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A STUDY OF CHEQUE CLEARING MECHANISMS :

An Early Canadian Case

by

SUNG HUH, B.A., M.A.

**A thesis submitted to
the faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of**

**Doctor of Philosophy
Department of Economics**

Carleton University

Ottawa, Ontario

August, 1994

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AN EARLY CANADIAN EXPERIENCE"**

submitted by

Sung HUH, B.A., M.A.

in partial fulfilment of the requirements
for the degree of
Doctor of Philosophy

Chair, Department of Economics

Thesis Supervisor

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Abstract

In his famous paper on the mathematical theory of banking, Edgeworth suggests that as banks move from a regime of bilateral to multilateral clearings there will be a reduction in the amount of reserves the banks will need for any given level of deposits and banking activity.

This study is an economic analysis of two alternative cheque clearing processes (i.e., bilateral and multilateral clearing options). In chapter I, the acceptance of the cheque as medium of exchange is explored. Then in chapter II, a theoretical investigation of two clearing options based on cost comparisons is followed. The analysis focuses on the potential savings in costs that a multilateral cheque clearing process can offer; savings in reserves as well as savings in physical costs are measured under the institutional framework of the model. A model is developed to measure the savings in the physical and reserve costs. Canadian case study is presented in chapter III.

It examines the reserves held by Canadian banks over the period of time when clearing houses were being established in Canada. Edgeworth's hypothesis is difficult to establish but the evidence would suggest that it cannot be rejected. Aside from data problems, Edgeworth's hypothesis is qualified by the effects on reserves of branch banking, the geographic dimension of banking in Canada, and the effects of risks in banking activity. This study would suggest some support for Edgeworth's hypothesis. The experience of other countries with multilateral clearing should be investigated before any conclusive results about Edgeworth's hypothesis can, however, be established.

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INTRODUCTION

A piece of paper called a cheque¹ can have completely different meanings to individuals in different places. For instance, a cheque generally fulfils the role of money among the traders in *the Spark Street Mall* in Ottawa. On the other hand, a cheque to *Bushmen* means nothing but a trouble as hazardous as "a Coke bottle dropped from heaven."² However, a cheque was not introduced even to the banking centres (say, Ottawa) without some *preludes*. It is noticed that before medium of exchange was adopted, barter trades were conducted. Then, commodity money preceded the development of credit money (such as bank notes and cheques).

The purpose of this thesis is not to discuss the entire evolutionary process of the chequing system. Rather, I will focus on the comparisons of two historically observed cheque clearing systems: bilateral cheque clearing and multilateral clearing systems. The discussion that follows will be presented in four chapters. Chapter I will provide a review of cheques as a medium of exchange. Discussion will focus

¹ A cheque could be drawn against deposits or lines of credit. In this analysis, however, I will only consider the ones written on existing deposits. For general description of cheques, see Boreham and Bodkin (1993), pp.51-3.

² Referring to the movie "The Gods Must Be Crazy (1984)"

on the development of media of exchange and the introduction of cheques in a market economy. This discussion is then followed by a *theoretical* investigation (chapter II) of cheque clearing systems. In Chapter II, a model to measure the costs of cheque clearing is developed. Physical costs as well as reserve costs of two alternative cheque clearing systems are analyzed. Chapter III examines the early Canadian cheque clearing practice based on the model developed in the previous chapter. In Chapter III, an empirical study using time series data is presented. Quantitative results obtained by employing an econometric model are supplemented by episodic evidence retrieved from archival sources. Some concluding remarks and suggestions for future research are attached in chapter four. Additionally, endnotes and appendices are attached to provide further information. In particular, appendices to Chapter III show the statistics of branch banking and the clearing figures by banks, which were previously only available in unpublished archival documents.

To begin, I start with the discussion on the introduction of medium of exchange to the barter economy.

Chapter I : Acceptance of Cheques

1.1 Medium of Exchange

One of the fundamental questions in monetary theory is what role money plays in market transactions. This has been a topic in monetary economics for well over one hundred years.³ Within this debate, a distinction has developed between money economies and barter economy. In barter exchange, a *double coincidence of wants* is necessary before trade can arise. On the other hand, as represented by writings such as those in Starr (1989)⁴, money permits the realization of indirect exchange in general equilibrium, when the double coincidence of wants is not always present.

The argument made by Starr and others can be illustrated by the following example. Suppose there are three individuals A, B, and C. Each individual is assumed to specialize in the production of one of the goods, X, Y, and Z respectively.⁵ Furthermore as shown in Table 1.1,⁶ the three individuals are assumed to demand only one good, Y, Z, and X, respectively. Suppose trade begins with A visiting

³ See Jevons (1875), p.3.

⁴ This is argued most strongly in the collection of articles by Starr (1989), particularly in pp.129-44. See also Blanchard and Fischer (1989), pp.164-5.

⁵ Values of these goods are assumed to be equal.

⁶ Table 1.1 has been constructed based on Starr's (1972; in Starr(1989)) model. It has to be noticed, however, that a 3-good 3-people case is used here while Starr offers a T good general equilibrium model.

C. A will offer X in exchange; however despite C's willingness to accept X, C does not have the Y necessary to fulfil A's demand for Y. Next, A might try and trade with individual B. There A can find the desired Y, but B will not accept X since B is interested in consuming Z, not X. (Moreover, the story can be repeated for any of the three individuals.) This inability to trade, despite a balance in the aggregate between all demands and supplies, arises because of the absence of a double coincidence of wants.

TABLE 1.1 Barter Trade Among Three Individuals

individuals	supply	demand
A	X	Y
B	Y	Z
C	Z	X
Σ	X+Y+Z	X+Y+Z

Under barter, a double coincidence of wants is necessary for successful trade. However, with indirect or intermediated trade, all the trades indicated in Table 1.1 can be realized. For instance, if A agrees to accept Z in trade with C, i.e., Z for his X, then A would be able to offer this Z to B in order to acquire the Y he desires. At the end of this exchange, goods X, Y, and Z will be successfully traded among the three individuals. Since any one of three goods could be used as the intermediating good,

the good which is cheapest to hold and transport⁷ would tend to be used as the medium of exchange. And this good which has the lowest transaction costs, would become *commodity money*. To realize fully the gains from trade, some individuals accept temporarily goods in exchange, that do not immediately lead to an increase in their utility, trading them later for the goods they ultimately require. In other words, some non-monotonic trades will be accepted.⁸

While works of Starr (1972) and Ostroy (1973) demonstrate successfully the inferiority of the barter system and illustrate how that inefficiency can be avoided by the introduction of a medium of exchange, they do not show how decentralized agents would agree on which particular good to use as the medium. When a commodity is generally accepted as a medium of exchange over others, that acceptance should be explainable in terms of the behaviour of the individuals who are involved in these transactions.

Jones (1976) suggests an individualistic solution to the collective choice problem implied by Starr's analysis.⁹ Jones measures the transaction cost of engaging in trade by the expected number of encounters an agent anticipates

⁷ Notice that, as Starr (1989) indicated, goods used as commodity money must be storable.

⁸ Starr (1989), p.129.

⁹ See Jones (1976).

before making a successful trade. Suppose an individual supplies a good i and demands a good j . If the probability that the individual will sell i is P_i and the probability that he will buy j in the market is P_j , then the probability that this person both sell i and buy j is $P_i \cdot P_j$.¹⁰

Consequently, the anticipated number of visits to the market before this individual will engage successfully in a trade is $1/(P_i \cdot P_j)$.

Let us now compare two options. Suppose the same individual who supplies i and demands j has the choice between (a) directly bartering i for j and (b) indirectly exchanging i for j through an intermediary good (say k). The expected number of trials this individual has to undertake before trading successfully in the two cases are respectively:

$$(a) \quad E(N_a) = \frac{1}{P_i \cdot P_j}, \text{ and}$$

$$(b) \quad E(N_b) = \frac{1}{P_i \cdot P_k} + \frac{1}{P_k \cdot P_j},$$

where k is any other intermediary good, for which the

¹⁰ This assumes statistical independence between two activities; i.e., $P(i \& j) = P_i \cdot P_j$, $\forall i, j \in \{1, 2, 3, \dots, n\}$.

probability of purchase and sale is P_k .¹¹ Whether indirect trade is more or less desirable can be determined by calculating whether the expected number of trips rises or falls under intermediated exchange. Using DN to represent the reduction in the expected number of trading trips under intermediated exchange, we find:

$$\begin{aligned}
 DN = E(N_a) - E(N_b) &= \frac{1}{P_i \cdot P_j} - \frac{1}{P_i \cdot P_k} - \frac{1}{P_k \cdot P_j} \\
 &= \frac{(P_k - P_j - P_i)}{P_i \cdot P_j \cdot P_k} \\
 &= \frac{P_k - (P_i + P_j)}{P_i \cdot P_j \cdot P_k}
 \end{aligned} \tag{1.1}$$

Because P_i , P_j , and P_k are all positive, DN is positive, if and only if $P_k > P_i + P_j$.¹² In other words, if the expected costs of trade vary directly with the expected number of trips, trade through an intermediate good becomes more efficient when the probability of finding the intermediate good exceeds the sum of the two independent probabilities of selling i for j . Pursuing this line of argument, cost minimization arises when the intermediary good adopted is the good with the highest frequency of appearing in trade.

¹¹ This individual trades i for k first, then he trades k for j to complete the transaction.

¹² An endnote to this section presents a simple numerical example of this argument.

FIGURE 1.1 Distribution of Trading Frequencies

Figure 1.1 illustrates a distribution of trading frequencies for the different goods traded in the market. In this example, the most frequently traded good is called k . By using k as an intermediating good, it has been shown that expected transaction costs can be reduced for some subset of goods trades (i.e., $E(N_b) = TC_b < TC_a = E(N_a)$). Gains from trade can be increased through intermediation. A more interesting observation is that, once k is adopted as a medium of exchange, its frequency in trade increases further, as traders recognize a further reduction in expected visits to the market can be achieved through its increased use. (See Figure 1.2.)

In Figure 1.2, $f_0(k)$ is the initial frequency of k ,

and $f_1(k)$ is the enhanced frequency of k after individuals recognize k as an intermediate good.¹³

Figure 1.2 Change in Frequencies

As P_k increases, more and more trade between goods (i and j) becomes intermedeable, and eventually k appears in almost all transactions. Since every transaction involves two trades, the appearance of k in all transactions means that one half of all trade involves money. Under such

¹³ In contrast, the frequency of other goods (collectively) would be reduced. In figure 1.2, $f_1(k) > f_0(k)$ but f' is below f for all the other points.

circumstance, $P_k \sim 0.5$ and $E(N)$ will be:

$$\begin{aligned}
 E(N)_{ij} &= \left(\frac{1}{P_i P_k} + \frac{1}{P_k P_j} \right) \\
 &= \frac{1}{P_k} \left(\frac{1}{P_i} + \frac{1}{P_j} \right) \\
 &= 2 \left(\frac{1}{P_i} + \frac{1}{P_j} \right)
 \end{aligned} \tag{1.2}$$

The most frequently traded good, k , can then be described as serving the role of medium of exchange. k becomes the commodity money by reducing the expected number of trips to the market for successful trade. (Eventually, in Figure 1.2, $f_1(k)$ would be 0.5 and the area below f' would be 0.5.)

In order to reduce the transactions costs further, fiat money can be used to replace k (commodity money) assuming that fiat money is accepted as a medium of exchange in all trades which commodity money facilitates. Since the commodity used to intermediate exchange need not itself be consumed, the costs of circumventing the double coincidence of wants (i.e., the deterioration of commodities used in intermediation) can be further lowered by using paper or fiat money. Given that a government decree is sufficient to establish its general acceptability in exchange, the cost of noncoincidence can be further lowered through the use of

fiat money.¹⁴ In other words, while the use of commodity money reduces the transaction costs expressed in terms of the number of expected visits to the market, the introduction of fiat money can further reduce the cost of *using the medium of exchange* for given number of trades conducted.¹⁵

¹⁴ In general, the establishment of confidence is not costless. When government decrees are credible, the resource savings represent the "seigniorage" earned by fiduciary fiat money.

¹⁵ It can be expressed as $f(k) = \min\{E(N)\}$, and $F(k) = \min\{f(k)\}$. In other words, while using commodity money, k , is an activity to minimize the expected number of trips required for successful trade ($f(k)$), replacing with fiat money can be viewed as the search for the most cost-saving way ($F(k)$) to make such minimized number of trips.

1.2 Introduction of Cheques

As discussed, the introduction of money can improve the payments mechanism. With a medium of exchange, the inconvenience associated with the double coincidence of wants¹⁶ can be removed. Further reductions in transaction costs can arise when fiat money comes to replace commodity money.

Though the use of coin and paper currency represents a substantive improvement over a barter economy, fiat money is in some instances inconvenient for settling the trading needs of all traders. For example, bulkiness of money still represents a physical limitation on some transactions (especially ones that require large amounts of money). In other circumstances, the generalized acceptability of fiat money creates a concern about the possibility of loss or theft. Typically, transactions over a distance are still not easily fulfilled with money.¹⁷ To weather these drawbacks, cheques¹⁸ were introduced to supplement money as

¹⁶ See Goodfriend (1991), p.10. For cheques to have these advantages, they should have the same frequency of successful trade; that is, they should be always accepted. To guarantee the acceptance of cheques cheque clearing must be present. Further discussion will follow in later chapters.

¹⁷ In other words, portability of money could be limited and was able to be improved with cheques.

¹⁸ Development of cheques as medium of exchange is discussed in Palgrave (1992), pp.347-8 (by R. Cameron).

a medium of exchange.

A cheque¹⁹ is an order given by a depositor asking his/her bank to transfer the written amount of deposits to the counterpart (in trade) for payment. (Since a cheque is an order form directed to the (demand) deposits, some argue that it is deposits which should be considered as a medium of exchange.)²⁰ It can be seen that traders who accept cheques as a major means of payment realize certain advantages cheques possessed over *money*.²¹ First of all, with the use of cheques, the risk of loss or theft of medium becomes minimal. Since a cheque is an order asking a bank to transfer parts of deposits to a particular partner in trade, it is very unlikely that a cheque would end up in the wrong hands. Even when a cheque is lost or stolen, a request made by a depositor can cancel the payment.

Secondly, cheques can be written for the exact amount of payment. This characteristic of cheques can reduce the burden of keeping different units of money. At the same time, liquidity²² of a person involved in trades can be

¹⁹ Alternatively, a cheque is defined as "a bill of exchange drawn on a bank, payable on demand". Cheques are different from other bills of exchange since they are drawn against deposits (or lines of credit if prearrangement are made) and payable on demand all the time. See also Boreham and Bodkin (1993), p.51.

²⁰ See Boreham and Bodkin (1993), pp.47-8.

²¹ Advantages of cheques over money are discussed in various places in the literature. See Boreham et al.(1969), White (1986), and Goodfriend (1991), for example.

²² Liquidity in transaction payment is defined as the convertibility of someone's assets into readily useable media of exchange.

improved with the use of cheques (along with money). Notice that, with overdraft arrangements, depositors are allowed to use cheques as media of exchange even when there are negative balances. When cheques are used, payment of transactions can be made up to the amount of deposits one can write cheques against (not by the amount of cash carried). For traders, the acceptance of cheques as a medium of exchange therefore improves the chance of selling one's products to others.

While cheques make transactions more available with *less delays*, they can also make some transactions over a distance much simpler. Since a cheque can be easily transported, transactions between two parties over some considerable distance can be readily fulfilled. In other words, cheques extend the boundary of the market where transactions are made with a *common medium of exchange*. Another advantage a cheque can offer is that it can be used as a *receipt*. Compared to the use of money, transactions carried out by cheques can be easily tracked and recorded.

On top of the advantages mentioned above, cheques can bring even further benefits to the depositors. A primary "efficiency gain" can be obtained by "substituting interest earning chequeable (demand) deposits for non-interest bearing currency."²³ By using cheques, demand for money

²³ Of course, when no interest is paid on demand deposits or service charges exceed the interest paid, this gain does not exist. See Goodfriend (1991).

does not have to bear all of the foregone interest income; until actual payment is made, depositors can *potentially*²⁴ earn interest on their demand deposits. As well an additional benefit associated with cheques is the resulting economization in the monitoring costs of banks. In this regard it can be observed that, when a cheque written on the account held in a particular bank is accepted, the other party (i.e., the party in whose favour the cheque is to be drawn) should presumably know the credibility of the cheque issuing bank. For this reason, when a depositor can use the cheque drawn on his bank as a medium of exchange without fear of the other bank's rejection, one can assume that his/her bank is perceived to be in a stable position; indirect sharing of monitoring costs is thereby achieved.

In short, for the reasons mentioned above, cheques have become the major medium of exchange for transactions. Cheques have inherited the advantages of money over barter and have generated additional benefits to their users. Once the convenience of cheques was realized, their use was quickly accelerated. In 1840, for example, it was reported that two thirds of the payments related to a country bank in the London area were made by cheques. By 1865, among "principle centres of business" in Britain, up to 96.8% of the payments made by customers took the form of cheques and

²⁴ Notice that interest payment to chequing accounts is a rather recent development in banking. See Boreham and Bodkin (1993), pp.93-4.

bills.²⁵ The use of cheques as the medium of exchange also became common in Canada and in the United States by the end of the nineteenth century.²⁶

²⁵ See Jevons (1920), pp.279-81. The ratio of cheques (and bills) used varied from 72% to 96.8% in different parts of the country in 1864-5. Other source indicated that 97.3% of the payments were made by cheques in 1865.

²⁶ See Boreham et al. (1969), pp.22-3. More discussion on the use of cheques in Canada is provided in chapter III.

1.3 Cheque Clearing: Preview

So far, the advantages of cheques as a medium of exchange have been discussed. While widespread use of cheques adds benefits to depositors, banks which supply cheque writing services to their customers have to worry about another aspect of cheque writing: cheque clearing.

Cheque clearing is the process of the collective exchange of cheques by banks and the corresponding settlement of funds.²⁷ For individual banks, the proper management of cheque clearing, while supplying satisfactory cheque services to their customers, is very important. From a collective perspective the adequate cheque clearing is a critically important process for banks to perform as competent suppliers of transaction services. Chapter II will therefore present a discussion on the cheque clearing process among banks. In this discussion cost structure, alternative methods of clearing, and statistical properties of two proposed models will be explored.

²⁷ More detailed discussion on the subject of cheque clearing is given in chapter II.

Endnote 1.1 : An example of the Savings in Transactions Cost

In this endnote, I present a numerical example of the transaction savings arising from intermediated trades.

Suppose there are three goods (i, j, and k) in the market (consisting of more than three goods) of which probability to trade is $P_i=0.1$, $P_j=0.1$, and $P_k=0.4$, respectively. If an individual²⁸ tries to sell i, and buy j, the expected number of trips he would make before finding a match would be:

$$TC_a = \frac{1}{P_i \cdot P_j} = \frac{1}{(0.1) \cdot (0.1)} = 100, \quad (a)$$

$$TC_b = \frac{1}{P_i \cdot P_k} + \frac{1}{P_k \cdot P_j} = \frac{1}{(0.1) \cdot (0.4)} + \frac{1}{(0.4) \cdot (0.1)} = 50 \quad (b)$$

where (a) indicates a direct barter and (b) is an example of indirect trade using k as a medium of exchange. As TC_a and TC_b indicate, transaction costs, measured in terms of the proposed number of trips to the market, can be reduced by using k, the most frequently traded good.

²⁸ Each individual is assumed to be endowed with one unit of a different good, and he/she cannot change the initial endowment without trade.

If k , the commodity money, is now generally accepted for all trades, (i.e., $P_k' = 0.5$), the transactions costs will be further reduced:

$$TC_k' = \frac{1}{P_i \cdot P_k'} + \frac{1}{P_k' \cdot P_j} = \frac{1}{(0.1) \cdot (0.5)} + \frac{1}{(0.1) \cdot (0.5)} = 40.$$

Now assume an individual who wishes to sell i and buy j visits the market 1000 times. If he depends on option (a), the direct barter system, the number of successful trades for him will be ten (1000/100) since he is required to make 100 trips to the market before making a successful trade. By the same token, the expected number of successful trades under the indirect barter system using the commodity money, good k , is twenty; whereas the maximum number of the successful trades (25) is reached when k becomes the generally accepted medium of exchange for all trades.

**Chapter II : Savings in Cheque Clearing Costs ;
A Model**

2.0. Introduction

In the previous chapter, the role of cheques as a medium of exchange was explored. For cheques to be used as an effective medium of exchange, a network of cheque clearing must be present. In this chapter, I will examine two alternative cheque clearing processes available to the banks: bilateral and multilateral cheque clearing. The analysis will then focus on the physical costs of exchange and the reserve holding costs.

This discussion will begin with an analysis and description of the origin of the cheque clearing process. A comparison of two possible cheque clearing options will then be provided. This will be followed by a section analyzing the size of variances of cheque clearing balances that arise under the two regimes. Based on the different sizes of variances and the square root rule, it will be shown how the savings in reserves under multilateral clearing can be measured. Later, the analysis is extended to the branch banking system. The chapter concludes with a preview of the Canadian case study, which follows in the next chapter.

2.1 Origin of the Cheque Clearing Process

In order to understand properly the cheque clearing system among participating banks, it is necessary to observe how banks *exchange* cheques. To start¹ let's assume that there are two persons and two banks involved; each person is assumed to have an account with one of the banks. Each wishes to write cheques on his account, which are used as medium of exchange.

Once cheques are accepted as a medium of exchange,² a depositor in one bank can use a cheque drawn on his account for the goods and services he obtains from someone else. The person who receives this cheque in payment for his *supply* of goods and services then possesses a claim on the other party. The receiver of the cheque deposits this cheque to his own bank and his bank contacts the payee's bank to collect the promised funds.³ (I assume that two banks - the cheque issuing bank and the cheque receiving

¹ Here I describe the conceptual origin of bilateral cheque clearing. Historic examples of early bilateral clearings will be presented later.

² Acceptance of cheques as a medium of exchange is discussed in chapter I.

³ It is assumed that a bank is superior to depositors in cheque clearing. That is, the depositors who write and accept cheques can directly clear cheques with their partners. However, a bank can do this job more effectively. Hence, an agent who possesses the claim on the other person's account uses his bank to trace the cheque and claims his credit.

bank - are not the same.⁴)

As more cheques are written and used by the depositors of each of the banks, both banks will accumulate cheques deposited by their customers which were issued by the customers of the other bank. Then, both banks will have to clear (i.e., exchange) these cheques with each other, and the net difference in the credit and debit positions between the two banks will have to be settled. The settlement of balances is conducted by cancelling the common claimed portion of each others' deposits and, at the completion of the settlement, the net debit one bank owes to its clearing partner must be physically transferred. To provide immediate payment of potential net claims, a bank will put aside a portion of its total deposits in precautionary cheque clearing reserves. In the early days of (bilateral) cheque clearing, these reserves were held mostly in the form of gold. Reserve gold served the role of a buffer stock held to avoid the extra costs of acquiring gold immediately when facing a net demand.

Cheque clearing refers to this series of actions (i.e., exchange and settlement) that arise between a pair of banks to complete the original transaction performed between two

⁴ A cheque can also be deposited to the same bank it is drawn on. In such case, no action will be needed. Only an internal book-keeping between branches is required. In this study only **inter bank cheque clearing** is considered. For intra bank (inter branch) clearing process under predominantly paper based system, see Galbraith (1970), chapter 41. I have also excluded the possibility that a person receiving a cheque might bring it to the bank it is drawn on to claim his credit. For every cheque clearing, agents use banking system.

agents using cheques.

2.2 Bilateral Cheque Clearing Process

As explained above, cheque clearing started bilaterally; cheques were exchanged between pairs of banks and their balances were adjusted accordingly. However, as more banks and more agents began to participate, the banks came to see that they faced a new option for cheque clearing: a multilaterally clearing arrangement. If the multilateral clearing option was adopted, then cheques drawn on all of the participating banks could be sent to one centrally organized clearing agent, i.e., a clearinghouse. The clearinghouse would then undertake both *exchange and settlement*. To compare these two clearing alternatives, it will be necessary to examine the practice of bilateral clearing in more detail.⁵

Predictably, bilateral clearing processes preceded the introduction of the multilateral clearing option. In fact, until the very first clearinghouse was established in 1775 by banks operating in the London area, bilateral clearing was the only *legal* procedure for bringing about settlement among banks. To illustrate how cheque clearing was conducted under an *exclusive* bilateral system, let us assume

⁵ I have based my analysis on historical evidence from England during the late seventeenth and eighteenth centuries. Earlier evidence of bilateral cheque clearing can be found in the banking system of Naples around the sixteenth century.

that there are n banks which clear cheques with each other.

Under the earliest form of bilateral clearing, a representative bank would typically hire one messenger to travel to all the other $n-1$ banks. The messenger carried the claims on each of $n-1$ banks (on which they expected payment in gold); at the same time the messenger had to carry a sack with a certain amount of gold in order to meet the unknown claims and accumulated net payments from the bank's bilateral partners. The overall settlement balance of a bank, therefore, would not be known until the "lonely" messenger returned back to his own bank.⁶ Notice that not all the banks had to hire their own messengers; this type of bilateral clearing could operate as long as there was one messenger travelling *between any pair of bilateral partners*.⁷

An alternative to the *one messenger bilateral system* emerged shortly thereafter. Under the previous bilateral clearing system, a messenger had to carry both claims and gold (reserves). The messenger was therefore be burdened by heavy weight as well as the risk of losing the precious reserves. To avoid this trouble, an alternative was developed whereby messengers were sent with just the claims.

⁶ See Gorton (1984), p.4 and Gibbons (1958), p.294. Though it sounds very primitive, this form of bilateral clearing still existed till the late eighteenth century in England.

⁷ As it will be shown later, this could also be expressed as a meeting between a pair of bilateral clearing partners.

Each bank, facing the travelling messengers from its bilateral partners, would pay gold corresponding to the claims presented. The messengers would then return to their banks with the collected gold.⁸

Another amendment made to the original form of bilateral clearing required more messengers being hired. Instead of having a single messenger travel in all directions, each bank could hire $n-1$ messengers with a messenger allocated to each partner bank.⁹ This way of fulfilling bilateral exchange greatly increased the labour cost; however, at the same time, it substantially reduced the time involved in the clearing process. As more banks became involved in the mutual cheque clearing process, this $n-1$ messenger arrangement became the most accepted form of bilateral clearing. It was well established in London by the 1770s. However, as more messengers came to be strolling across town at the same time, it was inevitable that they would "cross and recross" the lines of other messengers (often including the ones sent by the same bank). As a result these messengers could exchange cheques without having to reach their initially intended destination. Informal meetings among these messengers, encountered on the

⁸ This type of bilateral clearing was predominant in England by the early eighteenth century. For this system to work, it is assumed that each bank would hire its messengers to travel to $n-1$ banks to collect its claims. See Jevons (1875).

⁹ Messengers could leave their bank with both claims and gold or just claims.

way, eventually paved the way for the emergence of the first clearinghouse. This took place in Lombard Street in London by 1775.

Some methods of improving the initial bilateral clearing system have been discussed. However, no matter what amendments were introduced to bilateral clearing, there still remained a number of problems endemic to the bilateral exchange process which could not be solved without replacement by another type of clearing system.

First of all, under a bilateral system, the timing of cheque clearing is not "synchronized" among banks. Since each bank sends its messenger(s) to its counterparts - without knowing its clearing position- the actual clearing settlement would not be known till all the messengers return. Moreover, for any *single* bank, the reserves needed become a function of the order in which banks are visited as each bank would seek to claim credit balances first to reduce its level of reserves.¹⁰ Bilateral exchange tends to dissipate resources by encouraging strategic behaviour. (Consequently, each bank would attempt to hire its own messengers to derive the most favourable clearing order.) Second, the physical costs of clearing under the bilateral clearing option increase in *proportion* to the number of

¹⁰ A vigorous competition among messengers (under the bilateral system) running to their destination is well described in Neufeld (1964), p.174.

banks in the system.¹¹ The more banks engaged in a bilateral system, the more trips are required to bring about settlement among member banks. Thirdly, the (gold) reserves needed to meet the uncertain variability in each bank's clearing position will also increase as more banks are added to the bilateral system.¹²

¹¹ Physical costs of cheque clearing could be represented by the number of trips to be taken by a single messenger to all the partners or the number of messengers to be employed.

¹² Economization of reserve under multilateral cheque clearing system will be shown in later discussion. The size of each bank is assumed to be same here.

2.3 Emergence of a Clearinghouse¹³ : Savings in Shoe Leather Cost

Some of the limitations of a bilateral clearing system can be overcome by turning to the alternative of multilateral clearing. First, the "unsynchronized" time problem is easily resolved when all the banks send their messengers to one meeting place, a clearinghouse. That is, removing the sequential order of clearing removes the incentive to claim first. Under multilateral clearing, all credit and debit balances are presented to the clearinghouse before a given time and are *netted* together simultaneously.

The savings in the physical costs¹⁴ of cheque clearing are perhaps the most obvious savings when the multilateral clearing process is adopted. As explained above, the messengers sent by banks soon discovered that their trips to other banks could be shortened (and time and energy saved) by mutually exchanging claims (and reserves) with other messengers encountered along the way. As the practice of informal exchange among these messengers became more frequent and as more bank messengers became involved, a

¹³ Here I will deal with regional clearinghouse only. Later, in chapter III, I will discuss the development of multiregional clearinghouse.

¹⁴ Physical cost of cheque clearing is represented by the number of trips required between banks to complete the settlement. It is also measured as "shoe leather cost".

formalization of the *crossing and recrossing* of lines became almost inevitable. Sooner or later two or more messengers from different banks would decide to meet in one place to take advantage of this saving in "mileage". Eventually, the banks involved in bilateral clearing realized the potential advantages of mutual meeting and opened a conveniently located meeting place. It was in 1775 that the banks in the London area agreed to send their messengers (now one from each bank) to a common room on Lombard street to exchange cheques and settle outstanding balances. This marked the birth of the first *London clearinghouse*. In the U.S., the first clearinghouse was established in 1853 among New York banks. And the first clearinghouse in Canada was established in Halifax in 1887.¹⁵ The creation of the clearinghouse opened a new option for banks. In addition to bilateral cheque clearing, banks could now engage in multilateral cheque clearing by becoming a member of a clearinghouse.

With this background, we can turn our attention to the "two fold" cost structure of cheque clearing that arise from the two stages of the clearing process. In the first stage, cheques have to be **physically** presented to the banks on which they are drawn and returned for verification; then, the difference in claims between any two banks in the system

¹⁵ In part III of this study, we will look at the establishment of Canadian clearinghouse more in detail.

has to be **financially** settled. Cheque clearing is not complete until both stages are concluded.¹⁶

The main reason for adopting a clearinghouse system rather than engaging in a sequence of direct bilateral clearings is because it reduces costs. The simplest form of cost saving which a multilateral system can generate is found in "shoe leather costs". When the earliest clearinghouses were established, the savings in daily transportation costs formed the main incentive for gathering in one place. To see this benefit in a very simple context, assume that there is a set of commodity trades between the three individuals (A, B, and C) as shown in the first two columns in Table 2.1. Suppose further that the transactions between these agents are done at equilibrium prices so that in value terms the quantities traded equal the demands and supplies for the underlying commodities, X, Y, and Z. In Table 2.1, the commodity trades among the three individuals are settled with payments made by cheques. Cheques are expressed as the claim of a bank on another in terms of some common unit of account.

¹⁶ One implicit advantage of multilateral exchange is that these two steps can be separated, and banks can concentrate on each step when it arises.

TABLE 2.1 Settlement made Using Cheques

Individu	supply	demand	payment	receipt
A	$p_x X$	$p_y Y$	ba	ac
B	$p_y Y$	$p_z Z$	cb	ba
C	$p_z Z$	$p_x X$	ac	cb
Σ	$p_x X + p_y Y + p_z Z$	$p_x X + p_y Y + p_z Z$	ac+ba+cb	ac+ba+cb

To illustrate the table, I assume that individuals A, B and C deal exclusively with one bank, banks denoted by a, b and c, respectively.¹⁷ I also define a cheque ij to indicate the claim of bank i on bank j , for $i=a,b,c$ and $j=a,b,c$, $i \neq j$. (Notice that ij is the value of a cheque in terms of a common unit of account.) For example, individual A, who deals with bank a, can write an instruction asking bank a to pay B in order to obtain good Y. Then individual B will deposit this instruction to his bank b. Eventually, bank b will claim it on bank a (cheque **ba**) and the transfer of fund will settle this chain of claims.

¹⁷ This assumption of one bank for one agent is adopted to illustrate complete bilateral trades among agents - as well as a pure bilateral cheque clearing system among respective banks. In practice, it is possible that more than one agent have accounts at the same bank. Settlement of cheques exchanged among these agents would be conducted by the bank where their accounts are commonly held. (This is the case where partial multilateral cheque clearing (or internal bookkeeping) is possible even without an organized clearinghouse. Later, I will look at this possibility in terms of non-zero covariance. See chapter 2.7.) However, in this chapter, I will focus on the one agent - one bank case.

TABLE 2.2 Balance Positions of Three Banks

bank	credit	debit	net balance ¹⁸
a	ac	ba	ac-ba
b	ba	cb	ba-cb
c	cb	ac	cb-ac
Σ	ac+ba+cb	ac+ba+cb	0

In Table 2.2, the balance positions of three banks are listed. The "net balance" of a bank is the difference between the claim it has on other banks and the claim of others on it. As is shown in the last row of the table, the aggregate net balance of the system is always zero. However, the process of the clearing will be quite different depending whether bilateral clearing is adopted or multilateral clearing is used.

For the 3 individual - 3 bank case, if bilateral clearing is used, each bank has to meet once with each of its counterparts. The total number of the meetings needed to reach the zero aggregate net balance is three under bilateral system, and each bank has to make two meetings. However, if all three agree to meet in one place (i.e., clearinghouse), one trip for each bank to the meeting place will be sufficient to clear every bank's net balance.

In general, for n unsynchronized net balances of

¹⁸ Net balance of each bank becomes zero when the value of goods exchanged does not change.

independent banks, a total number of meetings¹⁹ equals to:

$$C_2^n = \frac{n!}{(n-2)!2!} = \frac{n(n-1)}{2} \quad (2.1)$$

would be needed under the bilateral system, each bank making (n-1) bilateral clearings with its counterparts. If the physical cost of cheque clearing is represented by the number of messengers (rather than the number of meetings) required, when each bank hires n-1 messengers, it would be:

$$P_2^n = \frac{n!}{(n-2)!} = n(n-1) \quad (2.1-a)$$

messengers. Equation (2.1-a) is only possible under the condition that no pre-arrangement between any pair of banks is made. In other words, all n banks send (n-1) messengers to their partners. Alternatively, it could be thought that (2.1) is the minimum number of the messengers to be hired when one messenger travels between a pair of banks, while (2.1-a) is the maximum number of messengers when a representative bank sends one messenger to each of its bilateral partners.

¹⁹ See Mengle (1992) p.5 for a similar argument made for the reduction in the number of payment messages under the U.S. Fedwire Message System.

If, instead of these bilateral clearing sessions, one organized a multilateral arrangement, one meeting of the n banks would be sufficient to bring the aggregate net balance to zero with a great deal of "shoe leather" saved.

To illustrate the savings in the physical cost of cheque clearing under the multilateral process, let's assume that transactions cost per trip is C_T .²⁰ In this case, the physical cost of cheque clearing for a representative bank can be written as:

$$\begin{aligned} C_T & - \text{under multilateral clearing, and} \\ (n-1)C_T & - \text{under bilateral clearing.} \end{aligned}$$

Similarly, total physical cost of the clearing system (which consists of n banks), will be:²¹

$$\begin{aligned} n C_T & - \text{under multilateral option, and} \\ \{n(n-1)/2\} C_T & - \text{under bilateral option.} \end{aligned}$$

²⁰ Transactions cost can be represented by the transportation expenditure per trip. I initially assume C_T is identical under both clearing options.

²¹ One might argue that the number of trips under multilateral clearing increases by the proportion of n while that under bilateral option increases by $n/2$. But it should be noted that $n(n-1)/2$ is the minimum number of trips required under the bilateral system when every pair of bilateral clearing can be fulfilled by prearranged single trip. As shown in the previous footnote, without any consensus among the bilateral partners, the number of trips could be $n(n-1)$, which exhibits the same proportional increase as the multilateral option does. And the different proportional increases in trips do not affect the main argument made below.

Now, the savings in the physical costs can be measured by:

$$\begin{aligned} S_p^i &= (n-1) C_T - C_T \\ &= (n-2) C_T \end{aligned} \quad (2.2)$$

for bank i . S_p^i is the difference in physical costs represented by the number of trips required for bank i under bilateral and multilateral clearing systems. Similarly, for the clearing system consisting of n banks, savings in physical costs will be:

$$\begin{aligned} S_p &= \frac{n(n-1)}{2} C_T - n C_T \\ &= n \left(\frac{n-3}{2} \right) C_T \end{aligned} \quad (2.2)'$$

where S_p is the savings in physical costs for the clearing system consists of n banks. Notice that Equation (2.2)' shows that there is no savings in physical cost in the three bank case. However, if the physical cost is measured with equation (2.1-a), the savings will be:

$$\begin{aligned} S_p &= n(n-1) C_T - n C_T \\ &= n(n-2) C_T \end{aligned} \quad (2.2)''$$

and there will be savings in physical costs even with the three bank case.

As shown in equation (2.2)', positive savings arise in physical costs as soon as more than three banks engage in multilateral clearing. And as the number of banks in the clearing system increases, additional savings can also be realized. This can be seen from:

$$\frac{\partial S_P}{\partial n} = \left(\frac{2n-3}{2} \right) C_T > 0 \quad (n \geq 2) \quad (2.3)$$

$$\frac{\partial^2 S_P}{\partial n^2} = C_T > 0 \quad (2.4)$$

The first derivative indicates that as more independent banks join the clearing system, the advantage of a multilateral clearing system in terms of physical cost reductions increases. The second order condition shows that these savings in physical costs increase at an increasing rate.²² (Endnote 2.3 shows a graphical illustration of equations (2.3) and (2.4).) The marginal conditions

²² Another complication can be added when transaction costs per trip differ depending on the clearing options. Since a clearinghouse is built in the location which shortens the distance of trips from each bank, transportation expenditure per trip under multilateral clearing would be smaller; however, banks should pay extra costs for the management of a clearinghouse such as membership fees when they elect multilateral clearing. Hence, to avoid further complications in savings measure, I assume here that transaction costs per trip can be same regardless of clearing options chosen.

indicate that banks in the clearinghouse system have an incentive to persuade additional banks (already participating in bilateral cheque clearing) to join the clearinghouse. (The benefit is also viewed to the banks outside of the clearinghouse by observing savings generated for the members.)

In short, one of the primary advantages of a clearinghouse system is the savings in daily operation costs, especially those in transportation and time. Even though this work focuses on the savings in physical costs in terms of transportation cost, savings in the time needed to settle the cheques were also quite important in demonstrating the advantage of multilateral clearing. For example, as shown in chapter III, the time needed to complete the entire cheque clearing and settlement process among the sixteen banks in the Montreal Clearinghouse on its first day of opening (January 8, 1889) was only thirty minutes. Typical bilateral cheque clearing among the same banks used to take a long day's work for messengers and clerks.

2.4 Variance in Cheque Clearing Balance

In the previous section, bilateral and multilateral cheque clearing options were compared in terms of the physical cost of exchanging cheques. Another difference between these two clearing processes is in terms of the reserves that are held. In the following sections, I discuss how the multilateral clearing process economizes on reserves. For the same level of deposits, it will be shown that a bank under multilateral clearing faces less uncertainty²³ in its net clearing balance, and consequently holds less reserves and achieves a lower cost of settlement. This section begins this analysis by focusing on the difference in the variance of reserves held under the two clearing options.

