Also, this has reduced regulatory costs.

The difference between the U.S. and Canadian banking regulations can be viewed as reflecting two different opinions in Industrial Organization. One is that the competition has the power to increase efficiency and social welfare. The other is that economic scale can reduce average costs in order to improve productive efficiency by saving resources. Both competition and economic scale have positive implications for efficiency, which come from two different hypotheses in the structure-conduct-performance framework.

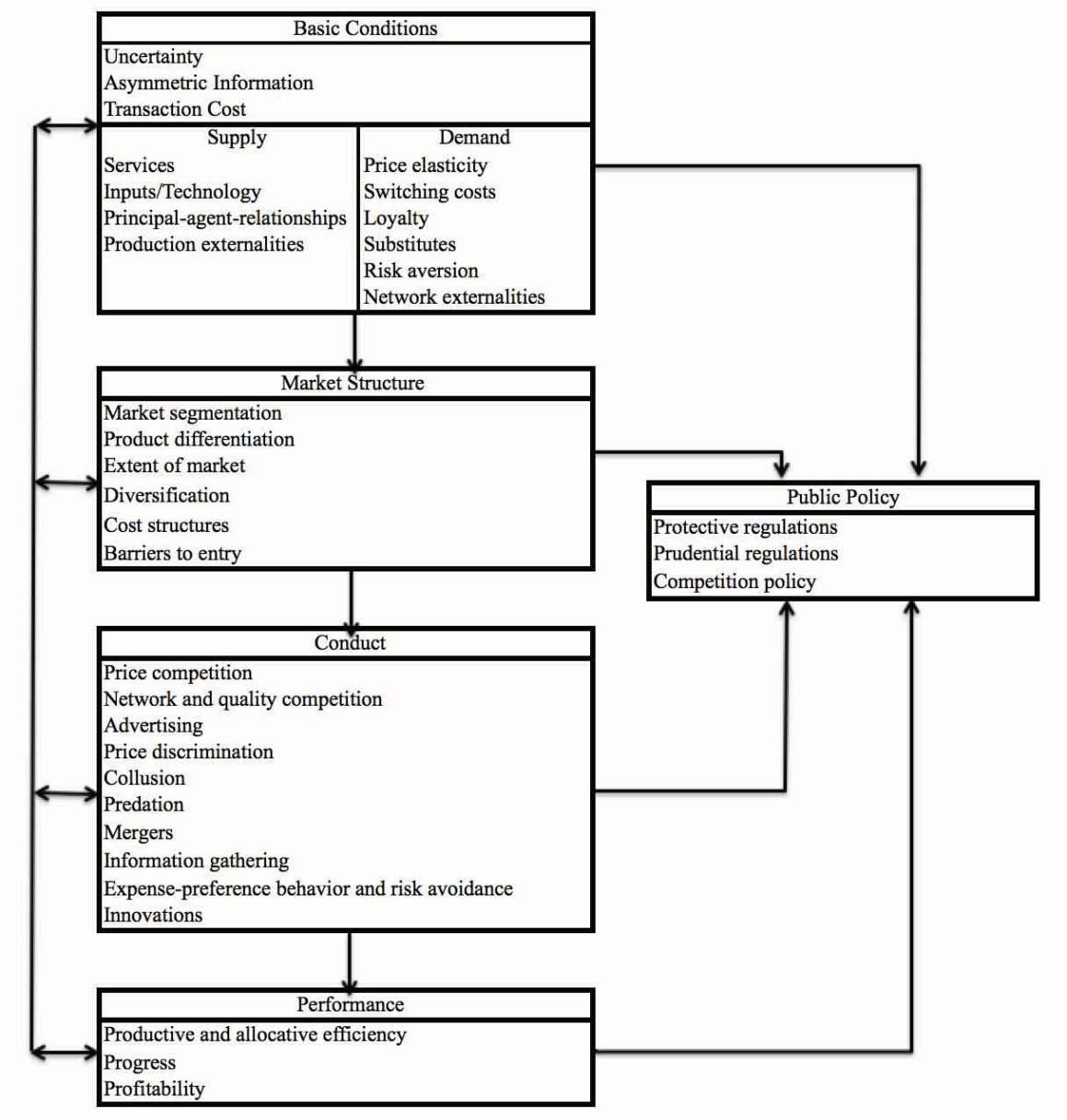
One is the structure-performance hypothesis and the other is the efficient structure hypothesis. Thus, in the Chapter 3, first, I illustrate the structure-conduct-performance framework; second, I introduce the concepts of efficiency in Industrial Organization; third, the literature review about the efficiency measurements is included.

3.1 The Structure-Conduct-Performance Framework

The Structure-Conduct-Performance (SCP) framework is an important tool of analysis in Industrial Organization. It was proposed by Edward S. Mason in 1939 and was developed in 1956 by Joe S. Bain. The SCP framework suggests that there is a causal relationship going from market structure to conduct to performance.

In 1997, D. Neuberger drew a revised SCP paradigm for the banking industry as illustrated in Figure 5.

Figure 5 Revised SCP Framework for Banks



Source: Based on Neuberger (1997)

The first step of the SCP framework is to determine the market structure, including horizontal, vertical and conglomerate dimensions. A methodology to determine the horizontal market structure is to calculate the degree of market concentration. Usually, the concentration of the market is measured by the number of firms in the market and how

the market shares are distributed among the firms. More firms in the market or higher dispersive market shares distributed among the firms means lower market concentration and less market power, which indicates a potentially higher level of competition in the market.

There are two opinions on the effects of market concentration on efficiency in the SCP paradigm. One is to prefer relatively low market concentration and the other is to prefer higher concentration.

3.1.1 Structure Performance Hypothesis

The point of view, which prefers low market concentration, is called the "structure performance hypothesis". In this hypothesis, competition is considered as a positive force to improve the development of industry and the society. This viewpoint was argued by J. R. Hicks, a British Economist, who proposed the "Quiet life hypothesis".

Hicks wrote:

> They are likely to exploit their advantage much more by not bothering to get very near the position of maximum profit, than by straining themselves to get very close to it. The best of all monopoly profits is a quiet life.

Hicks pointed out that firms enjoy the advantages of market power rather than pursuing maximum profits when considering their subjective costs (Hicks, 1935). The firms in highly concentrated markets would earn more revenues than those in less concentrated markets no matter how efficient they are. Based on his argument, if banks in a highly concentrated market get more market power, they would have limited incentives to pursue more profits. Furthermore, they also do not have incentives to improve service quality

and to create more consumer-based products, all of which will reduce the consumer welfare. Subsequently, the "Quiet Life" hypothesis was widely used to argue for a negative relationship between the market power and efficiency in banking industry. Empirical support has been provided by Berger and Hannan (1998), who used more than 5000 U.S. banks' data to find strong evidence that banks in more concentrated markets exhibited lower cost efficiency, and that the efficiency cost of concentration may be several times larger than the social cost from the deadweight loss (Berger and Hannan, 1998).

And also, the SCP framework predicts that if the banks are in an unconcentrated market, they will increase the amounts of loans and deposits, decrease the loan rates and raise the deposit rates in order to get more market share. Hence, competition can encourage the banks to pursue cost minimization and thereby, increase the efficiency level. Therefore, competition has been encouraged in most industry fields by academics and regulators based on Hick's argument and the empirical support for it.

3.1.2 Efficiency Structure Hypothesis

The other argument that it is preferable to have a high market concentration is the "efficiency structure hypothesis", which posits that a concentrated banking system would allow banks to achieve economies of scale and, through this, cost efficiency. The efficiency structure hypothesis states that firms can reduce average costs and increase cost efficiency via expanding market shares such that there is a positive relationship between market concentration and efficiency. The banks with a greater efficiency level can expand

their market share by using their extra profits, and, in return, achieve higher market shares enabling them to operate at lower costs. Berger et al. (1993) did an extensive review of literature on scale efficiency in banking industry and suggested that banks with $2 billion to $10 billion in assets could achieve the minimum average cost point. Medium-sized firms exhibited more efficiently than very small firms. Koett, Kolari, and Spierdijk (2012) found that insured U.S. commercial banks exhibited a positive relationship between the cost efficiency and market power from 1976 to 2007. In Canada, Allen and Liu's (2005) research suggested that Canadian banks do not face constant return to scale such that they could enjoy more cost saving from getting more market shares.

However, increased scale may also enable banks to more effectively compete with very large banks in international markets, which potentially exposes them to risky international assets. A reason why Canadian banks may have suffered less from the 2007-08 financial crisis, which is mentioned by the IMF in its Global Financial Stability Report (2012), is because of the government's 1998 decision to prohibit mergers of the major domestic banks in order to retain the competitive abilities of the national "champions" banks (IMF, 2012). It's an interesting argument from IMF.

In addition to economies of scale, another argument for fewer banks is that since banks and banking systems are more vulnerable to instability than other industries, keeping stability in this industry is the major concern of policy-markers. There is a general belief that an appropriate degree of market concentration can maintain the stability in banking sectors (Berger et.al, 1993; Koetter et.al, 2012; Allen and Liu, 2005).

Since both the “structure-performance” and “efficiency-structure” hypotheses have theoretical and empirical support, to test between these hypotheses, I compare the efficiency of Canadian and U.S. banks to investigate how these two factors affected the banking industry during 2007-08 financial crisis. If Canadian banks were found to be more cost effective, this would support the hypothesis that a branch banking system may be more efficient due to economies of scale, suggesting that the Canadian system is a best practice banking system. This could provide support for policy makers inclined to remove restrictions on branch expansion. Conversely, if the U.S. banks are found to be more cost efficient than the Canadian banks, policymakers might encourage competition among those financial institutions, relax the restrictions on institutions, which qualify as banks, and protect small banks to maintain the competition.

In the next two sections, I start out discussing the concepts of efficiency in economics, and then review the methodologies of efficiency measurements.

3.2 Overview of Concepts of Efficiency

Efficiency is a powerful means by which to assess the performance of firms, markets or an economy. The terminology used to define efficiency is varied in economics and can give rise to confusion.

In economics, efficiency can be divided into dynamic and static efficiency. Dynamic efficiency can be fostered by entrepreneurial creativity to improve production technology and to create new products continually. From a static efficiency standpoint, dynamic

efficiency requires sacrificing some social surplus in a given period in order to price sufficiently high that profits can be devoted to research and development. A market is dynamically efficient if the social surplus is maximized over time. Static efficiency includes allocative efficiency and productive efficiency. Allocative efficiency is based on a social perspective, which means that the total social surplus is maximized when the price is equal to the marginal cost in the long-run equilibrium under a perfectly competitive market if there are no externalities. Productive efficiency is defined based on how close output is in comparison to the best-practice production frontier or equivalently based on the extent to which the lowest possible cost levels are attained for a given output level. Productive efficiency has attracted lots of attention from academics and is scrutinized extensively under the field of Industrial Organization. For banks, low productive efficiency will restrict their abilities to create credit, in turn, harming their earnings and hampering their ability to take on risk.

The most significant proposal of the concepts of efficiency at the micro level was introduced by Farrell in 1957. Farrell also developed a method to measure the efficiency according to the "best-practice" benchmark. In his paper, he assumed that the benchmark efficiency level is all the points along the production frontier, and that efficiency at micro-level can be separated into technical efficiency and allocative efficiency. Technical efficiency means that the "firm's successful in producing maximum outputs from a given set of inputs". Allocative efficiency, also called price efficiency, represents a situation in which firms can allocate the inputs at the minimum total cost point when prices are given (Farrell, 1977). Technical and allocative efficiency are represented in Figure 6 below.

Figure 6 Technical Efficiency and Allocative Efficiency

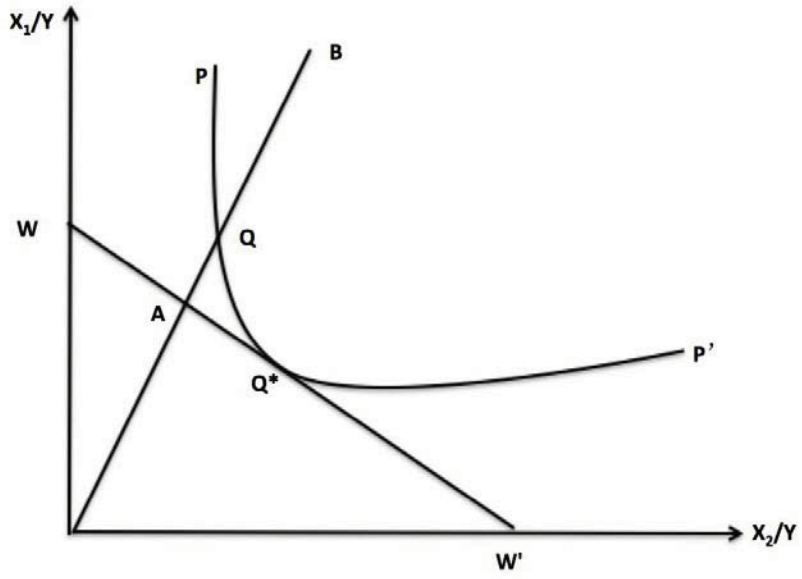


Figure 6 is an isoquant/isocost graph for a single output (Y) being produced with two inputs (X_1 and X_2). PP' represents the isoquant efficient frontier, with the price ratio represented by the slope of the isocost line, WW′. X_1/Y and X_2/Y represent the input to output ratios of X_1 and X_2. B represents the point where it is both technically inefficient and allocatively inefficient. By scaling back both inputs by the proportion QB/OB, the producer could reach the isoquant and, thus, achieve technical efficiency. But, by reallocating production in favor of input X_2 and away from X_1, the same output could be produced at an even lower cost at Q*. Thus, B can reach both technically efficiency and allocative efficiency. Therefore, technical efficiency (TE) can be represented as TE=OQ/OB and allocative efficiency is OA/OQ.