A bank holds a proportion of its demand deposits in the form of reserves to prevent a possible problem with liquidity; should an unexpected demand for funds (from another bank) not be covered by *precautionary reserves*, the cost of not immediately meeting that demand and being declared illiquid could be enormous. To meet the net settlement balance demanded, a bank will typically have to

²³ There are (at least) two types of reserves for banks. One type of reserves would be held regardless of the size of variance, which is equivalent to the transactions demand for reserves. And uncertainty adds precautionary demand for reserves. In this work, I will focus on the precautionary demand for reserves.

scramble to find a source of extra funds, which is normally very expensive. Alternatively, the bank may lose its reputation as a reliable clearing partner. When a bank loses its reputation as a reliable supplier of cheque clearing to its customers, the deposits would be reduced drastically (the cost is born in terms of reduced deposits). Reserves, then, allow the avoidance of these costs and by permitting the bank to immediately convert claims on deposits into currency.²⁴ At the same time, however, reserves reduce the potential profit of a bank. Since holding reserves lessens the amount of deposits that can be loaned out by the bank, larger reserves mean lower profits for any given level of bank deposits. In other words, the opportunity cost of holding liquidity in the form of reserves against deposits is the interest income foregone on these reserves.²⁵

Considering the benefit and cost of holding reserves, each bank will choose the level of reserves it holds for precautionary purposes by trading off their relative advantage. Because this problem has been analyzed extensively, the *optimal reserve decision* is not dealt with

²⁴ or gold under gold standard.

²⁵ It is assumed that no interest is paid to reserve. Deposits are divided into two components; R (reserve) and E (loan - income earning asset). That is, $D = R + E$. And an increase in R will reduce E with given amount of deposit (D). See Whalen (1966) for the costs and the benefit of precautionary reserves. See also Endnote 2.5.

in my thesis in any detail.²⁶ Rather, to illustrate my argument I simply assume that a bank has chosen the optimal portion of its deposits to hold as precautionary reserves. This implies that at that portion the cost of illiquidity precisely equals the interest foregone. For the remainder of this section, I therefore assume that the optimal reserve ratio is fixed.²⁷ (This assumption will be relaxed in following sections.)

When a multilateral cheque clearing process is adopted, the clearinghouse collects all the cheques written on member banks, and settles their net clearing balances by shifting reserves (held in accounts in the clearinghouse²⁸) from the bank experiencing a net debit balance to the bank with a net credit balance. By comparing this multilateral cheque clearing process to a sequence of bilateral clearings, I can show that a clearinghouse can handle the same volume of cheques written (with a given level of deposits) with fewer reserves than can a bilateral clearing system. To formalize the savings in reserve holding resulting from multilateral

²⁶ For example see works of Baltensperger (1980), and Galbraith and Rymes (1993).

²⁷ In more general form, I can assume $R = R(D)$, $\partial R / \partial D > 0$, where R is the reserve and D is deposit.

²⁸ In fact, bank reserves do not have to be held in the clearinghouse as far as proper level of reserves is held by each participating bank. The payment of net clearing balance could be made directly from one bank to the other. In this case, the clearinghouse makes sure the payment is made promptly with acceptable method of payment. In chapter III of this thesis, I will show how clearinghouses tackled the payment process in Canada.

clearing, assume that there are n ($n > 2$) banks, and as previously defined, let a cheque ij indicate the value of a claim of bank i on bank j . In other words, ij is the value of the cheque deposited to bank i 's account to be paid by bank j . Since it is common for bank j to have a cross claim on bank i , the net clearing balance of bank i with bank j (NB_{ij}) is:

$$NB_{ij} = ij - ji \quad (2.5)$$

(for $j = 1, 2, 3, \dots, n$ and $j \neq i$.)

Under bilateral clearing,²⁹ bank i has to clear with $(n-1)$ banks individually, and keep separate net balance account for each bank it deals with.³⁰ This practice of keeping $(n-1)$ accounts is based on the fact that the net clearing balance of bank i with any partner bank can not be known until its messenger returns from his trip. To prevent interruption in the clearing process, bank i will hold reserves for each of its partner (in its own respective

²⁹ By bilateral system, I mean that both the exchange of cheques and settlements are conducted bilaterally. As Gorton (1984, p.11) indicated, "[...] clearing checks required each bank to send a clerk everyday to all of the other banks to **exchange cheques and settle balances** to clear the transactions" under a bilateral clearing system.

³⁰ That is, bank i will have $(n-1)$ accounts;

$$\begin{aligned} NB_{i1} &= i1 - 1i, \\ NB_{i2} &= i2 - 2i, \\ &\dots\dots\dots, \\ NB_{in} &= in - ni. \end{aligned}$$

account). However, if bank i decides to clear its cheques multilaterally through the clearinghouse³¹, its clearing balance will be expressed in a single account:

$$\begin{aligned}
 NB_i &= \sum_{j=1}^n (ij - ji) \\
 &= \sum_{j=1}^n NB_{ij}, \quad \text{for } i \neq j
 \end{aligned}
 \tag{2.6}$$

where NB_i is the value of net clearing balance between bank i and the rest of $(n-1)$ banks, which is now recorded in the clearinghouse.

Using equations (2.5) and (2.6), the net clearing balance of bank i for the two clearing options can be checked. First of all, when equation (2.5) is positive, it indicates that bank i experiences a credit balance in its dealing with bank j ; negative value shows a debit balance by bank i under bilateral clearing with bank j . On the other hand, a positive value to NB_i (equation (2.6)) illustrates that the total value of cheques deposited to bank i exceeds the total value of all other bank's claims on bank i . And negative NB_i suggests the opposite.

Secondly, under the exclusive bilateral system, bank i

³¹ Under the clearinghouse multilateral process, the net of individual clearing balances will be settled.

clears with each one of $(n-1)$ banks independently;³² this indicates that bank i 's clearing position with bank j has no connection with bank i 's net clearing balance against bank k . However, when multilateral clearing is adopted, bank i 's position with banks j and k would be related. Since bank i manages only one clearing account with the clearinghouse, NB_{ij} and NB_{ik} under the multilateral option would all be contained in NB_i (equation (2.6) - multilaterally cleared total net balance of bank i). For example, assume bank i has a positive balance with bank j , and experiences a negative balance with bank k . Under a multilateral clearing system, these two net balances in different directions can cancel out each other readily in the clearinghouse. The net balance of bank i in a clearinghouse is obtained after its clearing positions with all the other clearing partners are collectively settled. On the other hand, when the bilateral clearing option is adopted, bank i 's clearing balance with bank j has no influence over its clearing process with bank k . Bank i *probably* would not know its positive position with bank j when it clears with bank k (longer distance to bank j or slower messenger dispatched to j direction); or bank k would demand immediate payment from reserve

³² This independency can be violated when messengers designated to different banks meet on their way and exchange cheques and corresponding reserves.

regardless of i 's position with j .³³

Furthermore, as explained below, the expected net balance of bank i (i.e., $E(NB_i)$) is 0.³⁴ Assuming three banks are involved (i , j , and k) if bank i is experiencing a positive (or negative) net balance with bank j , to have $E(NB_i)=0$, it would expect to have a negative (or positive) net clearing against bank k ; under the multilateral clearing system, NB_{ij} and NB_{ik} **are expected** to have a negative relationship.³⁵

For a large number of clearings among banks, the distribution of net balances approaches the normal distribution.³⁶ Assuming that the number of clearings is large and the expected net balance (i.e., $E(NB)$, average value of NB . See Table 2.2 .) is 0:

$$NB_i \sim N(0, \sigma_i^2) \quad (2.7)$$

³³ Given sequential transactions, you would still need reserves if you had to pay first even though you know with certainty that later more funds would come in. Uncertainty adds to this problem.

³⁴ On average, bank i would not have either net credit nor net debit clearing balance.

³⁵ That is, $\text{Cov}(NB_{ij}, NB_{ik}) < 0$, under multilateral clearing option. Here, a negative relationship between NB_{ij} and NB_{ik} is illustrated for three banks case. In practice, however, if there are n banks involved in the clearing $NB_{ij} > 0$ indicates $NB_{ik} < 0$, $\forall j, k, j \neq k$, and vice versa.

³⁶ See Freund (1977), p.204. Normal distribution of net balance is an approximation; typically upper and the lower limits of the NB 's are finite.

In general, the variance of NB_1 can be written as:

$$\sigma_i^2 = \sum_{j=1}^n E(NB_{ij} - E(NB_1))^2 \quad (i \neq j)$$

where $\sum_{j=1}^n NB_{ij} = NB_1$ and $E(NB_1) = 0$.

The reason a bank is concerned about the size of variance is because the size of variance and the level of precautionary reserves are positively related.³⁷ For any given level of deposits, a larger variance of NB represents more uncertainty about the ultimate clearing position of a bank. To prevent potentially larger negative balances the bank will choose to hold more of its deposits as reserves. In turn, this lowers the interest revenue of the bank and raises its costs of operation.

The cost associated with variance assumes that instant finance is not available to a bank without having to pay a premium. If instant (and costless³⁸) financing were available to the bank, then a bank with a constant mean would not worry about the size of NB. When that bank experienced a negative balance, it would simply borrow the

³⁷ A formal relationship between these two variables -the size of variances and the levels of reserves will be delivered later. It is shown in equations (2.16)-(2.20).

³⁸ Costless financing means that the cost of borrowing does not exceed the interest rate earned on loans. Also no penalty is imposed on the negative balance until the settlement is reached.

funds to settle. Similarly, a positive balance would be loaned out to the other members who are looking for clearing funds. Under such circumstances, no attention will be given to variance and the optimal level of reserve would be zero.

For multilateral clearing, bank i will have a single positive or negative clearing balance expressed as a net credit or a net debit entry on its clearing account. Variance of that net clearing balance is:

$$\begin{aligned}\sigma_i^2 &= E \left[\sum_{j=1}^n (NB_{ij} - E(NB_i)) \right]^2 \\ &= \sum_{j=1}^n E \left[(NB_{ij})^2 - 2NB_{ij}E(NB_i) + (E(NB_i))^2 \right]\end{aligned}\quad (2.9)$$

which can be rewritten for a multilateral clearing option³⁹ as:

$$\sigma_{iM}^2 = \sum_{j=1}^n \sigma_{ij}^2 + 2 \sum_{j,k=1; j \neq k}^n \text{Cov}(NB_{ij}, NB_{ik}) \quad (2.10)$$

³⁹ See endnote 2.4 for the negative covariance between NB_{ij} and NB_{ik} , $\forall j \neq k$. Notice the sum of covariances $(\sum \text{Cov}(NB_{ij}, NB_{ik}))$ is also negative.

Figure 2.1 Distribution of Net Clearing Balances

Under bilateral clearing, bank i clears with $(n-1)$ banks and has a clearing balance with each individual bank, and its balance with bank j can be written as:

$$NB_{ij} = ij - ji, \quad i \neq j, \quad j=1,2,\dots,n. \quad (2.11)$$

The variance of net bilateral clearing balance between bank i and a single bank j is then,

$$\sigma_{ij}^2 = E(NB_{ij} - E(NB_{ij}))^2 \quad ; \quad (2.12)$$

and the variance of its total net clearings balance with the (n-1) banks will be⁴⁰

$$\begin{aligned} \sigma_{iB}^2 &= \sigma_{iM}^2 - 2 \sum_{j,k=1; j \neq k}^n \text{Cov}(NB_{ij}, NB_{ik}) \\ &= \sum_{j=1}^n \sigma_{ij}^2 \end{aligned} \quad (2.13)$$

Equations (2.10) and (2.13) show that (since $\text{Cov}(\cdot) < 0$)

$$\sigma_{iM}^2 < \sigma_{iB}^2.$$

As shown, the inequality arises due to the negative covariance among the multilaterally arranged net balances. If the covariance between bank i and two other banks were zero (i.e., $\text{cov}(NB_{ij}, NB_{ik}) = 0$), then $\sigma_{iM}^2 = \sigma_{iB}^2$. In other

⁴⁰ Derivation of equations (2.10) and (2.13) are given in endnote 2.4(a). A set of assumptions are also provided.

words, if bank i's net balance with bank j is totally independent of the net balance between bank i and bank k under a multilateral option, equations (2.10 and 2.13) would be identical. Under the multilateral clearing system, even though the net clearing balance is expected to be zero, the net balance between bank i and bank j will be negatively related to the net clearing position between bank i and bank k. The balances are necessarily correlated and some difference in two variances is bound to exist.

The negative relationship among the three banks (i, j and k) illustrated above is expected for any combination of banks involved in multilateral cheque clearing. However, it is still possible to have positive covariance terms. Under positive covariance, a bank may be suffering from either a reputation problem ($NB_{ij} < 0$ and $NB_{ik} < 0$) due to inability to cancel any of the negative balance or has unnecessarily accumulated (and wasted) reserves ($NB_{ij} > 0$ and $NB_{ik} > 0$). For this reason I will assume that the covariances will be negative for **normal**⁴¹ operating of the clearing business.

⁴¹ It excludes the possibilities of bank runs, accumulation of negative/positive clearing balances, and reserve deficiencies.

2.5 Savings in Reserves (I): an observation with a simple balance sheet

Confronting variability in its net clearing balances, a bank holds precautionary reserves to meet unexpected demands for payment without irregularities. A 100% reserve ratio would guarantee payment without any delay; however, with all funds inactive there would be no interest income from loans. On the contrary, the bank would like to hold as little as possible in reserves without running into a problem of deficiency (i.e., illiquidity). When the cheque clearing settlement is conducted through reserves held by participating banks, the difference in variance for two clearing options will generate different levels of reserves.

In Figure 2.2, the cheque clearing process among three banks is illustrated with simple balance sheet accounts. It illustrates that the net clearing balance of each bank can be expressed by values of total deposits and liabilities written in cheques. For example, net cheque clearing balance of bank i is $(ij+ik) - (ji+ki)$.

In the balance sheet of a clearinghouse (Figure 2.2), reserve of bank i is denoted by R_i , and the absolute value of the matching net liability of bank i is shown by NB_i .⁴²

⁴² NB_i expresses the absolute value of $-NB_i$ ($|-NB_i|$), which is $(ij+ik)-(ji+ki)$.

<u>Clearing Balance Accounts</u>																				
<div>bank i</div> <table><tr><td>i</td><td>j</td></tr><tr><td>ik</td><td>ki</td></tr><tr><td>j + k</td><td>i + ki</td></tr></table>	i	j	ik	ki	j + k	i + ki	<div>bank j</div> <table><tr><td>j</td><td>i</td></tr><tr><td>jk</td><td>ki</td></tr><tr><td>i + k</td><td>j + ki</td></tr></table>	j	i	jk	ki	i + k	j + ki	<div>bank k</div> <table><tr><td>k</td><td>k</td></tr><tr><td>kj</td><td>jk</td></tr><tr><td>k + kj</td><td>ik + jk</td></tr></table>	k	k	kj	jk	k + kj	ik + jk
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kj	jk																			
k + kj	ik + jk																			
<div>clearinghouse</div> <table><tr><td>R_i</td><td>N B_i</td></tr><tr><td>R_j</td><td>N B_j</td></tr><tr><td>R_k</td><td>N B_k</td></tr><tr><td>R_i + R_j + R_k</td><td>N B_i + N B_j + N B_k</td></tr></table>			R _i	N B _i	R _j	N B _j	R _k	N B _k	R _i + R _j + R _k	N B _i + N B _j + N B _k										
R _i	N B _i																			
R _j	N B _j																			
R _k	N B _k																			
R _i + R _j + R _k	N B _i + N B _j + N B _k																			

Figure 2.2 Clearing Balance Accounts

Bank i would hold R_i in the clearinghouse⁴³ in order to manage unexpected outflows of funds.⁴⁴ For example, if bank i is experiencing a debit clearing balance (i.e., $NB_i <$

⁴³ The role of clearinghouse is restricted to cheque (note) clearing in this analysis. For additional roles of a clearinghouse in early banking, see Timberlake (1984).

⁴⁴ Here, the role of reserves is restricted to the supply of liquidity to banks. For other roles of (required) reserves, see Stevens (1991).

0), bank i will use R_i (transfer of funds from R_i to R_j and/or R_k) to settle ($NB_i=0$) with j and k . Notice I have assumed that all the banks hold their reserves at the clearinghouse.⁴⁵ And the settlement of the clearing balance is conducted by rearranging those accounts. In this way, every settlement is **final** and there will be no problem of *payment risk*. Payment risk arises when the settlement made by a particular method of payment (typically a draft drawn on a bank) is reversed due to insufficient funds on the debit side. By assuming that reserves are held at the clearinghouse, I can reduce the problem of payment risk.⁴⁷ In chapter III, I will discuss the risk problems associated with payments under the Canadian case study.

If bank i is clearing with bank j and bank k bilaterally (and i has debit clearing balances with both of them), it has to reduce its reserve to bring $NB_{ij}=0$ and $NB_{ik}=0$. Consequently, the total reserves⁴⁸ of bank i can be written as R_{ij} plus R_{ik} for the example given in Figure 2.2. That is:

⁴⁵ As it will be shown in chapter III, in the early periods, reserves were often held at each bank in different forms (species and/or notes). Centralization of reserves was the consequence of the maturation of the clearinghouses.

⁴⁷ More discussion on the payment risk is in endnote 3.3 in chapter III.

⁴⁸ A bank will consider holding positive reserves only when its benefit (i.e., liquidity) exceeds its opportunity cost (foregone interest income). Detailed analysis on the conditions of holding positive reserves can be found in Baltensperger (1980). In my study, it is assumed that banks hold positive reserves, such as deposits held with clearinghouse or gold, to bring the net clearing balance to zero where the financial market for clearing fund is not available.

$$R_{iB} = R_{ij} + R_{ik} \quad (2.14)$$

where R_{iB} is the total reserve of bank i consisting of its bilateral cheque clearing precautionary reserves for bank j (R_{ij}) and bank k (R_{ik}). More generally, the total reserves of bank required for i , which bilaterally clears with $(n-1)$ other banks, will be:

$$R_{iB} = \sum_{j=1}^n R_{ij} , \quad i \neq j, \quad j=1,2,3,\dots,n. \quad (2.15)$$

What I would like to show next is how R_{iM} , bank i 's cheque clearing precautionary reserves under multilateral clearing, differs from its bilateral counterpart, R_{iB} . Taking a look at Figure 2.2 one more time, the savings in reserves under multilateral clearing can be shown most simply by assuming that the bank has a net debit balance with bank j and a net credit balance with bank k . That is:

$$\begin{aligned} NB_{ij} &= ij - ji < 0 , \\ NB_{ik} &= ik - ki > 0 . \end{aligned}$$

When the cheque clearing process is conducted through a clearinghouse, bank i has to hold sufficient reserves to cover the *total net balance*, $(j_i - i_j) - (i_k - k_i)$. In the case of bilateral clearing, however, bank i has to hold sufficient reserves to cover $(j_i - i_j)$, the *total net liability to bank j* . Even though bank i receives $(i_k - k_i)$ from bank k and the net balance becomes identical (i.e., the same expected mean value of net clearing balance), bank i must keep a larger proportion of its deposits in reserves to meet the demand from bank j under the bilateral option. (This difference is based on the assumption that bilaterally clearing banks have to immediately settle their balances when cheques are presented.⁴⁹) The lack of synchronization⁵⁰ in NB_{ij} and NB_{ik} forces bank i to hold more reserves in order to cover its debit balance without taking advantage of its credit balance with other bilateral clearing partners.

⁴⁹ And there is no guarantee that the credit balance from bank k will be obtained before the debit balance owed to bank j is presented.

⁵⁰ Uncorrelated clearing between NB_{ij} and NB_{ik} is shown as $\text{Cov}(NB_{ij}, NB_{ik}) = 0$ in equations (2.10) and (2.13).

2.6 Savings in Reserves (II): measurement of savings

The relationship between the holding of reserves and the variance of deposit demand was recognized as early as the late nineteenth century by Edgeworth (1888). Even though his particular argument does not provide a clear answer to the question I am dealing with, his application of statistical theory to the banking reserve problem is useful. In fact, Edgeworth and *his followers*⁵¹ tried to explain the less-than-proportional relationship existing between reserves (in specific type(s) of asset) and deposits using a statistical approach.

According to Edgeworth, "probability is the foundation of banking. The solvency and the profit of a bank depend upon the probability that [it] will not be called upon at once more than **a certain amount of [its] liabilities**". Hence, the precautionary reserves of a bank should be aimed at meeting this "a certain amount" of liabilities. Using actual banking data (which follow asymptotically normal distribution) and the parable of a club manager preparing dinner,⁵² Edgeworth reached the conclusion of **the square**

⁵¹ For example, Wicksell (1898), Fisher (1912), Dvoretzky (1965), Olivera (1969, 1971) and Baltensperger (1974) are all indebted to Edgeworth, I believe, in their *statistical inspiration*. See Laidler (1992), pp.184-7 for the contribution Edgeworth made to the monetary theory.

⁵² Edgeworth (1888), pp.117-24. Notice that it is assumed that all the withdrawals of bank *i* are made by cheques.

root rule as a proper guideline for precautionary reserves. He suggested, assuming demand for deposits has a normally distributed density function, that an increase in the reserves of a bank does not have to be proportional to the increase in its deposits; rather, a bank has to increase its reserves *proportionally to the square root* of the increase in deposit.

Before we go further, let's look at the basic idea of the square root rule embedded in the cheque clearing process.⁵³ First assume that a bank's probability of experiencing a net claim from its clearing partners exceeds the level of its reserves is a constant, γ . That is:

$$\gamma = \text{Prob} (|-NB_i| \geq R_i) \quad (2.16)$$

where R_i is the level of the bank's precautionary reserves, $-NB_i$ is the net claim of other banks on bank i , which is equal to net demand for deposit by cheques. Notice I can write $-NB_i$ as:

$$\sum_{j=1}^n NB_j \text{ since } \sum_{j=1}^n NB_j + NB_i = 0.$$

⁵³ The basic framework of the analysis shown here is provided in Olivera (1971).

The total cost of holding reserves, R_i , can now be written as:

$$C_i(R_i) = r \cdot R_i + K_0 \cdot \text{Prob}(|-NB_i| \geq R_i) \quad (2.17)$$

where $r \cdot R_i$ is the interest income foregone by holding R_i ,
 (r is the rate of interest);
 K_0 is the cost a bank faces when illiquidity
 occurs (penalty cost).⁵⁴

Using *Tchebychev's inequality*⁵⁵, the second entry in $C_i(R_i)$ can be approximated to:

$$\text{Prob}(|-NB_i| - E(NB_i) \geq k\sigma^2) \leq \frac{1}{k}, \quad \forall k = \text{constant}.$$

By letting $k\sigma^2 = R_i$ (i.e., $k = R_i/\sigma^2$):

⁵⁴ K_0 could be a fixed penalty rate and/or non-monetary cost such as loss of reputation.

⁵⁵ See Kazimier (1979), p.160 for the application of Tchebychev's equality which is related to equation (2.19).

$$Prob(|-NB_i| - E(NB_i) \geq R_i) \leq \frac{\sigma^2}{R_i}.$$

Since $E(NB_i)=0$:

$$Prob(|-NB_i| - R_i \geq 0) \leq \frac{\sigma^2}{R_i}.$$

Therefore, for constant probability of liquidity:

$$C_i(R_i) = r \cdot R_i + K_o \cdot \frac{\sigma^2}{R_i} \quad (2.17)'$$

At equilibrium:

$$\frac{\partial C}{\partial R_i} = 0 ; \quad r - \frac{K_o \sigma^2}{R_i^2} = 0.$$

$$\begin{aligned} R_i^2 &= \frac{K_o \sigma^2}{r} \\ \therefore R_i &= \sqrt{\frac{K_o \sigma^2}{r}} \end{aligned} \quad (2.18)$$

Under the normal distribution and the central limit theorem:⁵⁶

$$\sigma = \rho \sqrt{E(D_i)} \quad ; \quad (2.19)$$

D_i is the deposit of bank i , and ρ is a fixed factor of proportionality in normal distribution.

Substituting (2.19) into (2.18), the reserve of bank i can be written as:⁵⁷

$$\begin{aligned} R_i &= \sqrt{\frac{K_o}{r} \rho^2 E(D_i)} \\ &= \left(\frac{K_o}{r}\right)^{1/2} \cdot \rho \cdot \sqrt{E(D_i)} \\ &= t \sqrt{D_i} \end{aligned} \quad (2.20)$$

where $t = \rho(K_o/r)^{1/2}$, $t > 0$.

Equation (2.20) derived above shows that the level of reserve (needed to keep a constant probability of liquidity,

⁵⁶ "The elasticity of the precautionary reserve with respect to expected demand equals 0.5." Olivera (1971). Also see Miller and Orr (1966). More precise mathematic proof of square root rule using the central limit theorem is provided in Feller (1974), pp.229-30. Also in Olivera (1977); "the precautionary reserve must be proportional to the standard deviation of net demand [for deposits]"

⁵⁷ The expected deposit is assumed to be equal to the actual deposit, i.e., $E(D_i) = D_i$.

γ) depends on the square root of total deposits and the value of constant t . From equations (2.19) and (2.20), when σ increases, the value of t increases and in turn R_i also increases. (Notice that K_0 and r are assumed to be constant.) Using this notation, equation (2.14) can be rewritten as:

$$R_{iB} = t_b \sqrt{D_i} \quad (2.21)$$

where, $t_b = \rho_B (K_0/r)^{1/2}$ and $\rho_B = \sigma_B / (\sum D_i)^{1/2}$.

Similarly, assuming that each individual bank faces the same distribution of net clearings so that the standard deviations facing bank i , j and k are equal:

$$R_{jB} = t_b \sqrt{D_j} \quad (2.21)'$$

$$R_{kB} = t_b \sqrt{D_k} \quad (2.21)''$$

Hence the total reserve needed under a bilateral clearing system (consists of three banks) will be:

$$R_B = t_b \sqrt{D_i + D_j + D_k} \quad (2.22)$$

In general, the reserve of bank i under bilateral option is (when there are n banks):

$$R_{iB} = t_b \sqrt{D_i} \quad (2.21-a)$$

And the total reserves, under the bilateral system, required to maintain desired level of liquidity will be:

$$R_B = t_b \sum_{i=1}^n \sqrt{D_i} \quad (2.22-a)$$

On the other hand, multilateral clearing reserves of bank i will be:

$$R_{iM} = t_m \sqrt{D_i} \quad (2.23)$$

where, $t_m = \rho_M (K_0/r)^{1/2}$ and $\rho_M = \sigma_M / (\sum D_i)^{1/2}$; γ is the fixed probability of liquidity. In a similar fashion, multilateral clearing reserves with n banks will be:

$$R_M = t_m \sum_{i=1}^n \sqrt{D_i} \quad (2.24-a)$$

Now, savings in reserves by a multilateral clearing option can be checked by comparing equations (2.22-a) and (2.24-a). Since R_B and R_M indicate the "required" level of reserves to maintain the desired degree of liquidity (i.e., γ) for bilateral clearing and its multilateral counterpart respectively, the difference between these two reserves will measure the savings.

In order to compare the reserves under the two clearing processes (R_B and R_M), recall equations (2.19) and (2.20). First, in equation (2.20), the reserves⁵⁸ of bank i are expressed as t multiplied by the square root of expected total deposits. But from equation (2.19), the term t can be shown to consist of σ (the standard deviation of net balance) and $(K_0/r)^{1/2}$. Since $(K_0/r)^{1/2}$ is assumed to be a constant, σ then determines the size of t . Therefore the larger the standard deviation of the net clearing balance, then the larger will be the value of t .

As shown in equations (2.10) and (2.13), the same level of deposits can generate different variances in net clearing balances depending on the clearing option that banks elect. Figure 2.3 illustrates the difference between the two cheque clearing options in terms of mean and variance. In the

⁵⁸ This represents the level of reserve needed to maintain liquidity facing total net debit entry in clearing under normal distribution, ($R_i \geq -NB_i$).

diagram, $\sigma_{iM}^2 < \sigma_{iB}^2$ is shown⁵⁹ (proof of this proposition vis a vis equation (2.10) and equation (2.13) is provided in endnote 2.4.), while expected value of NB_i is equal to zero for both cases. Then, using equations (2.19) and (2.20), I can deduce $t_b > t_m$ since $\sigma_B > \sigma_M$. Recalling that $R_{iB} = t_b(D_i)^{\frac{1}{2}}$ (2.21-a) and $R_{iM} = t_m(D_i)^{\frac{1}{2}}$ (2.23-a), the reserves of individual bank i can be saved by choosing the multilateral cheque clearing option.

Now, to measure the savings in reserves, express t_b as

$$t_b = (1 + \alpha) t_m$$

$$\alpha = \frac{t_b - t_m}{t_m}; \alpha \geq 0. \quad (2.25)$$

(α is the rate of difference between t_b and t_m . α is zero when two are equal.)

⁵⁹ Second order stochastic dominance (see Copeeland and Weston (1988), pp.92-4) is observed in multilaterally cleared net balance of bank i over its bilateral counterpart.

Figure 2.3 Distribution of NB_i

Since the difference between t_b and t_m is based on the different values of σ_B and σ_M , the size of α is determined by $(\sigma_B - \sigma_M)$, which in turn depends on the value of covariance terms in the variance-covariance matrix.⁶⁰ Hence, α can be written as:

⁶⁰ See endnote 2.4 (b) for the detailed analysis of variance-covariance matrix.

$$\alpha = \alpha(S) ,$$

$$\text{where } S = \left[2 \sum_{j=1}^n s_{jk} \right] , j \neq k , \quad (2.26)$$

(s_{jk} is the covariance between NB_{ij} and NB_{ik} .)

In other words, the larger the covariance terms, the greater will be the difference between σ_B and σ_M . Consequently, the difference between t_b and t_m is positively related to the size of the covariance terms.⁶¹

First, the savings in reserves for a representative bank (S_{Ri}) can be measured:

$$S_{Ri} = (t_b - t_m) \sqrt{D_i} - \alpha t_m \sqrt{D_i} \quad (2.27)$$

In equation (2.27), a representative bank's possibility to save its reserve by adopting the multilateral clearing option is shown.

⁶¹ That is, $\partial \alpha / \partial S > 0$. See endnote 2.7 (a).

Furthermore, the savings⁶² in reserves for n bank clearing system will be measured as:

$$\begin{aligned}
 S_K &= R_B - R_M \\
 &= t_b \sum_{i=1}^n \sqrt{D_i} - t_m \sum_{i=1}^n \sqrt{D_i} \\
 &= \alpha t_m \sum_{i=1}^n \sqrt{D_i}
 \end{aligned} \tag{2.28}$$

Assuming that the total deposits of a representative bank are constant⁶³, S_R can be rewritten as:

$$\begin{aligned}
 S_R &= n \alpha t_m \sqrt{D_i} \\
 &= n S_{Ri}
 \end{aligned} \tag{2.29}$$

Therefore, equation (2.29) shows that the savings in reserves depend on the number of banks in the system (n), the covariance factors ($\alpha(S)$), and the size of transactions in a representative bank. And $S_R = 0$, when $\alpha(S) = 0$, which indicates that $\sum s_{jk} = 0$ and $\sigma_B = \sigma_M$.

⁶² The savings in reserves shown in equation (2.28) is the maximum savings in reserves. It is obtained when n banks, which initially clear their cheques bilaterally each other, decide to join a clearinghouse simultaneously. Endnote 2.6 explains the possible savings in reserves for other cases.

⁶³ That is, $\sum_{ij} c_{ij} = c$, c is a constant. In turn, $(\sum_{ij} c_{ij})^{1/2} = c_1$, c_1 , the square root of c, is a constant. Then, we have $\sum_i c_i = n c_1$.

Notice that I have assumed so far that n independent banks previously clearing their cheques bilaterally form and join the clearinghouse. In other words, I have assumed the *unit banking system* consisting of n banks, which is what Edgeworth (1888) initially assumed. On the other hand, if branch banking is assumed, the number of banks independently participating in the clearinghouse could be smaller than n . Under the branch banking structure, internal (or intra bank) clearing could reduce the total value of the clearing processed in the multilateral clearinghouse. At the same time, branches of the same bank (in the same clearing district) can be represented by a larger branch. Consequently, the number of banks present themselves to the clearinghouse could be less than the total number of bilateral partners. In section 3.1, I will briefly discuss the possible impact of the banking structure on the savings in reserves using empirical tests. Also in chapter III, Canadian case studies will be highlighted to show the savings in reserves under the branch banking structure.

2.7 Further Observations on Savings

Additional insights can be obtained into the savings in reserve under the multilateral cheque clearing process with the analytical framework developed in the previous section. First, the square root rule of precautionary reserves under the normal distribution has been used to show the relationship between reserves and the expected level of deposits. Equation (2.20), as Edgeworth (and others) have argued, shows that the reserves of a bank are proportional to the square root of its deposits. Hence, the increase in reserve with respect to the increase in deposit has a decreasing rate of expansion. From equation (2.20), where $R_i = t(D_i)^{1/2}$, where $t = t(\alpha)$, so that the first and the second derivatives are:

$$\frac{\partial R_i}{\partial D_i} = \frac{1}{2} t D_i^{-\frac{1}{2}} > 0, \text{ and}$$

$$\frac{\partial^2 R_i}{\partial D_i^2} = -\frac{1}{4} t D_i^{-\frac{3}{2}} < 0 .$$

Despite the fact that the square root rule explains *per unit savings in reserves with respect to increase in deposits*, this formulation of the proposition cannot provide

sufficient insight into the savings in reserves that arise under multilateral clearing. In fact, equations (2.21) and (2.27) demonstrate that the square root rule can be applied to the case of bilateral clearing option and multilateral clearing. In both, reserves will be proportionally adjusted to the square root of deposits. However, to explain the savings in reserves under a multilateral clearing option with a given amount of deposits for an individual bank i , we have to focus on the difference in standard deviations under two alternative clearing options (and hence the difference in the factor of proportionality).

To explore how total savings are affected by variables such as standard deviations, the number of participating banks,⁶⁴ and the size of deposits, I turn to a closer analysis of the factor of proportionality. From equation (2.28), savings in reserves are shown to be greater when a difference between standard deviations of clearing processes is increased. And that difference between the standard deviations (or variances) is determined by the covariance factors embedded in clearing options. The negative covariances among the net individual net clearing balances in the multilateral clearing option is what makes its variance smaller than that of the bilateral clearing

⁶⁴ See Laidler (1991), pp.184-7 for Edgeworth's contribution to early banking theory.

option.⁶⁵ Hence, the absolute value of the sum of covariance terms (i.e, $S = |\sum \text{cov}(NB_{ij}, NB_{ik})|$) dictates the relative size of the two variances. In turn, the covariance terms will determine the savings in reserves. (See endnote 2.6.)

To see the impact of the covariance terms (S) on the savings in reserves, I can differentiate S_R with respect to S :

$$\frac{\partial S_R}{\partial S} = \frac{\partial \alpha}{\partial S} t_m \sqrt{D_i} \quad (2.30)$$

$$\frac{\partial^2 S_R}{\partial S^2} = \frac{\partial^2 \alpha}{\partial S^2} t_m \sqrt{\sum_{j=1}^n ij} \quad (2.30-a)$$

But since $(\sigma_B - \sigma_M)$ is positively related to the value of S , and $\partial S_R / \partial S > 0$.⁶⁶ This result indicates that the savings in reserves increase when the absolute value of covariance terms becomes larger. In other words, with a given number of banks(n) participating in the clearing process, the savings in reserves will be increased if a bank decides to shift from bilateral clearing to the multilateral option

⁶⁵ See equations (2.10) and (2.13); also equations (E2.2) and (E2.2-a) in endnote 2.4.

⁶⁶ See endnote 2.7 for the signs of the first and the second derivative of α with respect to S .

(hence increase the size of S). Therefore, the positive sign of equation (2.30) suggests that those banks that have already joined the clearinghouse have an incentive to recruit a member (or members) from the bilateral clearing group to increase the savings in reserves.⁶⁷ Notice α takes its maximum value when every s_{jk} under bilateral clearing is zero while its multilateral counterpart takes a negative value. That is, the maximum savings in reserves will be measured when all the bilaterally clearing n banks join the clearinghouse *simultaneously*. Equation (2.30-a) (second derivative = 0) shows that the savings in reserves increase as S increases at a *constant rate*.

As it has been discussed before, savings in reserves are also affected by D_i and n . First, I examine the impact of the level of deposit of a representative bank on the savings in reserves. In order to check the change in total savings in reserves with respect to D_i , I will examine:

$$\frac{\partial S_R}{\partial D_i} = \frac{1}{2} n \alpha t_m D_i^{-\frac{1}{2}} > 0, \quad (2.31)$$

$$\frac{\partial^2 S_R}{\partial D_i^2} = -\frac{1}{4} n \alpha t_m D_i^{-\frac{3}{2}} < 0 \quad (2.31-a)$$

⁶⁷ See section 3.4 for the effort made by the member banks of the Toronto Clearinghouse to recruit the Bank of Toronto.

The result shown above indicates that the savings in reserves under the multilateral clearing option will be added when the size of each bank's deposit grows; the second order condition, however, shows that the savings in reserves will increase at a decreasing rate when D_i increases. Notice that the number of banks in the clearing system is held constant.

Savings in reserves are also affected by the number of banks participating in the cheque clearing operation. From equation (2.29), I can find:

$$\frac{\partial S_R}{\partial n} = n \cdot \frac{\partial \alpha}{\partial S} \cdot \frac{\partial S}{\partial n} \cdot t_m \sqrt{D_i} + \alpha t_m \sqrt{D_i} \quad (2.32)$$

$$\frac{\partial^2 S_R}{\partial n^2} = n \cdot \frac{\partial^2 \alpha}{\partial^2 S} \cdot \frac{\partial^2 S}{\partial n^2} \cdot t_m \sqrt{D_i} + \frac{\partial \alpha}{\partial S} \cdot \frac{\partial S}{\partial n} \cdot t_m \sqrt{D_i} \quad (2.32-a)$$

In equation (2.32), $\partial S_R / \partial n > 0$ since $\alpha > 0$, $t_m > 0$, $\partial \alpha / \partial S > 0$, and $\partial S / \partial n > 0$.⁶⁸ Since (the absolute value of) the sum of covariance terms increases when the number of banks involved in the cheque clearing increases (i.e., $\partial S / \partial n > 0$), the savings in reserves would increase at an increasing rate (positive second derivative). In this case, the result

⁶⁸ Notice that I have assumed the total deposits of the clearing system are to be unchanged. This indicates that the size of deposits for a representative bank will be reduced as n increases.

shown in equation (2.32) indicates that there is positive externality in membership of clearinghouse. In other words, if an extra member joins the multilateral clearing system, not only will it benefit from the savings in reserves the system offers, but also existing members of the clearinghouse will gain additional savings in reserves.⁶⁹

In short, the savings in reserves under the multilateral option will be increased when more banks join the cheque clearing process.

⁶⁹ It should be noticed that, however, existing members want to be very selective in accepting new members. A few examples of membership conditions of Canadian clearinghouses will be described in chapter III. Also in chapter III, I will present examples which suggest that early members of the clearinghouse tried to attract the new members realizing this advantage of *larger membership*.

2.8 Savings in Cheque Clearing Costs: Branch Banking Case

In this chapter, I have shown the savings generated by the multilateral clearing option relative to a *unit banking system*.⁷⁰ However, if branch banking is allowed, some of the individual banks become operationally connected (outside of the clearinghouse). In this section, I will examine how the savings will be affected if branch banking is assumed for the members of the clearinghouse.⁷¹

For the branch banking system, I assume the following:

- (i) total number of branches (banking units) participating in the cheque clearing is n ,
- (ii) the number of *independent* banks is k ,
- (iii) each branch is represented by a representative branch (head branch) to the clearinghouse,⁷² and
- (iv) for each bank, the number of branches are the same, that is, each independent bank has n/k branches.⁷³

⁷⁰ See Cargill (1991), pp.175-80 for the brief discussion on the unit and branch banking systems.

⁷¹ Comparison is made between complete unit banking and complete branch banking system. Mixture of two systems is excluded.

⁷² Other branches present their cheques to their representative bank.

⁷³ This assumption of the same number of branches is needed to demonstrate internal savings in reserves. However, even without this assumption, savings generated by internal cheque clearing among branches are present; the only difference will be the different degrees of savings for different banks. Notice that n would be the multiple of k , which implies that n/k is an integer. Alternatively, the number of branches of each bank can be written as $[n/k]$, where $x-1 < [x] \leq x$, and $[x]$ is the largest integer which does not exceed x . (For example, $[1.6] = 1$.)

(a) Savings in physical costs

With k banks clearing their cheques bilaterally (and $(n/k)-1$ branches of each bank send their cheques to its representative branch), the total number of trips required for cheque clearing would be:

$$\begin{aligned} N'(B) &= \frac{k(k-1)}{2} + k\left(\frac{n}{k} - 1\right) \\ &= \frac{k(k-1)}{2} + (n-k) \end{aligned} \quad (2.33)$$

In equation (2.33), the first term indicates the extent of bilateral clearing among k banks while the second term shows the total number of trips made by branches to their representative branches (or headquarters).

When multilateral clearing is introduced, the number of trips required will be reduced to:

$$\begin{aligned} N'(M) &= k + k\left(\frac{n}{k} - 1\right) \\ &= k + (n-k) = n \end{aligned} \quad (2.34)$$

Assuming that the transaction cost is C_T (see equation (2.3)), savings in physical cost will be:

$$\begin{aligned}
S'_p &= [N'(B) - N'(M)] C_T \\
&\quad - \left(\frac{k(k-1)}{2} - k \right) C_T \\
&\quad = k \left(\frac{k-3}{2} \right) C_T
\end{aligned} \tag{2.35}$$

For three or more banks, equation (2.35) will be positive and savings in physical transportation costs can be realized. Comparing equations (2.2) and (2.35), I can show:

$$\begin{aligned}
S_p - S'_p &= \frac{(n-k)(n+k-3)}{2} C_T > 0 \\
&\text{since } n > k, \text{ and } n+k > 3.
\end{aligned} \tag{2.36}$$

Equation (2.36) shows that the savings in physical costs of moving to a multilateral clearing option will be greater when the alternative is unit banking. This is the expected result. Under the branch banking system, some degree of economization in physical cost (among branches of the same bank) already exists. This is one of the primary motives for branch banking in a system that utilizes bilateral clearing. (That is, when bilateral clearing is used, there are savings to be made shifting to branch banking from unit system.) When branch banking is adopted, one of the representative branches plays the role of a *clearinghouse* among the branches and the savings in physical

cost will be obtained for (n/k) branches regardless of the clearing options elected.

(b) Savings in reserves

Under the bilateral clearing option, the reserve required to settle the balances would be:

$$R'_B = t'_b \sum_{i=1}^n \sqrt{D_i} \quad (2.37)$$

And its counterpart under the multilateral clearing would be:

$$R'_M = t'_m \sum_{i=1}^n \sqrt{D_i} \quad (2.38)$$

In equations (2.37) and (2.38), notice that:

$$t'_b = \rho'_B \left(\frac{K_O}{I} \right)^{1/2}, \quad \rho'_B = \frac{\sigma'_B}{\sum \sqrt{D_i}} \quad \text{and} \\ t'_m = \rho'_M \left(\frac{K_O}{I} \right)^{1/2}, \quad \rho'_M = \frac{\sigma'_M}{\sum \sqrt{D_i}}$$

and the primed (') variables are comparable to those variables explained in equations (2.17) - (2.21) for the unit banking system. While the variance terms (standard deviations) in equations (2.21-a) and (2.24-a) (σ_B and σ_M in t_b and t_m , respectively) are obtained from a (n x n) matrix, their primed counterparts are calculated from a (k x k) matrix.⁷⁴ And also I have assumed that the total amount of deposits ($\sum D_i$) is the same under the two different banking systems.

As it is shown in equation (2.28) for unit banking system, the savings in reserves would now be shown as:⁷⁵

$$S'_R = R'_B - R'_M$$

$$= \alpha (S') t'_m \sum_{i=1}^n \sqrt{D_i} \quad (2.39)$$

Equation (2.39) indicates that the savings would be determined by t'_m and S' , which is the difference in variance terms (or value of non-zero covariance terms under multilateral clearing option).

⁷⁴ The number of independent bank in unit banking system is n, while the number of **separate banks** under branch banking system is k (total number of branches is n).

⁷⁵ See equations (2.25) and (2.26) for α .

Under the branch banking system, it can be said that:

$$\sigma_E^{2'} = \sigma_M^{2'} + 2S' \quad (2.40)$$

where⁷⁵

$$\begin{aligned} S' &= \sum_{i,j=1}^k s_{ij}, \text{ and} \\ S &= \sum_{i,j=1}^n s_{ij}, i \neq j \end{aligned} \quad (2.41)$$

But since $k < n$, $|S'| < |S|$.

To compare the savings in reserves under the two alternative banking systems, I can examine

$$\frac{S_R}{S_R'} = \frac{\alpha(S) t_m \sum_{i=1}^n \sqrt{D_i}}{\alpha(S') t_m' \sum_{i=1}^n \sqrt{D_i}} \quad (2.42)$$

⁷⁵ See endnote 2.4 for detailed description of covariance terms.

Since $t_m > t_m'$ and $\alpha(S) > \alpha(S')$ ⁷⁶, equation (2.42) will be greater than 1. In other words, benefits in terms of savings generated by the introduction of clearinghouse would be smaller under branch banking as compared to the unit banking system.

As is the case with physical cost, some savings in reserves are already present for those branches of the branch banking system even before a clearinghouse is introduced. When the branches of a bank use one of their representative branches as the clearing post, a similar economization of the reserves would be achieved among these branches. Notice that the comparisons between S_r and S_r' (savings in reserves) and S_p and S_p' (savings in physical costs) are not comparable to those between savings of n and k independent unit banks. Under the branch banking system assumed in this section, each of k independent banks represents the number of branches and it plays the role of *pseudo* clearinghouse among them. Those branches are assumed to maintain independent operation of their businesses except for (cheque) clearing.

In this section, I have shown the impacts of the branch banking system on the savings generated by the multilateral clearing option:

(i) multilateral clearing under the branch banking system

⁷⁶ $\partial\alpha/\partial S > 0$, and $S' < S$.

shows two levels of savings in physical cost and reserves. A representative bank can economize the costs of clearing without a clearinghouse; further savings would be obtained by establishing a clearinghouse.

(ii) savings in physical cost would be larger under the unit banking system.

(iii) more savings in reserves would be generated under the unit banking system when a clearinghouse is formed.

Despite the fact that branch banking could supplement the savings in cheque clearing costs, there is no theoretical argument showing that the branch banking system is in a position to compete with the multilateral clearing system itself. I think the adoption of a branch banking system is not mainly initiated to lower the costs of cheque clearing. Rather, the establishment of a branch banking system in some countries provided additional savings. In fact, in this section, I have shown the comparison between two banking systems in a single clearing centre setting (consisting of n banking units). However, when branch banking is expanded to the banking centres which are not large enough to have *independent* multilateral clearinghouses, the savings in cheque clearing costs (of clearinghouses) can be extended to these branches in smaller banking towns through intrabranh clearing with the major branches. In chapter III, I will show the expansion of the

branch banking system in Canada, which had contributed to the savings in cheque clearing costs with/without the existence of clearinghouses.

2.9 Remarks

A *small rebellion* initiated by some bold messengers carrying cheques to the banks on the street corners of London had brought consequences they never could have imagined. When those messengers agreed to meet on their ways (instead of going full distances), they did not realize that their decision would pave a way to save reserves and to reduce standard deviations. They only cared about their weary feet and time for an extra cup of coffee: equation (2.28) meant nothing for them.

However, once a clearinghouse was formed, it brought considerable savings in reserves as well as reductions in physical costs (i.e., shoe leather cost) of cheque exchange. Hence, for a given level of deposits, banks could save resources and increase profits by adopting a multilateral cheque clearing system. The analysis of chapter II so far has shown how these savings are generated by comparing the two alternative cheque clearing systems.

Before I move to part III (and examine the early Canadian experience), a few comments should be added to the findings I have provided in part II. First, it should be realized that the measurement of savings in reserves under the multilateral clearing option is calculated by comparing the two options in a *hypothetical setting*. In actual

practice banks choose only one at any given time; either bilateral⁷⁷ clearing or join a clearinghouse system. This means that, because I will deal with actual clearing data, I have only one of the actual reserves (either R_b or R_m) and its "what if" counterpart must be calculated. For example, in early eighteenth century London, cheque clearings were conducted in a bilateral fashion. Hence the sum of reserves held by those banks would correspond to my R_b . For my argument (i.e., $R_b > R_m$), I have to set up an imaginary clearinghouse and calculate R_m . In fact, I would use equation (2.24-a) with existing data revealed in R_b . Similarly, when a multilateral clearing is actually adopted, R_b will be calculated by equation (2.22-a), while R_m can be picked from the balance sheet of a clearinghouse.

As shown above, the savings in reserves (equation 2.28) are measured "in a laboratory" like setting.⁷⁸ However, *the marginal changes in the savings* can be detected from actual changes in the practice of cheque clearing. Equations (2.30)-(2.32-a) show that the savings in reserves are affected when there are changes in the clearing scenes. When a bank decides to switch from bilateral clearing to a clearinghouse (equations 2.30 and 2.30-a), the size of deposits changes (equations 2.31 and 2.31-a), and the number

⁷⁷ It includes *less-than-complete* bilateral cheque clearings.

⁷⁸ Notice again that I have assumed that no bank runs are observed in banking practice.

of banks operating for cheque clearing process increases, the savings in reserves would be influenced. In fact, results shown in those equations have sparked my statistical investigation of cheque clearing practices. In chapter III, these variations in the savings will be checked with reference to early Canadian cheque clearing experience.

Finally, as is indicated in sections 2.4 - 2.7, the decision of how much reserve to hold is made by banks. Banks decide the level of reserves needed to keep a certain degree of liquidity (i.e., $\bar{\gamma}$) and they hold reserves voluntarily. In other words, there is no state intervention in the cheque clearing process; no required reserve is present. When a required reserve ratio is enforced, it (instead of banks) will determine the size of t (see equation (2.20)) and affect the value of γ (see equation (2.16)). Consequently, t_m in 2.4 - 2.7 will be replaced by t_r (a required reserve ratio). However, in so far as $t_r < t_b$, my argument made through equations (2.22)-(2.32) would not be fundamentally affected.

Endnotes

(Endnote 2.x is attached to section 2.x. For example, endnote 2.3 belongs to section 2.3.)

Endnote 2.3 : An Illustration of the Number of Trips Required

In equations (2.2)', (2.3) and (2.4), I have shown the savings in physical costs under the multilateral cheque clearing system. As evidenced in those equations, savings in physical costs of multilateral clearing process are based on different numbers of trips required under the two alternative clearing options. In this endnote, I will provide a graphical explanation of the difference between the numbers of trips.

Now recall the numbers of trips (among n banks) to exchange and settle the clearing balances are:

$$\begin{aligned} N(M) &= n, \text{ and} \\ N(B) &= \frac{n(n-1)}{2} \end{aligned}$$

where $N(B)$ and $N(M)$ are the number of trips required under bilateral and multilateral clearing options, respectively. On Figure E2.1, $N(M)$ and $N(B)$ are drawn.

As shown in the figure, $N(B) > N(M)$ when $n > 3$. In other words, savings in physical costs can be realized when more than three banks are participating in the cheque clearing practice. (See equation (2.2)'.)

Figure E2.1 Physical Clearing Costs

The positive sign attached to equation (2.3) is also observed through the figure. As n increases ($n > 3$), the gap between $N(B)$ and $N(M)$ widens. With the quadratic form $N(B)$ exhibits and the linearity of $N(M)$, the positive second derivative (equation (2.4)) of S_p is also pictured in Figure E2.1.

Endnote 2.4 : Derivation of Covariance Terms for Two Cheque Clearing Processes

To determine the level of reserves under two different clearing options, assume there are three banks which clear multilaterally. (Banks 1, 2 and 3 are used.) Bank 1's net clearing balances with bank 2 and bank 3 are denoted as $NB_{12}=12-21$ and $NB_{13}=13-31$, respectively.⁷⁹ The expected overall net balance of bank 1 is:⁸⁰

$$\begin{aligned} E(NB_1^M) &= E(NB_{12}) + E(NB_{13}) \\ &= E(NB_{12} + NB_{13}) \end{aligned} \quad (E2.1)$$

The variance of bank 1 is, then:

$$\begin{aligned} Var(NB_1^M) &= E[(NB_{12} + NB_{13}) - (E(NB_{12}) + E(NB_{13}))]^2 \\ &= E[(NB_{12} - E(NB_{12})) + (NB_{13} - E(NB_{13}))]^2 \\ &= E(NB_{12} - E(NB_{12}))^2 + 2(NB_{12} - E(NB_{12})) \cdot (NB_{13} - E(NB_{13})) \\ &\quad + E(NB_{13} - E(NB_{13}))^2 \\ &= \sigma_{12}^2 + \sigma_{13}^2 + 2COV(NB_{12}, NB_{13}) \end{aligned} \quad (E2.2)$$

⁷⁹ Again ij is bank i 's claim on bank j , where $i, j=1, 2, 3$, $i \neq j$.

⁸⁰ Expectation of the sum is equal to the sum of expectations, i.e., $E(X+Y) = E(X) + E(Y)$. See Wonnacott and Wonnacott (1977), pp.128-9.

On the other hand, if bank 1 is engaged in bilateral clearing its expected net balance will be:

$$\begin{aligned} E(NB_1^B) &= E\left(\sum_{j=2}^3 NB_{1j}\right) \\ &= E(NB_{12} + NB_{13}) \end{aligned} \quad (E2.1-a)$$

Similarly, the variance of bank 1 under bilateral clearing is:⁸¹

$$\begin{aligned} Var(NB_1^B) &= E[NB_{12} - E(NB_{12})]^2 + E[NB_{13} - E(NB_{13})]^2 \\ &= \sigma_{12}^2 + \sigma_{13}^2 \\ &= \sigma_{1B}^2 \end{aligned} \quad \begin{array}{l} (E2.2- \\ a) \end{array}$$

Comparing the two pairs of equations [(E2.1 and E2.2) and (E2.1-a)-(E2.2-a)], the variance of the multilaterally cleared net balance will always be smaller than that of the bilateral option (as long as $cov < 0$), while the expected

⁸¹ NB_{12} and NB_{13} are perceived to be independent since bank 1 clears with bank 2 and 3 independently, and neither of them has any influence on the other. On the other hand, under the multilateral process, bank 1 is concerned with the aggregated net balance with both bank 2 and 3 rather than its individual bilateral clearing with bank 2 and bank 3. And if two variables (X and Y) are independent

$Var(X + Y) = Var(X) + Var(Y)$,
while if two variables are not uncorrelated

$Var(X + Y) = Var(X) + Var(Y) + 2Cov(X, Y)$

See Wonnacott and Wonnacott (1977), pp.130-1.

means are the same.⁸²

This mean and variance analysis can be applied directly to the more general n bank case. To obtain equation (2.13) exactly, the following restrictions were added:

(i) each bilateral clearing is normally distributed⁸³ about an expected net balance ($E(NB_{ij})$) of zero, i.e.,

$$NB_{ij} \sim N(0, \sigma_{ij}^2), \quad i=1,2,\dots,n, \quad j=1,2,\dots,n; \quad i \neq j.$$

(ii) NB_{ij} and NB_{ik} ($j \neq k$) are independent under bilateral clearing; for a multilateral process, however, $\text{Cov}(NB_{ij}, NB_{ik}) < 0$.

When each bank is clearing cheques with $n-1$ other banks, the variances and covariances of the clearing system can be written in matrix form. Here, I show how equations (2.10) and (2.13) can be deduced from a standard matrix setting.

First, let's assume that the vector U_i is:

⁸² Statistically, multilateral clearing method possesses second order stochastic dominance over bilateral option. See Copeland and Weston (1988), p.93, pp.100-1.

⁸³ See Olivera (1977), p.1098. "... the normal distribution is infinitely divisible, [and] any normally distributed net demand [for precautionary reserve] can be viewed as a sum of independent and identically distributed values."

See also Gredenko and Kolmogorov (1954), chapter 3.

$$U_i = \begin{pmatrix} NB_{i1} \\ NB_{i2} \\ \vdots \\ NB_{in} \end{pmatrix},$$

where NB_{ij} is again the net cheque clearing balance of bank i with bank j . Vector U_i is assumed to have a multivariate normal distribution, i.e., $U_i \sim N(0, \sigma^2 I)$, where I is $(n \times n)$ identity matrix. In other words, $E(NB_{ij}) = 0$, $\text{var}(NB_{ij}) = \sigma_{ij}^2$, and $NB_{ij} \sim N(0, \sigma_{ij}^2)$, for $j=1, 2, \dots, n$.

To find the variance-covariance matrix, let vector U stand for:

$$U = \begin{pmatrix} NB_{i_1} - E(NB_{i_1}) \\ NB_{i_2} - E(NB_{i_2}) \\ \vdots \\ NB_{i_n} - E(NB_{i_n}) \end{pmatrix},$$

or

$$U = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix},$$

where $a_j = NB_{ij} - E(NB_{ij})$, $j = 1, 2, \dots, n$, $j \neq i$.

And by definition, the variance of NB_{ij} is $\text{var}(NB_{ij}) = E(NB_{ij} - E(NB_{ij}))^2$, and covariances can be written as $\text{cov}(NB_{ij}) = E(NB_{ij} - E(NB_{ij})) \cdot (NB_{ji} - E(NB_{ji}))$, for $j=1, 2, \dots, n$, $j \neq i$. Hence the variance-covariance matrix would be obtained by $E(UU')$, where U' is the transpose of U .

That is:

$$E(UU') = E \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix},$$

where $a_{jk} = a_j \cdot a_k$.

Since:

$$E(UU') = \begin{pmatrix} E(a_{11}) & E(a_{12}) & \dots & E(a_{1n}) \\ E(a_{21}) & E(a_{22}) & \dots & E(a_{2n}) \\ \dots & \dots & \dots & \dots \\ E(a_{n1}) & E(a_{n2}) & \dots & E(a_{nn}) \end{pmatrix},$$

the variance-covariance matrix V will be

$$V = \begin{pmatrix} \sigma_1^2 & s_{12} & \dots & s_{1n} \\ s_{21} & \sigma_2^2 & \dots & s_{2n} \\ \dots & \dots & \dots & \dots \\ s_{n1} & s_{n2} & \dots & \sigma_n^2 \end{pmatrix}.$$

In the variance-covariance matrix V , σ_j^2 is the variance of cheque clearing balance of bank i with bank j , and s_{jk} ($j \neq k$, $j, k = 1, 2, \dots, n$) stands for the covariance between net cheque clearing balances (i.e., $\text{cov}(NB_{ij}, NB_{ik})$).

The variance of NB_i (net clearing balance of bank i clearing with $n-1$ other banks) can be obtained by using an $n \times 1$ vector A . (Vector A is a column vector; all the elements in A are 1's.) The variance of NB_i is:⁸⁵

$$\begin{aligned} \text{Var}(NB_i) &= A'VA \\ &= (1 \ 1 \ \dots \ 1) \cdot \begin{pmatrix} \sigma_1^2 & s_{12} & \dots & s_{1n} \\ s_{21} & \sigma_2^2 & \dots & s_{2n} \\ \dots & \dots & \dots & \dots \\ s_{n1} & s_{n2} & \dots & \sigma_n^2 \end{pmatrix} \cdot \begin{pmatrix} 1 \\ 1 \\ \dots \\ 1 \end{pmatrix}. \end{aligned}$$

⁸⁵ See Johnston (1984), pp.89-100.

From the result shown above, I can write $\text{var}(NB_i)$ as:

$$\text{Var}(NB_i) = \sum_{j=1}^n \sigma_j^2 + \sum_{j=1}^n s_{jk} + \sum_{k=1}^n s_{kj} \quad (\text{E2.3})$$

($j, k = 1, 2, \dots, n ; j \neq k$) .

Notice that equation (E2.3) will be equal to equation (2.10) since $s_{jk} = s_{kj}$. And when NB_{ij} and w_{ik} is independent, $s_{jk} = 0$, $j, k = 1, 2, \dots, n, j \neq k$. Under this condition:

$$\text{Var}(NB_i) = \sum_{j=1}^n \sigma_j^2 \quad (\text{E2.4})$$

Hence, equation (2.13) (and equation (E2.4)) is obtained when all the off diagonal elements (covariances) in matrix V are zero.

**Endnote 2.6 : Comparison of Two Less-Than-Complete
Clearing Options**

Even though it is initially assumed that the covariance terms under the bilateral clearing option are all zero (see Endnote 2.4(a)), some of the individual entries in the covariance sum can be non-zero. If bank i can mutually agree with a pair (j,k) of other banks (without an organized *clearinghouse*) to cancel their clearing balances through (the account in) bank i (but still maintain bilateral clearings with the rest of banks), $\text{cov}(NB_{ij}, NB_{ik}) < 0$. In turn, $\sum \sum \text{cov}(NB_{ij}, NB_{ik}) \neq 0$. This situation describes the scene of *less-than-complete bilateral* clearing operations. Under such a circumstance, the size of $\alpha(S)$ will be affected by the absolute values of two sets of covariance factors under alternative clearing options. For this reason, S_R obtains its maximum value when $|\sum_j \sum_k \text{cov}(NB_{ij}, NB_{ik})|_B = 0$. S_R still takes a positive value (i.e., savings in reserves due to the difference in standard deviation is present) as far as

$$|\sum_j \sum_k \text{cov}(NB_{ij}, NB_{ik})|_B < |\sum_j \sum_k \text{cov}(NB_{ij}, NB_{ik})|_H .$$

On the other hand, even when a clearinghouse is formed, a few banks might be still engaged in bilateral cheque

clearing among themselves. This practice of *bilateral cheque clearing under a multilateral clearing system* can be explained by some economic reasons. First of all, a pair of closely located banks have an incentive to clear the cheques drawn on each other bilaterally. Since cheque clearing requires time,⁸⁶ partial bilateral clearing could reduce some of the uncertainty associated over a clearing period. Another case exists when two banks make an arrangement for picking up the out-of-town cheques for their partners. This happens when one bank has easier access to the out-of-town banks (for example, through branches) than the others. Those cheques picked up for other banks would be usually cleared bilaterally between two partners despite the existence of the clearinghouse. (See chapter III for the early experiences of Canadian banks.) Secondly, a bank might adopt a bilateral cheque clearing with a particular partner in order to investigate its clearing positions more closely. In other words, if a bank wants to look into the net clearing balance of its clearing partner(s) to prevent financial problems (such as bank runs), it will demand to have bilateral cheque clearing between them. In this case it can still maintain a multilateral cheque clearing with the rest of banks. Furthermore, some banks want to reveal their clearing balances only to their direct clearing

⁸⁶ A standard cheque clearing period (exchange and settlement) was up to a fortnight before the introduction of electronic information exchange.

partners. When banks clear their cheques through a clearinghouse, it is inevitable that their clearing balances with the rest of the clearing partners become available to all of the participating banks. Historically, there is a piece of evidence supporting this view. When the first clearinghouse was formed in the Halifax area in 1877, a few banks protested against the idea of rival banks gaining access to their financial positions.⁸⁷

Of course, there are costs for adopting this partial bilateral option on top of a multilateral clearinghouse. In the variance-covariance matrix, V (endnote 2.4), if a pair of banks (bank j and bank k) decided to clear their cheques bilaterally, their covariance entries would be zero. That is, $s_{jk}=s_{kj}=0$, for $j \neq k$. Consequently, the savings in reserves for the clearing system would be less than the maximum, which is obtained when $s_{jk} < 0$, $\forall j, k=1, 2, \dots, n$. For an individual bank, (say, bank j), to maintain a certain level of liquidity with its bilateral clearing partner, it will have to bear a higher ratio of reserves ($t_b > t_m$) than it would under a multilateral clearing option. For this reason, the clearinghouse would normally try to persuade banks to join the multilateral clearing to maximize the savings in reserves ($s_{jk}=s_{kj} < 0$, $\forall j, k=1, 2, \dots, n$); on the other hand, an individual bank would weigh the benefit (savings in reserves and transportation cost) and the cost

⁸⁷ See Jamieson (1955).

(revealing information to other partners) before joining the clearinghouse.

**Endnote 2.7 : Examination of Signs Attached to Equations
(2.30) and (2.30-a)**

In this endnote, I will examine the signs of partial derivatives contained in equations (2.30) and (2.30-a).

Recall that:

$$\alpha = \frac{t_b - t_m}{t_m} , \text{ and}$$

$$\begin{aligned} t_b &= \rho_B \left(\frac{K_0}{I} \right)^{1/2} \\ &= \frac{\sigma_B}{\sqrt{D_i}} \left(\frac{K_0}{I} \right)^{1/2}; \end{aligned}$$

$$\begin{aligned} t_m &= \rho_m \left(\frac{K_0}{I} \right)^{1/2} \\ &= \frac{\sigma_m}{\sqrt{D_i}} \left(\frac{K_0}{I} \right)^{1/2}; \end{aligned}$$

Then:

$$\frac{t_b - t_m}{t_m} = \frac{\frac{\sigma_B}{\sqrt{D_i}} \left(\frac{K_0}{I} \right)^{1/2} - \frac{\sigma_m}{\sqrt{D_i}} \left(\frac{K_0}{I} \right)^{1/2}}{\frac{\sigma_m}{\sqrt{D_i}} \left(\frac{K_0}{I} \right)^{1/2}} .$$

Therefore,

$$\alpha = \frac{\sigma_B - \sigma_M}{\sigma_M} \quad (E2.5) \quad .$$

From equation (2.13), we have

$$\begin{aligned} S &= \sigma_B^2 - \sigma_M^2 \\ &= (\sigma_B - \sigma_M) \cdot (\sigma_B + \sigma_M) \end{aligned} \quad (E2.6) \quad .$$

Using equations (E2.5) and (E2.6),

$$\alpha = \frac{S}{\sigma_M(\sigma_M + \sigma_B)}$$

Consequently,

$$\begin{aligned} \frac{\partial \alpha}{\partial S} &= \frac{1}{\sigma_M(\sigma_M + \sigma_B)} > 0 \quad (\because \sigma_B, \sigma_M > 0), \text{ and} \\ \frac{\partial^2 \alpha}{\partial S^2} &= 0 \quad . \end{aligned}$$

Appendix

As I have mentioned before, the optimal reserve question is not discussed in chapter II. However, for the better understanding of the argument made in chapter II, I will insert brief summaries of two contending models of optimal required reserve.

Appendix A - Baltensperger Model

According to Baltensperger (1980),¹ a bank would choose its reserve to balance its two costs. By holding reserves, a bank will face the opportunity cost of losing interest income, but at the same time, it will reduce the probability of illiquidity and its adjustment cost. The total cost of holding reserves, R , would be:

$$TC = rR + \int_R^{\infty} P(X-R) f(X) dx \quad (a) ,$$

where r is the yield (interest) on loans,

R is the reserve,

X is the outflow of deposits (withdrawals),

$f(X)$ is the density function, and

¹ See Baltensperger (1980), pp.4-6 for details.

p is the cost per unit of reserve deficiency.²

First, the opportunity cost of holding reserves is indicated. Since unreserved funds can be distributed to income earning assets, the total opportunity cost of the reserves is rR . On the other hand, the second entry on the right side of equation (a) is the "expected adjustment cost due to reserve deficiency". In figure A2.1,³ $(X-R)$ indicates the reserve deficiency (i.e., excess outflow of deposit over reserve). The area underneath of $f(X)$ curve (shaded) is given by $\int_R^X (X-R)f(X)dx$.

Since we are interested in the total expected cost of reserve deficiency, X would be in the range of (R, ∞) . Notice that in this analysis a penalty is levied on the negative balance of a bank. At the same time, however, no interest is paid to the extra reserves held. This **asymmetry** in the cost-benefit structure brings in the precautionary incentive to hold reserve.

To find the marginal costs of holding an extra unit of reserve, equation (a) is dealt with partial derivatives with respect to R .

² p also can be interpreted as the penalty rate on negative balances.

³ I constructed figure A2.1 based on Baltensperger (1980), with the assumption of normal stochasticity for R and X .

Figure A2.1 Distribution of Reserves and Outflows

That is:

$$\frac{\partial TC}{\partial R} = r - \int_R^{\infty} p f(x) dx = 0 ;$$

$$r = p \int_R^{\infty} f(x) dx \quad (a)' .$$

Equation (a)' above shows that the additional opportunity cost incurred by holding one more unit of reserve is matched by the extra reduction in the expected adjustment cost due to reserve deficiencies. Rearranging equation (a)', we find that the optimal reserve condition can be expressed as:

$$\frac{r}{p} = \int_R f(X) dX \quad (a)'' .$$

From equation (a)'', it is obvious that the optimal management of portfolio(D) is based on the unit costs (r and p and its stochastic nature of deposits (f(X)).

Further observations can be made on equation (a)''. First, this equation provides the guideline for the penalty rate, p, under which a bank will hold positive reserves. In equation (a)'', if $r/p = 1/2$ then R will be equal to zero. In turn, it becomes $p = 2r$. This means that when the penalty rate on reserve deficiency is twice the rate of interest earned from the loan, a bank will hold zero reserves. And when $p > 2r$, a bank will hold positive reserves to prevent the high adjustment cost involved with a net negative balance.

Appendix B - Galbraith-Rymes Model

According to the previously described liquidity management model (Baltensperger model), a representative bank compares the marginal cost and marginal benefit of a unit of extra revenue. Then, as has been explained, the optimal reserve is determined by the interest differentials and the structure of the asymmetric information represented by service charges.⁴

From the result found in Appendix A, when the penalty rate is greater than twice the interest rate paid on bank loans (i.e., $p > 2r$), the desired reserve of a bank would be positive. On the contrary, when $p < 2r$, a bank will seek to hold negative balances; $p = 2r$ is the condition required to make the optimal level of reserves zero.

For the analysis shown in Appendix A, the following settings in cheque clearing practice are presumed:

- (i) all the banks clear their cheque balances through the clearing agent (e.g., clearinghouse);
 - (ii) no interest is paid on (positive) reserves;
 - (iii) debit balance is (immediately) treated with penalty;
- penalty is expressed as the rate on positive net

⁴ The service charge levied by a clearing agent reflects the cost of information gathered from both creditor and debtor banks. The size of service charge is positively related to the degree of asymmetry in information between two parties.

- outflow of deposits;
- (iv) a bank can loan its deposits and earn interest income;
 - (v) instant financing is not available for the debit
experiencing banks; borrowing rates are assumed to be
larger than lending rates; and
 - (vi) reserves of a bank are held in the clearinghouse in
the form of a real asset.

Under these assumptions, a profit maximizing bank must choose its optimal reserves. The formation of a clearinghouse is viewed as an efficient way of reducing the size of the required⁵ positive reserve; a square root rule offers the less-than-proportional increase in reserves. In terms of the Baltensperger model, my analysis of variance and the square root rule implicitly⁶ assumes $p > 2r$.

An initial challenge to the existing liquidity model is based on the rigidity of the model. As discussed by Galbraith,⁷ Baltensperger's **two to one** rule for optimal reserves only applies to particular institutional settings. Moreover legal restrictions (interferences) are present for the proper function of the liquidity management model.

⁵ The term "required" does not necessarily indicate legal requirement. Members of private clearinghouse can decide its desired size for themselves.

⁶ Analysis given by Edgeworth (and others) does not specify the conditions under which a bank holds positive reserve. It simply indicates that positive reserve (out of the deposits) is a reasonable precautionary measure.

⁷ Galbraith and Rymes (1993), pp.1-2.

(These conditions are comparable to the assumptions given above, (i) - (vi).) In other words, a more general solution for the desired optimal reserves ought to exist under the framework which is not restricted by legal constraint and specific institutional settings.

To see the "general" optimal reserve position of a bank, a two tier banking system is conceived. First, a bank is employed as an intermediary among agents. It earns interest on its loan(s) using deposits; also a bank pays **the same rate of interest** to its depositors. At the same time a bank levies service charges to both creditors and debtors who are using the bank as an intermediary. These service charges cover the costs needed to gather information about the parties (i.e., creditors and debtors) engaged in the offered transaction services.⁸ In other words, agents can only provide the transaction services for themselves at a higher cost.

Under these circumstances, a bank's profit will be solely dependent upon the generated service revenue. That is, if more debit and credit entries are recorded (i.e., more transactions are made through a bank), the total service revenue of a bank would be increased. Unlike the

⁸ A bank is superior to the agents in gathering and evaluating the information. Hence, service charges paid would be the minimum information cost faced by agents.

models I have shown before, no net interest income⁹ will be generated; the interest paid on deposits is equal to the rate levied on bank loans. The service charges might be different for debtors and creditors depending on the asymmetric structure of the involved information.¹⁰

Similarly, banks use a clearinghouse as an intermediary for the supply of transaction services amongst themselves. In other words, there exists an institution - a clearinghouse (or a central bank) - which plays the role of banker's bank. As a bank uses a single interest rate for deposits and loans, a clearinghouse also would employ the same interest rate. Since there is no interest differential, the cost of using a clearinghouse would be entirely dependent upon the number of transactions a bank conducted through the clearinghouse. Notice that a bank has to pay the service charge whenever it either possesses a credit or debit balance with a clearinghouse. Hence, for an optimal size of reserve a bank will seek to hold a new (compared to liquidity model) desired level; none.

This "zero" desired reserve is the conclusion based on the legal-restriction free framework stated above. When a banking system is characterized by:

⁹ Net interest income refers to the interest income generated by the spread between lending and borrowing rates, which is zero in the case mentioned here.

¹⁰ In a more symmetric framework (e.g., Galbraith and Rymes model), the same rates of service charge is levied on both parties.

(i) no interest differential between lending and borrowing;
(ii) profit generated from the service charges;
(iii) no restriction on interest payment on positive reserve balance with a clearinghouse;
(iv) no arbitrary penalty rate on negative reserve balance;
and
(v) pure credit system (no real asset is held) ,
a bank would seek to hold zero reserves at a given time because any positive or negative entry in the clearinghouse requires the corresponding payment of service charges. One very important implicit assumption for this model is that there exists a capital market which allows the instant transaction for a bank when it experiences a debit balance.¹¹

¹¹ See Galbraith and Rymes (1993) for more details of the model structure and assumptions.

Chapter III : A Case Study of Early Canadian Experience

3.0 Introduction

The discussion in Chapter II showed that the multilateral clearing process would bring about savings in physical clearing as well as reserve holding costs. There the reduction in physical costs under a multilateral clearing system was illustrated by the example of a reduction in the number of trips required for settlement. Most of the analysis, however, focused on modelling the savings in reserve costs that the multilateral clearing system could generate for participating banks. Based on the model constructed in chapter II, I now turn to examine the savings in costs (especially reserve costs - see equations 2.2 and 2.28.) that Canada experienced in its early banking history between 1873 and 1913.

Before I begin the investigation of the Canadian case, a few *precautions* should be mentioned. First, the transition from a bilateral to a multilateral clearing system in Canada involved a considerable period of *mixed clearing*. That is, in chapter II, I assumed that the shift from a bilateral to a multilateral clearing process occurred completely and discretely.¹ However, while clearinghouses

¹ The possibility of incomplete transition was discussed in part II as well. However, the savings in reserves (see equation 2.28) was measured under the assumption of a complete dichotomy of the clearing system.

were established in different *major* banking centres of Canada in the late 1880s and 1890s, both bilateral and multilateral clearing systems coexisted for a while. In general, the period between 1887 and 1900 is considered one of transition, as the clearing system changed slowly from bilateral to multilateral clearing.²

To *analyze* the specific characteristics of Canadian banking development from a cheque clearing point of view, I will examine various "episodes" in early Canadian banking history. Developments in banking institutions, the evolution of bank structure, changes in legislation and other events that had an impact on the cheque clearing process will be explored.

Before I begin I wish to place the historic episodes of sections 3.2-3.5 in context by presenting a statistical overview of the quantitative data that are available. Section 3.1 presents an empirical test of the reserve holding hypothesis associated with cheque clearing behaviour in Canadian banking during this period. Despite limitations in the data set, the empirical tests broaden the analysis of cheque clearing in Canadian banking history. Also a few new statistical tables are added to reveal some "fresh" findings from the history.

² Development of early clearinghouses and the related institutional evolution (such as the Canadian Bankers' Association) are discussed in sections 3.3 and 3.4.

3.1 A Statistical Overview of Two Alternative Clearing Options: Canadian Case, 1873-1913

To place the historical evolution of the Canadian cheque clearinghouse system in context, I first present a statistical overview of the data that are available in early Canadian banking history. There are a number of difficulties in applying quantitative measures to test the reserve hypotheses, however. First of all, the data in this early banking period are often incomplete and non-homogeneous.³ Frequent changes of data categories (or definitions) are just one example of the problems with the early data. In addition, there are some disagreements between different sets of data. Finally, many structural changes cannot be easily quantified. For example, various revisions in the Banking Act and the different amendments in Clearinghouse Rules have had crucial impacts on the clearing system, but are qualitative variables that cannot easily be expressed as numbers. (More technically serious problems with data such as nonstationarity will be discussed later.)

For these reasons, rigorous empirical studies of this period must be quite limited. However, in this section, I do present some limited statistical information on the *trend*

³ In endnote 3.1 (a), sources of data available in this period (including ones used in this study) are listed.

in reserves holdings observed in this period (1873-1913). I begin by reviewing the reserve ratios⁴ of the banks; it will be followed by an econometric test of the hypothesis developed in Chapter II (i.e., savings in reserves).

Figure 3.1 shows the trend in the reserve ratio⁵ both for banks in the aggregate as well as for a few of the key individual banks (e.g., Bank of Montreal, Bank of Commerce, and Bank of Nova Scotia) from 1873 to 1913. To make the comparisons between different clearing options, I divide the entire period (1873-1913) into three subperiods: subperiod I (1873-1888)⁶, subperiod II (1889-1900) and subperiod III (1901-1913). Subperiod I represents the years of the bilateral clearing system; subperiod II consists of the first dozen years of the multilateral clearing period (with some degree of mixed clearings) when the clearinghouses and the Canadian Bankers Association (CBA) were still voluntary organizations; and subperiod III is the period following the incorporation of the CBA in 1900 of the multilateral system. In principle, bilateral clearings among the banks where

⁴ Reserve ratio is defined as the reserves (notes and gold) held over deposits.

⁵ See Galbraith and Guthrie (1970) for the discussion on the reserve ratios in banking operation.

⁶ For the Bank of Commerce, subperiod I extends to 1891, in which year the Toronto Clearinghouse was established.

clearinghouse was available were banned by the CBA after 1900.⁷

Figure 3.1 Average Reserve Ratios, 1873-1913

- (a) average of all banks
- (b) Bank of Montreal
- (c) Bank of Commerce
- (d) Bank of Nova Scotia

⁷ Despite the regulation imposed by the CBA, it was still practically conceivable that some banks exchange cheques bilaterally, which they had done for a long time in a small inner circle. See section 3.5 for more discussion.

Reserve Ratios, 1873-1913

Table 3.1 Average Reserve Ratios in Subperiods

	I(1873-88)	II(1889-1900)	III(1901-13)
all banks	18.1 %	10.9 %	12.1 %
Bank of Montreal	18.5 %	12.1 %	8.1 %
Bank of Commerce	12.9 %	5.1 %	9.1 %
Bank of N.S.	11.3 %	11.0 %	14.1 %

source : *Monetary Times*, 1873-1913, and Urquhart and Buckley (1965).

First, Figure 3.1 (a) shows that the aggregate reserve ratio declined constantly over 1873-1888. The reduction in the reserve ratio is partly caused by the expansion of the branch banking. (See Sections 3.2 and 3.3 for detailed discussion on the impact of branch banking on reserves.) A further decline in the average reserve ratio took place in subperiod II. This could reflect further savings in reserve holdings when the clearing system shifted from bilateral to multilateral clearing. Contrary to our expectations, subperiod III exhibits a slight increase in the aggregate reserve ratio. However, considering the numerous bank failures that occurred between 1900 and 1913 (see Table 3.15 in section 3.5), a slight rise in the reserve ratios in that period need not imply that the savings in reserves due to

the adoption of the clearinghouses were not realized.⁸ One specific incident which is sometimes thought to have triggered higher reserve ratios in subperiod III was the Financial Crisis of 1907.⁹ In fact, the average reserve ratio in the first half (1901- 1906) of this subperiod was 10.8 %, which is comparable to the ratios in subperiod II, while in the second half (after the Financial Crisis, i.e., 1907-1913) it was 13.1 %.¹⁰

The trends of the reserve ratio for the three individual banks are sketched in Figure 3.1 (b)-(d) and Table 3.1. Three quite distinct patterns are observed. The Bank of Montreal, as shown in Figure 3.1 (b), shows a constantly declining reserve ratio even in subperiod III. Notice that, however, the Bank of Montreal had the largest proportion of the secondary reserve among the Canadian banks in the form of call loans in the New York Stock Exchange. (See *Monetary Times*, 1900-1913.) In other words, the Bank of Montreal was able to rely on the protection of secondary reserves during this financially unsettled period. (Figure

⁸ Along with branch banking, the impact of mergers is considered in the regression tested later in this section.