3.3 Literature Review of Efficiency Measurements

There is a large volume of research on bank efficiency. It can be classified into two

categories. The first category focuses on identifying and measuring the impacts of regulations on the banking industry. These regulations include deregulation, regulation on mergers and acquisitions, market structure, financial liberalization and foreign entry. Analyzing the impacts on the banking industry provides a guide to policy makers regarding whether they should encourage, discourage or modify polices. Zouari and Mensi (2010) used the Data Envelopment approach to distinguish between the efficient structure theory and the market power theory. They tested the SCP hypothesis, the Quiet Life hypothesis and the Relative Market Power hypothesis of Tunisian banks from 1990-2005. Their research supported the market power hypothesis but disfavored the SCP hypothesis and the Quiet Life hypothesis. Their work suggested that only banks with large market shares and diversified products could gain abnormal returns and that banks tend to fix the price of credit related products. They suggested that policy makers should pay attention to those banks with abnormal profits but with lower market share; otherwise, it will harm consumers eventually.

The second category is to improve the quality of research methodologies, such as the measurements of outputs and inputs, functional forms, model specification and so on. These studies are based on varieties of mathematical and statistical testing and modeling techniques. These improved research methodologies may provide a more reliable estimation of efficiency. Berger (1993) proposed the "Distribution Free Approach" to relax the restriction on the distribution of technical inefficiency. This allows the inefficiency to follow any distribution pattern as long as it is a non-negative number.

Now that I have reviewed some literature about productivity efficiency measurements, in

Chapter 4, I demonstrate the methodologies of productive efficiency measurement in more detail.

Chapter 4 Methodologies of Productive Efficiency Measurement

There are several ways to measure the productive efficiency scores of banks. The first method uses the Key Performance Indicators (KPI), which use several financial ratios to profile the conditions of banks. The KPI includes Return on Assets (ROA), Return on Equity (ROE), Debts to Equity (D/E) and so on. The KPI provides valuable insights into various aspects of banks, such as profitability, liquidity, risk and asset management ability. The second method uses economic indices, such as the Malmquist Index. The Malmquist index is used to identify productivity differences between two different production units. The third method uses econometric techniques to estimate the efficiency scores of banks. These include the Data Envelopment Approach (DEA), the Stochastic Frontier Approach (SFA), and the Distribution Free Approach (DFA). In this paper, I focus on using econometric approaches to measure productive efficiency.

4.1 Econometric Approaches to Productive Efficiency Measurement

In recent years, academic research on the performance of banks has increasingly focused on frontier efficiency analysis, which measures the deviations in a given bank's actual performance from that of the "best practice" banks on the efficient frontier, while holding exogenous factors constant. Berger and Humphrey (1997) reviewed 130 studies of frontier efficiency analyses of financial institutions across 21 countries and concluded that this kind of analysis was a valuable way for policymakers and managers to evaluate

the effects of mergers and acquisitions, deregulations, market structures and management quality (Berger and Humphrey, 1997).

Efficiency measurement in econometric techniques can be classified into parametric and non-parametric approaches. The main difference between these two techniques or approaches is whether the functional form of the efficiency frontier is pre-determined. The parametric approach uses a pre-specified functional form to estimate the production frontier while, under the non-parametric approach, the frontier is estimated by the actual data.

There are two commonly used parametric approaches, the Deterministic Frontier Analysis (DFA) and the Stochastic Frontier Analysis (SFA).

In 1957, Farrell was a pioneer to propose a deterministic frontier approach to measure technical inefficiency and use a graph to clearly illustrate it, but he didn't propose a formula to measure the technical inefficiency. Building on his work, Aigner and Chu (1968) used the Cobb-Douglas production function to model the productive inefficiency. Subsequently, Aigner, Lovell, Schmidt and Meeuse, van den Broeck (1977), and Charnes, Cooper and Rhodes (1978) modified the initial formula purposed by Aigner and Chu respectively. I illustrate the process of modifying the measurement of technical inefficiency in next three sections.

4.1.1 Deterministic Frontier Approach

In 1968, Aigner and Chu used a Cobb-Douglas function to estimate an efficient production frontier. The equation for the initial deterministic frontier model is:

$$Y_i = Ax_{1i}^{\alpha_1} x_{2i}^{\alpha_2} .. x_{Ni}^{\alpha_N} U_i \,, \qquad [1]$$

where Y_i is output of bank i; $x_{1i}, x_{2i},.., x_{Ni}$ are factors inputs and A is total factor productivity; U_i is the proxy of technical efficiency of firm i and is a random disturbance between 0 and 1.Technical efficiency is related to the productive efficiency and is widely used to estimate the efficiency level of firms and industries. Technical efficiency can be measured in two ways, cost minimization or profit maximization. Cost minimization measures the bank's ability to minimize their costs of inputs to produce given outputs. In comparison, profit maximization reflects the bank's ability to use given inputs to earn maximum profits. Since neither of the market structures in U.S. and Canadian banking industries are monopolies, it is not reasonable to assume that banks in these two countries are able to maximize the profit of the market. Therefore, in this paper, I utilize the cost minimization measure.

Transforming [1] into log-form gives:

$$\ln Y_i = lnA + \sum_{n=1}^{N} \alpha_n \, lnx_{ni} + lnU_i. \qquad [2]$$

Letting, $\beta = lnA, X_{Ni} = lnx_{Ni}, \varepsilon_i = lnU_i$ where ε_i is a non-negative variable, gives:

$$\ln Y_i = \beta + \sum_{n=1}^{N} \alpha_n \, X_{ni} - \varepsilon_i. \qquad [3]$$

Then, re-arranging the equation [3], the technical inefficiency can be expressed as:

$$\varepsilon_i = \beta + \sum_{n=1}^{N} \alpha_n X_{ni} - \ln Y_i \,. \qquad [4]$$

The sum of the individual firm's logged technical inefficiency terms $\text{Min}_{\alpha,\beta} \sum_{i=1}^{n} \varepsilon_i$ is then minimized subject to the constrain such that:

$$\ln Y_i - \beta - \sum_{n=1}^{N} \alpha_n X_{ni} \geq 0, i = 1,2,3 \ldots \qquad [5]$$

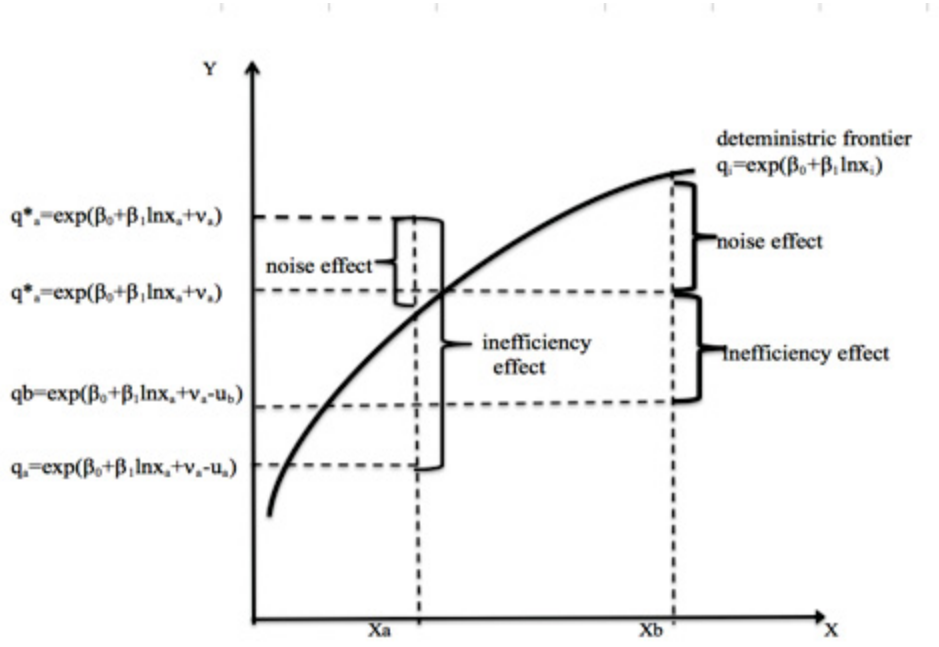
The accuracy of this estimation largely depends on whether the production frontier is formulated appropriately. Another problem is that ε represents all possible influences, noises and total deviations from the efficient production frontier. All those disturbances are accounted for as the result of technical inefficiency. Subsequently, two methods were used to improve the frontier estimation.