⁹ It is believed that banks became more cautious with major financial crunch in 1907 (both in Canada and the United States). At the same time, banks in Canada increased their call loans in New York Stock Exchange after 1907 to maintain adequate liquidity. See Rich (1988).

¹⁰ Similar observations are made for individual banks. The Bank of Montreal had the average reserve ratio of 7.3% between 1900 and 1906 and 8.8% between 1907 and 1913. Same figures for the Bank of Commerce were 7.1% and 10.9%, respectively. The Bank of Nova scotia recorded 14% between 1900 and 1906 and 14.3% in the second half.

3.1 (b) shows only primary reserves.) On the other hand, the Bank of Commerce exhibits (Figure 3.1 (c)) the most similar pattern to the general trend shown in Figure 3.1 (a), even though the reserve ratios of the Bank of Commerce were well below those of the entire banking industry. And the reserve ratios of the Bank of Nova Scotia indicate the reduction in average reserve ratios from subperiod I to II was much smaller (11.3% to 11.0%) compared to other banks mentioned. Rather, the Bank of Nova Scotia recorded a considerable increase in reserves from period II to III. This reflects the view McLeod (the General Manager of the Bank of Nova Scotia) expressed in 1902 in his letter sent to the general managers of the banks in Canada. He argued that to maintain the proper level of liquidity, about 13% of reserve requirement should be imposed.¹¹ (Notice that the average reserve ratios of the Bank of Nova Scotia in this period was 14.1%.)

To analyze further the expected savings in reserves associated with the Edgeworthian square root rule shown in Chapter II,¹² recall equation 2.20:

¹¹ Bank of Nova Scotia, *Correspondence of General Managers*, H.C. McLeod Series, April 24, 1902, BNS Archives.

¹² While the reserve ratios reported in Figure 3.1 and Table 3.1 show the relative size of reserves (to the deposits), values of t are obtained under the assumption that the square root rule links two variables, D_i and R_i .

$$R_i = t\sqrt{D_i} \quad (2.20)$$

where R_i is the level of reserves of bank i ;
 D_i is the level of deposits in bank i ; and
 t is a coefficient related to constant desired degree
of bank liquidity. (See equations 2.16 - 2.20 for
detailed relationships between t and other variables.)

As discussed in Chapter II, as a multilateral clearing
system comes to replace a system of bilateral process, the
smaller variance in daily clearings under the multilateral
clearing will allow savings in reserves by decreasing the
value of t^{13} in equation (2.20) required to maintain the
same degree of liquidity (γ).

To see what other variables might have had an impact on
the values of t (on top of σ), let's recall the equations
2.16-2.19 in Chapter II, in which t is expressed as:

¹³ Smaller variance permits the same level of liquidity with lower reserves. This leads to savings in reserves.

$$t = \rho \cdot \left(\frac{K_0}{r} \right),$$

where $\rho = \sigma / (E(D_i))^{1/2}$ ($\rho > 0$);

σ is the standard deviation of net clearing balance of bank i (NB_i);

K_0 is the penalty cost levied on the debit settlement balance; and

r is the rate of interest.

As the expression indicates, t decreases when σ decreases. That is, we expect that, other things being equal, t will be smaller under the multilateral system because the standard deviation of NB_i under the clearinghouse system will be smaller. (See endnote 2.4.) In moving between subperiods discussed in this section, the variables, K_0 and r , were *not fixed*. For example, figure 3.2 shows the changes in the interest rate in Canada between 1873 and 1913.

Figure 3.2 Interest Rates in Canada, 1873-1913
(5 year average)

Source: Rich (1988), p.292,
 Urquhart and Buckley (1972), p.291,
 Homer and Sylla (1991), p.546

As indicated in the figure, the rate of interest (r) dropped constantly between 1900 and 1913. This implies that t will rise as the opportunity cost of holding reserves falls.

A second set of considerations arise from changes in the penalty costs of holding reserves. If the value of K_0 (the penalty cost of net negative settlement balance) increases, more reserves will be held and the observed level of t will rise. Testing this prediction is difficult since no direct statistics are available on how the values of K_0 changed in the early period of Canadian cheque clearing practice. However, *indirect* evidence suggests that the unpaid net debit balances were taken more seriously than before, particularly once the CBA officially took charge of the cheque clearing process in 1900. (See sections 3.4 and 3.5 for more detail and a discussion of the rules which regulated the debit balances at the end of each clearing day.)

A third set of conditions are factors influencing the standard deviation of the daily net clearing balance (i.e., σ). In particular, the savings in reserves that are expected to be observed when the cheque clearing process switched from bilateral option to its multilateral counterpart assumes that there are no other changes in other banking structures that influence σ . However, not only changes in the cheque clearing process but also other significant banking structural changes (such as expansion of branch banking, mergers, the financial crises) arose concurrently. Because of the significance of these *qualitative* changes in structure, a full understanding of

the evolution of the banking system requires a historical institutional investigation of the particular episodes that have helped build a *more effective Canadian cheque clearing system*.

Despite the described limitations of the quantitative data in this problem, a historical statistical investigation was undertaken to see what insight could be obtained through regression analysis. That is, a simple econometric test was run to see how much of the observed variation in bank reserve holdings could be explained by the quantitative variables.

Period

Empirical study is conducted with annual data from 1873 to 1913. The entire period is divided into three sub-periods :

period I : 1873 - 1888 (bilateral clearing)

period II : 1889 - 1900 (introduction of clearinghouse;
some mixed clearing)

period III : 1901 - 1913 (exclusive multilateral clearing)

Model

Based on the equation (2.20) and the other variables predicted to have impacts on the reserves, R_i can be expressed in functional form as

$$R_i = f(\sqrt{D_i}, b_i, i, mer, ins, dum) \quad (3.1)$$

Variables used in equation (3.1) are :

R_i - Primary reserves include specie and dominion notes¹⁴ in millions of dollars.

This variable is drawn from quite consistent series of data. Between 1873 and 1913, there is no change in headings (cash and dominion notes) either in *The Monetary Times* nor Urquhart and Buckley (1965). As well as cash and dominion notes, call loans held in foreign countries, mostly in New York [call and short loans elsewhere than in Canada] are considered as the secondary reserves. (See Rich (1988).) However,

¹⁴ Even though it is possible that a part of other assets (such as notes of other banks) could be used to pay negative settlement balances, there is no concrete evidence that the settlement balances were paid by anything other than specie and dominion notes. In 1894, the Bank Legals (large denomination Dominion notes) were introduced to be exclusively used among the banks. Despite the possibility of using other assets and the liabilities on a common bank for the cheque clearing settlement, empirical study should use specie and dominion notes as a logical proxy for R_i .

separate figures of secondary reserve are only available after 1900.

D₁ - deposits in millions of dollars.

Deposits of entire banking sector are reported in Urquhart and Buckley (1965). Data for individual banks are available in The Monetary Times (1873-1913) and Canada Year Book (1889-1913).

b₁ - number of branches.

Aggregate data on the number of banks and branches are available in The Monetary Times, Urquhart and Buckley and Breckenridge (1910). Obtaining the data of the branches for each individual bank is more challenging. Branch statistics of three banks can be obtained from the following sources :

Bank of Montreal ; Bank of Montreal Archives (based on unpublished annual reports). Dennis (1921) also contains the numbers of branches for each ten year period.

Bank of Commerce ; a list of the branch banking chronology is reported in Ross (1927).

Bank of Nova scotia ; complete data set of the branch statistics are supplied by the Bank of Nova Scotia Archives (scattered in various documents).

i - rate of interest. percentage

Homer and Sylla (1991) and Rich (1988) are major sources. I used the annual average percentage return

on Canadian Dominion bonds. Homer and Sylla (1991) suggest that this rate is the most representative interest rate of the period.

mer - the number of bank mergers per year.

Data are reported in Urquhart and Buckley (1965).

More detailed explanation of each merger can be found in Perry (1991).

ins - number of insolvencies reported each year.

Data are found in Urquhart and Buckley (1965) and Neufeld (1972).

dum - binary variable. Two sets are used.

d2=1 for 1889-1900 and d2=0 otherwise.

d3=1 for 1901-1913 and d3=0 otherwise.

These variables are introduced to capture the changes in the clearing structure.

Regression Forms

As suggested in the recent literature, time series analysis is often the subject of spurious correlation problem. That is, when the variables included in the regression are not stationary over time, conventional statistical inferences are misleading.¹⁵ Since this

¹⁵ See Charemza and Deadman (1992) for more discussion on the limits of conventional econometrics and suggested alternatives.

analysis deals with a set of data simultaneously rising over time, a closer examination of the individual series should be made. In fact, when unit root tests were undertaken augmented Dickey-Fuller test statistics indicate that R_i , square root of D_i and b_i are nonstationary,¹⁶ while i , mer and ins are stationary.

To correct this problem, I have developed an error correction formulation of the test designed to capture the short-run fluctuations of the cointegrated variables around the long run equilibrium relationship. (Cointegration results among the three variables, R_i , D_i and b_i , justify the inclusion of an error correction term.)¹⁷ In other words, the nonstationarity of the error terms causes the violation of the *ceteris paribus* assumption needed to apply conventional statistical inferences. However, systematic components of the error, when applied with the appropriate auxiliary hypothesis, lead to an improved analysis of time series data.

¹⁶ Unit root tests were conducted with SHAZAM. For all three banks, the null hypothesis of nonstationarity could not be rejected. See endnote 3.1(b) for the complete test results.

¹⁷ In case of Bank of Commerce, the hypothesis of no cointegration is not clearly rejected (at asymptotically 10 % level). However, test statistics are too close to dismiss the cointegration.

The forms of the regressions are:

(1)

$$\Delta R_i = \alpha_0 + \alpha_1 \Delta SD_i + \alpha_2 \Delta b_i + \alpha_3 ECT + \alpha_4 d2 \Delta SD_i + \alpha_5 d3 \Delta SD_i + \alpha_6 i + \alpha_7 mer + \alpha_8 ins$$

β 's in ECT (error correction term - see below for the definitions of variables) are calculated from a long-run relationship between reserves, deposits and branch banking, i.e.,

$$R_i = \beta_0 + \beta_1 SD_i + \beta_2 b_i.$$

(2)

$$\Delta R_i = \alpha_0 + \alpha_1 \Delta SD_i + \alpha_2 \Delta b_i + \alpha_3 ECT + \alpha_4 d2 \Delta SD_i + \alpha_5 d3 \Delta SD_i + \alpha_9 \Delta i + \alpha_{10} \Delta mer + \alpha_{11} \Delta ins$$

β 's in ECT are calculated from:

$$R_i = \beta_0 + \beta_1 SD_i + \beta_2 b_i.$$

(3)

$$\Delta R_i - \alpha_0 + \alpha_1 \Delta SD_i + \alpha_2 \Delta b_i + \alpha_4 d2 \Delta SD_i + \alpha_5 d3 \Delta SD_i + \alpha_6 i + \alpha_7 mer + \alpha_8 ins$$

ECT not included.

(4)

$$\Delta R_i - \alpha_0 + \alpha_1 \Delta SD_i + \alpha_2 \Delta b_i + \alpha_4 d2 \Delta SD_i + \alpha_5 d3 \Delta SD_i + \alpha_9 \Delta i + \alpha_{10} \Delta mer + \alpha_{11} \Delta ins$$

ECT not included.

Four regressional forms listed above employed different model specifications. In regressions (1) and (2), an error correction term is included while in (3) and (4) it is not. In table 3.2 (results of the regression), impacts of the independent variables on reserves can be analyzed with cointegration-error correction techniques ((1) and (2)) and with a conventional econometric modelling ((3) and (4)). Notice that regressions (1) and (3) are using levels of stationary variables (i.e., *i*, *mer*, and *ins*), but in (2) and (4) first order differences are employed.

variables

Variables used in the equations described above are

dependent variable :

$$\Delta R_i = \log(R_i) - \log(R_{i-1})$$

R_i is the reserves of bank *i*.

explanatory variables :

$$\Delta SD_i = \log(SD_i) - \log(SD_{i-1})$$

SD_i is the square root of the deposits of bank i .

$$\Delta b_i = \log(b_i) - \log(b_{i-1})$$

b_i is the number of branches of bank i .

$$ECT = \log(R_{i-1}) - \beta_1 SD_{i-1} - \beta_2 b_{i-1}$$

(Error Correction Terms)

β 's are calculated from a perceived long-run relationship.

$$\Delta d2SD_i = \Delta(d2SD_i)$$

$d2$ is the dummy for second subperiod.

(i.e., $d2=1$ for 1889-1900, $d2=0$ otherwise.)

$$\Delta d3SD_i = \Delta(d3SD_i)$$

$d3$ is the dummy for third subperiod.

(i.e., $d3=1$ for 1900-1913, $d3=0$ otherwise.)

i is the rate of interest.

$$\Delta i = i - i_{-1}$$

mer is the number of banking mergers.

$$\Delta mer = mer - mer_{-1}$$

ins is the number of insolvencies in the banking industry.

$$\Delta ins = ins - ins_{-1}$$

Expected signs of model parameters :

$\alpha_1 > 0$; based on the square root rule

$\alpha_2 < 0$; when branch banking is strengthened. More internal clearing is conducted and reserve holdings would be reduced.

$\alpha_3 < 0$; when an error correction term captures the change in cointegrated variables, coefficient would be negative.

$\alpha_4 < 0$; $d_2=1$ for 1889-1900 and $d_2=0$ otherwise. This variable tests whether savings in reserves are realized in subperiod II (1889-1900).

$\alpha_5 < 0$; $d_3=1$ for 1901-1913 and $d_3=0$ otherwise.

The existence savings in reserves in subperiod III is checked.

α_6 (α_9) < 0 ; reserve holdings will decrease when opportunity cost of holding reserves increase.

α_7 (α_{10}) > 0 or < 0 ; expected signs for merger can be +/-.

In general, mergers can eliminate some weak players in a cheque clearing and reduce the reserve holdings of the remaining banks, in which case $\alpha_7 < 0$. In some cases, however, it can be argued that an increasing merging trend over a period can create uneasiness among the cheque clearing banks and put upward pressure ($\alpha_7 > 0$) on R_1 .

$\alpha_8 (\alpha_{11}) > 0$; The number insolvencies is used as the proxy for risk in banking sector. When the number of insolvencies increases, banks are expected to hold more reserves.

Results ¹⁸

Here I report the regression results of the three banks considered using the regression models mentioned above. In Chapter II, I talked about the savings in reserves for a *representative bank*. In reality, there is no such representative bank. The three banks selected here (the Bank of Montreal, the Bank of Commerce and the Bank of Nova Scotia) evolved from three different banking centres where the first clearinghouses in Canada were established. At the same time, the data sets available for empirical analysis for these three banks are better than those available for other banks.

Table 3.2 Results of Regressions

¹⁸ SHAZAM® is used in the econometric work (DOS version 6.2/7.0). Heteroscedasticity consistent standard errors are estimated using White (1980) method.

Bank of Montreal

variable	(1)	(2)	(3)	(4)
const.	-0.34 (0.89)	-0.57 (4.16)	-0.38 (0.76)	0.02 (0.62)
ΔSD_i	1.48 (4.32)	1.48 (4.36)	1.54 (3.66)	1.51 (2.79)
Δb_i	-0.13 (0.81)	-0.12 (0.84)	-0.32 (1.73)	-0.30 (1.24)
ECT	-0.87 (4.78)	-0.81 (4.81)		
$\Delta d2SD_i$	-0.03 (1.69)	-0.02 (1.52)	-0.001 (0.01)	-0.01 (0.66)
$\Delta d3SD_i$	-0.05 (3.16)	-0.05 (3.62)	-0.02 (0.73)	-0.02 (1.38)
i	-0.07 (0.67)		0.10 (0.72)	
mer	-0.04 (0.74)		0.07 (0.87)	
ins	-0.001 (0.06)		0.02 (0.60)	
Δi		0.07 (0.53)		0.23 (1.43)
Δmer		-0.06 (1.34)		-0.04 (0.78)
Δins		-0.01 (1.07)		-0.004 (0.46)
R^2	0.67	0.68	0.42	0.44
DW	2.03	2.05	2.76	2.59

Heteroscedasticity consistent t ratios are reported in parentheses.

Bank of Commerce

variable	(1)	(2)	(3)	(4)
const.	-1.01 (1.80)	-0.54 (2.17)	-0.67 (1.14)	0.02 (0.70)
ΔSD_i	1.41 (2.72)	1.32 (2.56)	1.34 (2.31)	1.51 (3.02)
Δb_i	-0.09 (0.43)	-0.10 (0.45)	-0.27 (1.32)	-0.33 (1.88)
ECT	-0.22 (2.89)	-0.18 (2.15)		
$\Delta d2SD_i$	-0.07 (3.51)	-0.08 (3.23)	-0.04 (0.14)	-0.07 (2.33)
$\Delta d3SD_i$	-0.04 (1.99)	-0.03 (1.15)	0.007 (0.24)	-0.007 (0.28)
i	0.07 (0.65)		0.16 (1.08)	
mer	0.11 (1.59)		0.11 (1.23)	
ins	0.04 (1.86)		0.04 (1.66)	
Δi		0.13 (1.23)		0.15 (1.34)
Δmer		0.02 (0.65)		0.04 (0.74)
Δins		0.02 (1.32)		0.02 (1.71)
R^2	0.53	0.47	0.42	0.39
DW	2.08	1.90	2.10	1.97

Heteroscedasticity consistent t ratios are reported in parentheses.

Bank of Nova Scotia

variable	(1)	(2)	(3)	(4)
const.	-1.96 (3.34)	-2.18 (10.20)	0.54 (0.83)	0.07 (1.58)
ΔSD_1	1.09 (1.38)	0.75 (1.05)	1.81 (1.79)	1.42 (1.58)
Δb_i	0.14 (0.82)	0.24 (1.60)	-0.95 (4.40)	-0.87 (4.39)
ECT	-0.83 (10.60)	-0.85 (11.35)		
$\Delta d2SD_1$	-0.08 (1.59)	-0.06 (2.34)	-0.007 (0.09)	0.03 (0.77)
$\Delta d3SD_1$	-0.07 (1.34)	-0.05 (1.53)	-0.006 (0.07)	0.03 (0.70)
$\dot{z}$	-0.05 (0.44)		-0.12 (0.78)	
mer	0.01 (0.38)		0.001 (0.002)	
ins	-0.008 (0.33)		0.005 (0.14)	
Δi		0.06 (0.63)		-0.04 (0.03)
Δmer		-0.06 (1.33)		-0.05 (1.21)
Δins		0.006 (0.35)		-0.003 (0.11)
R^2	0.79	0.79	0.49	0.49
DW	1.95	1.78	2.29	2.15

Heteroscedasticity consistent t ratios are reported in parentheses.

As expected, α_1 is positive for all three banks. A statistically strong positive relationship (supported by t ratios of α_1) between R_1 and D_1 is observed. In other words, the square root relationship between reserves and deposits is empirically supported for the three banks studied in this period. The value of α_1 shows the change in reserves with respect to the change in the square root of deposits while holding all the other variables constant. Different sizes of α_1 indicate that there is not a uniform square root relationship applicable to the three banks at the same time.

Expected signs of α_4 and α_5 are observed in most cases. The negative sign attached to α_4 indicates that the savings in reserves could be realized via reductions in the value of t (in equation (2.20)) in the initial stage of the multilateral clearing system.¹⁹ That is, savings in reserves were observed during the first dozen years followed the introduction of clearinghouses in Canada. Notice that during this subperiod (1888-1900), bilateral clearings were still practised in various places. Similarly, a negative value of α_5 implies that the savings in reserves continued in the subperiod III (1900-1913). In sections 3.4 and 3.5, some institutional changes introduced under the direction of the CBA are discussed.

¹⁹ The period between 1889 and 1900 can be interpreted as one of mixed cheque clearings.

In general, the hypothesis of savings in reserves predicted by the model is supported in the early period of Canadian cheque clearing experience (except for the Bank of Nova Scotia in subperiod III without ECT). Notice that those savings in reserves are supported by the right signs appearing for α_4 and α_5 .

The possible dissavings in reserves witnessed for the Bank of Nova Scotia in subperiod III (1901-1913) is believed to be based on the *high reserve policy* adopted during this period. McLeod (General Manager of the Bank of Nova Scotia) emphasized the adequacy of reserves for banking operations in the 1900s. He suggested that the reserve ratio should be at least 13 % to protect the best interests of the customers and the banks. The Bank of Nova Scotia, consequently, maintained a much higher reserve ratio than did the others.

Among the other independent variables, consider b_1 (branch banking) first. As expected the sign of α_2 is negative.²⁰ In other words, the expansion of branch banking seemed to have allowed banks as a whole to economize on reserve holdings. General practice with intrabank clearings could have generated further savings in reserves for the cheque clearing banks.

Notice that the savings in reserves generated by the expansion of branch banking is not hindered by the different

²⁰ For the Bank of Nova Scotia, negative signs are only attached to the non error correction models.

patterns of establishing branches in the new territories of Manitoba, the Northwest Territories (later Alberta and Saskatchewan) and British Columbia.²¹ Table 3.3 shows the sketch of the branch banking pattern of the three banks. (See Appendix C to this chapter for more statistics of branch banking.)

Table 3.3 Percentage of branches in New Territories, 1899 and 1912

	1899 (percentage)	1912 (percentage)
Bank of Montreal	26	33
Bank of Commerce	13	48
Bank of Nova Scotia	3	12

(Percentage is calculated by dividing the number of branches in British Columbia, Alberta, Saskatchewan, Manitoba and territories by the total number of branches. Total number includes the branches in Newfoundland.)

Source : *The Monetary Times and Canada Year Book*

Signs found for α_6 , α_7 and α_8 all show mixed results. In case of α_6 , some banks (including the Bank of Montreal and the Bank of Commerce) did not adjust their reserve holdings sensitively to the changes in the opportunity cost of holding reserves as measured by interest rate series. With the sign attached to α_7 , I can say that the Bank of

²¹ As shown in Table 3.3 below, the Bank of Commerce expanded into the new territories faster than the other banks. Despite this move, branch banking still contributed to the reserve savings of the Bank of Commerce. See table 3.2.

Montreal ($\alpha_7 < 0$ - in model (1)) might have perceived that mergers²² provided safer banking environment. On the other hand, the experience of a positive α_7 by the Bank of Commerce indicates that some banks might have viewed the prolonged merging trend in this period as a sign of instability, which required higher reserve holdings for the *surviving members* of the banking community.

The mixed findings associated with α_8 suggests that the reserve holding decisions of banks in response to a change in the number of insolvencies is not homogenous. Notice, however, that individual t statistics indicate that the reserve holdings of banks were not significantly affected by the change in any of those other variables (i, mer and ins).²³

The empirical results reported above show that a number banking structure variables have some explanatory power over reserve holdings. The savings in reserves and the impacts of other variables exhibit correct signs in most cases. However, a decisive conclusion from this series of empirical studies cannot be reached due to the lack of statistical significance indicated by some of the individual t statistics.

²² As Neufeld (1972) discussed, most of the mergers in this period were hostile takeovers of weaker banks.

²³ Quite similar results are found for the first differences of i, mer, and ins. Statistical significance could not be found for these variables, either.

The statistical analysis provided in this section should be combined with those episodes *unearthed* in the following sections to appreciate early developments in the Canadian cheque clearing system. It is important to emphasize that the episodic evidence provided in the following sections²⁴ and the statistical findings presented in this section are not mutually independent. In fact, the statistics reported in this section can be used to supplement the argument made in the following sections.

To begin, I now *revisit* the beginning of banking in Canada.

²⁴ Sections 3.2 to 3.5 also contain fair amount of supporting statistics.

3.2 Early Canadian Banking: Bilateral Cheque Clearing Experience²⁵

From the beginning, the first Canadian banks were formed as a response to the growing demand for a stable medium of exchange by the quickly expanding economy of the colonies.²⁶ While the demand for "money" on this side of the Atlantic grew steadily (and fast), the colonial authorities could not meet the increasing demand. The limited supply of currency always made the merchants in the colonies long for a more stable supply of media of exchange.²⁷ Only rarely did Colonial authorities feel the need to introduce an emergency measure to fill the inadequate balance between demand for and the supply of money. For example, during *the Revolutionary War* and *the*

²⁵ In this section, mainly *bilateral* cheque clearing experience of Canada prior to 1887 (the first clearinghouse in Halifax) will be discussed.

²⁶ Shortage of specie in British Colonies was considered to be one of the main factors explaining the emergence of banking system. Hammond (1957) makes this argument for British Colonies in "new lands." See Neufeld (1964) for Canadian experience. For other incentives to found banks in Canada, see Marr and Patterson (1980), chapter 8.

²⁷ Hammond (1957) argued that (in British North American Colonies) "[need for banking] arose from the need of a medium of exchange and a legal tender in the absence of specie, which the need of imports kept driving away. For as fast as specie was received, it was exported for goods that could not be produced at home." Similar arguments were made for Australia in Steven (1969) and Jackson (1977). For alternative view on currency situation in the early nineteenth century Canada, see Redish (1984).

War of 1812²⁸ "Army Bills" were introduced; they were used as legal tender, but completely redeemed and withdrawn from circulation after the wars.²⁹

An early attempt to set up a Canadian bank was launched in 1792. In 1792, the *Canadian Banking Company* was established in Montreal to counter "unsatisfactory currency and credit conditions".³⁰ Unfortunately, however, it did not last long.

During this period, merchants in Lower Canada loudly expressed their opinion on the circulation of specie: "there are many inconveniences and discouragements from the quantity of specie in circulation being greatly an inadequate to its necessities and increasing population."³¹ Merchants in Upper Canada were also equally interested in adequate supply of a medium of exchange. Despite the fact that the acceptance of paper money among the public was not that high, the Lieutenant Governor of Upper Canada suggested (1794) that "the necessity of a paper currency where there is not sufficient gold and silver is most obvious." Further

²⁸ See Finlay and Sprague (1989), pp.99-105 for the impacts of the war of 1812 with the United States on Lower and Upper Canadas. Army bills were issued in denominations of \$1, \$2, \$3, \$4, \$5, \$10, \$12, \$16, \$20, \$25, \$50, \$100, and \$400. The original limit of the Army Bills was £250,000 but it was extended to £1,500,000. See also Neufeld (1972), pp.36-9 for more discussion on currency issues in the pre confederation period.

²⁹ See Perry (1991), p.34. See also Easterbrook and Aitken (1979), p.449.

³⁰ See Easterbrook and Aitken (1979), p.448.

³¹ Castel-Hopkins (1898) p.461 cited in Redish (1984).

efforts put forward by the merchants in Kingston between 1817 and 1821 also show that they believed that "the establishment [of a bank] would be beneficial to the country by remedying the great want of specie by securing to ourselves whatever advantages are to be derived for the issue of a paper currency."³² In other words, early efforts to form Canadian banking tried to ensure the circulation of medium of exchange suitable to the need of merchants in Canada, which would not be easily drained off as the species shipped from Europe often did.³³

Following the experiment of the unsuccessful but pioneering attempt by *the Company*, efforts to found banks continued in Canada. After a number of further unsuccessful attempts,³⁴ the Canadian banking industry finally achieved its first successful entrant; in 1817 the *Bank of Montreal* appeared as the first bank of discount, deposit and issue. Once the Bank of Montreal was successful, two other banks quickly followed. In 1818 the Quebec Bank and the Bank of Canada entered the banking industry. All three banks operated as private partnerships until their charters were

³² Upper Canada House of Assembly Journal (April 6, 1821) in Redish (1984).

³³ A large portion of species shipped was used to purchase goods from Europe, and shipped back without much circulation in Canada.

³⁴ To find more about these efforts to form Canadian banks (during 1792-1817), see Neufeld (1964), pp.30-44, and Breckenridge (1894), pp.18-20. During this period, large merchants were also performing limited banking roles.

granted³⁵ in 1822. One of the main features of the charter was the right to issue bank notes, and their notes quickly became an important part of *money supply* in Canada. This was good news to the merchants. Since they were eager to have a stable medium of payment, bank notes quickly became accepted in many transaction payments.

Circulation of bank notes grew steadily through the 1820s and the 1830s. Among the three banks chartered in 1822, the Bank of Montreal supplied most of the bank notes in Lower Canada. Table 3.4 shows the pattern of growth in bank notes in Lower Canada. While the notes issued by the existing banks continued to grow, new banks emerged³⁶ adding their own notes and accelerating the acceptance of bank notes as medium of exchange. Notice that as far as the supply of medium of exchange in Canada in the 1820s and 1830s (in terms of bank notes) was concerned, the Bank of Montreal was dominant in size.³⁷

³⁵ The charter granted to the Bank of Montreal became the model for all following banks in Canada. The original charter of the Bank of Montreal is believed to be based upon the operation of the First Bank of United States, of which bylaws were drafted by Alexander Hamilton in 1791. Charter granted in 1822 was soon extended to the Bank of British North America. More on the original charter of the Bank of Montreal can be found in Denison (1966), and Neufeld (1964), pp.53-67.

³⁶ The number of banks in Lower and Upper Canadas grew to six by 1829. In 1836, twenty one chartered banks were operating in Canada.

³⁷ For banking and bank notes in Upper Canada and the Maritimes, see MacLaren (1901), Breckenridge (1894), Neufeld (1964), Schull and Gibson (1982), Ross (1922) and Easterbrook and Aitken (1956).

Table 3.4 Selected Statistics of Bank Notes Circulation in Lower Canada

banks	year	notes in circulation (\$)
Bank of Montreal	1824	370908
	1825	550320
	1826	532020
	1828	592156
	1830	714208
	1832	894232
Quebec Bank	1824	102260
	1825	113708
	1826	145664
	1828	177312
	1830	154852
	1832	190548
Bank of Canada	1824	156824
	1825	45788
	1826	96508
	1828	14020
	1830	13912
	1832	--- *

Source : Breckenridge (1894), p.31.

* The Bank of Canada was acquired by the Bank of Montreal in 1831.

Despite the financial crises Canada experienced in the 1830s and 1840s and subsequent (yet diminishing) doubts over paper money,³⁸ the number of bank notes continued to grow

³⁸ See Breckenridge (1894), pp.68-84 for suspension of payment on bank notes experienced in the late 1830s. Also see Neufeld (1964), pp.132-4 on the financial crisis of 1848-9.

and became a major component of the media of exchange (along with notes and coins) by 1850. As shown in Table 3.5, aggregate bank note circulation grew continuously through the 1850s and 1860s.

Table 3.5 Total Bank Notes in Circulation, 1850-1869

year	notes in circulation(millions)
1850	1.3
1856	4.2
1867	14.1
1868	15.0
1869	18.3

source : Neufeld (1964), p.140, and Urquhart and Buckley (1965), p.231

In Canada, cheques were not generally accepted as a general method for payment until 1850s. Once *chequing privileges* were introduced, however, deposits became a part of the money supply when cheques written on these deposits were accepted in exchange.³⁹ Since a cheque is an order given to the bank to pay a written amount from deposits, the size of deposits indicates how widely cheques are accepted as a medium of exchange.⁴⁰ By the early 1850s, the total

³⁹ Some argued that cheques quickly became a substitute for bank notes. See Marr and Paterson (1980), p.248.

⁴⁰ Until the clearinghouses were established and the clearing statistics were recorded, no cheque circulation figures were available.

deposits held at chartered banks were approximately equal to the bank notes in circulation. Deposits continued to grow rapidly and by Confederation aggregate deposits were more than twice that of banks notes. In fact, by 1867, there were over \$32 million in bank deposits in Canada, while total bank notes in circulation totalled \$14 million. One piece of evidence indicating how widely cheques were used as a means of payment during the 1860s and 1870s is found in the Bank of Montreal letterbooks. In these letterbooks, numerous payments to/from clients are recorded. These payments were conducted predominantly through cheques.⁴¹ Furthermore, private letters of the General Manager of the Bank of Montreal, E.S. Clouston, indicate that most of the payments for his personal items (such as new clothing, stationeries and travel expenses) were also made by cheques.⁴²

Along with the growth in public acceptability of chequing, government intervention to limit the size of the bank note issue may also have contributed to the emergence of cheques as the major medium of exchange. Since the late 1840s, it was argued that governments had to intervene more actively to limit the size of the note issue of the

⁴¹ See the Bank of Montreal Letterbook numbers 1 and 2, 1869-1879. (Public Archives of Canada, Ottawa ; manuscript division). Acceptance of cheques as medium of exchange and the advantages of cheques are discussed in part I.

⁴² The Bank of Montreal Letterbook, Number 4, September 1878-November 1891, Public Archives of Canada.

chartered banks to control inflation and ensure convertibility.⁴³ In 1866, the Provincial Note Act was passed in the House of Commons (of the Province of Canada). According to that Act, banks were asked to withdraw their bank notes from circulation and replace them with provincial notes. Banks⁴⁴ were not enthusiastic about the government proposal.

Among the chartered banks, only the Bank of Montreal decided to accept the offer.⁴⁵ McIvor (1961) explained why the Bank of Montreal was more enthusiastic about the provincial notes than others: "the Bank of Montreal was by far the largest of the Canadian banks, and was a creditor of the government to the extent of some two million dollars. It must also have owned a minimum of \$600,000 in government securities (one tenth of its capital). It was therefore in a particularly favourable position to change the monetary basis of its note issue. After doing so it, thereby becoming not only the government's financial agent but its note issuing agent also."⁴⁶ As a result, in Canada, both

⁴³ To see the problems associated with the bank notes in this period, see Breckenridge (1894), pp.108-18.

⁴⁴ Those banks opposed to the government notes argued that needs of their customers would not be satisfied with the government notes alone. Also less profit would be made if government securities had to be bought for reserves. See O'Brien and Lerner (1969), p.31.

⁴⁵ In 1866, the Bank of Montreal withdrew outstanding notes in circulation of \$3,130,818; later in the same year, these were replaced by government security backed note issue of \$3,147,180. See Breckenridge (1894), p.139

⁴⁶ McIvor (1961), p.53.

bank notes of the chartered banks and government notes began to circulate side by side.⁴⁷

Though the government's desire to restrict bank note circulation did not bring an immediate impact on the issue, it did accelerate the use of cheques (deposits) as the medium of exchange. It can also be noted that, with passage of the Dominion Notes Act in 1868, the chartered banks were restricted to issue notes of a minimum denomination of \$5.⁴⁸ The total issue was also restricted by the amount of the paid up capital of the banks. Consequently, these restrictions on bank notes made cheques drawn on deposits more attractive as a medium of exchange. Figure 3.3 shows the growth of bank notes and deposits from 1850 to 1887.

Notice that even the "moderate growth" in the size of the note issue (compared to deposits) did not necessarily lead to more notes in use as a *medium of exchange*. By the early 1890s, notes in large denominations (\$500, \$1000, and \$5000) were issued (known as "bank legals") and were used exclusively for the transfer of money between banks.

⁴⁷ In fact, the bank notes of the chartered banks continued to be circulated until 1950. But circulation of bank notes after 1935 (Bank of Canada) was reduced drastically. Before it was completely stopped from circulation (1950), notes in circulation was dropped to \$14 million by 1949 from \$141 million in 1931.

⁴⁸ Dominion bank notes of 25 cents, \$1, and \$2 were issued; their circulation was slow in the initial period. See Binhammer (1977), p.36. Initial plan of the Ministry of Finance was to replace the entire bank notes with newly issued dominion notes. Facing the fierce opposition from the banks, however, the replacement of the bank notes was limited to the denominations smaller than \$5. See Ross (1922) pp.27-45 for debates between politicians and bankers on the issue of dominion notes.

private customers were not allowed to hold them. In fact, these large notes were used only for the settlement of cheque balances between banks.⁴⁹

Figure 3.3

source : Urquhart and Buckley (1965), p.231 and Neufeld (1964), p.140.

⁴⁹ Dominion notes used as "legal tenders" were issued in denominations of \$1, \$2, \$4, \$5, \$500, and \$1000 which were payable to the "bearer" on demand. See Duncan (1958), p.150. See also Barter (1921), p.136. More discussion on "bank legals" will be provided in section 3.4.

Notes used for this purpose did not circulate as a medium of exchange among the public; rather they were employed as a device to enhance the use of cheques. (In the Executive Minutebook of the Canadian Bankers Association, "an issue by the Dominion Government of *legal tenders for clearinghouses and reserve purposes, not payable to bearer* [other than banks]" was suggested.⁵⁰)

In Canada, cheques and notes were *routinely* cleared among banks from the very beginning. As cheques were used more frequently, the exchange of cheques and the subsequent settlements among banks (i.e., *cheque clearing*) became a more significant part of Canadian banking.⁵¹ Mutual acceptance of rival cheques and notes became one of the key characteristics of Canadian banking.⁵²

At the beginning, each Canadian bank had to present the cheques drawn on its deposits to each of its clearing partners. According to Barter (1950), in Canada, each bank involved in cheque clearing had an account for every other bank. Whenever a cheque was received from its partner bank, a credit was recorded in its respective account, while debit entry would be shown when cheques written on its deposits

⁵⁰ The Canadian Bankers Association Executive Minutebook, vol. 1, p.37, February 14, 1893. See section 3.5 for detailed discussion on the issue of "bank legals".

⁵¹ More discussion on cheque clearing in general can be found in chapter II. Along with cheques bank notes were also often "cleared". In this study, however, I will focus on the process of *cheque clearing*.

⁵² See Schuler (1992), p.81.

were claimed by a partner bank. This process of *bilateral* daily cheque clearing among these banks started only when a credit bank presented its claim to its clearing partner. To present cheques (and to collect claims), banks hired *messengers*; in smaller cities, junior clerks were responsible for the presentation of cheques. In any given banking day, city streets would be filled with messengers and junior clerks tracking from one bank to the other. This "one way" bilateral cheque clearing would be completed when all the claims were collected from debtor banks. Consequently, the net cheque clearing balance of a bank would not be known until all the claims were collected and compared with the total payment made to all other partners.⁵³

Canada experienced quite a long period of *bilateral cheque clearing*. Even after Confederation, Canadian bankers and politicians did not seem enthusiastic toward immediately improving the cheque clearing system. During this period, the Dominion note issue preoccupied most of their discussions, and the major "breakthrough" in cheque clearing (the introduction of the clearinghouse) was on hold. In fact, in the Bank Note Act of 1868 and the inaugural

⁵³ Eckardt (1914), pp.89-90, presents an extensive account of the actual duties of bank clerks related to bilateral cheque clearing. Canadian Bill of Exchange in the early years was immensely influenced by the British Bill. See MacLaren (1901) for more details.

Dominion Bank Act of 1870, the cheque clearing process did not receive much mention.

When the first Canadian clearinghouse was established in 1887 in the Halifax area, its emergence as a multilateral alternative for the bilateral clearing system seemed to be much overdue. Not only had Britain and the United States already instituted a clearinghouse system but so had many other countries as well.⁵⁴ An episode in 1863 illustrates how little attention was devoted to the improvement of the cheque clearing process in the early days. One of the problems that *ad hoc* clearing could create was recorded by Campbell Sweeny:⁵⁵

...in Hamilton in 1863 there were five banks and the practice was to [bilaterally] exchange collections of notes and cheques each morning. This was the junior clerk's job, and the several youngsters were sent off daily with four parcels of just round the middle with a bit of string and not even wrapped up in paper. Disaster overtook one of them [from the Bank of Montreal] one morning when racing with the boy from the Bank of British North America to get first to the Bank of Upper Canada which was down James street. He slipped on a piece of ice in front of the Royal Hotel and his parcels went flying all about and the string of one of them broken [and the cheques] were scattered over the street. They were all fortunately recovered... .

During the period when the bank note issue was discussed extensively among bankers and politicians, actual cheque

⁵⁴ For example, in Japan, a clearinghouse was formed in Osaka, 1874.

⁵⁵ *The Monetary Times*, January 7, 1927. Reprinted in Neufeld (1964), p.174.

clearing was left in the junior clerks hands. Notice also that the example shows how "timing" in the order of arrival was another concern under bilateral clearing.⁵⁶

While the establishment of a clearinghouse was delayed in Canada, some efforts to improve the bilateral clearing system could be witnessed as early as the 1860s. For example, in 1860, the Bank of Montreal established an abbreviated telegraph code to communicate with other banks more efficiently. Among these codes, debit and transfer items *for cheque clearing* were included.⁵⁷ These codes also indicate that the Bank of Montreal had developed bilateral cheque clearing relationships with at least sixteen other banks.⁵⁸

By 1870, another effort to improve the bilateral cheque clearing was introduced by dividing the entire cheque clearing area into a few sub-sections. Then, one clerk was assigned to each sub section and he would be responsible for the messengers travelling to bilateral partners in his section. Communications and meetings between messengers on

⁵⁶ See sections 2.1-2.2 in chapter II for more discussion on the timing of cheque clearing under bilateral system.

⁵⁷ Telegraph codes were included in the letter from head office to managers. Bank of Montreal, Letterbooks, June 7, 1860; Public Archives of Canada, Ottawa.

⁵⁸ Individual telegraph code was created between the Bank of Montreal and the Bank of British North America, Bank of Upper Canada, Commercial Bank of Canada, Quebec Bank, City Bank, La Banque du Peuple, Molsons Bank, Bank of Toronto, Ontario Bank, Niagara District Bank, Bank of County of Elgin, Bank of Brantford, Gore Bank, Provincial Bank, La Banque Nationale, and Eastern Townships Bank. A letter (June 7, 1860) indicates that the total number of banks in Canada was 31, and at least sixteen banks were operating in Montreal.

their way were arranged by the clerk.⁵⁹ Even though the meetings arranged for the messengers resembled the coffee house meetings of the British cheque clearing messengers,⁶⁰ there is no indication that these arrangements led to the establishment of the Canadian clearinghouse. As mentioned above, the first clearinghouse in Canada did not appear until late the 1880s. Unlike the British experience, the establishment of multilateral clearing in Canada was initiated by bank managers.

So far I have discussed the cheque clearing experience of Canada and the development of credit money in Canada's first sixty years of banking history. One of the main characteristics over this period was the adoption and increasing use of credit money (notes and cheques) as the major medium of exchange. With this trend, the reserves⁶¹ held by the banks for liquidity began to receive growing attention.

Until the first Bank Act of Canada was passed in 1870, there had been no serious legal restrictions on bank reserves. Of course, there was some degree of intermittent government intervention before Confederation. During the commercial crisis of 1837-8, the provincial governments had

⁵⁹ See Eckardt (1914), pp.158-60.

⁶⁰ See Part II, 2.2 for the natural development of clearinghouse motivated by messengers.

⁶¹ See Urquhart and Buckley (1965) and Curtis (1931) for the definition of reserves.

to advise banks to halt specie payment (of the notes) and control the level of reserves. However, that intervention was removed as soon as the economy recovered in 1839. Also in 1851, the Assembly of the Province of Canada passed an act "to encourage the chartered banks to adopt [as fast as conveniently possible] the principles [of General Banking Act] in regard to the securing of the redemption of their bank notes".⁶² This was an attempt to reduce the liquidity problem which began in 1850 when banks faced more than usual demand for redemption of bank notes. But as indicated by the tone of the quotation above, the government merely *encouraged* the holding of adequate levels of reserves. In fact, as early as 1847, the government the Province of Canada had *recommended* holding specie reserves of one third of the note issue.

The first Banking Act of the Confederation in 1870 set the ground rules for banking in Canada.⁶³ Among the many changes introduced by the Act, none received as much attention as the "*required reserves*" imposed on the chartered banks. According to the Act, chartered banks were *required* to hold usually a half, and not less than a third,

⁶² See Breckenridge (1894), p.109, and Breckenridge (1910), p.58.

⁶³ The "Act respecting Banks and Banking" was passed by the House of Commons on April 5, 1870, and received Royal Assent on May 12, 1870. There was a revision of this Act in 1871. See Breckenridge (1894), pp.195-6.

of the their reserves in Dominion notes.⁶⁴ While the absolute proportion of reserves was not specified, this new restriction was viewed as the most serious government intervention on the credit management of the chartered banks up to that point. The reaction from the chartered banks was furious. Bankers who attended the Conference called by the Finance Minister, Sir Francis Hincks, unanimously disapproved of the government's idea. Comments from two of the most prominent bankers at that time show how strongly banks resented the idea. George Hague, of the Merchants Bank of Canada, said that the proposal was "unfair, irrational, misleading and betrays a want of practical familiarity with the subject."⁶⁵ Even more vociferous expressions were adopted in E.H. King's (the Bank of Montreal) letters to Galt. (He even referred to the Finance Minister as a *Mexican bandit*.)⁶⁶

Both Hague and King emphasized that the chartered banks in Canada already held sufficient reserves without the need for the introduction of *compulsory reserves*. In the letter

⁶⁴ One of the reasons for the government to implement the compulsory reserve in Dominion notes was the seigniorage from note issue. See Breckenridge (1910) for the discussions among parliamentarians regarding the requirement of reserves.

⁶⁵ See Hague (1893), Journal of CBA, vol.1.

⁶⁶ Numerous private letters sent from King to Galt are stored in the Public Archives of Canada. King's rage against Hincks' proposal can be most vividly seen in the letters dated from March 1, 1871 to March 7, 1871. See Ministry of Finance, Letterbooks (RG27 I D8), vol. 3, pp.1399-1477, in the Archives.

King sent to Alexander MacKenzie,⁶⁷ King insisted that the [cash] reserve of the Bank of Montreal was usually between one half and one third of its total liability. Reserve regulations, therefore, would not be needed by the banks. In fact, the reserve ratio of the Bank of Montreal from 1867 to 1870 was in the range of 29.1% to 43.5%.⁶⁸ While Hague's view was a general opposition to the idea of fixed rules regarding reserves, King's attack on the compulsory reserves was more focused on the form of reserves. He argued that notes, as paper promise to pay specie, would never be better than coin for protecting the interests of the public. Furthermore, he insisted that if banking legislation wanted to introduce legal reserves, it should be a proportional requirement (relative percentage of liabilities), in the form of coin.⁶⁹ In King's case, opposition was based on the fear that the Banking Act of 1870 was the first step toward the establishment of a Bank of Issue under Government control. The emergence of a government bank of issue would have taken away the monopoly position of the Bank of Montreal in the Dominion Note issue

⁶⁷ Letterbooks of Alexander McKenzie (M-197;microfilm), March 14, 1870, pp.162-5, Public Archives of Canada.

⁶⁸ *The Monetary Times*, Statement of Banks under Charter, vol.1-4, 1868-71. Reserve ratios from 1867 to 1870 were 43.5%, 30.3%, 40.0%, and 29.1%.

⁶⁹ Ministry of Finance, Letterbooks vol.3, pp.1441-2, Public Archives of Canada.

since 1868.⁷⁰ As the government's financial agent in the issue and redemption of dominion notes, the Bank of Montreal was claiming a 1% commission on the average circulation of those notes, whether held by itself or by other banks. This monopolistic privilege was terminated with the introduction of the first Dominion Bank Act in 1870.⁷¹ Ironically, this led King to disapprove compulsory reserves in the form of notes, but at the same time, to suggest a *proportional required reserve ratio*, which most of the other banks opposed. And it is still stranger that Hincks was also "at first in favour of a fixed minimum ratio for the banks".⁷² He changed the plan from *fixed ratio* to *compulsory reserve in notes* before handing in the Bill to the Parliament.

Even though the Bank Act of 1870 was seen by the banks as undue intervention by the government in the reserve management practices of the banks, chartered banks in Canada were not *required* to hold a fixed amount (or a fixed proportion) of reserves. In practice, banks held reserves voluntarily and as Hague (1893) pointed out, the level of reserves in most banks was large enough to ensure sufficient

⁷⁰ King was deeply involved in the decision of the Bank of Montreal in taking sole responsibility of government note issue; he was the general manager of the Bank from 1863 to 1869, and the president from 1869 to 1873.

⁷¹ See Ross (1921), p.57.

⁷² Curtis (1955), p.156.

liquidity.⁷³ The concept of a legal required reserve ratio was still a foreign notion to the banks in the Dominion. (Voluntary reserves had a long tradition in Canadian banking.) Table 3.6 shows the examples of reserve ratios in the Bank of Montreal and the Bank of Commerce, two of the major chartered banks in Canada, between Confederation and 1887.

Table 3.6 The Reserve Ratios of the Bank of Montreal and the Bank of Commerce

year	Bank of Commerce reserves *	ratio **	Bank of Montreal reserves	ratio
1868	816	60.3	4662	43.5
1869	1035	47.1	5682	30.3
1870	1287	36.7	4492	40.0
1871	1551	32.7	3841	29.1
1872	1194	20.6	3461	20.5
1873	1598	27.3	3284	19.1
1874	2283	32.2	3790	17.5
1875	1568	20.1	3606	19.5
1876	1701	21.8	4150	18.9
1877	1643	19.8	4062	19.2
1878	2079	21.3	4056	18.3

⁷³ Despite the resentment shown by the banks when the inaugural Canadian Bank Act was enacted in 1870, by the turn of the century, about 65% of the reserves held at chartered banks were in Dominion notes. Notice that discussion on the reserves shown above is about the reserves required to issue bank notes. See MacLaren (1901), p.80.

1879	2272	19.5	5719	18.3
1880	1912	15.7	5140	18.3
1881	2107	15.2	5256	16.9
1882	2246	13.9	5435	20.6
1883	2144	14.3	5982	17.7
1884	1938	14.9	6795	22.9
1885	1766	13.7	8862	15.2
1886	2494	17.8	4942	15.2
1887	1614	13.3	4485	14.0

source : Ross (1922), pp.573-4, The Monetary Times, 1868-88.

* ; both in notes and in species - \$thousand (constant; 1875=100)

** ; ratio is calculated by total reserves over total deposits.

(In the following section, 3.3, I will further discuss the issue of reserves under the clearinghouse system.) In Figure 3.4, the trend in the aggregate reserve ratio of all the chartered banks is shown from 1867 to 1899.

**Figure 3.4 Reserve Ratios of Canadian Chartered Banks,
1867-1899**

source : Urquhart and Buckley (1965), pp.231, 238-9.

While the notes (including provincial and Dominion notes) received most of the attention from the bankers and the politicians as we have seen, it is bank deposits (i.e., cheques) that emerged as the major component of the medium of exchange by Confederation. (See Figure 3.3.) As

discussed before, cheque clearing in this period was conducted exclusively in terms of bilateral arrangements. Each bank hired messengers⁷⁴ to exchange cheques and bring about final settlement with its cheque clearing partners. Hence, the physical costs of cheque clearing can be expected to be proportional to the size of deposits. However, this may not be true for the costs of holding reserves. Without legal requirements, reserves were determined by each bank's policy. As shown in table 3.6 and in figure 3.4, the typical trend shared by Canadian banks in the early years of Confederation was one of successive reductions in reserve holding ratios.⁷⁵ From Table 3.6 and Figure 3.4, a less than proportional increase in reserves is clearly demonstrated. The observations after 1888 also reveal the change in the cheque clearing structure (i.e., clearinghouse).⁷⁶

A structural change in cheque clearing in Canada was perhaps inevitable by the 1880s. With steady growth in both deposits per bank and the number of banks,⁷⁷ the bilateral clearing system was unlikely to cope with the growing

⁷⁴ A detailed illustration of the messenger's duties is given in MacLaren (1901), pp.158-9.

⁷⁵ This trend is observed even before the introduction of the clearinghouse.

⁷⁶ The impact of the clearinghouse system on reserve holdings is tested in section 3.1.

⁷⁷ By 1887, the number of chartered banks reached 35; the total number of branches was well over 500.

demands of the depositors. Eventually, a new cheque clearing system, the multilateral cheque clearing system, was implemented. When the first multilateral clearinghouses were established (1887 in Halifax and 1889 in Montreal), however, they were not the *bold* new experiment of the Canadian chartered banks. The clearinghouse system had already proved to be quite effective in other countries. Rather, the arrival of clearinghouses in Canada seems to be late considering the importance of cheques (deposits) as a major part of the medium of exchange in Canada. No logical explanation has yet been given for the delay in the start of multilateral cheque clearing in Canada.

Was the arrival of the clearinghouse in Canada really *late* though? Maybe not. I would argue that the structure of Canadian banking is one of the reasons that Canada experienced what might seem to be an excessively prolonged period of exclusive bilateral cheque clearing. Unlike British or American banking systems, Canadian chartered banks formed a branch banking system *from the beginning*.⁷⁸ With a branch banking system, not all the cheques deposited to an individual bank have to be "cleared".⁷⁹ Cheques drawn on the other branches of the same bank could be easily

⁷⁸ The Bank of Montreal opened its first branch outside of Montreal in Quebec in 1818, just one year after it started business. For the early development of branch banking system in Canada, see Breckenridge (1894), chapter 5, MacLaren (1901), pp.1-4, and Beckhart (1929), pp.357-60.

⁷⁹ For "branch banking", see Patterson (1932), pp.273-8. See also section 2.8.

handled through internal bookkeeping transfers (i.e., interbranch clearing), without requiring the use of scarce reserves. Also, smaller branches could use the cheque clearing facility of their larger branches (of the same bank) to clear their cheques. In other words, the relative number of cheques to be handled by each banking unit under the branch banking system (requiring immediate and final settlement) would be significantly smaller than that under a unit banking system.

As shown in section 2.8 of the previous chapter, the savings generated by establishing a clearinghouse (for a given amount of deposits) would be smaller under a branch banking system. For this reason, what has been considered to be a *late start*⁸⁰ (of the multilateral clearing) might be a timely introduction of a new system for Canada. In a sense, it can be said that branch banking was in a position to *compete* with the multilateral system until the clearinghouse was actually established. Larger branches of individual banks served the role of *pseudo clearinghouse*⁸¹ in terms of reserve savings. But as I will show in later sections, once the multilateral system was adopted, the two mechanisms (branch banking and clearing system) complemented each other in order to obtain the optimal savings in reserves.

⁸⁰ Barter (1921), p. 125.

⁸¹ See equations (2.39) and (2.41) in chapter II.

Notice, in Canada, the increased number of *banking units* was often a result of branch expansion by existing banks. In fact, between 1868 and 1888, the number of banking units in Canada had increased from 123 to 402 but the number of independent banks only grew from 37 to 41. In other words, the average number of branches per bank was increased from 3.3 to 9.8 during this period.⁸² This expansion of the branch banking system in Canada allowed each bank to achieve a certain degree of savings in cheque clearing costs even before the clearinghouse system was adopted.⁸³ (See section 2.8 for a theoretical comparison between the two banking structures.)

In any case, by the 1880s, the total deposits of Canadian chartered banks had outgrown the economic capacity of the bilateral clearing system and a more drastic change in the cheque clearing system was inevitable. Now let our attention be shifted to this historic opening of the first Canadian clearinghouse.

⁸² See Urquhart and Buckley (1965), section H.

⁸³ In section 3.1, a statistically significant impact of branch banking on the reserve holdings in this period is reported. According to the results, reserve holdings would be reduced if the branch banking became stronger.

3.3 Emergence of Canadian Clearinghouse

Seventy years after the Bank of Montreal was founded as the first Canadian bank, another evolution in Canadian banking began in the Halifax area. The first Canadian clearinghouse designed to clear cheques multilaterally began to function in July 1887⁸⁴ among the banks operating in Halifax.

Unfortunately, not many details have been reported on how this clearinghouse conducted multilateral cheque clearings in its first few months. However, the Halifax clearinghouse minute book reveals that a formal constitution for clearinghouse operation was confirmed in the meeting held on January 26, 1888.⁸⁵ At that meeting, a draft of constitution⁸⁶ was passed after representatives from the seven participating banks discussed the contents.⁸⁷

⁸⁴ The exact opening date of the first Canadian clearinghouse is unknown. Generally, it is believed to be around July 2, 1887. There is also a claim stating that the clearinghouse in Halifax opened on July 1, 1886. See Lee (1958), pp.116-7 and also *The Monetary Times* (1910), p.325.

⁸⁵ In the minutes, it is also indicated that there had been a trial run of the clearinghouse -without formal rules- in Halifax for at least six months.

⁸⁶ See the *Constitution of the Halifax Clearing-House Association* (1888) (reproduced in Appendix A to this chapter), Public Archives of Halifax.

⁸⁷ Banks participating in the process of establishing the Halifax clearinghouse were the Bank of Montreal, the Bank of Nova Scotia, Bank of British North America, Merchants Bank of Halifax (later Royal Bank), Halifax Banking Company, Peoples Bank of Halifax and Union Bank of Halifax. These were all seven banks operating in Halifax around 1887-8.

In the original constitution, the intent of the clearinghouse was clearly stated. The clearinghouse was to operate "for the purpose of effecting a more perfect and satisfactory settlement of the daily balances between [the banks in the city of Halifax]." ⁸⁸ This constitution consisted of thirteen articles specifying the rules for multilateral clearing of cheques and notes in Halifax. Daily multilateral clearing would now be conducted *at one place and at one time*. A board of management would be formed and it would take care of the details of clearing and answer any questions regarding the operation of the clearinghouse. Also the board was to appoint a bank to act as the clearing bank. The duty of the clearing bank was described in the Constitution: ⁸⁹

It shall be the duty of such Bank to receive the balances due from debtor banks, giving the usual receipt therefor, and pays the creditor banks, and be in all respect responsible for the money received by it in payment of balances due by the respective banks in the daily exchanges as for deposits received by the said bank in its regular business, but the responsibility of the clearing bank is strictly limited ⁹⁰ to distribution among the creditor banks.

Articles VI, VII, and VIII in the Constitution described the

⁸⁸ Constitution of Halifax Clearing-House Association (1888), p.3.

⁸⁹ Constitution (1888), p.4. The initial clearing bank for the Halifax clearinghouse was the Bank of Montreal.

⁹⁰ For example, a clearing bank is not responsible for the unpaid settlement balances among banks.

proposed time table of the clearing process. According to these guidelines, multilateral clearings would be conducted between 10:15 a.m. and 12:30 p.m.; by one o'clock all the debit and credit balances were to be settled.⁹¹ Settlement of the balances was to be completed in *Dominion notes*. The Constitution also stated that the operating costs of the clearinghouse would be shared; how it would be shared among different members was not mentioned.

With this constitution, the first clearinghouse in Canada started to function formally in 1888. And until the *Bylaws of the Clearinghouses* were passed by the Canadian Bankers Association in 1900,⁹² this constitution of the Halifax clearinghouse stood as a *simple but significant* cornerstone of multilateral cheque clearing in Canadian banking. Savings in physical costs and reserves under multilateral clearing could be finally realized for banking in Canada.

Among the participants who were present at the meeting for the Constitution of the Halifax clearinghouse was Thomas Vincent MacDonald, the person who had originated the idea of establishing a clearinghouse in Halifax.⁹³ In fact, during the meeting of January 26, 1888, a motion was raised

⁹¹ One particular rule given by the constitution was that no credit balance would be transferred to a bank until all of its debit balances were paid to the clearing bank. See Article VI in the Constitution.

⁹² See *Journal of Canadian Bankers Association* (1900), pp.135-41.

⁹³ See Schull and Gibson (1982), p.70.

to express thanks to MacDonald "for his service in connection with the inauguration of the clearinghouse system." His contribution to the establishment of Canadian clearinghouses did not end in Halifax, though. When a branch of the Bank of Nova Scotia⁹⁴ opened in Montreal in February 1888, MacDonald was transferred to Montreal. Within ten months time, he managed to form a committee to study the establishment of a clearinghouse in Montreal. On December 24, 1888, representatives from nine banks in Montreal attended a meeting held at the Merchants' Bank.⁹⁵ After reviewing a couple of reports prepared by the committee appointed in the previous meeting (December 13), they drew the conclusion that a clearinghouse should be tried.

On January 4, 1889, a document prepared by MacDonald and John Galt (of the Merchants' Bank) was sent out to all sixteen banks operating in Montreal. In that letter, it was announced that the multilateral clearing system through a clearinghouse would start on January 7. On the first day of operation all sixteen banks participated in the clearing;⁹⁶

⁹⁴ This was the first branch opened by the Bank of Nova Scotia outside of the Maritimes. See Halifax Morning Herald, August 10, 1887.

⁹⁵ See The Monetary Times, vol.22 #26, December 28, 1888, p.738.

⁹⁶ Banks participated in the clearinghouse on January 7, 1889 were the Bank of Montreal, Merchants Bank of Canada, Canadian Bank of Commerce, Bank of British North America, Quebec Bank, Molsons Bank, Bank of Toronto, Ontario Bank, Union Bank, Banque du Peuple, Bank of Nova Scotia, Banque Nationale, Merchants' Bank of Halifax, Banque de Hochelaga, Banque Jacques Cartier, and Banque Valle Marie. See Denison (1966), p.242.

the total amount of clearing among these banks was \$1,458,474.84, and was completed in fifty minutes. For the receipt and disbursement of balances, the Bank of Montreal was appointed as the clearing bank,⁹⁷ and the net amount of cash needed to fulfil final settlement on this first day was merely \$400,000.

The advantages of multilateral clearing were observed from the first day of operation of the Montreal clearinghouse. The savings in physical costs, as represented by the time and the number of messengers required to handle cheques, were tremendous. The reduction in clearing time was so impressive even to *outsiders* that a lengthy article describing the time efficiency of the clearinghouse appeared in the *Montreal Gazette*.⁹⁸ More importantly, however, the savings in reserves were well recognized by the banks. For example, with the opening of clearinghouses, the Bank of Montreal alone enjoyed a 20 to 60 percentage drop in reserves in Halifax, Montreal, Toronto and Hamilton in the first years of clearinghouse operation.

The advantages of the clearinghouse system were soon recognized by banks in other parts of the country. By 1902, consequently, eleven clearinghouses were already operating in Canada; Toronto and Hamilton (1891), Winnipeg (1893),

⁹⁷ The Bank of Montreal was also performing the role of the clearing bank in the Halifax clearinghouse in the same period.

⁹⁸ The Montreal Gazette, January 8, 1889, p.2.

Saint John (1896), Victoria and Vancouver (1898), Ottawa and Quebec (1901), and London (1902).⁹⁹ Table 3.7 shows the number of clearinghouses operating in Canada in various years.

While the development of clearinghouses in Canada was a rational decision collectively made by banks, a question still remains regarding the origin of the initial Canadian clearinghouse. Why was the first clearinghouse established in Halifax? Even though it was true that Halifax was one of the main banking centres in Canada in the 1880s, the size of the banking community in Halifax was not comparable to that in Montreal or Toronto.¹⁰⁰ In comparison to the experience in Britain and the U.S., where the first clearinghouses were formed in London and in New York respectively, Halifax was not at the forefront of Canadian banking by any means.

⁹⁹ Because of branch banking system in Canada, success in one city could be easily adopted in other cities with the branches of the same banks. See Carpenter (1935), p.82.

¹⁰⁰ Some distinctive characteristics of banking in Halifax are also discussed in section 3.1.

Table 3.7 Number of Clearinghouses in Canada, selected years

year	number of clearinghouses
1888	1
1898	7
1905	11
1910	14
1916	25
1924	31
1925	33
1948	35
1958	58

source : Journal of Canadian Bankers Association, *various years*

A few explanations can be offered. First of all, the banks in Halifax were very cooperative with each other. As reported in *The Monetary Times*,¹⁰¹ the banks in the Halifax area often agreed on the common goals of banking operations, and frequently made collective decisions. Banks in the other major centres in Canada did not engage in the same degree of cooperation.¹⁰²

On top of the tradition of *Maritime cooperation*, the

¹⁰¹ See *The Monetary Times* (1870), vol.4, p.503.

¹⁰² For example, in Toronto, the major banks constantly complained that there were too many banks operating in the city; cooperation among these banks was hard to expect. See Schull (1958), p.3.

banks in Halifax contained one of the great minds of Canadian banking in Thomas MacDonald. As already mentioned, it was his idea to set up a clearinghouse in Halifax. MacDonald was only thirty-three when he initiated the first clearinghouse in Halifax. By the time he retired from banking in 1892 (at the age of thirty eight), he had already had an instrumental hand in beginning the first two clearinghouses in Canada.

Besides *tradition and leadership*, another economic factor has been suggested as contributing to the early development of the clearinghouse in Halifax. Denison (1966) has insisted that, as a port city engaged in extensive international trade, the amount of cash demanded in the Halifax area¹⁰³ relative to the size of deposits was quite large. For this reason, it has been argued that savings in cash reserves were badly needed. Figure 3.5 shows the cash/deposit ratios in Halifax relative to those in Ontario and Quebec, which were the main centres of Canadian banking. As indicated in that figure, however, the ratios in Halifax did not typically exceed those in Ontario and Quebec; the average cash/deposit ratio in Halifax was 14% (1873-87), while the same ratio in Ontario-Quebec was 13%. Evidently, the demand for cash, as Denison has argued, was not *exceptionally* high and thus should not be counted as one of

¹⁰³ See Denison (1966), vol. 2, p.243. Saint John was experiencing a similar situation. For more on banking in Nova Scotia, see Traves (1984), pp.88-113.

the major reasons for the clearinghouse being established in Halifax before Montreal or Toronto.

Figure 3.5 Cash/Deposit Ratios in Halifax and Ontario-Quebec

source : Statement of Banks under Charter, *The Monetary Times*, vol.6 - vol.21, various years

More importantly, I think, is the influence that the structure of banking in the region contributed to the

emergence of the first clearinghouse in Halifax. For example, prior to the introduction of clearinghouses, both Montreal and New York had the largest number of banking units in Canada and the U.S., respectively. With the unit banking system, the bilateral cheque clearing process proved to be more cumbersome in New York City than in any other banking centre in the U.S..¹⁰⁴ Consequently, the need to adopt the multilateral clearing option for the banks operating in New York City was also the largest. On the other hand, in Montreal, the complication and inconveniences involved with the bilateral clearing process could be somewhat reduced by the internal cheque clearing (i.e., intra branch settlement) offered by the branch banking system. Being the centre of the branch banking network for Quebec and the Maritimes, the need for clearinghouse in Montreal would have been relatively smaller.

However, the banks in Halifax could foresee the greater advantage in establishing a clearinghouse. Unlike the situation in Montreal (and Toronto), independent banks in Halifax could not take full advantage of the branch banking system. In fact, five out of seven participating members of the clearinghouse in Halifax in 1887 did not have a single

¹⁰⁴ See Gorton (1984) for a discussion on pre-clearinghouse banking conditions in New York.

branch outside of the Maritimes.¹⁰⁵ With less benefit generated by intra branch clearing, the banks in the Halifax area became keen to take advantage of the clearinghouse sooner than other banks in major Canadian banking centres.

As shown by the cases in Halifax and Montreal, a large number of banks needed to be involved in order to realize the advantages of multilateral clearing. This suggests that the start up costs of establishing a clearinghouse were not insignificant. For this reason, smaller banking centres with only a few banks were better off staying with bilateral clearing. With respect to the size of banking community suitable for the adoption of a clearinghouse, Schuler (1992) has made the following argument (while quoting from Knight (1904)¹⁰⁶) : "economies of scale sufficient to justify establishing a clearinghouse did not exist until there were at least seven banks in a city." He then added that bilateral clearing was satisfactory for banks in Canada before 1887. While it is true that a smaller banking community might have been better off with the bilateral clearing system, I find Schuler's argument (or Knight's) unconvincing. Even before 1880, there were sixteen banks operating in Montreal, and at least twelve banks still

¹⁰⁵ The first branch opened by Halifax bank (outside of the Maritimes) was the Montreal Branch of the Merchant Bank of Halifax in 1888. Among the original members of the Halifax Clearinghouse, the Bank of British North America and the Bank of Montreal were the only exceptions that had direct contact with branch banking network in Montreal.

¹⁰⁶ See Schuler (1992), p.81. And also see Knight (1904), p.37.

exchanged cheques *bilaterally* in Toronto as late as 1891. In fact, Knight (1904) has failed to offer any economic reason why seven banks in the same city were the required minimum number of banks to ensure the advantages of multilateral clearing. My interpretation of *the significance of the number seven* is that this was *the number of banks who initially participated* in the Halifax clearinghouse (in 1888).

The introduction of a clearinghouse system to Canadian banking drastically changed the daily practice of clearing operations. As discussed, a clearinghouse was able to reduce the physical costs of cheque clearing and eliminate some of the timing inefficiencies related to bilateral clearing. At the same time, the reserves held by the banks could be lessened for most banks. Despite these advantages of multilateral clearing, however, the bilateral clearing of cheques and notes did not quickly disappear.

It is possible that some banks were not willing to participate in the clearinghouse (despite the realization of the benefits in multilateral clearing) because they did not want to disclose their financial position to rivals.¹⁰⁷ However, such "resistance" tended to exist mainly before the establishment of the clearinghouses. Once the multilateral clearing system started, the disadvantages of not being a

¹⁰⁷ As it is reported in Montreal clearinghouse case, the debit-credit positions of each bank would be exposed through the clearing bank.

3

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member of the clearinghouse (i.e., multilateral clearing process) became too severe for any competitive bank to bear. For example, when clearinghouses opened in Halifax and Montreal, all seven and all sixteen banks (respectively) joined the clearinghouses simultaneously.¹⁰⁸ Therefore, as a general rule, the coexistence of multilateral and bilateral clearing is observed at the same time in different places in Canada, but not in the same major banking centre at the same time. Of course, there were some exceptions. For instance, Toronto experienced brief period(s) when a dual clearing system operated. When the clearinghouse opened in 1891 in Toronto, the Bank of Toronto did not join the clearinghouse and remained outside until November 25, 1895.¹⁰⁹ In this case, the Bank of Toronto was concerned about the potential for other bank insolvencies;¹¹⁰ it did not want to share the problems of the other banks. (The opportunity cost of not joining was the foregone savings in clearing costs.) During this period, the Bank of Toronto maintained bilateral cheque clearing.¹¹¹

A few more thoughts on savings in reserve cost will be

¹⁰⁸ The trial run period in Halifax (July 1887-January 1888) is believed to be the time required for Thomas MacDonald to persuade all the banks in Halifax to join the clearinghouse.

¹⁰⁹ See Toronto Clearinghouse Register, CBA Archives, Toronto, 1895.

¹¹⁰ The problem of risk involved with the multilateral clearing process is discussed in endnote 3.4.

¹¹¹ Surprisingly little information about cheque clearing during this period (1895-97) is recorded in the Bank of Toronto Minutebook and printed Circulars (in Toronto Dominion Bank Archives).

added here. First, as indicated by the growth in the number of clearinghouses in Canada (see table 3.8), more and more banking centres in Canada adopted the multilateral clearing system. In chapter II of this study, I discussed the savings in reserves (S_R) among n banks when they switch from bilateral clearing to multilateral clearing system. (See section 2.6 and 2.7.) The increased adoption of clearinghouses in various parts of Canada exposed more Canadian banks to the potential savings in reserves.

While more clearinghouses were *established*, more banks continued to join the clearinghouse system in each clearing centre as well. For example, the number of banks in the Montreal Clearinghouse grew from 16 to 18 by the end of the 1890s and the membership of Toronto Clearinghouse similarly increased from 12 to 15 by 1897. Equations (2.32) and (2.32-a) in chapter II showed that the savings in reserves in each clearinghouse would be increased when more members joined the multilateral clearing system; additional *non-zero* entries in variance-covariance matrix would be observed (see endnote 2.4).¹¹²

In Canada, most of the additions to clearinghouses came from branch banks of experienced players joining the clearinghouses in various Canadian cities. For instance, one of the members newly added to the Toronto clearinghouse

¹¹² Of course in the case of Montreal and Toronto clearinghouses, unlike the experiment in chapter II, the number of banks and the size of the deposit grew simultaneously.

in 1897 was the Bank of Nova Scotia, which was a founding member of the clearinghouses in Halifax and Montreal. Table 3.8¹¹³ shows the changes in the number of chartered banks and branches under the multilateral clearing system in its first ten years. Notice that the clearinghouses in different cities were not formally interconnected (except through their headquarters (main branches)) until 1900.

**Table 3.8 Number of Banks, Branches, and Mergers
1889-1900**

year	banks	branches	mergers
1889	41	402	-
1890	41	426	1
1891	41	468	-
1892	41	479	-
1893	40	502	1
1894	38	513	2
1895	37	530	1
1896	37	533	-
1897	37	555	-
1898	37	622	1
1899	36	663	1
1900	35	708	2

source : Urquhart and Buckley (1965), p.246, and
Breckenridge (1910), p.310.

¹¹³ In this table I considered 1889 as the first year of clearinghouse operation in Canada.

Quick inspection of Table 3.8 reveals that branch banking rapidly expanded in Canada during the first decade of multilateral clearing. The number of branch banks increased while the number of distinct banks decreased.¹¹⁴ Notice that the relationship between branch banking and multilateral clearing is partly a function of the stage of development in cheque clearing. As shown in the previous section, under the bilateral system, the branch banking *could substitute* some of the advantages of clearinghouses, and thereby serve to delay the adoption of the multilateral clearing system. The reluctance to switch to the clearinghouse system displayed by the banks in major Canadian banking centres can be explained by the relatively smaller (would-be generated) savings with the branch banking network. (See section 2.8 for the difference in the amount of savings.) However, once the clearinghouse system was adopted, branch banking became a complementary element to the savings generated by the clearinghouses.¹¹⁵

First of all, it can be predicted that, as branches become more prevalent, the banking system will become more *homogeneous*, which is one of the necessary conditions for

¹¹⁴ Increase number of branches in Canada made the number of people served by each branch smaller. For example, in 1868 average number of people served by each branch was 28,900. This figure dropped to 7,600 by 1900. See Perry (1991), part II, p.37.

¹¹⁵ Regression results reported in section 3.1 support the role of the branch banking in reserve savings.

the application of the square root rule.¹¹⁶ Goodhart (1988) noticed this characteristic and comments that "*branch banks* all of whom could participate, more or less *equally*, in the main clearing centres. The two main examples are *Scotland* and *Canada*."¹¹⁷ I think it was no accident that the main players in the establishment of the first Canadian clearinghouses in Halifax and Montreal were Scottish immigrants, including T.V. MacDonald himself.¹¹⁸

Secondly, the branch banking system indirectly expands the advantages of multilateral cheque clearing to the smaller centres, where a formal clearinghouse has not been formed. Since there were no clearinghouses in small towns, each bank in the town still had to maintain an account for every other bank in town. (See Appendix C for the geographical expansion of branches in Canada.) However, when cheques were directed to/from other cities or when their aggregate balances exceeded a certain amount,¹¹⁹ these cheques were handed to the larger branches (of the same banks) in the nearest clearing centre. The large branches then cleared these items through their

¹¹⁶ Homogeneity among banks is of course limited to the terms of clearing operation among these banks.

¹¹⁷ See Goodhart (1988), p.33.

¹¹⁸ Another example of a prominent banker from Scotland who was ¹¹⁸ deeply involved with the establishment of clearinghouses in Canada was Thomas Fyfe, who was the Cashier of the Bank of Nova Scotia from 1876 to 1897. See Schull and Gibson (1982), pp.51-61.

¹¹⁹ See Eckardt (1914), p.90.

clearinghouses. Between these branches (in two different places) accounts could be settled by internal book keeping settlements. For example, a circular sent by the general Manager of the Dominion Bank to its branch in Guelph in 1894 asks any cheque in excess of \$2000 to be sent to the head branch in Toronto in order to be presented to the Toronto clearinghouse.¹²⁰ Chudy (1989) mentions that "branch banking had effects similar to those of the clearinghouse" in terms of *savings in transaction costs*.¹²¹ In another instance, the Bank of Yarmouth (Nova Scotia) hired the Bank of Nova Scotia as its representative in the Halifax clearinghouse.¹²² Even though its cheques were presented and settled by the Bank of Nova Scotia in the same manner as cheques from its rural branches would be, the relationship was different from that between two branches of the same bank. Separate reserves for the Bank of Yarmouth were prepared by the Bank of Nova Scotia and service charges were levied for this indirect access to the clearinghouse. It was not until 1903 that the Bank of Yarmouth *could take full advantage of the clearinghouse* as a branch of a major bank; the Bank of Yarmouth was acquired by the Bank of Montreal in

¹²⁰ The Dominion Bank, Circular, February 24, 1894, TD Bank Archives.

¹²¹ The branch banking itself can be viewed as the channel to the clearinghouse for smaller branches. See Chudy (1989), p.179.

¹²² Similar arrangements between banks in the Toronto area can be found in circulars of the banks including the Bank of Nova Scotia, the Bank of Toronto, The Dominion Bank, and the Bank of Commerce. See also Traves (1984), pp.88-113.

1903.¹²³ In short, branch banking in Canada complemented the savings in reserves generated by the establishment of clearinghouses during the 1880s and the 1890s.¹²⁴

Thus far I have discussed the emergence of the first clearinghouses in Canada, and their impact on the costs of clearing processes. The future of the clearinghouses became more visible by the end of the 1880s (and their role in Canadian banking) and was most vividly envisioned by a writer of the *Montreal Gazette*. After witnessing the first day of operation of the clearinghouse in Montreal, he wrote: "[...] it is sincerely trusted, now a good start has been made, the clearinghouse[s] will be heartily supported and long continued."¹²⁵ Indeed, they were.

¹²³ In Perry (1991), part II, the major mergers and acquisitions of chartered banks in Canada are tabled.

¹²⁴ Free banking was experimented in Canada as well. In 1850, the Free Banking Act was passed. However, those banks started under the Act did not last long. By the time the first Canadian clearinghouse was formed none of those free banks played any role in the multilateral clearing system of Canada. See Breckenridge (1894), chapter V for a discussion on free banking in Canada.

¹²⁵ The Montreal Gazette, January 8, 1889, p.2.

3.4 The Canadian Bankers Association and the Rules of Clearinghouses: Progress in Cheque Clearing in the 1890s

The introduction of clearinghouses into Canadian banking was an important step in economizing on the costs of cheque clearing. As in the Halifax and Montreal clearinghouse cases, the banks that participated in the new (i.e., multilateral) process expected to reduce the physical and reserve costs of cheque clearing. To ensure these savings, the banks arranged a set of rules necessary to run the clearinghouse. The clearinghouses that emerged in the other cities following Halifax and Montreal drafted similar rules for running their operation. Since the early Canadian clearinghouses were voluntarily established by the banks operating in the region, the rules adopted by each clearinghouse mainly reflected the concerns of banks in the area. However, as more banks opened branches in various banking centres and more cheques were exchanged among them, a common set of rules (applicable to different clearinghouses) evolved.

By the time that the need for a common cohesive set of regulations for clearinghouses was realized, the banks operating in the different banking centres of Canada had formed the banking institution called *the Canadian Bankers*

Association (CBA), which started as a voluntary organization in 1891. The CBA was given responsibility for the development of formal rules common to all the clearinghouses. In order to examine how the cheque clearing process improved in the 1890s, therefore, I will start the discussion with the formation of the CBA.

At the same time as the first multilateral clearing system was initiated by banks in the Halifax area (1887), the *Bankers' Section of the Toronto Board of Trade*¹²⁶ was formed by twelve banks operating in Toronto. The Section displayed a wide range of interests in banking. The subjects handled in its meetings from 1887 to 1890 included the solvency of bank note circulation, excessive competition among banks, provincial and municipal taxation, the Bank Act, and the expiry of bank charters.¹²⁷ The establishment of the clearinghouse in Toronto in 1891 was also managed by the Section.¹²⁸ Notice that initial recommendation for the clearinghouse in Toronto was also made in 1889. In the *Reports of the Board of Trade*¹²⁹ (for Toronto), the banks in Toronto showed interest in forming a clearinghouse for which the model was the clearinghouse in Montreal. The

¹²⁶ See Stanford (1974) for general discussion on the early operation of the Toronto Board of Trade.

¹²⁷ See Perry (1967), p.102.

¹²⁸ Initial recommendation for the clearinghouse in Toronto was made in 1888. See Stanford (1974), p.66.