4.1.2 Stochastic Frontier Approach

One method of modifying the ε term was proposed by Aigner, Lovell, Schmidt (1997), and Meeuse, van den Broeck (1977). This method is called the Stochastic Frontier Approach (SFA) and is illustrated in Figure 7. Under the SFA approach, the random error can be divided into two parts, such that $\varepsilon_i = v_i + u_i$ where v_i is the part that can't be controlled by the firm so that it is a random error (also known as the noise effect in Figure 7). It can be any value, and it is independently and identically distributed as N (0, σ_v^2). u_i is the part that represents technical inefficiency of firms, which is still a non-negative variable working as a proxy of the technical inefficiency and is assumed to be independent of v_i. The Stochastic Frontier Model is:

$$\ln Y_i = \beta + \sum_{n=1}^{N} \alpha_n X_{ni} + (v_i - u_i) \qquad [6]$$

Figure 7 The Stochastic Frontier



Source: Based on Coelli et.al (1998)

In Figure 7, q_a and q_b represent the output levels produced by firm A and B given input levels x_a and x_b. Technical inefficiency is assumed to exist in these two firms such that when there is no technical inefficiency, firms A and B would produce at q_a^* and q_b^*. From this figure, we can see the random disturbance can be any positive or negative value that makes the outputs above or below the deterministic frontier but technical inefficiency can only be less than 1, which makes the output level below the deterministic frontier.

4.1.3 Data Envelopment Approach

The other method to improve the initial deterministic frontier is to avoid using a pre-determined production function. The Data Envelopment Approach (DEA), introduced by Charnes, Cooper and Rhodes (1978), is a popular non-parametric measurement, which is used to evaluate the relative efficiency of decision-making units (DMUs), and is illustrated in Figure 8. The DEA model uses empirical data to calculate the efficiency score of each comparable DMU and the score ranges from 0 to 1, but this score is not an absolute standard and is defined relative to the other DMUs. A score less than one means that a linear combination of other DMUs from the sample could produce the same vector of outputs using a smaller vector of inputs. Let X_0 be the inputs into a DMU for which we want to determine the efficiency and let Y_0 be the outputs. So the X's and the Y's are the data. The measure of efficiency for DMU_0 is given by the following linear program:

$$\min_{\theta,\lambda} \theta$$

subject to:

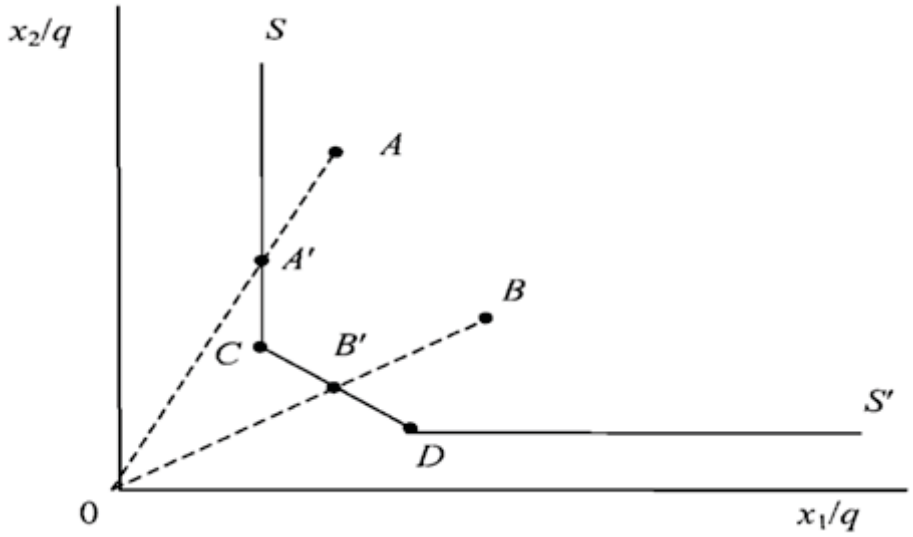
$$\sum_{i=1}^{n} \lambda_i X_i \leq \theta X_0$$

$$\sum_{i=1}^{n} \lambda_i Y_i \geq Y_0$$

$$\lambda \geq 0$$

Where X_i represents the vector of inputs into the i^{th} DMU, Y_i is the corresponding vector of outputs, λ_i is the weight given to DMU_i in its efforts to dominate DMU_0, and θ is the efficiency of DMU_0. Therefore, the λ_i and θ are the variables.

Figure 8 Efficiency Measurement and Inputs Slacks



Source: Figure based on Coelli etc.al (1998)

In Figure 8, C and D are the efficient firms with technical efficiencies equal to 1. In comparison, A and B are the inefficient firms. A and B could reduce the amount of inputs used to achieve the efficiency level at A' and B'. The main advantage of the DEA model is to avoid mis-specifing the production models and it is suitable for multi-input and multi-output DMUs. However, the drawbacks of the DEA are also worthy of consideration. The first is that the DEA model does not include a random error term, which may affect the DMU's performance. The other is that DMUs must be comparable, which means they should at least be under similar environments, such as culture, regulation, etc.

4.2 The Advantage of the Stochastic Frontier Approach

In this thesis, I chose to use the SFA to compare the efficiency level of Canadian banks and of U.S. banks. There are three reasons why I used this methodology.

The first is that the inputs and outputs of the SFA are more suitable for measuring the efficiency of banks in comparison to the DEA. With respect to inputs, the DEA was initially developed to measure the technical efficiency for not-for-profit agencies and public sectors where the price information is not reliable and the assumption of profit maximizing or cost minimizing is not appropriate. As such the DEA does not allow us to make use of pricing or optimality assumptions for those agencies. To contrast, the price information of banks is available, and cost minimization or profit maximization is a reasonable assumption regarding the objectives of those banks. Moreover, it is better to use the price information of banks because this can reflect the reactions of bank management to market fluctuations. With respect to the outputs part, using price information to measure efficiency can provide information about the allocative abilities of banks.

The second reason for preferring the SFA is that it distinguishes between the inefficiency and other disturbance elements during the estimation of the efficiency level. In this approach, a standard production function is modeled to separate the inefficiency score and the random components, which excludes short fluctuation. During the recent decades, many banking regulations have been introduced to moderate economic booms and recessions. If all of the disturbances brought about by these changes were ignored, the

efficiency scores would likely be erroneous and of particular concern is that the timing of changes in the banking environment were different in Canada versus the U.S., such that temporary management adjustments would have occurred at different times in the two countries.