¹²⁹ The Toronto Board of Trade, Reports of President, Treasurer and Secretary, 1889.

Board hoped that the establishment of a clearinghouse in Toronto could generate savings in clearing costs and, at the same time, that clearing statistics could be used as "valuable information" for other businesses.¹³⁰ (In 1891, the Toronto Clearinghouse was established to fulfil these goals.)

As the *only organized banking group* in Canada during the 1890 Bank Act revision, *the Section* played an active role in defending the interests of the banks.¹³¹ Convinced by the performance of the *Section*, the banks strongly felt the need to establish an integrated organization representing the general interests of banking in Canada. As a result, on December 17, 1891, an organization called the Canadian Bankers' Association was formed.¹³² The initial membership of the Canadian Bankers' Association consisted of twenty five banks out of the thirty eight banks¹³³ then operating in Canada. The membership of the organization extended not only to banks in Ontario and Quebec, but also

¹³⁰ "The figures showing the daily clearings in a clearinghouse, while they do not represent the total amount of business done in a particular city, are readiest mean of showing the increase or decreases of a city's business." Later, Urquhart and Buckley (1965) claimed that the use of clearing statistics as a business index had problems.

¹³¹ See Ross (1927), p.398 for the summary of the Bank Act of 1890. The main change introduced in the Act was the Bank Note Redemption Fund. More discussion of the Fund will be provided later.

¹³² See Jamieson (1955), p.30.

¹³³ This number of banks in 1891 varies from one set of records to the other. While Perry (1967) and *The Monetary Times* (1891) reported that there were 38 Canadian chartered banks in 1891, Urquhart and Buckley (1965) recorded that 41 banks were operating in the same year.

to banks in the Maritimes and the Bank of British Columbia.

The banks that joined the Canadian Bankers' Association agreed on the main functions of the Association which included:¹³⁴

- (i) observing proposed legislation and court decisions which had relevance to the banking sector;
- (ii) protecting the interests of investors and creditors;
- (iii) promoting the efficiency of officers;
- (iv) guarding the bank note redemption fund; and
- (v) the establishment of the *Journal*.

Among the proposed functions of the Association, in particular, its role in the bank note redemption fund reflected the lobbying efforts made by the Toronto Bankers' Section during the Bank Act Revision of 1890.

The bank note redemption fund was introduced by the Bank Act revision in 1890.¹³⁵ According to that Act,¹³⁶ five percent of the annual average circulation of the notes was to be contributed to the Fund by the note issuing banks. The Fund would then be used to "ensure prompt and certain redemption of the notes of a failed bank."¹³⁷ In other words, an insurance scheme for note circulation was

¹³⁴ See Perry (1967), p.103, and Jamieson (1955), p.30.

¹³⁵ See Breckenridge (1910), pp.131-9 for a detailed description of the Bank Act Revision in 1890.

¹³⁶ See sections 64 and 65 of the Act.

¹³⁷ See McLeod (1933), p.24. There was limitation for the contribution to the fund by each bank. See Breckenridge (1910), p.138.

installed with the redemption fund; the banks communally became the guarantor of every other bank's note circulation.¹³⁸ Table 3.9 shows the Note Redemption Fund of all the chartered banks from 1892 to 1900.

Table 3.9 Growth of Note Redemption Fund, 1892-1900

year	Note Redemption Fund
1892	1035127
1893	1775462
1894	1989119
1895	2066497
1896	2215728
1897	2172822
1898	210216
1899	2194312
1900	2130421

source : Canada Year Book, 1892-1900.
(constant dollar ; 1900=100)

The imposition of the note redemption fund might be viewed as an extra regulation to the note issuing banks. However, it should be noticed that, during the process of Bank Act revision of 1890, banks showed they were more than willing to accept *the Fund* as the price for the safety feature of note circulation. Initial proposals made to the

¹³⁸ The first use of the redemption fund was in 1916. When the Bank of Vancouver failed in 1916, \$225,000 was used to redeem the notes issued by the bank; later, the fund was fully repaid by the liquidator of the failed bank. See Ross (1927), p.398.

House of Commons were a lot more rigid. Had these proposals passed, banks might have been allowed to issue notes only up to 60-70% of the paid capital, or forced to hold high fixed reserves. In fact, banks (and *the Bankers' Section*) worked hard to change the plan to the five percent note redemption fund.¹³⁹ As explained, banks were impressed by the persuasion tactic the Section showed during the process; the bank note redemption fund was considered a triumph of the organization. In turn, safer note circulation backed by the Note Redemption Fund could also enhance the cheque clearing process.¹⁴⁰

While most of banks joined the Association voluntarily in 1891 (25 out of the 38 banks in Canada), a separate supplementary organization was formed in Montreal in 1894. The Montreal Board of Trade Bankers' Section was designed by the major banks in the Montreal area to "obtain conformity of action amongst the banks in the city concerning their interest." Despite the efforts of the Canadian Bankers' Association to affiliate the Montreal Section, it decided to remain as a *separate and distinct* entity in Canadian banking

¹³⁹ See Neufeld (1964), pp.192-5.

¹⁴⁰ In other words, increased trust in the credit form of the medium of exchange would increase the use of cheques. Even though the note redemption fund was not directly related to deposits, it could provide additional insurance to the customers.

during the 1890s.¹⁴¹ However, the existence of the Montreal Section did not cause conflicts in collective decisions regarding general banking issues. While the Association represented the general interests of the banks in the legislation process, the Montreal Sector was mainly focused on *provincial and municipal issues* such as bank failures, note circulation in the area, and provincial taxation. In fact, between 1891 and 1897, the Secretary of the Canadian Bankers' Association also served as the Secretary of the Montreal Section.¹⁴² Notice that the Toronto Section was also operating under the direction of the Canadian Bankers' Association until 1899 when it was completely affiliated by the Association. Hence, while the Canadian Bankers' Association remained as a voluntary organization during the 1890s, separate Sections in two major banking centres in Canada were operating concurrently to tackle the issues most immediately relevant to them.

In the discussion above, I examined the development of banking organizations in the early 1890s. One of the main objectives of the Canadian Bankers Association (and the Sections in Toronto and Montreal), as we have seen, was notes and cheque clearing. To increase the acceptance and

¹⁴¹ Subsequent meetings to discuss the formation of Bankers' Section (to be affiliated to the Board of Trade) in Montreal were held in the CBA Executive Council. See the CBA Executive Council Minutebook, vol.1, pp.24-8, Dec. 8 1893 - Jan. 8 1894.

¹⁴² W.W.L. Chipman, the first secretary of the CBA, was also the Secretary of the Montreal Section for the same period of time. See Perry (1967), p.102.

circulation of notes, the Bank Note Redemption Fund was supported. In addition, the Canadian Bankers Association promoted the development of clearinghouses in various cities.¹⁴³ As one would then expect, the banks joining the Canadian Bankers' Association were generally in favour of clearinghouses.

One noticeable exception is found in the case of the Bank of Toronto. The Bank of Toronto was an active member of both the Toronto Bankers' Section and the CBA from the beginning. In fact, the first chairman of the Section was D. Colson, General Manager of the Bank of Toronto. He also became one of the chief officers of the CBA when it was established in 1891. While the Bank of Toronto was a main contributor to the establishment of the organization, it did not join the clearinghouse in Toronto until 1895.

Protest by the Bank of Toronto showed its concern with the operations of other banks. As one of the larger banks in Ontario (see table 3.10), the Bank of Toronto was not particularly comfortable with the reserve management practices of other banks in the Toronto area. However, it is believed that the Toronto clearinghouse expected the Bank of Toronto to join the multilateral clearing process

¹⁴³ The clearinghouse in Toronto was backed by the Bankers' Section of the Toronto Board of Trade. Other clearinghouses developed between 1891 and 1899 were assisted by the CBA. Of course, clearinghouses in Halifax and Montreal preceded the emergence of the Association (See 3.2).

eventually. In the *Toronto Clearinghouse Register*,¹⁴⁴ there was a column reserved for the Bank of Toronto clearing record from the first day; this column remained blank until November 25, 1895.

**Table 3.10 The Relative Size of the Bank of Toronto in
Asset and Liability Compared to Total Figures
in Ontario, 1890-95**

Year	asset (%)	liability (%)
1890	16.8	13.8
1891	14.3	13.9
1892	12.9	13.9
1893	13.5	14.1
1894	12.9	13.1
1895	12.3	14.2

source : *The Monetary Times*, vol.23-29.

This table is constructed based on the figures reported at the end of each year.

The views of the Bank of Toronto on banking practices of other banks in Toronto at that time can be found in Schull (1958):¹⁴⁵

Toronto was an over-banked metropolis with a dozen institutions in *varying conditions of solvency*. [...] The currency in circulation was of bewildering variety. Its value was fluctuating and in many cases doubtful.

¹⁴⁴ *Toronto Clearinghouse Register*, 1891-1895, CBA Archives.

¹⁴⁵ See Schull (1958), p.3. See also Neufeld (1972), pp.101-2 for a discussion on the problem of overbranching.

Notice that the Bank of Toronto was one of *the original members* of the clearinghouse in Montreal in 1889,¹⁴⁶ which indicates that dissatisfaction of the Bank of Toronto was limited to the banking conditions in the Toronto area. With bilateral trade, the Bank of Toronto could regulate (or avoid dealing with) a partner¹⁴⁷ bank which had shown unsatisfactory performance in its cheque settlement. However, under the multilateral clearing option, the Bank of Toronto would not directly influence its partners; decisions regarding clearing (and settlement) practice were to be made by the clearinghouse, and the Bank of Toronto could be forced to deal with some *suspicious partners*. When the Bank of Toronto finally joined the Toronto clearinghouse, however, it really was a boost for the other member banks. On its first day in the clearinghouse, the Bank of Toronto managed to clear 14.6% of the total clearings of the Toronto clearinghouse.¹⁴⁸

Joint responsibility of the banks in providing adequate confidence was emphasized by the CBA *before and after* the Bank of Toronto decided to join the clearinghouse in Toronto. In 1892, during the meeting held at the CBA, Mr.

¹⁴⁶ See Denison (1966), p.242.

¹⁴⁷ It is not known which banks the Bank of Toronto did not want to deal with.

¹⁴⁸ On November 25 1895, \$160,474 out of a total of \$1,099,498 was cleared through the Bank of Toronto.

Thomas (of the Bank of Nova Scotia) asked the banks to stop the clearing (and circulation) of the bills of a weak bank. The Executive Council of the CBA expressed its opinion saying that the desired result would be attained with the involvement of the clearinghouses.¹⁴⁹ In 1898, the president of the CBA criticized *unnamed banks* for holding too low reserves; his remark was another piece of evidence showing that the Canadian Bankers Association was very much concerned with proper clearing practices among the member banks.

Another effort to provide more efficient cheque clearing among its members was launched by the CBA. In 1893, a meeting was held to discuss the issue of "special legal tender certificate for clearinghouse and reserve purpose [not payable to bearer]."¹⁵⁰ Following subsequent discussions, the Executive Council made a proposal asking the government to issue legal tenders for clearinghouses (solely used by the banks). By 1894, the issue of legal tenders (known as "bank legals") in denominations of \$500, \$1000 and \$5000 was authorized with Chapter 31 of the revised Statutes of Canada (which was originally passed in

¹⁴⁹ The CBA Executive Council Minutebook, vol.1, p.9, september 21, 1892.

¹⁵⁰ The CBA Executive Council Minutebook, vol.1, p.21, November 16, 1893. See also Appendix B to this chapter.

1888).¹⁵¹ Each participating bank agreed to pay \$2500 to cover the cost of initial issue of the legal notes.

While the CBA made continuous endeavour to improve the cheque clearing system, individual member banks also contributed to the establishment of *better environments* for clearing. For example, it is evident that major banks in Toronto and Montreal had some mutual arrangement for cheque collection between them; when a cheque was presented in a town where a bank had no branches, its partner bank (which had its own branches) would collect this cheque and deliver it to the head office.¹⁵² Then, the head office would enter this cheque at the clearinghouse for its partner bank and notify the original bank. Furthermore, the charges levied on this type of collection service were declining over time, which provided added savings in clearing costs. Typical charges on collection recorded in the circulars of the Dominion Bank (1892-95), for example, were reduced from 1/8 cent to 1/10 - 1/16 cent per service. By 1896,¹⁵³ the Dominion Bank eventually agreed with the Bank of Commerce to

¹⁵¹ In the sample form of the note, it says "this note is good only in the hands of a bank to which 'the Bank Act' of Canada applied; it is negotiable only between such banks; and will be redeemed only when presented by one of such banks." The CBA Minutebook, vol.1, pp.37-51.

¹⁵² Reports of the Board of Trade (Toronto) indicate that these arrangements existed since 1889 in Ontario and Quebec. Circulars of the bank of Toronto, the Dominion Bank, the Bank of Nova Scotia, and the Bank of Commerce show the arrangements among these and other banks to collect the cheques (and notes) for each other. For typical examples of these arrangements, see the Printed Circulars of the Dominion Bank, 1892-1900 in Toronto Dominion Bank Archives.

¹⁵³ See the Dominion Bank, Circulars, June 11, 1896.

collect each other's cheques at no cost. Other banks soon followed this trend as well.

Along with the development of clearinghouses and mutual arrangements among banks, the branch banking system in Canada was also strengthened in the 1890s. As explained before, the branch banking in Canada could supplement the clearinghouses in terms of savings in clearing costs. Therefore, the expansion of branches can be viewed as another contributing factor for the cost savings in cheque clearing. Table 3.11 and Figure 3.6 show the expansion of branch banking in the 1890s.

Table 3.11 Expansion of Bank Branches in Canada, 1890-1900

year	Quebec	Ontario	Maritime	Manitoba	B.C.	total
1890	77	237	85	14	9	426
1891	94	247	89	21	9	468
1892	94	254	89	24	10	479
1893	102	263	93	24	12	502
1894	103	272	99	19	12	513
1895	115	275	99	20	13	530
1896	112	272	102	22	16	533
1897	114	269	108	29	24	555
1898	128	285	109	46	36	622
1899	113	321	114	50	41	663
1900	123	336	129	56	48	708

source : Urquhart and Buckley (1965), p.246 and
Willis and Beckhart (1929), p.362

As branches were built in various cities, chartered banks revealed their strong willingness to control their local branch's operation in order to maintain an adequate cheque clearing process. Two episodes of the Bank of Nova Scotia show how head office was involved in the management of the clearing process at the branch level. First, a letter sent by the General Manager to the local branch in St. Johns (in 1899) shows that the head office was recommending a revision in the reserve level held by the branch to provide adequate liquidity. At the same time it allowed the St. Johns branch to use "telegraphing advice (instead of formal written report) of settlement [of] cheques [to head office] unless they exceeded \$20,000", which permitted prompt settlement between local branches.¹⁵⁴

¹⁵⁴ *The Bank of Nova Scotia Executive Officers' Records*, H.C. McLeod Series, December 4, 1899, Bank of Nova Scotia Archives.

Figure 3.6 Average Number of Branches per Chartered Bank, 1890-1900

The movement of the "Head Office"¹⁵⁵ to Toronto in 1900 allowed the Bank of Nova Scotia to get closer to the major banking centre in Canada. Of course, the movement of the head office from Halifax to Toronto was not solely motivated by the possibility of centralized management of cheque clearing. The Bank of Nova Scotia could also take advantage of having its centre of operation in the major

¹⁵⁵ The new office moved to Toronto was to be called "General Office"; the "Head Office" of the Bank of Nova Scotia is still in Halifax. The Bank of Nova Scotia Numbered Circulars, unit 3, March 17, 1900.

cheque clearing spot.¹⁵⁶ Notice that, prior to this movement, the Bank of Nova Scotia joined the Toronto clearinghouse on November 2, 1897.

During this period, most of the out of town cheques deposited in local branches were directed to the head offices. Usually they were presented to the clearinghouse in Montreal or Toronto through its main branches. Sometimes, however, these cheques were sent to other banks (in major banking centres) at the direction of the head offices. For example, a branch of the Dominion Bank in Guelph was ordered to send Montreal items to the Bank of Montreal in Montreal (not to head office of the Dominion Bank in Toronto), the U.S. items (except Chicago) to the Bank of British North America (in New York), and the Chicago items to the American Exchange National Bank (in Chicago).¹⁵⁷ In such case, each branch was asked to add a debit entry (for those out of town cheques) on Head Office Daily Advice Slip which branches were required to provide everyday. In this way, out of town cheques would be settled with less delay and also the banks could save the costs related to the handling of out of town cheques. On top of the directions given for the out of town cheques, head offices often sent memoranda to the branches asking to

¹⁵⁶ A similar argument can be made for the movement of the Royal Bank's head office from Halifax to Montreal in 1907.

¹⁵⁷ See the Circular of the Dominion Bank, October 20, 1899, TD Bank Archives.

process cheques promptly and carefully.

Improvements in cheque clearing were also observed at the individual clearinghouses. For example, in the Montreal clearinghouse, the errors involved with recording were reduced substantively. In the Annual Report of the Montreal clearinghouse, it is said that errors were usually found in the delivery statements and envelope tags due to carelessness.¹⁵⁸ Through the discipline exercised by the managers, the time lost in waiting for corrections was reduced from sixteen hours in 1898 to four hours in 1899. It is also noticeable that two bank failures in the 1890s, which brought down the membership to sixteen from eighteen, did not cause default at the clearinghouse. With the advanced advice of the clearinghouse, these two banks "wisely refrained from clearing when the crisis came." (These two banks did not present their cheques to the clearinghouse.)

By the end of the 1890s, the Montreal Clearinghouse not only remained as the largest clearinghouse in Canada but also made an attempt to interact with the clearinghouses in the U.S.. Mr. Crombie, the Chairman of the Montreal Clearinghouse, for instance, visited the Boston clearinghouse in August 1898.¹⁵⁹ One noticeable

¹⁵⁸ Report of the Chairman of the Montreal Clearinghouse, January 17, 1900, pp.2-3, the Bank of Montreal Archives.

¹⁵⁹ Report of the Montreal Clearinghouse, p.3, 1900.

observation he made during his visit was that "(in U.S. clearinghouses) it was still customary for the debtor banks to settle their balances by borrowing from the creditor banks of the day." He added that he would be sorry to see the U.S. system replace the current Canadian settlement system of using legal tender notes. At the same time, however, he mentioned that it was worth while considering some alternative device for carrying the balances over from day to day (such as "cheque secured by collateral lodged with the settlement bank") which could furnish further economization of the use of reserves and obviate the risk of handling legal tenders.

In order to provide an efficient chequing system, the CBA not only worked with its member banks (and clearinghouses) but also responded sensibly to the request made by the business community. The decision made by the Executive Council of the CBA regarding the request of Mr. Vigeon shows the CBA was quite determined to supply adequate chequing services:¹⁶⁰

the letter of Mr. Vigeon, President of the Chartered Accountants of Toronto, requesting that the banks take action to discouraging the drawing of cheques *nominally payable to order but in reality to bearer*, such as B/P or B/R, met with the approval of the council. The Secretary was desired to thank Mr. Vigeon for his suggestion and to issue a circular to the banks desiring them to discourage the drawing of cheques to any order but that of an individual or firm, payable of giving a proper endorsement.

¹⁶⁰ The CBA Executive Council Minutebook, April 26, 1899.

With this decision, the CBA made sure that cheques were used for proper transaction purposes. The CBA hoped that added confidence in cheques and lessened confusion with endorsements could improve the cheque clearing system even further.

As more clearinghouses were established, an attempt was made by the Canadian Bankers Association to work out common regulations for clearinghouses across banking centres. On April 2, 1897, a committee was appointed by the CBA to set the common rules of operation for the six¹⁶¹ clearinghouses then operating in Canada. The need for general rules was growing since the volume of the cleared items had increased quite quickly as more clearing houses were added during the 1890s. Table 3.12 and Figure 3.7 show the increase in the clearings in clearinghouses.

¹⁶¹ Clearinghouses were established in Halifax, Montreal, Toronto, Hamilton, Winnipeg, and Saint John by 1897.

Table 3.12 Clearings in Various Clearing Centres, 1890-99

year	Halifax	Montreal	Toronto	Hamilton	Winnipeg	St. John
1890	60233	458344	--	--	--	--
1891	61701	492876	--	--	--	--
1892	61280	611443	337872	39692	--	--
1893	60588	573325	311989	38130	5014*	--
1894	63819	593491	303221	37243	54942	--
1895	69171	660430	349528	42556	63275	--
1896	73690	635208	411553	40617	77191	--
1897	74457	802704	482424	39118	99620	33313
1898	68631	802704	482424	39118	99620	33313
1899	76822	864101	549041	43849	117286	35503

unit : \$ thousand (constant; 1900=100)

* December only

Figure 3.7 Total Clearings Conducted in Canadian Clearinghouses, 1890-99

source : Breckenridge (1910), p.309.

Notice that Montreal remained the largest clearinghouse in Canada throughout the 1890s. Despite the creation of new clearinghouses and the continuous growth of the existing ones, the Montreal clearinghouse still managed to tackle 48 percent of the total clearing in 1899. In terms of the value of cheque clearing in 1895, Montreal was ranked as the tenth largest clearinghouse in North America (compared to

sixty five clearinghouses in the U.S. and Canada). It moved into ninth place by 1889.¹⁶²

The proposal made by the CBA committee regarding the common rules for the clearinghouses was believed to have been ready by 1899. The rules of clearinghouse adopted in 1900, when the Canadian Bankers Association was incorporated, reflected the earlier efforts made by the committee. Without a central clearing agency available at the time, the CBA supplied guidelines to the clearinghouses in different banking centres of the country. The vision of a clearinghouse system operating under uniform rules is well echoed in Mr. Crombie's report to the Montreal clearinghouse: "Canada is being more and more closely knit in interprovincial trade, and the day may come when we shall have economic methods of clearing between cities as well as between the banks of one city."¹⁶³

The membership of the CBA continued to grow throughout the 1890s. In 1899, all but two of the Canadian chartered banks were members of the Association.¹⁶⁴ However, the

¹⁶² Annual Reports of Montreal Clearinghouse, 1895, 1899 and 1900, the Bank of Montreal Archives.

¹⁶³ *Report of the Montreal Clearinghouse*, p.3, 1900.

¹⁶⁴ That is, thirty four out of thirty six banks were members of the CBA. One of the non-member banks in 1899 was the Bank of Nova Scotia. The Bank of Nova Scotia was, in fact, one of the original members of the Association, but withdrew from the CBA in 1899. It was a protest against the accusation made on the action taken by its Winnipeg branch manager about handling a customer's accounts. It did not return to the Association until 1902. See Schull and Gibson (1982), pp.84-5, and Executive Officer's Records, H.C. McLeod Series, units 1-5 (BNS Archives).

most important structural change of the Association, up to that point, occurred in 1900. Until then the CBA was a voluntary organization of banks. With the new Bank Act revision in 1900, the Canadian Bankers Association was formally incorporated under a Dominion statute.¹⁶⁵ The main responsibilities of the *incorporated* CBA were increased and those relevant to clearing practice were:

- (i) the inspection and supervision in all aspects of the note issue of all chartered banks;
- (ii) the appointment of a *curator* to supervise the affairs of a bank that suspends [settlement] payment; and
- (iii) the establishment of clearinghouses and the rules for their conduct.

In the Bylaws,¹⁶⁶ which the Canadian Bankers' Association adopted in 1900, considerable space was dedicated to the rules of clearinghouses. In article sixteen of the general Bylaw of the Association, "the rules and regulations governing all clearinghouses [now] existing and established or that maybe hereafter established" were listed. since these rules immediately became another cornerstone for the development of clearing processes in Canada, I now will examine the rules adopted in the bylaws.

¹⁶⁵ A corporation was created by the Special Act of the Parliament of Canada, 63 and 64 vic.c.93 (1900).

¹⁶⁶ See Journal of Canadian Bankers Association (1900), p.308. In fact, the power to pass Bylaws respecting clearinghouses belonged to the Executive Council of the CBA. (Victoria Statute 63-64, chapter 93, item 16-2, July 7, 1900.)

First, the purpose of the clearinghouse was again emphasized; in sub-article 2 of the rules¹⁶⁷ it says, "the clearinghouse is established for the purpose of facilitating daily exchange and settlements between banks." And further, it stressed the rights of the banks engaged in the clearinghouse to refuse any items bilaterally presented to them, without going through the channels of the clearinghouse. This restriction included in new rules of the clearinghouse would soon make bilateral clearings most improbable among banks. Banks found that bilateral clearings were obsolete as clearinghouses became available in most Canadian cities. This new regulation discouraging bilateral clearing reflects two incidents that happened between 1891 and 1899 in the Toronto clearinghouse. As discussed before, the Bank of Toronto did not join the clearinghouse in Toronto until 1895. Also the Quebec Bank withdrew from the clearinghouse of Toronto in 1897 and, until it rejoined in 1900, its cheques were not presented to the clearinghouse. As an organization promoting the establishment of the clearinghouses, *resistance* from the banks in the major banking centre could have damaged the CBA seriously. After a decade of gruelling experience, therefore, the Canadian Bankers Association made it explicitly clear that any attempt to mix bilateral clearing

¹⁶⁷ Rules and Regulations Respecting Clearing Houses made in pursuance of the power contained in the Act to incorporate the CBA.

with the clearinghouse system would not be welcomed.

Among the rules adopted by the CBA in 1900, at least a few of them looked quite similar to the rules which existed since the earliest days of the clearinghouses in Canada. For example, according to subarticle 10 of the rules of clearinghouse, the Board of Management would arrange with one bank to act as the clearing bank.¹⁶⁸ The same practice of appointing a clearing bank by the Board of Management had been proposed by Article V of the original Constitution of the Halifax Clearing House Association as well.¹⁶⁹ And the payment of the balances was to be made in legal tender notes of large denomination under *the old Constitution as well as by the new rules*. But the new rules also allowed the banks to pay the balances by draft¹⁷⁰ provided it was agreed in the clearinghouse. To avoid any trouble associated with settlement, clearinghouses would disallow any bank use of the draft if it had the experience of default in settlement.

As *the rules* tried to incorporate the principles of existing clearinghouses, the CBA also made sure that any new clearinghouses opened later would have to adopt rules which

¹⁶⁸ Journal of CBA (1900), p.137.

¹⁶⁹ Constitution of Halifax Clearing House Association (1888), p.4. One might find expressions regarding the role of clearing bank in Constitution (1888) and rules (1900) were strikingly similar. Also the clearinghouse in Montreal (1889) had a similar clause for the role of clearing bank.

¹⁷⁰ Despite partial acceptance of the American method of settlement, banks in Canada were predominantly using Dominion Notes for settlement purposes. See Montreal Clearinghouse Annual Reports, 1895-1900. And more discussion is provided in Appendix B.

were consistent with the guidelines it supplied.¹⁷¹ The rules endorsed by the Association contained more general regulations for clearinghouses: meeting schedules, expenses, withdrawal from the clearinghouse, collection of unpaid balances, amendment of rules, returned items, defaults and the suspension of clearing. And any changes in the rules of the individual clearinghouses were to be approved by the CBA.

Until now, I have discussed the development of the CBA and its impact on clearinghouses. As has been observed, the clearing processes in Canada shifted from a bilateral system to a multilateral clearinghouse system during the 1890s. And as a consequence, the costs involved with cheque clearing were reduced considerably.¹⁷² (See section 3.1 for the savings in reserves observed in the 1890s.) These results were expected by the model developed in the chapter II of this thesis. (Equations 2.2 and 2.28 show the savings in physical costs and reserves, respectively.) In chapter II, savings are calculated based on the assumption that n banks in a banking centre, which cleared cheques bilaterally in the beginning, decided to form a clearinghouse and all n banks became the members of the clearinghouse. In other words, the savings equation (eq. 2.28) shown in chapter II

¹⁷¹ See subarticle 17 of the rules ; Journal of the CBA (1900), p.140.

¹⁷² See Perry (1967) and Breckenridge (1910).

is the maximum savings in reserves which would be obtained if all bilaterally clearing banks joined the clearinghouse simultaneously.

However, the Canadian experience indicates that this shift from bilateral clearing to the multilateral option could take some time. The previously mentioned example of the Bank of Toronto indicates that bilateral clearing coexisted along with the clearinghouses in some regions. (While all the banks in the Halifax and Montreal areas joined the clearinghouses from the beginning, there was no restriction to prevent additional bilateral arrangements among the banks.) And as shown in chapter II (see endnote 2.6), an incomplete multilateral clearing system fails to capture the maximum potential savings in reserves. For these reasons, the years between the emergence of the clearinghouse (1887) and the incorporation (1900) of the CBA can be viewed as the *transitory period* in the clearing system. With the new rules adopted by the CBA in 1900, the banks in Canada would clear their cheques and notes exclusively through the clearinghouse, wherever it was available.¹⁷³

¹⁷³ In Endnote 2.4, covariance matrices of bilateral and multilateral clearings are compared. In terms of the Canadian clearing experience, the clearing system prior to 1887 can be related to the exclusive bilateral system; every off-diagonal element was non-zero entry. As clearinghouses developed through the 1890s, more and more off-diagonal elements became zero, and the variance of net clearing became smaller. Consequently, savings in reserves would follow. When the clearinghouse system was imposed by the Bylaws of the incorporated CBA, the savings in reserves became amplified (i.e., most, if not all, of the off-diagonal entries became zero). See chapter II, especially endnote 2.4 and sections 2.6-7.

In summary, the savings in reserves from multilateral clearing began to emerge with the introduction of the clearinghouse in 1887. By 1900, the potential savings in reserves for each banking centre were well realized;¹⁷⁴ Bylaws of the CBA indicated that the Association intended to rule out the coexistence of bilateral clearing practices. Along with the establishment of clearinghouses in the 1890s, other banking conditions had also matured to bring out the savings in cheque clearing costs. Once all the banks started to clear with each other multilaterally, savings in reserves, which originated from the adoption of multilateral clearing option, would be affected further by the changes in the banking structure; the number of banks in each clearinghouse, the size of the banks and the other structural changes would have impacts on the savings.¹⁷⁵

With this analytical framework in mind, I will now turn to the savings in the costs of the Canadian clearing system in the early 1900s.

¹⁷⁴ Different levels of savings in reserves in the initial stage of the multilateral clearinghouse system are reported in section 3.1. See tables 3.2(b), 3.3 and 3.4.

¹⁷⁵ See section 3.1 for the empirical analysis of the impact of selected variables on reserves.

3.5 Further Development in Banking and Clearing, 1900-1914

The period immediately following the incorporation of the CBA (1900) witnessed the most exciting period of economic expansion that this young country had ever experienced.¹⁷⁶ Rapid development in Western Canada, the increasing inflow of foreign capital and ever increasing immigration were just a few of the important ingredients of economic expansion in the early 1900s. As a consequence of general economic expansion, there was an increased demand for banking services. In this section, I explore development in cheque clearing in Canada in the early twentieth century prior to the First World War. The discussion will focus on the growth of multilateral clearing, the changes in the banking environment (such as special note issue and the *Central Gold Reserve*) and further integration of cheque clearing among clearinghouses. I examine how savings in reserves under the clearinghouse system had been affected in this period.

To understand the changes in the economic climate in the early twentieth century, first, let's look at the growth of aggregate output in Canada from 1900 to 1913. Estimates of Gross National Output reported in Urquhart (1993) are

¹⁷⁶ In fact, the exceptional growth of the Canadian economy started in 1896 in some provinces when the international price of staples - particularly wheat - started to rise. See McIvor (1961), p.79.

used here.

Table 3.13 Increase of National Output in Canada, 1900-1913

year	GNP estimated	rate of growth*
1900	901	3.1 %
1901	987	9.5 %
1902	1098	11.2 %
1903	1140	3.8 %
1904	1187	4.1 %
1905	1279	7.8 %
1906	1361	6.4 %
1907	1468	7.9 %
1908	1419	- 3.3 %
1909	1596	12.5 %
1910	1706	6.9 %
1911	1832	7.4 %
1912	1916	4.6 %
1913	2048	6.9 %

unit : \$ million (constant; 1900=100)

source : Urquhart (1993), pp.11-4.

The table indicates clearly that aggregate output in Canada experienced exceptional growth; the annual average rate of growth was 6.3 percent during the period.

The rapid growth of the Canadian economy in the early 1900s can be partly attributed to an "enormous" inflow of

foreign capital, most of which came from Britain.¹⁷⁷ The rapid expansion is illustrated diagrammatically in Figure 3.8.

Figure 3.8 Total Net Inflow of Capital, 1900-1913

By 1910, the net capital inflow grew to 15 % of total gross output of Canada while the same figure in 1900 had been merely 4%. At the same time, the development of

¹⁷⁷ See Paterson (1976). In this work, Paterson provides an in-depth analysis of capital inflows from Britain between 1890 and 1930.

manufacturing in Ontario and Quebec along with a strong wheat economy in the prairie provinces had contributed to an unprecedented expansion of the Canadian economy during the first decade of the century. Table 3.14 provided below shows the exceptional performance that took place in these sectors.¹⁷⁸ It shows the growth of wheat exports¹⁷⁹ and manufacturing production during the period of 1902-1913.

Table 3.14 Growth Rates of Wheat Export and Manufacturing Production, 1902-1913

year	wheat export (%)	manufacturing (%)
1902	62.7	19.3
1903	26.3	6.7
1904	- 49.1	- 1.9
1905	- 12.4	21.2
1906	174.8	17.9
1907	- 1.6	10.5
1908	1.6	- 13.0
1909	18.8	16.3
1910	10.5	11.3
1911	- 7.9	3.8
1912	38.5	9.9
1913	17.5	0.3

source : Urquhart and Buckley (1965), p.363, and Urquhart (1993), pp.13-4

¹⁷⁸ The expansion of Canadian economy during the 1900s was not based on just these factors; however, I will examine these figures as the proxy for all the other sectors experienced extraordinary growth during the period.

¹⁷⁹ Dependence of Canadian economy on wheat export is discussed in Easterbrook and Aitken (1958).

It demonstrates that the manufacturing sector was growing rather steadily over the period while agricultural growth experienced a much higher degree of fluctuation.¹⁸⁰

Despite the variability, the volume of wheat exports still recorded an annual average rate of growth of 9.8 % from 1901 to 1913. See Appendix C for the expansion of branches in different parts of Canada in this period.

The rapid expansion of the Canadian economy discussed above required more trades and the media of exchange. Along with the continuously growing demand for money, the nominal supply of money was also pushed to increase. First, let me discuss the increase in money supply in terms of bank note issues here.

Through this period, the maximum bank note issue was still restricted to the amount of paid up capital of the bank.¹⁸¹ McIvor (1961) mentioned that it was remarkable that the Canadian monetary system still "remained based on gold" through this phenomenal period of growth. The supply of bank notes grew moderately as banks increased their paid up capital gradually. Consequently, the note issue grew in proportion to the change in paid up capital of the banks.

¹⁸⁰ Fluctuations in the wheat sector was due to both domestic and foreign oriented; large changes in production and demand caused high year to year variations.

¹⁸¹ O'Brien and Lerner (1969), p.33. Notice that banks had rejected one of the proposals regarding note issue during the process of Bank Act Revision of 1890. If it had been passed, banks would have been allowed to issue only up to 60-70% of their paid up capital. See Neufeld (1964), pp.192-5.

Figure 3.9 shows the *proportional* change in note issue and paid up capital from 1900 to 1906.

**Figure 3.9 Increase in Note Issue and Paid Up Capital,
1900-1906**

source : Curtis (1931), p.33, and Urquhart and Buckley (1965), p.242

Even though the issue of bank notes continued to grow from 1900 to 1913, the limit to the existing system seemed to be reached by the mid 1900s. There then seemed to arise a problem of *insufficient medium of exchange* that peaked

each year during the "crop moving" season. In 1907, the problem finally reached a critical point. A low quality wheat crop, which had been damaged by frost during its harvest, had to be quickly moved to the market to prevent further deterioration and complete loss in value. But the ceiling of note issue had been already touched, and only an emergency measure would save the situation.

Initially, the financial crisis in 1907 originated in the U.S. in October. However, until the crop moving dilemma, the chartered banks in Canada coped with this external shock pretty well.¹⁸² In response to the urgent representation made by the Manitoba Grain Growers' Association and the Winnipeg Board of Trade, the government introduced a new scheme. With an Order-in-Council passed on November 12, 1907, the government advanced Dominion notes to the banks engaged in grain trade.¹⁸³ Under this arrangement, \$ 5,315,000 was borrowed between November 20, 1907 and January 2, 1908. In order to ensure prompt repayment, the government charged interest of 4 percent (per annum) for the first sixty days; the interest would be 5 percent for next sixty days and it would rise to 6 percent

¹⁸² See Greening (1965), pp.10-3, and Jamieson (1955), pp.37-8. Because of the disturbed financial conditions outside of the country, the banks were even more cautious than usual in extending the credits.

¹⁸³ With the absence of a central bank in Canada at that time, the Bank of Montreal again acted as the government agent for this **emergency loan**. See Denison (1966), p.294. For alternative view on 1907 crisis, see Rich (1988), chapter 6.

if the credit was further extended.¹⁸⁴ By May 1, 1908, the entire sum of extra Dominion notes was repaid.

The financial crisis of 1907 was tackled promptly by the response of the government. More significantly, however, this *short but severe* monetary shock produced a remarkable change in the Canadian monetary system. In order to extend the credit to the banks engaged in grain trade during the crop moving season of 1907, the government issued the notes in excess of the amount which could be issued with given gold coverage. To do so was a definite violation of the Dominion Note Act introduced in 1868. To prevent further irregularities, in 1908, a special amendment was added to the Bank Act.¹⁸⁵ This amendment ensured that the added circulation of notes during the crop moving season could be made *without violating the law*. With this modification, banks were allowed to issue excess notes up to an additional 15 percent of their paid up capital from October 1 to January 31. The extra notes were subject to a 5 % interest charge to encourage their prompt withdrawal. The period of extra note circulation was later extended to between September 1 and February 28.¹⁸⁶ (One response of the banks observed after the Crisis was the increase in

¹⁸⁴ Initial plan of the government was 6 percent for the first three months, and 7 percent afterward; protest of the banks had changed the rates of interest. See Jamieson (1955), p.38.

¹⁸⁵ See Statutes of Canada, 1908, c.7.

¹⁸⁶ Statutes of Canada, 1912, c.5.

reserves to prepare further for possible credit crunches in the future. See section 3.1 for statistical data.)

In 1913, an alternative to the amendment discussed above was introduced by the Bank Act revision.¹⁸⁷ According to this new regulation, banks which desired to issue extra notes (in excess of paid up capitals) had to deposit with the *Central Gold Reserve* a deposit equivalent to the amount of excess note issue in gold or Dominion notes. And as far as they could back their extra notes with 100% gold (or Dominion notes) reserves, banks were allowed to issue their own extra notes at any time of the year.

Replacement of the 1908 Act with the 1913 revision brought a few significant changes to Canadian banking structure. First of all, the supply of bank notes again became based on gold.¹⁸⁸ Since the extra note issue was tied to the deposit of gold in the *Central Gold Reserve* while the *normal* note issue again could not exceed paid up capital, the elasticity of money supply in 1913 (compared to 1908-1912) would be reduced.¹⁸⁹ Secondly, the extra note issue now could meet the high demand for money from sectors other than agriculture; issue of extra notes was not going to be limited to crop moving season any longer. At the same

¹⁸⁷ Statutes of Canada, 1913, c.9. Also see CBA Executive Council Minutebook, December 5, 1913.

¹⁸⁸ Notice the issue of Dominion notes was also based on gold.

¹⁸⁹ O'Brien and Lermer (1969), p.33-4.

time, grain farmers still could receive a seasonal boost from the government. The farmer's extended financial need during the harvest season was going to be met by the farm loans which were made upon "the security of threshed grain grown upon the borrower's farm."¹⁹⁰

¹⁹⁰ McIvor (1961), p.84.

**Figure 3.10 Increase in Note Issue and Paid Up Capital,
1907-1913**

source : Curtis (1931), p.33, and Urquhart and Parkley (1965), p.242

In short, the Bank Act revisions that occurred between 1908 and 1913 had extended the bank note issue beyond the

limit of paid up capital.¹⁹¹ Consequently, the issue of bank notes during this period was typically more than proportional to the increase in paid up capital.¹⁹² Figure 3.10 illustrates the increase in bank note issue and paid up capital between 1907 and 1913.