The third reason for preferring the SFA is that the DMUs do not need to be comparable. Since, this paper will measure the efficiency scores of two different countries and will consider bank sizes, different dimensions of banks, the numbers of branches, regulatory environments, and the periods and the timing of externalities, the use of the SFA is considered to be the most suitable approach for this paper.

4.3 Data and Variables

McAllister and McManus (1993) reviewed the scale efficiency literature and found that estimated cost functions vary substantially depending on the range of bank sizes included in the sample. Therefore, I considered Canadian and U.S. banks of comparable size. And also, given data availability, banks with assets from 100 billion to 800 billion were chosen. These included six Canadian banks and ten U.S. bank holding companies. The ten U.S. BHCs were selected for the sample because their business activities were similar to the Canadian banks as listed in the Federal Financial Institutions Examination Council (FFIEC) as the Office of Bank Holding Companies with the parent holding companies being domestically owned. These U.S. and Canadian sample banks are very large banks with multiple business divisions. They have not only developed traditional businesses, but also have been involved in investment banking and wealth management.

A list of sample banks is illustrated in the Table 1 below.

Table 1 List of Sample Banks

Canadian Banks	Office of U.S. Bank Holding Companies
Bank of Montreal	Bank of New York Mellon Corporation
The Bank of Nova Scotia	U.S. Bancorp
Canadian Imperial Bank of Commerce	PNC Financial Services Group, Inc.
National Bank of Canada	Capital One Financial Corporation
Royal Bank of Canada	State Street Corporation
The Toronto-Dominion Bank	BB&T Corporation
	SunTrust Banks, Inc.
	Fifth Third Bancorp
	Regions Financial Group, Inc.
	Northern Trust Corporation

The data set will be chosen from balance sheets and income statements of these 16 banks. The resources of data set are from Bloomberg, FFIEC and OSFI. All data are yearly data and were automatically converted to the U.S. dollar-dominated by Bloomberg. Due to the limitations of data availability, completeness and consistency, the time frame of this analysis is from 2005 to 2013.

Since the banks work as intermediaries, which use labour, capital and funds to produce interest-bearing assets and non-interest incomes in the economy, I used the intermediation approach to measure the outputs and inputs of banks. This approach was developed by Sealey and Lindley (1977) and is the standard method used in the literature. Banks are modeled as using the inputs of labor, capital, and deposits to produce outputs in the form of different types of loans and non-traditional activities. I followed the method of Allen et.al (2006) to define the outputs and the inputs of banks.

The outputs consist of the book value of loans (TL), including consumer loans, mortgage loans and all other loans and total other earning financial assets (TOFA). These total other earning financial assets include depositor services fees, underwriting fees, foreign exchange trading fees, and wealth management fees. The inputs consist of labour, capital investment and loanable funds. The price of labour (PL) is measured by the employee compensation divided by the equivalent number of full-time employees. The cost of capital (PK) is measured by the annual expense on land and fixed assets divided by the book value of land and fixed assets. The price of loanable funds (PF) is measured by interest expenses on deposits (including time deposits and all other loanable funds) to dollar value of deposits (including time deposits and other loanable funds). The aggregate cost is measured by the sum of the three factors' expenses (See Table 2).

Table 2 Variables of Formulae

Variable		
TC	Total Costs	Interest cost+Labour cost+Premises & equipment Cost
TL	Total Loans	Dollar value of all loans in balance sheets, including consumer loans, mortgage loans, commercial loans, and all other loans
TOFA	Other Financial Earning Asset	Dollar value of other financial earning assets, including deposits, securities and derivatives.
PL	Price of Labour	Total salaries and benefits divided by the number of full time equivalent employees
PK	Price of Capital	Expense on premise and equipment divided by total stock of premise and equipment
PF	Price of Funds	Total interest expense divided by the dollar value of deposits.

All bank-specific data were directly converted to U.S. dollars in Bloomberg. Since we made comparisons between two countries, all variables were deflated by the core

consumer price index (CPI), in their respective country using the base year of 2002. Table 3 provides an efficiency variables summary of U.S. and Canadian banks for the inputs and outputs of the translog cost function over the period from 2005 to 2013.

Table 3 Summaries of Efficiency Variables

	U.S.			Canada		
	Mean	Max	Min	Mean	Max	Min
Total Interest Expense	2,020.40	3,565.00	827.53	7,296.83	11,397.67	1,992.56
Total Deposits	119,745.61	185,563.44	62,957.73	286,473.54	423,647.67	79,845.33
Price of Loanable Funds	0.02	0.03	0.01	0.03	0.03	0.02
Total Other Earning Financial Assets	25,828,893.75	257,742,036.67	20,432.67	205,570.93	339,591.44	68,762.44
Salaries and Employee Benefits	2,832.09	4,631.11	1,332.22	4,822.00	8,357.78	1,618.56
Number of Employee	31,547.17	57,997.89	12,233.33	50,122.57	68,850.44	18,109.11
Price of Labour	0.09	0.12	0.07	0.10	0.12	0.07
Expense of Physical Capital	704.20	1,095.22	401.89	1,493.46	1,971.89	555.44
Total Physical Capital	2,019.12	3,621.67	492.04	2,050.02	3,418.11	403.44
Price of Capital	0.40	0.84	0.18	0.85	1.38	0.57
Total Loan	88,687.97	183,097.33	10,961.00	216,807.63	290,536.78	60,651.33

Note: this table illustrates the performance of U.S. banks and Canadian banks from 2005 to 2013. All the amounts are in million USD in year 2002 purchasing power. Mean， Max and Min are based the average value of each bank for each entry.

As shown in Table 3, in comparison to U.S. banks, Canadian banks adhere more to traditional bank services, such as making loans and taking deposits, as indicated by higher means of total loans and total deposits than those of U.S. banks. In contrast, U.S. banks are highly involved in innovative financial products, which is indicated by the far higher total other financial earning assets than that of Canadian banks. The mean price of capital of Canadian banks is also higher than that of U.S. banks, which might indicate that Canadian banks invest in physical capital to open new branches across the country.

However, the U.S. banks paid less for branch expansions.

4.4 Model Specification

Cost efficiency is measured by how far a bank's cost is from the "best-practice" banks of similar size with similar outputs. I used a translog cost function to measure cost inefficiency levels of Canadian and U.S. banks. This follows the approach used in most of the literature.

Generally, in the above-mentioned literature, the cost frontier for banks is estimated by regressing the natural logarithm of total cost on outputs and price of inputs of banks:

$$lnTC_{kt} = f_t(y_{kt,1}, \dots\dots, y_{kt,i}, p_{1t}, \dots\dots, p_{jt}) + \varepsilon_{kt}\ , \qquad [6]$$

where TC_{kt} represents the total cost of bank k at time t. $y_{kt,i}$ represents the produced amount of output i by bank k at time t. p_{jt} represents the price of input j at time t. ε_{kt} is the disturbance term at time t of bank k.