So far I have discussed the increase in money supply in terms of the bank note issue. As mentioned, however, an increase in bank notes did not satisfy the expanding Canadian economy in the early 1900s. In fact, changes in bank note issue were often used as a drastic measure as was observed in 1907. An increased use of cheques, on the other hand, was more directly connected to the expansion of the economy and the banking sector,¹⁹³ in particular. Table 3.15 shows the increase in the volume of cheques cleared through the clearinghouses from 1900 to 1913.

¹⁹¹ Despite the possibility the aggregate note issue did not exceed the total paid up capital until 1915. See Curtis (1931), p.33-4.

¹⁹² Notice the difference in trends by comparing the figures 3.6 and 3.7.

¹⁹³ See Urquhart (1993), pp.522-3 for the banking sector GDP growth compiled by T.K. Rymes.

Table 3.15(a) Summary of Volume of Clearings in Canadian Clearinghouses, 1900-1906

city	1900	1901	1902	1903	1904	1905	1906
Halifax	77	87	87	89	89	83	81
Montreal	734	890	1075	1084	1052	1247	1371
Toronto	513	600	798	787	832	986	1090
Hamilton	40	42	44	51	58	64	69
Winnipeg	106	134	185	239	290	347	450
St. John	37	40	41	47	50	49	53
Victoria	32	30	28	29	32	34	40
Vancouver	42	46	45	52	65	69	78
Ottawa	--	--	96	101	103	114	120
Quebec	--	--	69	79	73	81	81
London	--	--	23	40	44	47	51
Total	1589	1874	2506	2620	2702	3143	3575

unit : \$ million (constant; 1900=100)

Table 3.15(b) Summary of Volume of Clearings in Canadian Clearinghouses, 1907-1913

city	1907	1908	1909	1910	1911	1912	1913
Halifax	79	77	82	80	71	76	81
Montreal	1324	1261	1624	1762	1944	2172	2227
Toronto	1045	1002	1250	1344	1520	1650	1686
Hamilton	74	61	73	85	102	127	143
Winnipeg	507	527	670	803	962	1174	1263
St. John	56	56	62	65	63	67	65
Victoria	46	47	61	85	110	139	136
Vancouver	162	157	249	374	445	492	468
Ottawa	132	131	150	162	174	186	160
Quebec	91	95	102	103	109	120	127
London	55	48	53	56	58	64	69
Calgary	58	55	85	126	178	210	191
Edmonton	38	32	43	60	99	168	164
Regina	--	--	12 *	42	60	87	102
Brandon	--	--	--	--	23	24	24
Brantford	--	--	--	--	22	23	24
Ft. Wil'hm	--	--	--	--	6 *	30	37

	1907	1908	1909	1910	1911	1912	1913
Moose Jaw	--	--	--	--	32 *	48	45
Saskatoon	--	--	--	--	51	87	71
Lthbridge	--	--	--	--	23	25	21
Med. Hat	--	--	--	--	--	--	16 *
N.Wstmstr	--	--	--	--	--	--	22
Total	3680	3561	4528	5159	6068	6984	7161

* : part of the year

unit : million dollars (constant; 1900=100)

source : Canada Gazette, 1900-1913, end of year figure

* - dominion notes and specie held in Canada

** - call loans elsewhere than in Canada

The data provided in Table 3.15 indicate that multilateral clearing had expanded to more banking centres in Canada. In other words, *direct*¹⁹⁴ multilateral clearing became available even to the smaller banking centres of the country.

On top of the emergence of the new clearinghouses and the increase in bank clearings (i.e., deposits), there was another noticeable change in the banking sector. Between 1900 and 1913, quite a number of mergers took place among banks; eighteen mergers were observed during this period, and the number of banks operating in Canada was reduced to 24.¹⁹⁵ At the same time, the number of branches of *larger banks* increased drastically. Between 1900 and 1913, the number of branches of chartered banks grew from 708 to 2962. Figure 3.11 shows the change in the number of chartered banks in Canada and the average number of branches per chartered bank during the period of 1900-13.

¹⁹⁴ Notice that branches in the smaller towns had access to clearinghouses through their branches in the larger banking centres.

¹⁹⁵ See Perry (1991), part II, p.37 for a detailed schedule of banking mergers and acquisitions of chartered banks. The Bank of Montreal and the Canadian Bank of Commerce were the most active players in this restructuring process; each bank acquired four banks from 1900 to 1913.

Figure 3.11 Number of Chartered Banks and the Average
Number of Branches per Chartered Bank, 1900-1913

source : Urquhart and Buckley (1965), p.241.

As more branches were added¹⁹⁶ by the chartered banks, banking became increasingly accessible to the Canadian public. In fact, the average number of people served by

¹⁹⁶ Expansion of banking was most impressive in Ontario. In fact, by 1904, already twenty (out of 38) banks had their head quarters in Toronto. By 1910, about 44% of the total branches were concentrated in Ontario. See the Monetary Times (1910), p.222 and Stanford (1974), p.115.

each branch was reduced from 7600 in 1900 to 3900 by 1910.¹⁹⁷ While the expanded branch banking system began to serve Canadians better, it would generate savings in cheque clearing costs along with the clearinghouse system. Notice that it can be said that the trend shown by the volumes of clearings reported in Table 3.15 are a *underestimation* of the increase in use of cheques during this period. Since more branches were operating with a fewer number of distinct banks (see Figure 3.11), internal cheque clearings among these branches grew rapidly. Transactions made between the branches of the same bank were not typically reported in the clearinghouse statistics; internal bookkeeping was the only requirement for those *clearings*.¹⁹⁸

A few more observations related to the development of branch banking should be discussed. First, the expansion of the branch banking system could lower the risk of cheque clearing. As explained in *endnote 3.4*, when the volume of cheques formally cleared through the clearinghouses were filtered due to pre arrangements between banking units (in this case, between branches of the same bank), the risk involved with cheque clearing settlement could be diminished. For example, that there were six bank failures between 1900 and 1913; after "fewer and larger" banks were

¹⁹⁷ See Perry (1991), part II, p.37.

¹⁹⁸ see Paterson (1932), pp.273-9 for the practice of branch clearings during this period.

established only one bank failed between 1915 and 1928.¹⁹⁹

Even though the size of the banks and the illiquidity problem of settlement balance do not have a direct causality, it is common that larger and better financed banks would further prevent the liquidity problem of cheque settlement balances. And as Table 3.16 below reveals, most of the banks which acquired smaller banks in that period (1900-13) are still operating; this can be a piece of indirect evidence proving that branch banking reduced the risk efficiently. Notice, however, those banks witnessed the extensive mergers of the *would-be failed* banks adjusted their reserves upward to prevent further illiquidity problems of their own. Along with the financial crisis in 1907, I think this added pressure on the surviving banks could have caused higher reserves this period (i.e., 1900-1914).

¹⁹⁹ See Beckhart (1929), p.327. The trend of branch banking continued through the 1910s and 1920s.

**Table 3.16 Mergers and Acquisitions of Chartered Banks,
1900-13**

acquiring bank	bank acquired	initial acquisition ²⁰⁰
Bank of Montreal	Exchange Bank of Yarmouth (1903) People's Bank of Halifax (1905) The Ontario Bank (1906) People's Bank of NB (1907) St. Stephen's Bank (1910)	Bank of British North America (1918)
Bank of Nova Scotia	Summerside Bank (1901) Bank of NB (1913)	Bank of New Brunswick (1913)
Canadian Bank of Commerce	Bank of British Columbia (1900) Halifax Banking Company (1903) Merchants Bank of PEI (1906) Western Bank of Canada (1909) Eastern Township Bank (1912)	Standard Bank of Canada (1928)
Royal Bank of Canada	Commercial Bank of Windsor (1902) United Imperial Bank of Canada (1906) Crown Bank of Canada (1908) Northern Bank (1908) Union Bank of Halifax (1910)	Union Bank of Halifax (1910) Union Bank of Canada (1925)

²⁰⁰ Some acquisitions in this period were made by the banks which would be eventually acquired by larger banks later. For example, the Bank of British North America acquired the St. Stephen's Bank in 1910; itself became the subject of a merger with the Bank of Montreal in 1918.

	Traders Bank of Canada (1912)	
Home Bank of Canada (failed in 1923)	Banque Internationale du Canada (1913)	

source : Perry (1991), chapter II, p.37.

While the expansion of branch banking and the establishment of clearinghouses contributed to the savings in cheque clearing costs, other developments in banking also seem to have provided some favourable conditions for the existence of an efficient cheque clearing process. First, let's look at the modifications (amendments) of the rules and regulations of the clearinghouses in the early 1900s. Amendments made in 1906 on the *Constitution of the Halifax Clearinghouse* indicate that it tried to impose more strict rules regarding daily settlement deadline.²⁰¹ Amended articles in the *Constitution* re-emphasized the time schedule²⁰² for settlement and warned that banks that defaulted would be banned from clearing until settlement balance was completely paid through the clearing bank. The Halifax Clearinghouse, prior to this amendment, also made an effort to ensure "a uniform practice by all banks in Canada" regarding the proper date for acceptance of the cheques deposited. With the consultation of the CBA it was

²⁰¹ Halifax Clearinghouse Minutebook, March 12, 1906, Bank of Nova Scotia Archives.

²⁰² It was 12:30 Monday to Friday, and 11:00 on Saturday.

confirmed that the date of acceptance would be the date cheques drawn after sight rather than the date of presentation.²⁰³ The amended Constitution of the Toronto Clearinghouse (1908) also shows that it tried to improve the cheque clearing process in that city.²⁰⁴ In item 5 of the Constitution, it includes a clause saying that "any member may be expelled on a two thirds vote of the members." This means that the clearinghouse in Toronto was very serious about the sound operation of the cheque clearing. In fact, I would argue that this new regulation reflects the difficult experience the Toronto Clearinghouse had with the Ontario Bank. When it was having financial difficulties, the Ontario Bank absented itself from the clearinghouse from May 1 to July 1, 1903. It rejoined the clearinghouse after this two-month period, but continued to record spotty inattendance until finally it failed on November 15, 1906.²⁰⁵ Item 5 of the amended Constitution seems to be a device to expel undesirable members to maintain consistent and sound operation of the clearinghouse.

At the same time, the Toronto Clearinghouse took extreme care to prevent information from being leaked to someone other than its members. According to item 11 of the

²⁰³ *Halifax Clearinghouse Minutebook*, November 6, 1901.

²⁰⁴ *Toronto Clearinghouse Constitution, Bylaws, Rules and Regulations*, May 12, 1908, the CBA Archives.

²⁰⁵ *Toronto Clearinghouse Register*, 1903-1906, the CBA Archives.

Constitution, "no one shall be admitted into the clearinghouse except the representatives of the banks forming the clearinghouse." And the *item 15* directs that "no officer of the Toronto Clearinghouse, or of any bank who is a member of it, other than the Chairman, shall furnish to or cause to be printed in any newspaper or other publication any information in connection with the Toronto Clearinghouse." These restrictions specified in the Constitution provided added confidence to the members in the cheque clearing through the clearinghouse. Notice that one of the initial reasons for the banks not to join the clearinghouse immediately was the fear to reveal its financial information to others²⁰⁶; with items 11 and 15, member banks in Toronto Clearinghouse could keep their sensitive information within a inner circle.

Some actions taken by the individual banks in this period are also worth while mentioning. For example, a circular sent out by the head office of the Bank of Toronto to its branches advices that any out of town cheques not completely satisfied (however slight the doubts are) should be sent back to "the point upon which it is drawn."²⁰⁷ Another circular sent to the country branches warns of the risk of losing resources when the items cleared through

²⁰⁶ See endnote 2.6 in chapter II.

²⁰⁷ *The Bank of Toronto Printed Circulars*, circular 602, April 7, 1904, Toronto Dominion Archives.

Toronto and Montreal offices are dishonoured (with several days of delay required to settle).²⁰⁸ The decision made by the CBA Executive Council on February 22, 1906 provided some security against these worries: "In case of all items, whether restrictively endorsed or otherwise sent through the exchanges by members of the Association [CBA], the members sending the items shall be deemed and held on guaranteeing the authenticity of all endorsements thereon, and if such guaranteeing do not expressively appear it shall be implied."²⁰⁹

The Dominion Bank's Circular issued in 1907 asks its branch to prepare clearing accounts more carefully.²¹⁰ This memo emphasizes that carelessness in preparing Branch Clearing Accounts costs Head Office dearly. And a circular of the Bank of Toronto (1913) instructs its branches to follow a certain set of rules to "[save] considerable labour and expense" in clearings.²¹¹ It asks the branches to report the savings in expenses in next four months to check the effect of the new scheme. The actions mentioned here are just two examples of the numerous efforts made by the

²⁰⁸ *Printed Circulars*, circular 705, September 5, 1905.

²⁰⁹ *The CBA Executive Council Minutebook*, vol. 2, February 22, 1906.

²¹⁰ The Dominion Bank, *Circular No. 330*, July 3, 1907, TD Bank Archives.

²¹¹ *The Bank of Toronto Printed Circulars*, circular 1504, September 10, 1913. See circular 1504 for the details of the rules given to the branches.

individual banks to achieve more savings²¹² in cheque clearing.

In order to ensure savings the clearinghouses generate for member banks, admission to the clearinghouse was closely monitored. A sincere letter²¹³ of appreciation made by the Manager of the Bank of New Brunswick for admission to the Halifax Clearinghouse shows that existing members of the clearinghouse wanted to accept only the reliable banks to its clearing circle. In the Toronto Clearinghouse, more frequent entries of new members (compared to the clearinghouses in Montreal and Halifax) were recorded.²¹⁴ (The number of member banks grew from sixteen in 1900 to twenty two by 1908; it dropped to seventeen by 1913.)

In some cases, the CBA was directly involved with the decision on the new members admitted to the clearinghouses. For instance, regarding the application made by the Royal Trust Company to the Toronto Clearinghouse, the CBA Executive Council expressed its opinion that approval would be pended due to the disagreement in "legal opinion upon the rights of trust companies."²¹⁵ Evidently, clearinghouses and the CBA were well aware of the fact that only competent

²¹² Most savings intended by these circulars were savings in *physical costs*.

²¹³ *Halifax Clearinghouse Minutebook*, October 17, 1907, Bank of Nova Scotia Archives.

²¹⁴ *Toronto Clearinghouse Register*, 1900-1913.

²¹⁵ *The CBA Executive Council Minutebook*, vol.2, September 26, 1910.

members could guarantee the sound operation of the cheque clearing process and generate savings in costs.

As more clearinghouses were established in Canada, the CBA came up with a plan to integrate them. As explained before, cheques deposited in small branches, which did not have direct access to clearinghouses, and out of town cheques were cleared through Montreal and Toronto Clearinghouses. Based on these existing practices, the CBA Executive Council suggested that "settlement of daily balance should be made only at Montreal, Toronto, Vancouver and Winnipeg in order to concentrate and centralize cash reserves, and all other clearing centres be requested to settle by draft on the most [convenient] central points."²¹⁶

With this plan, reserves of Dominion Notes ("bank legals") would be held at Montreal, Toronto, Vancouver and Winnipeg, and daily settlement was made under the direction of chief bank officers which acted for all branches in their *assigned districts*. Smaller clearing centres still would be connected to these four central points since settlement "at lesser clearing points was to be made by the draft upon the relative "reserve" point."²¹⁷ Consequently, all the cheque clearings in Canada would be settled in these four central points. To ensure the security, drafts used for clearing

²¹⁶ The CBA Executive Council Minutebook, vol. 2, August 14, 1914.

²¹⁷ Duncan (1958), p.150.

purposes had to be issued against authorized note circulation of the bank.

It is reported that by late 1914 Quebec, Halifax and Saint John already made arrangements for settlement by draft on Montreal. One interesting observation found is that the Vancouver Clearinghouse, along with the Victoria Clearinghouse, was initially using Winnipeg as a "central" point despite the fact that the CBA Executive Council assigned Vancouver as a *separate* clearing point.²¹⁸ (Later Vancouver assumed the role of a central clearing point.)

Among the various efforts attempted by clearinghouses and the CBA to generate the savings in costs, I think, this integration of settlement was the most effectual. As discussed in chapter II, the clearinghouse (or multilateral clearing) generates savings in reserves (see equation (2.28)) for member banks. And each of those four major clearing points played, in fact, the role of a "clearinghouse for clearinghouses"; savings in reserves were further enhanced with this centralization plan. Notice that in 1927 integration of the clearinghouses went a step further. With the new intensified scheme, each bank maintained its entire reserves of Dominion Notes in Montreal.²¹⁹ Each day managers of the clearinghouses in

²¹⁸ The CBA Executive Council Minutebook, vol.2, November, 1914.

²¹⁹ It is an irony that the entire reserves of clearing banks were held at the Royal Trust Company, of which application to the Toronto Clearinghouse the CBA rejected in 1910. See Duncan (1958), p.150.

three cities (Toronto, Vancouver, and Winnipeg) advised the Montreal Clearinghouse (by telegram) the debit or credit balance of each member bank. Then, the Montreal Clearinghouse completed the settlement by shifting reserves from one bank to the other accordingly.

Hence, assigning four major clearing points in 1914 was a step toward the establishment of the integrated reserve pool for all banks in Canada, which taken place in 1927 and later inherited to the Bank of Canada in 1935. It is noticeable that throughout this period Dominion Notes remained as the main method of settlement. Risk related to alternative settlement device such as draft²²⁰ mentioned in endnote 3.4 was not realized as a serious problem for Canadian banks.

Since the beginning of the banking in Canada, the optimal level of reserves was left to be determined by each bank. In 1902, the General Manager of the Bank of Nova Scotia argued that required reserve should be introduced to prevent "undue risks [imposed] on community."²²¹ In the letter sent to the *General Managers of the Banks of Canada*, McLeod argued that the average cash reserves of all banks in Canada was reduced steadily over the period of 1885-1901.

²²⁰ Even when draft was used, they were drawn upon the circulation of dominion notes and well certified. See the CBA Executive Council Minutebook, September 18, 1914 and November 12, 1914.

²²¹ The Bank of Nova Scotia, Correspondence of General Manager's Office, April 24, 1902, Bank of Nova Scotia Archives (H.C. McLeod series).

For example, the percentage of cash reserve in Quebec dropped from 14.41% in 1885 to 6.21% in 1901. And he insisted that the CBA had to intervene to amend the Banking Act to include legal reserve requirements.

Even though his observation (declining reserve ratios) was quite true to the fact, reduction in cash reserve (including Dominion notes) did not necessarily increase the risk involved with cheque clearing. As observed, establishment of more clearinghouses, expansion of branch banking and the structural changes in banking environment could have contributed to the reduction in (necessary) reserves. Also reserves of the Canadian banks after 1902 were restored above 11%. At the same time, it should be noted that Canadian banks in the early 1900s started to rely on alternative form of reserves. In the *Statements of the Banks*, an item entitled "Call and Short Loans Elsewhere than in Canada" starts to appear in 1900.²²² This item was almost completely consisted of call loans on the New York Stock Exchange (although a small part was in London). Viner (1975) first pointed out that the call loan market in New York played an important role to keep the liquidity situation in Canada constant.²²³ (More recently the importance of the secondary reserve held at New York Stock Exchange has been analyzed by Timberlake (1984) and Rich

²²² The Canada Yearbook (1900) and The Monetary Times (1900).

²²³ See Viner (1975), chapter 8.

(1988).²²⁴) In fact, the reserve ratio including secondary reserve outside of Canada was quite consistent around 14 %.. (Of course, not all of the call loans were held for precautionary reserve for cheque clearing.) Curtis (1931) mentioned that there was an advantage in this form of reserves since they were also earning interest. Table 3.17 and Figure 3.12 below show this trend in reserves.

Table 3.17 Cash Reserve and Secondary Reserve of Canadian Banks, 1900-1913

Year	cash reserve *	2nd reserve **	total
1900	28083	20079	48962
1901	27701	28592	56293
1902	30910	33692	64603
1903	40137	18145	58282
1904	48868	17139	66007
1905	47326	29107	76433
1906	51078	32624	83703
1907	56237	19529	75767
1908	70377	26098	96475
1909	76516	34876	111392
1910	82210	34093	116304
1911	99686	31174	130861
1912	86757	31313	118071
1913	101086	45092	146179

unit : thousand dollars (constant; 1900=100)

source : *Canada Gazette*, 1900-1913, end of year figure

* - dominion notes and specie held in Canada

** - call loans elsewhere than in Canada

²²⁴ Also roles of the secondary reserve other than precautionary purpose are discussed in these works.

Figure 3.12 Reserve Ratios of Canadian Banks, 1900-1913

source : *Canada Gazette*, 1900-1913.

In short, banking developments during this period of rapid economic expansion (1900-1913) promoted the use of cheques and notes. Consequently, more cheques and notes began to be cleared through the clearing system. Evidence gathered through the historic episodes indicates that banks and the clearinghouses (consistently) made efforts to create

a more effective cheque clearing system. Establishment of more clearinghouses, the increased volume of cheque clearing, the expansion of branch banking and the regulations and policies regarding cheque clearing show that serious attempts were to improve the Canadian cheque clearing system in the 1900s. The observed slow down in savings in reserves reported in section 3.1, on the other hand, reflects the changes in the economic climate. The financial crisis of 1907, vigorous mergers and low interest rates might have contributed to the observed increase in reserves.²²⁵

In this chapter, I have investigated the early Canadian cheque clearing experience based on the model developed in the previous chapter. First, from the statistical data, I found some expected results of savings in reserves. An econometric test suggests that the reserve holdings might have been related to variables previously assumed constant by the model. Results reported in section 3.1 show that some variables reveal mixed signs for their impacts on reserves. Among the independent variables, branch banking and the clearing structure show the most consistent and expected influence on reserves.

Further examination through historic episodes

²²⁵ The impacts of these unfavourable changes in the banking environment are not supported by statistically significant t values in the results reported in section 3.1.

illustrates that the banks and the CBA made consistent efforts to improve the clearinghouse system started in 1888. Even though this endeavour does not appear directly in the statistics, reserve holding decisions and the savings in reserves in the long run were enormously affected by those qualitative variables.²²⁶

²²⁶ Most of the episodes related to cheque clearing, which are reported in sections 3.2 - 3.5, are fresh findings from crude archival sources.

Chapter IV : Conclusions and Suggestions for Further Research

4.1 Conclusions and Suggestions for Further Research

This study attempts to measure the savings in reserves generated under a multilateral clearinghouse system. Even though there have been other works on the potential savings in reserves with the application of the square root rule, not enough attention has been paid to actual measurement of savings in reserves. In this work, first, a general model is developed to measure the savings in reserves. Bilateral and multilateral cheque clearings are compared under a given banking structure.¹ Then, the model is applied to the early Canadian clearing experience in order to investigate how the savings in reserves were realized when the cheque clearing system changed in the real world. Despite the limitations and difficulties associated with the data,² some empirical evaluations are conducted to test the hypothesis proposed by the model. Besides the empirical findings, pieces of historical evidence are added to fill the gap that incomplete statistical analyses inevitably leave behind.

As shown in the previous chapter, the predicted savings in reserves were not always clearly observed in the early

¹ See chapter II for the assumptions made on the banking structure in this study.

² The time consuming process of obtaining relevant data from archives and minutes (not from CANSIM) should never be overlooked.

Canadian cheque clearing practice. Statistical analyses (conducted in chapter III) show that the potential savings in reserves were not always realized.³ To explain this disagreement between the theory and the real world experience, developments in banking structure, which are believed to affect the reserve holdings of the cheque clearing banks, are inspected. In section 3.1, a functional relationship between the reserve holdings and the independent variables (previously assumed constant) is explored. Regression results suggest that the reserves of a bank are related to variables such as branch banking, interest rates, mergers and the clearinghouses. Notice that some of these independent variables do not possess sufficient explanatory power to exhibit individual statistical significance. However, a correct functional relationship is backed by the expected signs. Further explanation is sought through historic episodes in sections 3.2-3.5. *Fresh findings* obtained from the archival works indicate that the efforts of the CBA and the member banks, along with the changes in the cheque clearing environment, had a significant impact on the reserve holdings of the banks

Despite the inconclusive results reported, it is incorrect to disregard the hypothesis of savings in reserves

³ See section 3.1 for the observed savings in reserves in subperiod II (1889-1900) for the selected cases.

predicted by the model altogether. Under the *pure Edgeworthian* world, where each of n banks is of the same size and all the parameters except the variance of cheque clearing are constant,⁴ the multilateral cheque clearing system would bring unambiguous savings in reserves. These savings would be enhanced further when clearinghouses centralized the reserves. Eventually, the theory predicts, the savings would be optimized with a single super clearinghouse. In real world experience, however, this trend in the savings in reserves does not happen without some difficulties.

As witnessed in the early Canadian cheque clearing experience, savings in reserves observed in the initial period of multilateral system,⁵ did not carry on into the first decade of the twentieth century. Despite the slow down in the realization of the savings in reserves between 1900 and 1914, more members were added to the clearinghouses and centralized clearing arrangements among the clearinghouses were established in the same period. The banks appear to have adjusted their reserve holdings slightly upward when unfavourable short term structural changes were observed, but were willing to optimize the savings in reserves in the long run.

⁴ That is, all the elements in banking structure remain unchanged.

⁵ Savings in reserves in subperiod II did not apply to the Bank of Nova Scotia. See Table 3.3.

As a matter of fact, in Canada, clearinghouses and member banks decided to centralize their reserves to four central clearing spots in 1914 in order to attain further savings in reserves. When these centralized reserves were integrated into a single reserve centre (in Montreal) by 1927, the banks in Canada clearly demonstrated their willingness to optimize the savings in reserves, which were predicted by the model. In short, despite the fact that the inconclusive statistical results reported can only partly support the savings in reserves predicted by the theory, it is evident that Canadian banks were well aware of the advantage of the multilateral clearing system and made continuous efforts to obtain it.

The hypothesis offered by Edgeworth is the *guiding light* shining over the different banking structures. *The degree of brightness*, however, varies depending on *where you are*; you can feel the bright sensation or merely the sense of light somewhere. Despite the different levels of short term effect, the insight of savings in reserves would eventually reach every corner of the cheque clearing systems. Cheque clearing banks would step out of the shadow and follow the *light*.

The Canadian case study reported in chapter III of this thesis is the result of the application of a general model to a specific banking system. That is, savings in reserves realized under a specific industrial arrangement (banking

system) are not likely to be exactly the same as those anticipated by the theory. In order to see how well the model that has been developed (in chapter II) captures the savings in reserves under different banking structures and environments, further research to extend this study is suggested. Of course the comparison of the results (i.e., savings in reserves) from the different data sets must be interpreted with a proper understanding of developments in different banking systems. Notice that one of the main contributions of this thesis, achieved through extensive archival research, is the collection of findings from early Canadian banking experience related to the development of the cheque clearing process. Any further research of a comparative nature must include a similar investigation of historical episodes in the other banking environments being studied.

This study was the first attempt to test the measurement of savings in reserves generated under the multilateral cheque clearing system. Despite its somewhat inconclusive findings from the early Canadian experience, I believe that this study should encourage further research on reserve savings under different banking settings. The results of such similar studies would potentially improve the general theoretical framework that has been developed in this thesis.

Endnotes

(Endnote 3.x is attached to section 3.x. For example, endnote 3.1 belongs to section 3.1.)

(Notice : Endnotes and Appendices presented here belong to Chapter III. However, for a smoother connection between Chapter III and Chapter IV, they are attached after Chapter IV.)

Endnote 3.1 (a) : Sources of Data used in this study

Data used in this study are gathered from various sources. Some inconsistencies inevitably exist. Here are the main sources of data.

***Journal of Canadian Bankers Association* (1893-1935);**

Even though some of the clearing statistics are more detailed than the other sources, I do not think that this publication provide much relevant data for my analysis.

Clearings : totals of bank clearings

aggregate and clearinghouse level

1898 - 1923

annual, monthly

replaced by *debits to individual accounts* in

1924

Assets and liabilities : aggregate

monthly

1919 - 1936

assets : cash and bank balances

bank balance abroad

call and short loans

securities

loans abroad

other assets

total asset

liabilities : note circulation

deposits - government

deposits - public in Canada

deposits - foreign

bank balances - Canadian

bank balances - foreign

bills payable and acceptances

capital and rest fund

other liabilities

total liabilities

Neufeld - 1965

**(section H : Banking and Finance in Urquhart and Buckley,
1965)**

As far as aggregate banking data are concerned this source is most consistent and well documented. I think I will use this source for total banking sector estimation along with Canada Year Book.

(all the data are annual figures.)

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notes

Dominion note issue :	held by banks	
	held by others	
	total	

chartered bank note issue :	held by banks
	held by others
	total

pp. 236-9

chartered bank deposits ; () first year categorized,
[a] amendment

- specie (1867)
 - [a] gold and subsidiary coin in Canada (1913)
 - central gold reserve deposits (1913-28)
- Dominion notes (1867)
- balances due from other banks in Canada (1867)
- government of Canada and provincial securities (1867)
 - [a] holdings of certain securities (1880)
 - (i) government of Canada
 - (ii) provincial, municipal and foreign public
 - (iii) total
- certain loans in Canada and abroad (1867)
 - (i) governments of Canada and provinces

- [a] a) government of Canada (1880)
 - b) provincial governments
- (ii) collateral loans
- (iii) others
 - [a] a) loans to or deposits made in other banks (1880)
 - b) other current
 - (iv) total
- notes of and cheques on other banks (1867)
 - [a] notes of other banks (1913)
 - cheques on other banks
- balances due from banks and other agencies abroad (1867)
 - [a] certain foreign assets (1890)
 - call loans
 - current loans
 - [a] gold and subsidiary coin abroad (1913)
 - [a] other cash items (1922)
- liabilities of customers under letters of credit (1913)
 - other assets (1867)
 - total (1867)
- notes of and deposits with bank of Canada (1934)

pp.241-4

chartered bank liabilities (1867 - 1935)

- notes in circulation
- Canadian deposits
 - (i) government of Canada
 - (ii) provincial governments
 - (iii) personal savings
 - (iv) public demand
 - (v) other banks
 - (vi) total
- Canadian and foreign interbank deposits
- foreign deposits
- acceptances, guarantees and letter of credits
- capital and rest fund
 - (i) capital paid up
 - (ii) rest fund
 - (iii) total
- total liabilities

cash ratios

- percentage of cash to Canadian deposits

p.246

others

- number of banks active at year end
- new bank active
- amalgamation
- insolvencies
- number of branches in Canada (aggregate)

Curtis - 1931

Most detailed aggregate monthly data - comparable data in annual figure form are well summarized in Neufeld (1965). See the attached for categorization (standard for all the rest sources) and explanation of each item (highlighted ones are most relevant to my analysis). Very useful in understanding the variables and how the categories are summed together.

The Monetary Times (1867 - 1935)

main source of data for individual banks. annual. Some limitations are existing (i.e., some banks did not supply information) in early part of the period.

- categories are consistent with Curtis (1931)
- assets and liabilities data for each bank are to be used
(after proper grouping, in some cases)

Canada Year Book (1886 - 1937)

This source includes individual bank and aggregate level data. Assets and liabilities are listed under more broad definitions. annual. Clearing figures will be taken from this source (except 1887-1900; Breckenridge (1910) is used for that subperiod). Other items such as failures, number of banks, number of branches are contained. Some series change the definition and/or categories often.

- only source including the historical interpretation of the data
- historical series included after 1920 give some
consistent aggregate time series data

- even though individual bank data are listed, they are a little too widely grouped (compared to the Monetary Times)
- separate series of bank reserves could be useful; this includes specie, dominion notes, call and short loans
- most complete clearing figures
 - ; aggregate and clearinghouse level
- assets and liabilities categories for aggregate data are same as those in Neufeld.

Rich (1988)

- secondary reserves
- interest rates

Homer and Sylla (1991)

- various interest rates

Other Sources

- Breckenridge (1910) : some early banking data -
 - inconsistent with numbers printed in Neufeld (1965)
- Urquhart (1993) : National Output and prices are taken from this source
- Buckley (1974) : capital formation
- Ross (1922) : chronology of the Bank of Commerce branches
- CBA archives • bank by bank clearing statistics in the Toronto clearinghouse (1891-1917)

- Bank of Nova Scotia : branch statistics
- other archival materials

Endnote 3.1 (b) : Cointegration Tests Results

As discussed in section 3.1, some time series data are nonstationary. For these variables to be used in the model, recent literatures in econometrics suggest cointegration tests. In this endnote, I will provide the test results of the three tests related :

- (i) unit root test (augmented Dicky Fuller test)
- (ii) test for integration at order 1, and
- (iii) cointegration test.

In unit root tests, the nonstationarity hypothesis cannot be rejected if test statistics are larger than critical values. When variables are found to be nonstationary, integration tests are conducted. If reported statistics are significantly smaller than critical values, these variables are integrated at order 1. Then, finally, cointegration tests are performed to see if first order integrated variables are cointegrated together. (Similarly, cointegration is confirmed when test statistics are smaller than given critical values.)

In this endnote, results of three tests for the Bank of Montreal, the Bank of Commerce and the Bank of Nova Scotia are reported. Also test results of *i*, *mer*, and *ins* (stationary variables) are attached. See White et al. (1993) for technical details of SHAZAM.

Bank of Montreal

```

UNIT 6 IS NOW ASSIGNED TO: c:\shazam\lbom0.out
|_file input c:\shazam\lbom0.sha
UNIT 5 IS NOW ASSIGNED TO: c:\shazam\lbom0.sha
|_file 11 c:\shazam\t2.dat
UNIT 11 IS NOW ASSIGNED TO: c:\shazam\t2.dat
|_file 12 c:\shazam\pricel.dat
UNIT 12 IS NOW ASSIGNED TO: c:\shazam\pricel.dat
|_file 13 c:\shazam\mona.dat
UNIT 13 IS NOW ASSIGNED TO: c:\shazam\mona.dat
|_file 14 c:\shazam\dum3.dat
UNIT 14 IS NOW ASSIGNED TO: c:\shazam\dum3.dat
|_sample 1 41
|_read (11) y d r bk br i mer ins dum1 dum2 gnp
|_11 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1
|_read (12) y p
|_2 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1
|_read (13) y dd r1 b1
|_4 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1

|_genr lb=lag(b1)
|_..NOTE.LAG VALUE IN UNDEFINED OBSERVATIONS SET TO ZERO
|_sample 2 41
|_genr bb=(b1-lb)/lb
|_genr di=dd/p
|_genr sd=sqrt(di)
|_genr d2=dum1*sd
|_genr d3=dum2*sd
|_genr ri=r1/p
|_genr lr=log(ri)
|_genr ld=log(di)
|_genr lsd=log(sd)

```

Unit Root Test

```

|_coint ri sd b1/ nlag=0 log
|_...NOTE..SAMPLE RANGE SET TO: 2, 41
|_DATA WILL BE TRANSFORMED TO LOGS

```

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

TOTAL NUMBER OF OBSERVATIONS = 40

VARIABLE : LOG(RI)

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%	

CONSTANT, NO TREND			
A(1)=0 Z-TEST	-5.0056	-11.2	
A(1)=0 T-TEST	-1.4165	-2.57	
A(0)=A(1)=0	1.5120	3.78	
		AIC =	-2.586
		SC =	-2.501

CONSTANT, TREND			
A(1)=0 Z-TEST	-23.963	-18.2	
A(1)=0 T-TEST	-3.9128	-3.13	
A(0)=A(1)=A(2)=0	5.6019	4.03	
A(1)=A(2)=0	7.7315	5.34	
		AIC =	-2.839
		SC =	-2.711

VARIABLE : LOG(SD)
 DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%	

CONSTANT, NO TREND			
A(1)=0 Z-TEST	-0.18985	-11.2	
A(1)=0 T-TEST	-0.17891	-2.57	
A(0)=A(1)=0	3.7658	3.78	
		AIC =	-5.410
		SC =	-5.324

CONSTANT, TREND			
A(1)=0 Z-TEST	-13.886	-18.2	
A(1)=0 T-TEST	-2.9810	-3.13	
A(0)=A(1)=A(2)=0	6.0655	4.03	
A(1)=A(2)=0	4.5346	5.34	
		AIC =	-5.582
		SC =	-5.454

VARIABLE : LOG(B1)
 DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%	

CONSTANT, NO TREND			
A(1)=0 Z-TEST	1.5585	-11.2	
A(1)=0 T-TEST	1.8700	-2.57	
A(0)=A(1)=0	9.3316	3.78	
		AIC =	-5.031
		SC =	-4.946

CONSTANT, TREND				
A(1)=0	Z-TEST	-1.6546	-18.2	
A(1)=0	T-TEST	-0.86911	-3.13	
A(0)=A(1)=A(2)=0		7.7942	4.03	
A(1)=A(2)=0		3.6014	5.34	
			AIC =	-5.072
			SC =	-4.944

Integration Test

```
|_coint ri sd b1/ ndiff=1 nlag=0 log
...NOTE..SAMPLE RANGE SET TO:      2,      41
      DATA WILL BE TRANSFORMED TO LOGS
DEGREE OF DIFFERENCING =      1
```

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

TOTAL NUMBER OF OBSERVATIONS = 39

VARIABLE : (1-B) LOG(RI)

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		
<hr/>				
CONSTANT, NO TREND				
A(1)=0	Z-TEST	-59.292	-11.2	
A(1)=0	T-TEST	-10.027	-2.57	
A(0)=A(1)=0		50.394	3.78	
			AIC =	-2.814
			SC =	-2.728
<hr/>				
CONSTANT, TREND				
A(1)=0	Z-TEST	-59.264	-18.2	
A(1)=0	T-TEST	-9.8637	-3.13	
A(0)=A(1)=A(2)=0		32.670	4.03	
A(1)=A(2)=0		48.883	5.34	
			AIC =	-2.762
			SC =	-2.633

VARIABLE : (1-B) LOG(SD)

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 Z-TEST	-54.356	-11.2		
A(1)=0 T-TEST	-9.9470	-2.57		
A(0)=A(1)=0	49.502	3.78		
			AIC =	-5.677
			SC =	-5.591

CONSTANT, TREND				
A(1)=0 Z-TEST	-54.429	-18.2		
A(1)=0 T-TEST	-9.7937	-3.13		
A(0)=A(1)=A(2)=0	32.119	4.03		
A(1)=A(2)=0	48.148	5.34		
			AIC =	-5.625
			SC =	-5.496

VARIABLE : (1-B) LOG(B1)

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 Z-TEST	-18.757	-11.2		
A(1)=0 T-TEST	-3.4521	-2.57		
A(0)=A(1)=0	5.9722	3.78		
			AIC =	-5.221
			SC =	-5.135

CONSTANT, TREND				
A(1)=0 Z-TEST	-21.836	-18.2		
A(1)=0 T-TEST	-3.7470	-3.13		
A(0)=A(1)=A(2)=0	4.6928	4.03		
A(1)=A(2)=0	7.0251	5.34		
			AIC =	-5.220
			SC =	-5.091

Cointegration Test

|_count ri sd b1/ type=resd nlag=0 log

...NOTE...SAMPLE RANGE SET TO: 2, 41

DATA WILL BE TRANSFORMED TO LOGS

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

COINTEGRATING REGRESSION - CONSTANT, NO TREND NO.OBS = 40

REGRESSAND : LOG(RI)

R-SQUARE = 0.8409

DURBIN-WATSON = 1.650

DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS = 0 M = 3

	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

NO CONSTANT, NO TREND				
	Z-TEST	-32.701	-22.7	
	T-TEST	-5.2216	-3.45	
			AIC =	-3.212
			SC =	-3.170

COINTEGRATING REGRESSION - CONSTANT, TREND NO.OBS = 40

REGRESSAND : LOG(RI)