The function of $f_t(y_{kt,1}, \dots\dots, y_{kt,i}, p_{1t}, \dots\dots, p_{jt})$ is usually approximated by a second-order Taylor expansion in the log form of a general cost function (Boisvert, 1982). This function is called the translog cost function. Although some coefficients of the translog cost function are hard to interpret, this function provides a general specification of a Cobb-Douglas function, which does not place restrictions on returns to scale, production elasticity and substitution elasticity. Therefore, when I assume that a bank is a multi-products and multi-inputs firm, I get the translog cost function as:

$$lnTC_{kt} = \beta_0 + \sum_{i=1}^{n} \beta_i \, lny_{ikt} + \sum_{j=1}^{m} \beta_j lnp_{jkt} + \frac{1}{2}\sum_{i=1}^{n}\sum_{h=1}^{n} \beta_{ih} lny_{ikt} lny_{hkt}$$

$$+ \frac{1}{2}\sum_{j=1}^{m}\sum_{l=1}^{m} \beta_{ih} lnp_{jkt} lnp_{lkt} + \sum_{i=1}^{n}\sum_{j=1}^{m} \beta_{ih} lny_{ikt} lnp_{jkt} + \varepsilon_{kt} \,,$$

where $\varepsilon_{kt} = v_{kt} + u_{kt}$.

Furthermore, I modified the translog cost function according to a panel-data translog cost function proposed by Battese and Coelli (1995) as:

$$lnTC_{kt} = \beta_0 + \beta_1 lnTC_{kt} + \beta_2 lnTOFA_{kt} + \beta_3 lnPL_{kt} + \beta_4 lnPK_{kt} + \beta_5 lnPF_{kt}$$
$$+ \beta_6 (lnTL_{kt})^2 + \beta_7 (lnTOFA_{kt})^2 + \beta_8 (lnPL_{kt})^2 + \beta_9 (lnPK_{kt})^2$$
$$+ \beta_{10} (lnPF_{kt})^2 + \beta_{11} (lnTL_{kt})(lnTOFA_{kt}) + \beta_{12} (lnTL_{kt})(lnPL_{kt})$$
$$+ \beta_{13} (lnTL_{kt})(lnPK_{kt}) + \beta_{14} (lTL_{kt})(lnPF_{kt})$$
$$+ \beta_{15} (lnTOFA_{kt})(lnPL_{kt}) + \beta_{16} (lnTOFA_{kt})(lnPK_{kt})$$
$$+ \beta_{17} (lnTOFA_{kt})(lnPF_{kt}) + \beta_{18} (lnPL_{kt})(lnPK_{kt})$$
$$+ \beta_{19} (lnPL_{kt})(lnPF_{kt}) + \beta_{20} (lnPK_{kt})(lnPF_{kt}) + \beta_{21} T_{kt} + \beta_{22} {T_{kt}}^2$$
$$+ \beta_{23} T_{kt} lnTL_{kt} + \beta_{24} T_{kt} lnTOFA_{kt} + \beta_{25} T_{kt} lnPL_{kt} + \beta_{26} T_{kt} lnPK_{kt}$$
$$+ \beta_{27} T_{kt} lnPF_{kt} + \varepsilon_{kt},$$

where $\varepsilon_{kt} = v_{kt} + u_{kt}$,

$$\sigma_\varepsilon^2 = \sigma_v^2 + \sigma_u^2 \; and \; \gamma = \frac{\sigma_v^2}{\sigma_\varepsilon^2} \; .$$

Where, TC_{kt} is the k^{th} bank's total cost at time t; ε_k is the composite error term, including the random error term, $v_{kt} \sim i.i.d \; N\,(0, \sigma_v^2)$, and u_{kt}, is the bank-specific inefficiency factor, which is assumed to be distributed as a normal distribution which has

been truncated at zero ~$|N\ (\mu_{kt}, \sigma_u^2)|$. The term $= \frac{\sigma_v^2}{\sigma_\varepsilon^2}$, the ratio of the variance of the random error and composition error term is used to test for the presence of technical inefficiency. If the variance of the random term is high relative to the total variance of the error, then, the bank is considered to be relatively efficient because the error term is mainly due to random noise and not to technical inefficiency.

The technical efficiency score ranges from 0 to 1. The nearer to 1 the score is, the greater efficiency the banks achieve. The technical inefficiency effects can be expressed as:

$$TE_{kt}=\exp(-u_{it}).$$

where u_{kt} is the bank-specific inefficiency factor.

4.5 Likelihood Ratio Tests and Hypotheses

I used Maximum Likelihood Estimation to estimate the efficiency scores of the banks. Before doing so, I used the generalized likelihood ratio (LR) test to test two hypotheses. The first tested whether the function was modeled appropriately. The second tested whether there is statistically significant inefficiency, which means banks might operate efficiently since all the inefficiency is just caused by the random error. The generalized LR test is:

$$LR=-2[\ln\{L(H_0)- L(H_1)\}].$$

The first test is to test model specification. In order to determine which of the two functional forms, the Cobb-Douglas or the translog cost function, fits the data better. The null and alternative hypotheses are respectively:

$$H_0: \beta_6 = \beta_7 = \beta_8 = \cdots = \beta_{27} = 0$$

$$H_1: \beta_6 = \beta_7 = \beta_8 = \cdots = \beta_{27} \neq 0$$

If I fail to reject the null hypothesis, this indicates that the Cobb-Douglas cost function fits the data better than the translog cost function.

The second test is to determine whether technical inefficiency exists. The null hypothesis and alternative hypotheses are respectively proposed as:

$$H_0: \gamma = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2} = 0$$

$$H_1: \gamma = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2} \neq 0$$

If I fail to reject the null hypothesis, this suggests that $\sigma_u^2 = 0$ such that there is no technical inefficiency in cost efficiency model.

4.6 Discussion of Results

In this section, I discuss the results regarding the estimations. The Maximum-likelihood function was used to estimate the technical efficiency scores for each bank and the coefficients of each variable of the cost function. These are displayed in Table 4 and Table 5.

4.6.1 The Results of Likelihood-ratio Test

The results of the likelihood ratio test are explained below.

4.6.1.1 The Result of the Model Specification

Table 4 Likelihood-ratio Result for Model Specification

Likelihood-ratio test	LR chi2(21)=341.00
(Assumption: b nested in a)	Prob>chi2=0.00

The result of model specification was that LR=341, which was greater than the critical value of mixed Chi-square distribution at a 5% significant level, which was 34.08 based upon Kodde and Palm's (1986) Table 1. Therefore, the null hypothesis was rejected and it was concluded that the translog cost function better fit the data than the Cobb-Douglas cost function.

4.6.1.2 Result of Technical Inefficiency Existence Test

The result of the second test for technical inefficiency is displayed in Table 5.

Table 5 Results of SFA

Inefficiency Effect Model (Truncated-normal)			
Group Variable		Bank	
Time Variable		t	
Number of Observations		144	
Number of Groups		16	
Observations per Group		min=9	
		avg=9.0	
		max=9	
Prod>chi2		0.00	
Wald chi2(36)		6675.26	
Log likelihood		1934.5998	
lntc			
Frontier	Coef.	Std.Err	z
lntl	-2.2254	1.3717	-1.62
lntofa	5.9554	0.8721	6.83
lnpl	-7.3936	3.0206	-2.44
lnpk	-6.7116	0.9572	-7.01

lnpf	1.5317	1.137	1.35
$lntl^2$	0.0785	0.0308	2.55
$lntofa^2$	-0.0316	0.004	-7.85
$lnpl^2$	-1.2428	0.3723	-3.34
$lnpk^2$	-0.3106	0.0622	-4.99
$lnpf^2$	0.1062	0.0326	3.25
lntltofa	-0.103	0.036	-2.85
lntlpl	-0.4805	0.1727	-2.78
lntlpk	-0.0023	0.066	-0.04
lntlpf	-0.0289	0.0405	-0.71
lntofapl	0.5125	0.155	3.31
lntofapk	0.2466	0.0717	3.44
lntofapf	0.0034	0.0442	0.08
lnplpk	-0.813	0.2548	-0.32
lnplpf	-0.1241	0.127	-0.98
lnpkpf	-0.0132	0.0589	-0.22
t	-0.0192	0.429	-0.04
t^2	-0.0021	0.0027	-0.79
tlntl	-0.0057	0.0149	-0.39
tlntofa	0.0049	0.0166	0.3
tlnpl	-0.0189	0.0344	-0.55
tlnpk	-0.0268	0.0193	-1.39
tlnpf	0.0012	0.0189	0.06
_cons	-41.8827	26.2535	-1.6
sigma_u	0.2638	0.0597	4.42
sigma_v	0.0358		
lambda	7.3607		

From Table 5, since $\sigma_u^2 = (\sigma_u)^2 = (0.264)^2 = 0.07\ and\ \sigma_v^2 = (\sigma_v)^2 = (0.04)^2 = 0.0016$. Substituting into $\gamma = \frac{\sigma_u^2}{\sigma_v^2+\sigma_u^2}$ gives 0.98, which is near to 1. This result suggests that most of the deviation from the efficient frontier was attributable to technical inefficiency such that we fail to reject the null hypothesis that there is no technical inefficiency effect.

4.6.1.3 The Result of the Maximum-Likelihood Regression

Table 5 illustrates the estimated coefficients of the stochastic frontier of translog cost function. The estimated coefficients on total loans, total other financial earning assets, price of labor, price of capital and price of loanable funds represent the elasticity of total costs with respect to the quantities and prices of each of the factor inputs. The total other financial earning assets and the price of funds had positive signs, which suggested that a 1% increase in those two variables would increase total costs by 5.96% and 1.53% respectively. The price of labor and the price of capital have negative signs, which is unexpected from what is commonly believed. An explanation might be that because banks have relatively high elasticities for these two production factors, (the cost elasticity of labour is -7.29 and that of capital is -6.31), that once the price of labor or capital increases, banks can decrease the total amounts of these factors to reduce their total cost because there are high returns to this "high quality". For example, the technology of internet banks has allowed for the opening of online banks, which has reduced the total labour required but the labour needed would be more skilled and hence of higher value. Also, the banks face the increasing prices of labor and capital, which would increase the banks' demand elasticity to labor and capital.

The total loan elasticity coefficient suggests that a 1% increase in total loans decreases banks' costs by 2.23%. Although total loans and total other financial earning assets are both in the assets part, they have an opposite sign. This might reflect that since making loans is a traditional earning method of banks, banks do not need to invest so much on developing this traditional business. In comparison, since total other earning assets, such

as the wealth management business, is a new way for banks to earn money, banks have to invest in research and development, hire professional persons with high wages and bear a higher risk to loss in order to develop this business. Therefore, increasing the total loans can decrease the cost but increasing the total other earning assets may increase the total costs. The result may also reflect that, although securities, derivatives and other financial instruments provide banks with lucrative opportunities in the short run, when considering the costs of these products in the long run, it might not be more profitable than the more traditional way to make loans, as occurred with Bear Sterns, Merrill Lynch and Lehman Brothers. Moreover, although these firms were profitable in the short term while their prices were going up during the bubble, considering the high-cost and high-risk characteristics of financial products, such as mortgage backed securities, forward contracts, etc., it is reasonable to hypothesis that traditional loans have made these banks less vulnerable to financial panics and less sensitive to the business cycle.

4.6.1.4 Comparison of U.S. versus Canadian Banks

Table 6 reports my estimates of the technical efficiency of each bank. Overall, both Canadian and U.S. banks' technical efficiency scores are around 89%, which suggests, based on the model specified, that banks in both countries could reduce their costs on average over the time frame by 11% to achieve the minimum cost level.

Also, as illustrated in Figure 10 notice that the average technical efficiency level of Canadian and U.S. banks alternates, which suggests that Canadian banks were more efficient than the U.S. banks after the financial crisis 2007-08. This is consistent with

Canadian banks being less affected by the financial crisis than the U.S. banks.

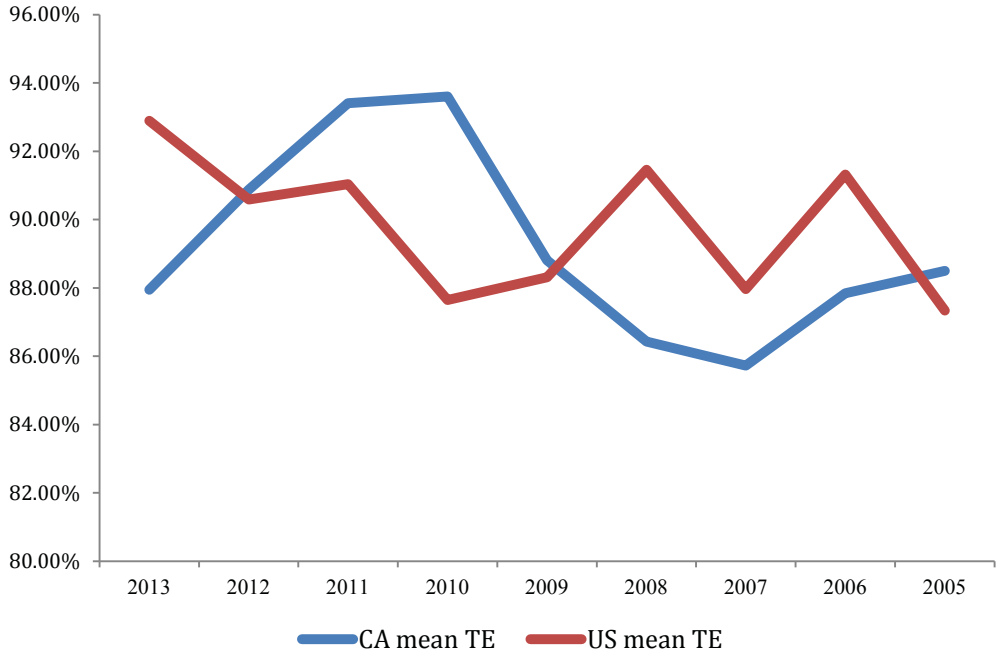
Table 6 TE of Each Bank

	2005	2006	2007	2008	2009	2010	2011	2012	2013
BMO	97.54%	97.40%	97.23%	97.95%	96.52%	98.56%	98.50%	89.86%	97.78%
NBC	82.26%	85.23%	80.53%	97.35%	91.21%	98.51%	95.72%	91.10%	78.09%
Scotiabank	97.53%	93.35%	85.56%	79.69%	84.94%	90.36%	95.34%	94.22%	95.80%
CIBC	79.62%	83.52%	84.24%	88.96%	95.63%	96.53%	93.39%	93.30%	88.46%
RBC	80.26%	76.36%	75.33%	78.19%	78.65%	88.58%	81.68%	82.03%	73.11%
TD	93.80%	91.18%	91.45%	76.41%	85.89%	89.07%	95.84%	94.77%	94.42%
Mean of Canadian Bank	**88.50%**	**87.84%**	**85.72%**	**86.43%**	**88.81%**	**93.60%**	**93.41%**	**90.88%**	**87.94%**
BNY	83.51%	77.57%	73.91%	70.11%	70.46%	69.47%	83.26%	89.15%	96.95%
USB	93.93%	96.20%	96.63%	97.34%	96.87%	92.97%	92.07%	91.57%	93.82%
PNC	44.58%	95.53%	96.01%	97.98%	81.93%	86.66%	85.75%	84.68%	88.16%
COF	89.99%	96.37%	82.01%	85.80%	85.00%	93.85%	92.50%	96.70%	86.34%
STT	94.87%	96.80%	78.42%	88.00%	81.17%	78.41%	93.82%	95.97%	97.26%
BB&T	94.24%	95.20%	96.81%	97.94%	96.48%	93.25%	96.53%	93.80%	90.65%
STI	93.31%	89.28%	94.93%	97.59%	88.80%	86.58%	91.10%	81.47%	96.27%
RF	85.57%	75.14%	84.94%	94.50%	92.33%	88.73%	88.38%	96.58%	96.52%
NTRS	98.45%	97.20%	81.55%	89.42%	97.30%	93.22%	91.61%	82.63%	85.32%
FITB	94.91%	93.84%	94.42%	95.94%	92.76%	93.29%	95.30%	93.28%	97.64%
Mean of U. S. Bank	**87.34%**	**91.31%**	**87.96%**	**91.46%**	**88.31%**	**87.64%**	**91.03%**	**90.58%**	**92.89%**

During the financial crisis of 2007-2008, the mean of U.S. banks' technical efficiency was actually higher than the mean of the Canadian banks. This result supports the argument of Bordo et.al (2011) that the problems in the U.S. banking system are due to the instability of U.S. banking system rather than the banks themselves. The problem of U.S. banking system is due to the existence of a "shadow banking system" within which the banks are operating like the commercial banks but are not subject to the strict regulation. Bordo (2011) argued that these kinds of banks worked well during the ordinary times, but failed during the financial crisis and stagnated the real investments through the whole country. However, after considering the comparability of Canadian

banks and U.S. banks, since I have not included those banks for which the main business is investment banking, this judgment of Bordo (2011) needs to be testified further.

Figure 9 Comparisons of the Mean Technical Efficiencies of U.S. and Canadian Banks Over Time



The 9-year mean of the technical efficiency level of Canadian banks was estimated to be 89.24% and that of U.S. banks to be 89.84%, such that we can see there were no absolutely different impacts of competition and economies of scale on the efficiency. However, in order to maintain the competition among the banks, the restrictions on U.S. banks' expansions and a fragmented banking system have spurred the U.S. banks to use financial markets to transfer funds across the states and economic sectors, which has made the U.S. financial system deeply market-based. It has made the banks highly reliant on the capital market, which has increased the vulnerability of the banks to the panics and the business cycles. However, since the Canadian banking regulatory authorities never put restrictions on branch expansion and they also set high standards on the entrance of

new banks, which shielded the oligopoly banks from competition, the Canadian financial system is still “bank-based”. Canadian banks have benefitted from this kind of market structure, as it appears to have made the banks less sensitive to the business cycles and to the financial panics.

Moreover, maintaining competition among the banks means there are lots of small and fragile banks operating in the U.S. market. Those banks have difficultly accessing the national funding market since they do not have cross-state branching systems. As a result, when the financial panics happened, they have had difficulties dealing the liquidity problems. Therefore, there were more bank bankruptcies in the U.S. than in Canada where the branching system is highly developed; Canadian banks can provide relief for liquidity panics through a nation-wide branch banking system.

In conclusion, my findings based on a comparative history of regulation and empirical analysis suggest that Canadian banks have benefitted from the oligopoly market and nation-wide branch banking system, which has protected them from competition, and enabled them to diversify their resources with respect to funds and the users of their loanable funds. Therefore, considering the special characteristics of banks in the economy, my research supports the hypothesis that the branch banking system and oligopoly market structure should be encouraged, since they appear to enable the stability of banking system without eroding its efficiency.

Chapter 5 Conclusion

The paper investigated the U.S. and Canadian banks in two ways. First, I reviewed the histories of U.S. and Canadian banking regulations, and found that the initial function of banks in the U.S. and Canada was totally different and that the attitudes of banking regulators in these two countries have also been different. The first U.S. bank was temporarily established to fund the Revolutionary War so that the federal banking regulator didn't have a long-term plan to develop the banking industry. This led to the development of U.S. banks being less regulated and a "dual banking system" came into being. Meanwhile, government authorities have preferred to keep competition among the banks, which is consistent with the "structure-performance" hypothesis in the Industrial Organization. In contrast, the first Canadian bank was established purposely to mobilize funds for businesses, which means the Canadian banks have significant status in the Canadian economy. Therefore, Canadian regulators prefer "big players" in the banking industry and have shielded the oligopoly market structure of the banking industry in Canada. I have argued that the Canadian approach to regulation has been based on the "Efficient Structure" hypothesis in the Industrial Organization.

Secondly, I used the Stochastic Frontier Approach to measure the cost efficiency of U.S. and Canadian banks to see which of the two regulatory approaches has improved the efficiency of banks and made them less vulnerable to the 2007-08 financial crisis. The technical efficiency indicators suggest that the cost efficiency of U.S. and Canadian banks are near to each other. This suggests that both competition and economies of scale can improve the banks' efficiencies regarding cost management. Therefore, the problem of

U.S. banks during this financial crisis may not have been due to technical inefficiency but may instead have come from the dual-system within which small state banks had few buffers to face the crisis given that most of the bankruptcies were of these small state banks. In this regards, due to data limitations, this hypothesis needs to be studied further. Moreover, considering the banking market sizes of U.S. and Canada, and limitations on regional data in the U.S., the results could be analyzed in more detail.

Finally, I found there are several limitations in the Stochastic Frontier Approach, which would need to be modified in future studies. Firstly, the estimated coefficients of the translog cost function needs to be investigated further. Although some of them significantly affect the cost function, the impacts of those variables are hard to interpret. Secondly, since the cost frontier function was measured without considering the banks' capital structures, we can't interpret the effects of total other financial earning assets in detail. This TOFA component might be responsible for a great difference between the Canadian banks and U.S. banks, and could be scrutinized in the future studies. Thirdly, the model does not consider the time-lag of variables, which might affect the impact of those variables on the cost function.

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