R-SQUARE = 0.8425

DURBIN-WATSON = 1.621

DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS = 0 M = 3

	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

NO CONSTANT, NO TREND				
	Z-TEST	-32.367	-28.5	
	T-TEST	-5.1845	-3.84	
			AIC =	-3.234
			SC =	-3.192

Bank of Commerce

```

UNIT 6 IS NOW ASSIGNED TO: c:\shazam\lboc0.out
|_file input c:\shazam\lboc0.sha
UNIT 5 IS NOW ASSIGNED TO: c:\shazam\lboc0.sha
|_file 11 c:\shazam\t2.dat
UNIT 11 IS NOW ASSIGNED TO: c:\shazam\t2.dat
|_file 12 c:\shazam\price1.dat
UNIT 12 IS NOW ASSIGNED TO: c:\shazam\price1.dat
|_file 13 c:\shazam\coma.dat
UNIT 13 IS NOW ASSIGNED TO: c:\shazam\coma.dat
|_file 14 c:\shazam\dum3.dat
UNIT 14 IS NOW ASSIGNED TO: c:\shazam\dum3.dat
|_sample 1 41
|_read (11) y d r bk br i mer ins dum1 dum2 gnp
|_11 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1

|_read (12) y p
|_2 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1

|_read (13) y dd r1 b1
|_4 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1

|_genr lb=lag(b1)
..NOTE.LAG VALUE IN UNDEFINED OBSERVATIONS SET TO ZERO
|_sample 2 41
|_genr bb=(b1-lb)/lb
|_genr di=dd/p
|_genr sd=sqrt(di)
|_genr d2=dum1*sd
|_genr d3=dum2*sd
|_genr ri=r1/p
|_genr lr=log(ri)
|_genr ld=log(di)
|_genr lsd=log(sd)

```

Unit Root Test

```

|_coint ri sd b1/ nlag=0 log
...NOTE...SAMPLE RANGE SET TO: 2, 41
DATA WILL BE TRANSFORMED TO LOGS

```

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

TOTAL NUMBER OF OBSERVATIONS = 40

VARIABLE : LOG(RI)

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 Z-TEST	0.43593	-11.2		
A(1)=0 T-TEST	0.24930	-2.57		
A(0)=A(1)=0	1.1207	3.78		
			AIC =	-2.704
			SC =	-2.619

CONSTANT, TREND				
A(1)=0 Z-TEST	-3.8264	-18.2		
A(1)=0 T-TEST	-1.4437	-3.13		
A(0)=A(1)=A(2)=0	2.2496	4.03		
A(1)=A(2)=0	2.1874	5.34		
			AIC =	-2.766
			SC =	-2.638

VARIABLE : LOG(SD)
 DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 Z-TEST	0.78246	-11.2		
A(1)=0 T-TEST	1.0067	-2.57		
A(0)=A(1)=0	9.9936	3.78		
			AIC =	-5.727
			SC =	-5.642

CONSTANT, TREND				
A(1)=0 Z-TEST	-5.3456	-18.2		
A(1)=0 T-TEST	-1.6605	-3.13		
A(0)=A(1)=A(2)=0	8.4491	4.03		
A(1)=A(2)=0	2.4609	5.34		
			AIC =	-5.777
			SC =	-5.649

VARIABLE : LOG(B1)
 DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 Z-TEST	1.5082	-11.2		
A(1)=0 T-TEST	2.9210	-2.57		
A(0)=A(1)=0	27.306	3.78		
			AIC =	-5.598
			SC =	-5.513

CONSTANT, TREND

A(1)=0	Z-TEST	-0.29331	-18.2
A(1)=0	T-TEST	-0.19837	-3.13
A(0)=A(1)=A(2)=0		19.104	4.03
A(1)=A(2)=0		5.1884	5.34

AIC = -5.593

SC = -5.465
-----Integration Test

|_count ri sd b1/ ndiff=1 nlag=0 log
 ...NOTE...SAMPLE RANGE SET TO: 2, 41
 DATA WILL BE TRANSFORMED TO LOGS
 DEGREE OF DIFFERENCING = 1

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

TOTAL NUMBER OF OBSERVATIONS = 39

VARIABLE : (1-B) LOG(RI)

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%	

CONSTANT, NO TREND			
A(1)=0	Z-TEST	-44.498	-11.2
A(1)=0	T-TEST	-7.1750	-2.57
A(0)=A(1)=0		25.742	3.78
		AIC =	-2.720
		SC =	-2.634

CONSTANT, TREND

A(1)=0	Z-TEST	-47.299	-18.2
A(1)=0	T-TEST	-7.5366	-3.13
A(0)=A(1)=A(2)=0		18.972	4.03
A(1)=A(2)=0		28.456	5.34

AIC = -2.745

SC = -2.615

VARIABLE : (1-B) LOG(SD)

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%	

CONSTANT, NO TREND			
A(1)=0	Z-TEST	-40.911	-11.2

A(1)=0 T-TEST	-6.9127	-2.57	
A(0)=A(1)=0	23.965	3.78	
			AIC = -5.807
			SC = -5.721

CONSTANT, TREND			
A(1)=0 Z-TEST	-42.391	-18.2	
A(1)=0 T-TEST	-6.9737	-3.13	
A(0)=A(1)=A(2)=0	16.379	4.03	
A(1)=A(2)=0	24.497	5.34	
			AIC = -5.785
			SC = -5.656

VARIABLE : (1-B) LOG(B1)
 DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%	
<hr/>			
CONSTANT, NO TREND			
A(1)=0 Z-TEST	-23.814	-11.2	
A(1)=0 T-TEST	-4.0543	-2.57	
A(0)=A(1)=0	8.2192	3.78	
			AIC = -5.513
			SC = -5.427
<hr/>			
CONSTANT, TREND			
A(1)=0 Z-TEST	-31.589	-18.2	
A(1)=0 T-TEST	-5.0055	-3.13	
A(0)=A(1)=A(2)=0	8.3525	4.03	
A(1)=A(2)=0	12.528	5.34	
			AIC = -5.624
			SC = -5.495

Cointegration Test

|_count ri sd b1/ type=resd nlag=0 log
 ...NOTE...SAMPLE RANGE SET TO: 2, 41
 DATA WILL BE TRANSFORMED TO LOGS

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

COINTEGRATING REGRESSION - CONSTANT, NO TREND NO.OBS =
 40
 REGRESSAND : LOG(RI)

R-SQUARE = 0.8780

DURBIN-WATSON = 0.5361

DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS = 0 M = 3

	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

NO CONSTANT, NO TREND				
Z-TEST	-11.627	-22.7		
T-TEST	-2.7458	-3.45		
			AIC =	-2.965
			SC =	-2.922

COINTEGRATING REGRESSION - CONSTANT, TREND NO.OBS =
40
REGRESSAND : LOG(RI)

R-SQUARE = 0.9620

DURBIN-WATSON = 1.046

DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS = 0 M = 3

	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

NO CONSTANT, NO TREND				
Z-TEST	-20.492	-28.5		
T-TEST	-3.5395	-3.84		
			AIC =	-3.567
			SC =	-3.524

Bank of Nova Scotia

```

UNIT 6 IS NOW ASSIGNED TO: c:\shazam\lbns1.out
|_file input c:\shazam\lbns1.sha
UNIT 5 IS NOW ASSIGNED TO: c:\shazam\lbns1.sha
|_file 11 c:\shazam\t2.dat
UNIT 11 IS NOW ASSIGNED TO: c:\shazam\t2.dat
|_file 12 c:\shazam\price1.dat
UNIT 12 IS NOW ASSIGNED TO: c:\shazam\price1.dat
|_file 13 c:\shazam\bnsa.dat
UNIT 13 IS NOW ASSIGNED TO: c:\shazam\bnsa.dat
|_file 14 c:\shazam\dum3.dat
UNIT 14 IS NOW ASSIGNED TO: c:\shazam\dum3.dat
|_sample 1 41
|_read (11) y d r bk br i mer ins dum1 dum2 gnp
|_11 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1

|_read (12) y p
|_2 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1

|_read (13) y dd r1 b1
|_4 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1

|_genr lb=lag(b1)
..NOTE.LAG VALUE IN UNDEFINED OBSERVATIONS SET TO ZERO
|_sample 2 41
|_genr bb=(b1-lb)/lb
|_genr di=dd/p
|_genr sd=sqrt(di)
|_genr d2=dum1*sd
|_genr d3=dum2*sd
|_genr ri=r1/p
|_genr lr=log(ri)
|_genr ld=log(di)
|_genr lsd=log(sd)

```

Unit Root Test

```

|_coint ri sd b1/ nlag=1 log
...NOTE...SAMPLE RANGE SET TO: 2, 41
DATA WILL BE TRANSFORMED TO LOGS

```

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

TOTAL NUMBER OF OBSERVATIONS = 40

VARIABLE : LOG(RI)

DICKEY-FULLER TESTS - NO.LAGS = 1 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 T-TEST	-0.72384	-2.57		
A(0)=A(1)=0	5.1052	3.78		
			AIC =	-3.069
			SC =	-2.940

CONSTANT, TREND				
A(1)=0 T-TEST	-3.4540	-3.13		
A(0)=A(1)=A(2)=0	8.1944	4.03		
A(1)=A(2)=0	6.0158	5.34		
			AIC =	-3.304
			SC =	-3.132

VARIABLE : LOG(SD)
 DICKEY-FULLER TESTS - NO.LAGS = 1 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 T-TEST	-0.67431	-2.57		
A(0)=A(1)=0	12.474	3.78		
			AIC =	-6.214
			SC =	-6.084

CONSTANT, TREND				
A(1)=0 T-TEST	-3.5288	-3.13		
A(0)=A(1)=A(2)=0	14.985	4.03		
A(1)=A(2)=0	6.3479	5.34		
			AIC =	-6.465
			SC =	-6.293

VARIABLE : LOG(B1)
 DICKEY-FULLER TESTS - NO.LAGS = 1 NO.OBS = 38

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 T-TEST	-0.18741	-2.57		
A(0)=A(1)=0	5.3828	3.78		
			AIC =	-4.433
			SC =	-4.304

CONSTANT, TREND				
A(1)=0 T-TEST	-1.5108	-3.13		
A(0)=A(1)=A(2)=0	4.4955	4.03		

4 of/de 4

PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
NBS 1010a ANSI/ISO #2 EQUIVALENT

PRECISIONSM RESOLUTION TARGETS

A(1)=A(2)=0	1.1763	5.34	AIC =	-4.446
			SC =	-4.274

Integration Test

```

|_count ri sd bl/ ndiff=1 nlag=1 log
...NOTE..SAMPLE RANGE SET TO:      2,      41
          DATA WILL BE TRANSFORMED TO LOGS
DEGREE OF DIFFERENCING =      1

```

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

TOTAL NUMBER OF OBSERVATIONS = 39

VARIABLE : (1-B) LOG(RI)

DICKEY-FULLER TESTS - NO.LAGS = 1 NO.OBS = 37

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%	

CONSTANT, NO TREND			
A(1)=0 T-TEST	-6.4246	-2.57	
A(0)=A(1)=0	20.640	3.78	
			AIC = -3.135
			SC = -3.005

CONSTANT, TREND				
A(1)=0 T-TEST	-6.3234	-3.13		
A(0)=A(1)=A(2)=0	13.437	4.03		
A(1)=A(2)=0	20.154	5.34		
			AIC =	-3.085
			SC =	-2.910

VARIABLE : (1-B) LOG(SD)

DICKEY-FULLER TESTS - NO.LAGS = 1 NO.OBS = 37

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		
<hr/>				
CONSTANT, NO TREND				
A(1)=0 T-TEST	-6.8531	-2.57		
A(0)=A(1)=0	23.502	3.78		
			AIC =	-6.364
			SC =	-6.233

CONSTANT, TREND		
A(1)=0	T-TEST	-6.7759
A(0)=A(1)=A(2)=0		15.359
		-3.13
		4.03

A(1)=A(2)=0	23.018	5.34	AIC =	-6.316
			SC =	-6.142

VARIABLE : (1-B) LOG(B1)
DICKEY-FULLER TESTS - NO.LAGS = 1 NO.OBS = 37

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 T-TEST	-3.5376	-2.57		
A(0)=A(1)=0	6.3034	3.78		
			AIC =	-4.410
			SC =	-4.279

CONSTANT, TREND				
A(1)=0	T-TEST	-3.4656	-3.13	
A(0)=A(1)=A(2)=0		4.1568	4.03	
A(1)=A(2)=0		6.1902	5.34	
			AIC =	-4.361
			SC =	-4.187

Cointegration Test

```

!_count ri sd bl/ type=resd nlag=1 log
...NOTE..SAMPLE RANGE SET TO:      2,      41
          DATA WILL BE TRANSFORMED TO LOGS

```

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND    NO.OBS =
40
REGRESSAND : LOG(RI)
```

R-SQUARE = 0.9786 DURBIN-WATSON = 1.357

DICKEY-FULLER TESTS ON RESIDUALS - NO. LAGS = 1 M = 3

	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

NO CONSTANT, NO TREND				
T-TEST	-3.4841	-3.45		
			AIC =	-3.550
			SC =	-3.464

COINTEGRATING REGRESSION - CONSTANT, TREND NO.OBS =
 40
 REGRESSAND : LOG(RI)

R-SQUARE = 0.9786 DURBIN-WATSON = 1.377

DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS = 1 M = 3

	TEST STATISTIC	ASY. CRITICAL VALUE 10%	

NO CONSTANT, NO TREND			
T-TEST	-3.4993	-3.84	
			AIC = -3.541
			SC = -3.455

Tests for Stationary Variables; i, mer and ins

```

UNIT 6 IS NOW ASSIGNED TO: c:\shazam\mer0.out
|_file input c:\shazam\mer0.sha
UNIT 5 IS NOW ASSIGNED TO: c:\shazam\mer0.sha
|_file 11 c:\shazam\t2.dat
UNIT 11 IS NOW ASSIGNED TO: c:\shazam\t2.dat
|_file 12 c:\shazam\pricel.dat
UNIT 12 IS NOW ASSIGNED TO: c:\shazam\pricel.dat
|_file 13 c:\shazam\mona.dat
UNIT 13 IS NOW ASSIGNED TO: c:\shazam\mona.dat
|_file 14 c:\shazam\dum3.dat
UNIT 14 IS NOW ASSIGNED TO: c:\shazam\dum3.dat
|_sample 1 41
|_read (11) y d r bk br i mer ins dum1 dum2 gnp
|_11 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1
|_read (12) y p
|_2 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1
|_read (13) y dd r1 b1
|_4 VARIABLES AND 41 OBSERVATIONS STARTING AT OBS 1
|_genr lb=lag(b1)
..NOTE.LAG VALUE IN UNDEFINED OBSERVATIONS SET TO ZERO
|_sample 2 41
|_genr bb=(b1-lb)/lb
|_genr di=dd/p
|_genr sd=sqrt(di)
|_genr d2=dum1*sd
|_genr d3=dum2*sd
|_genr ri=r1/p
|_genr lr=log(ri)
|_genr ld=log(di)
|_genr gd=log(sd)

```

Unit Root Test

```

|_count i mer ins/nlag=0
...NOTE...SAMPLE RANGE SET TO: 2, 41

REQUIRED MEMORY IS PAR= 12 CURRENT PAR= 140

TOTAL NUMBER OF OBSERVATIONS = 40

VARIABLE : I
DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

```

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 Z-TEST	-12.475	-11.2		
A(1)=0 T-TEST	-2.6541	-2.57		
A(0)=A(1)=0	3.5221	3.78		
			AIC =	-2.749
			SC =	-2.664

CONSTANT, TREND				
A(1)=0 Z-TEST	-15.288	-18.2		
A(1)=0 T-TEST	-3.0981	-3.13		
A(0)=A(1)=A(2)=0	3.2867	4.03		
A(1)=A(2)=0	4.9301	5.34		
			AIC =	-2.766
			SC =	-2.638

VARIABLE : MER

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%		

CONSTANT, NO TREND				
A(1)=0 Z-TEST	-17.206	-11.2		
A(1)=0 T-TEST	-2.9663	-2.57		
A(0)=A(1)=0	4.5473	3.78		
			AIC =	-1.008
			SC =	-0.923

CONSTANT, TREND				
A(1)=0 Z-TEST	-23.125	-18.2		
A(1)=0 T-TEST	-3.7278	-3.13		
A(0)=A(1)=A(2)=0	4.8252	4.03		
A(1)=A(2)=0	7.0761	5.34		
			AIC =	-1.075
			SC =	-0.947

VARIABLE : INS

DICKEY-FULLER TESTS - NO.LAGS = 0 NO.OBS = 39

NULL HYPOTHESIS	TEST STATISTIC	ASY. CRITICAL VALUE 10%

CONSTANT, NO TREND		
A(1)=0 Z-TEST	-47.974	-11.2

A(1)=0 T-TEST	-7.6887	-2.57		
A(0)=A(1)=0	29.558	3.78		
			AIC =	0.288
			SC =	0.374

CONSTANT, TREND				
A(1)=0 Z-TEST	-48.044	-18.2		
A(1)=0 T-TEST	-7.6151	-3.13		
A(0)=A(1)=A(2)=0	19.355	4.03		
A(1)=A(2)=0	29.033	5.34		
			AIC =	0.334
			SC =	0.462

Endnote 3.3 : A Brief Explanation of Note Clearing

In sections 3.1 and 3.2, I have discussed the development of Canadian banking in its early years, and the cheque clearing practice among Canadian banks. Along with cheques, notes were also exchanged among those Canadian banks. In this endnote, I will briefly examine the general problems associated with note clearing.²³⁴

For the banks issuing their own notes, a critical question was whether they should accept the notes of rival banks. One type of bank believed that they should refuse to accept notes from other banks. They argued that, by refusing other banks notes, acceptability of those notes would be limited and in turn the demand for their own notes could be enhanced.²³⁵ There was also another method attempted by banks to promote the circulation of their own notes. This tactic called *note duelling* (or *note picking*) required the aggressive purchase of rival banks notes in their markets. After the purchase, the bank would wait for a strategic time to suddenly return the large quantities to their issuing bank for redemption in specie. This tactic was intended to gain market share by ruining the reputation

²³⁴ The historic role of clearinghouses for note clearing is described in Roberds (1993), p.2.

²³⁵ See White (1989), p.227, for the example of refusal of notes in Scotland.

of rival banks which could face a serious insolvency situation as a result of the aggression. But note duelling was soon found to be a "costly and ineffective" method of promoting the circulation of one's own notes due to possible retaliation from other banks and the fact that no bank was able to capture considerable gains in market share.²³⁶ At the same time, all the banks participating in note duelling were required to hold higher reserves to prevent damage from the aggression of other banks.

However, banks increasingly found that there was an incentive to accept notes from other banks. If each member decided to accept the notes from other banks, the acceptance of notes as a medium of exchange would be increased and thereby each bank could enjoy more circulation of its own notes in the market.²³⁷

Once the notes of other banks were accepted, banks had to find a way to efficiently exchange these notes amongst themselves. As it was explained in the discussion of the cheque clearing process, in the beginning, a couple of banks agreed upon the idea of exchanging notes between them. In other words, note clearing started with bilateral arrangements as was seen for the acceptance of notes. Then a series of bilateral clearings among the banks would be

²³⁶ See Schuler (1992), p.81. In Canada, note duelling never was a serious problem. By 1860, the acceptance of notes (and cheques) by competitive banks was granted.

²³⁷ That is, there is a positive externality to note acceptance.

followed. Soon, however, a multilateral clearing process (i.e., clearinghouse) would replace cumbersome bilateral processes. In fact, a clearinghouse could be used as a multilateral clearing spot for notes as well as cheques.²³⁸

Some similarities as well as differences exist between cheque clearing and note clearing. First of all, note clearing conducted under multilateral clearing would increase the saleability of notes. Provided that every member of the clearinghouse accepted the notes of other banks *at par*,²³⁹ the acceptance of the notes among the public would be increased as well. Secondly, the transaction costs of note clearing would be reduced with the introduction of a clearinghouse. This reduction in costs would lower the service charge of notes paid by the public; circulation of notes could thereby be even further enhanced as a result of reduced service fees.

A main difference, however, between multilateral note clearing and cheque clearing is found in relation to reserve savings. As has been discussed in chapter II of this thesis, precautionary reserves for cheque clearing would be

²³⁸ See Chudy (1989), p.175. Despite the fact that notes were cleared in clearinghouses, the intention of establishing a clearinghouse was still in economization of *cheque clearing*. This intention of clearinghouses was clearly stated in their early documents in Great Britain, the U.S., and Canada. See Carpenter (1935), Gorton (1984), and Lee (1958) for the purposes of the initial clearinghouses in those three countries.

²³⁹ Notice that notes were frequently discounted. Here the topic of discount is not going to be addressed.

reduced with the introduction of a clearinghouse. But the opposite is argued for note clearing. Chudy (1989) argued that multilateral note clearing would force banks to hold more reserves. According to her argument, the establishment of clearinghouses made bank notes circulate more frequently, and "banks were forced to redeem a given value of outstanding notes more often."²⁴⁰ Consequently, a higher level of reserves (in specie) would be required to redeem the notes on request.

Does Chudy's argument indicate that savings in reserves generated under multilateral clearing did not apply to the note clearing? I do not think so. What Chudy observed was that the introduction of clearinghouses would create more circulation of notes and in consequence actual reserves (required to cover more note clearings) would be increased as well. Notice that Chudy's point is the ex-post observation of the change in reserves following the institutional change (i.e., introduction of clearinghouses), which should not be interpreted as a case of diseconomies of scale in reserves.

²⁴⁰ Chudy (1989), p.177. See also Trivoli (1979) for Suffolk bank experience.

Endnote 3.4 : Risks involved with Settlement Methods

In sections 3.2-3.4, I have discussed the development of clearing processes in Canada in its early banking history. In order to observe savings in costs under the different structures of clearing, I have adopted the model developed in chapter II of this thesis. The Canadian experience prior to 1900 shows that the introduction of the clearinghouses had reduced the costs of clearing as expected by the model. In other words, the main role served by the clearinghouse was the optimization of the savings in physical costs and reserves for the banks participating in the clearing process.

One of the implicit assumptions imposed on the analysis so far is that clearinghouses were not concerned about the (settlement) risks²⁴¹ involved with clearing. Under these circumstances, the clearing process was completed once the exchange of cheques and the subsequent settlement of balances were acquired. When all the settlements are made by specie or legal tender (Dominion notes), as was assumed in chapter II, the risk involved with default is minimal. In other words, the only type of risk involved with the

²⁴¹ The analysis of the risk involved with clearing is rather recent development in the economic literature. The basic idea is that the risk of settlement as various types of settlement tools are adopted. See Mengle (1992), pp.4-8.

settlement process is of a stochastic nature. If a bank were experiencing an unexpected negative debit balance, it would indicate that this bank's reserve management was inadequate.

However, if banks were allowed to use a *draft* (or claim on a bank) for settlement, an additional risk of clearing is introduced. This type of risk would arise from the possibility that payment could be delayed (or cancelled) with insufficient funds on the debit side of the other bank (even after the initial settlement was made).²⁴² That is, the clearing position could be reversed -settlement cancelled- even after the initial settlement if the bank presented drafts that did not have enough funds. To distinguish this situation from the type of risk mentioned above, I assume that this illiquidity is the result of the opportunistic behaviour of the defaulting banks. What is further assumed is that both credit banks and the clearinghouse do not possess perfect information about the banks presenting the drafts.²⁴³ In this endnote, I will examine the possible impact of this risk involved with settlement on the clearing processes discussed above. Through the experience of early Canadian banking I will also

²⁴² In fact, several forms of risk are discussed in the banking literature. Among the risks mentioned in Mengle (1992, p.9), operational risk based on the possible breakdown of computers would not apply to my analysis. Risk in forms of default, illiquidity and transfer of illiquidity could be applied.

²⁴³ That is, moral hazard problems exist due to imperfect information about **aggressive** banks.

try to explore how the risk factor was handled by the collective decisions of the chartered banks.

In the clearinghouses opened in Halifax (1888) and Montreal (1889), the settlement of the balances was made by Dominion notes.²⁴⁴ As far as legal tender notes were exclusively used as a means of payment, the location of risk could be readily identified. The only possible risk in this case was the lack of dominion notes on the side of the debit bank. And this illiquidity position simply represented the improper level of reserves held by an individual bank. Unlike the case where cheques drawn on banks were used as payment for settlement, in this case, no reverse of the settlement position would be observed.²⁴⁵ In other words, once settlement was reached with the Dominion notes, the clearing would be finalized; initial settlement is not possible if there are not enough funds.

By 1891, however, it is believed that clearinghouses (in a limited sense) considered the use of cheques drawn on banks as a supplementary method of settlement. This development placed "far too much responsibility" on the receiving bank since all cheques received by the bank were "in trust" until settlement was made.²⁴⁶ Consequently, the

²⁴⁴ See Constitution of Halifax Clearinghouse (1888), p.4 article VI, and the Montreal Gazette, January 8, 1889, p.2.

²⁴⁵ For general discussion on means of settlement see Garber and Weisbrod (1990).

²⁴⁶ Barker (1926), p.54.

Bylaws endorsed by the CBA in 1900 reflected the concerns of banks about the risk involved in settlement. Before I examine the early Canadian experiences, let us first look at the general solutions suggested in the literature for the risks involved with the settlement process.

Theoretical investigations of the risk problem involved with the clearing process are a rather recent development in the banking literature; the solutions suggested are also included in more *modern* works.²⁴⁷ In Mengle (1992), some measures to control risk are suggested:

- (i) membership standards;
- (ii) quantitative limits on risk exposure; limit on debit position;
- (iii) requirement of collateral;
- (iv) loss sharing;
- (v) netting and net settlement²⁴⁸ ; reduction in the volume of transactions; and
- (vi) simultaneous exchange and settlement.

Since the risk involved with the early clearing process was limited to illiquidity problems, not all the solutions suggested are applicable to the period I have discussed.

²⁴⁷ See Summers (1991), Gilbert (1992), Garber and Weisbrod (1990), and Mengle (1992) for further discussion on the risk involved with settlement of clearing balances.

²⁴⁸ The idea of netting is explained in detail in Gilbert (1992).

However, it is still possible to examine how the efforts of clearinghouses made in the earlier period could be explained by these proposals made by more recent contributions to the literature.

In the *Rules and Regulations respecting Clearing Houses*,²⁴⁹ membership restriction was first specified. According to clause one of article sixteen, chartered banks "may form themselves into a clearinghouse" to optimize the clearing process. And new members who wished to join would be admitted to the clearinghouse by a vote of the members. This voting process, then, set a membership standard and was one of the most effective risk control measures.²⁵⁰ Undoubtedly, new members before being accepted to the clearinghouses, ought to convince the existing members that their emergence to the "club" would increase the potential savings in the clearing costs that the clearinghouse could offer without adding significant new risk. The membership restriction imposed in the Bylaws served to filter the entrants and minimize any new risk of illiquidity.

Other clauses²⁵¹ in the rules and regulations also show that the clearinghouse wished to reduce the risk of default when the payments were made by drafts. If any bank

²⁴⁹ Rules and Regulations are listed under article sixteen of the Bylaws of the CBA adopted in 1900. See *Journal of the CBA* (1900), pp.135-41.

²⁵⁰ See Mengie (1992), p.10.

²⁵¹ See clauses 11 and 15 under article sixteen.

failed to pay the presented draft equivalent of its net debit amount, it was specified that clearinghouse "shall notify in writing all the other banks of such default." Once the default was realized, the amount of unpaid draft would be *repaid* (i.e., the clearing position would be reversed) by the credit banks proportional to their balances with the default bank. The duty of the clearinghouse was then to collect the unpaid amount from the debit bank and distribute the net loss proportionally among the credit banks. If the default was neglected or the debit bank refused to pay the amount to the clearinghouse, the clearinghouse could deprive the debit bank of its clearing right in the clearinghouse. Cancellation of membership was the ultimate penalty. This rule, of course, could not prevent the risk of default altogether. However, the disadvantage associated with the default (especially the loss in reputation by being excluded from the clearinghouse) would have had an impact lowering the aggregate risk²⁵² of settlement using drafts.

On top of the regulations enforced by the CBA, other risk control measures can be found in the early Canadian clearing experience. First, the Bank Note Redemption Fund

²⁵² Notice that the settlements made in the clearinghouses during the 1880s and the 1890s were interday settlement (i.e., the final settlement position was known after a day of cheque clearing). Hence the risk involved with intraday -banks have to observe their current payment balance- settlement (Garber and Weisbrod (1990)) would not have been observed.

introduced by the Bank Act of 1890 served as a tool to spread losses as a result of defaults. As mentioned, the existence of the Fund constantly reminded the banks of their joint responsibility for note clearing. Also, an amendment made on the Constitution of the Halifax clearinghouse indicates that clearinghouses wanted to separate certified items from others.²⁵³ This separation allowed them to concentrate on the "suspected" items in order to control the risks.

One of the risk control schemes suggested in the recent literature is "*netting*" and "*net settlement*".²⁵⁴ By using netting techniques (i.e., combining their net balance with other banks with their balance with the clearinghouse), banks would sometimes make a settlement with some partners in a bilateral fashion while combining with other banks in the usual multilateral exchange. Mengle (1992) suggests that the volume of transaction passing through the clearinghouse is reduced with netting.²⁵⁵ With reduced settlement balances (which is also *filtered*) observed in the system, the risk of default would be also diminished. In Canadian banking, the branch banking system achieved the same effect that netting would have brought about. Since

²⁵³ Halifax Clearinghouse Minutebook, July 1, 1886, Bank of NS Archives.

²⁵⁴ See Gilbert (1992).

²⁵⁵ See Mengle (1992), p.5 for the simple illustration of netting and net settlement.

cheques (and notes) cleared among the branches of the same bank were conducted internally (without going through the clearinghouse), the total volume of transactions under branch banking was substantially smaller than that under the unit banking system. Hence, the development of the branch banking system in Canada itself functioned as the installed risk device of the settlement mechanism.

In short, the establishment of clearinghouses along with the introduction of the Bank Note Redemption Fund and the development of branch banking contributed to the reduction in the risk involved with the settlement balances. Despite the possible risk associated with a settlement device other than Dominion legal notes, Canadian clearinghouses did not face a great deal of settlement risk. In the major clearinghouses, Dominion legal tenders were continuously used as the predominant method of settlement. For example, the Report of the Montreal Clearinghouse in 1900 shows that the Montreal clearinghouse rejected the adoption of the U.S. system (which uses drafts and/or borrowing). It was argued that the current clearing system, using Dominion notes, was well trusted. The revised Constitutions of the clearinghouses in Toronto (1908) and Halifax (1909) also indicated that those clearinghouses exclusively used "legal tenders in large denomination." Hence the risk of clearing (i.e., to be rebuked due to insufficient fund for settlement) did not interrupt the

operation of the clearinghouses.

Appendix A

Constitution of the Halifax Clearinghouse Association

In this appendix, the constitution of the first Canadian clearinghouse is reproduced. As discussed in the text, this constitution remained as a cornerstone for rules of the clearinghouses until the CBA formally began to regulate the clearinghouses in 1900.

(source : Public Archives of Nova scotia)

Constitution of the Halifax Clearing-House Association

- January 1888 -

The undersigned Banks in the City of Halifax, for the purpose of effecting a more perfect and satisfactory settlement of the daily balances between them, hereby agree upon the following Articles of Association:

ARTICLE I.

The name of the Association shall be "**The Halifax Clearing House Association.**"

ARTICLE II.

The daily exchanges between the several Banks shall be made at one place and at one time, and the payment of balances resulting from such exchanges shall be made as

hereinafter set forth.

ARTICLE III.

The Cashiers and Managers of the several Banks shall constitute a Board of Management, the Chairman of which shall be elected annually at a meeting held the first Thursday of December, at three o'clock p.m. At all meetings of the Board a quorum for the transaction of business shall consist of Five, and a majority of the members present shall at all times determine whatever questions may be submitted.

ARTICLE IV.

It shall be the duty of the Board to procure from time to time a suitable room, to provide stationary, furniture, and whatever else may be deemed necessary; and the several Banks shall bear the expenses incurred, share and share alike.

ARTICLE V.

The Board shall arrange with a Bank to act as the Clearing Bank. It shall be the duty of such Bank to receive the balances due from debtor Banks, giving the usual receipt therefor, and pay the creditor Banks, and be in all respects responsible for the money received by it in payment of the balances due by the respective Banks in the daily exchanges as for deposits received by the said Bank in its regular business, but the responsibility of the Clearing Bank is strictly limited to distribution among the creditor Banks of the balances actually paid in by the debtor Banks on

presentation of the usual Clearing-House Certificate properly discharged.

ARTICLE VI.

The hour for making the exchanges at the Clearing Room shall be 10.15 o'clock a.m. precisely. between the hours of 11.30 and 12.30 the debtor Banks shall pay at the Clearing Bank the balance due by them respectively in Dominion legal tender notes. Between the hours of 12.30 and 1 the creditor Banks shall receive from the Clearing Bank the respective balances due to them, provided all the balances due from the debtor Banks shall then have been paid, but on no condition is any creditor balance, or portion thereof, to be paid until all the debtor balances have been settled.

ARTICLE VII.

Should any Bank fail to pay the balance due from it by 12.30 o'clock of the same day, such Bank shall be ruled out by such default, and notice thereof given immediately by the Cashier or Manager of the Clearing Bank to the respective banks, who shall furnish forthwith to the Clearing Bank the amount of such balance in proportion to their respective balance against the defaulting Bank resulting from the exchanges of that day, and the amounts so furnished to the Clearing Bank shall constitute claims on the part of the responding Banks respectively against the defaulting Bank.

ARTICLE VIII.

Errors in the exchanges and claims arising from the

return of cheques, or other causes, are to be adjusted by 11.45 o'clock of the same day, directly between the Banks which are parties thereto and not through the Clearing Bank.

In case of the refusal or inability of any Bank to promptly refund to the Bank presenting such cheques, drafts, or other items returned, the Banks holding them shall be the Clearing Bank's duty to take from the settling sheets of both Banks, the amount of such cheques, drafts, or other items so reported and to re-adjust the clearing statements and declare the correct balance in conformity with the changes so made, provided that such report shall be given to the Cashier or Manager of the Clearing Bank not later than 12 o'clock of the same day.

ARTICLE IX.

The foregoing Rules and Regulations may be amended at any meeting of the Board by a vote of the majority of the members present, notice in writing of the proposed amendments having been given at a previous meeting and lodged with the Chairman, who shall forthwith furnish each Bank with a copy.

ARTICLE X.

The Chairman shall call a meeting of the Board within 48 hours, on receiving in writing a requisition signed by three members.

ARTICLE XI.

The Assistant Receiver-General of the Dominion of

Canada, located at Halifax, may be admitted to the privileges of the Clearing House.

ARTICLE XII.

Any Bank may retire from this association by giving written notice to the Chairman of the Board between the hours of 1 and 3 o'clock, p.m., and paying its share of any expenses which may be then due, the retirement to take effect from the close of business of the day on which such notice is given. It shall be the duty of the Chairman to promptly notify the other Banks of such withdrawal.

ARTICLE XIII.

Article VIII does not refer to cheques deposited between the different Banks in the afternoons, and it is understood that after the cheque slip deposited in the afternoon has been initialled and returned to the depositing Bank, the items specified thereon shall be considered as certified, except those payable at other places or at other Branches or Agencies or the receiving Bank.

Appendix B

As Timberlake (1984) and Dowd (1993) observed, savings in reserves generated by the clearinghouse in the United States were accompanied by the introduction of a new *medium of exchange*: Clearinghouse Loan Certificates. (Dowd called this *surrogate currency*.) Unlike the U.S. experience, however, Canadian banks which formed the clearinghouses did not add new methods of settlement after a multilateral clearing was adopted. They continued to make settlement by Dominion notes.

Here are some of the references :

Ross (1922) : "[during the first World War] In order to conserve Canadian gold supply against demands from foreign sources, the banks were authorized to make payments in bank notes until further notice, instead of gold or Dominion notes. [...] Settlements at the clearinghouses, however, continued to be made in **Dominion notes.**"

Willis and Beckhart (1929) : "Since 1868, **Dominion notes** are used principally for the settlement of clearing balances."

Stokes (1939) : "In 1927 through the efforts of the Association (CBA), a central clearing fund was

established at Montreal to facilitate the settlement of balances between clearinghouses located in Montreal, Toronto, Winnipeg and Vancouver. [...] each bank was required to keep a supply of **Dominion notes** sufficient to meet its adverse balances."

Crombie (1900) : *The Montreal Clearinghouse Annual Report of Chairman* (Bank of Montreal Archives) "(after visiting Boston and New York Clearinghouses) I noticed also that it was still customary for the debtor banks to settle their balances by borrowing from the creditor banks of the day. I should be sorry to see this system introduced here to displace our present practice of settling by **legal tender notes**."

CBA Executive Council Minutes (unpublished manuscript, CBA Archives) : (Nov.16, 1893 - Feb.14, 1894) discussions on "the issue by the Dominion Government of **special legal tender Certificate** for clearinghouses and reserve purposes not payable to bearer."

Duncan (1957) : "these **large legal notes negotiable only between banks** were the chief means of settlement of clearinghouse balances, supplemented of course by the smaller notes, silver and copper to make up the exact amount due to or owing by each bank."

Barker (1953) :

(under bilateral system) "settlement was realized by the **notes of the Dominion of Canada**."

(under multilateral system) "when the clearinghouses were established one bank was appointed as the clearing bank, and then instead of each bank settling with every other bank, the debtor banks, after the daily clearings had been balanced and the proper vouchers issued, deposited with the clearing bank, **in [bank] legals**, the exact amount owing, and the creditor banks presented their vouchers and received, **in legals**, the exact amounts to which they were entitled "

Journal of CBA (1933) : "the banks maintain in Montreal, by arrangement among themselves, a central clearing fund, each bank keeping in the fund a quantity of **Dominion notes**, adequate to take care of any net debit."

Bank of Toronto : Printed Circular (September 10, 1913)

"...this arrangement will not interfere with the present method of using **Dominion Government cheques (notes)**..."

Halifax Clearinghouse Constitution (1888) : Article VI

"...the debtor banks shall pay at the clearing bank the balances due by them respectively in **Dominion legal tender notes**."

Halifax Clearinghouse Constitution (1908) : Article VI

"...the debtor banks shall pay at the clearing bank the balances due by them respectively in **Dominion legal tender notes**."

Toronto Clearinghouse Constitution (1908) : Article 9

"...the payment of balances shall be in **legal tenders of large denominations.**"

Toronto Board of Trade (1890) : Reports of President

"...as against an absolute famine of currency necessitating a resort to such peculiar instrument such as **clearinghouse certificate happily unknown in Canada**, we have year after year an adequate supply of currency."

As shown above, settlements of balances in Canada in the early period were conducted predominantly by Dominion legal notes. Therefore, the savings in reserves I examined in section 3.1 measure the advantage of the multilateral clearing without the introduction of new method of settlement (such as clearinghouse loan certificate). I believe this type of savings in reserves are more suitable verification of the prediction made in Chapter II (Edgeworth model). At the same time, for the empirical analysis given in section 3.1, reserve figures (R_i) would not contain any other assets than dominion notes (plus species).

Appendix C : Location of Branches

In Figure A3.1, I present the ratios of branches in different regions of Canada. As shown, western provinces and Maritimes recorded faster growth in the expansion of branches than Ontario and Quebec. In the tables following the figure (Table A3.1 - Table A3.6), branch statistics of the three banks (Bank of Montreal, Bank of Commerce and Bank of Nova Scotia) are included. Most of these statistics are compiled from archival materials.

Figure A3.1

Table A3.1 Bank of Montreal - Branches in Canada (I)

	1867	1877	1887	1892	1893	1895	1897	1899	1900	1901	1902
Ontario	22	23	21	22	22	22	23	24	24	24	24
Quebec	3	3	3	4	4	4	5	6	7	7	8
B.C.	--	--	1	4	5	5	7	8	8	8	8
N.B.	--	4	3	--	--	--	--	--	--	--	--
Nfld.	--	--	--	--	--	1	1	1	1	1	1
N.S.	--	1	1	1	1	1	2	4	4	4	4
others *	--	--	2	3	3	3	3	4	4	4	4
total	25	31	31	33	35	36	41	47	48	48	49

source : Bank of Montreal Annual Report, selected years
(Statistics are supplied by the Bank of Montreal Archives.)
Canada Yearbook

* : Others are the branches in Manitoba, Saskatchewan and Alberta. Foreign branches are not included.

Table A3.2 Bank of Montreal - Branches in Canada (II)

	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Ontario	26	27	27	57	49	49	49	48	48	50	54
Quebec	5	7	17	20	18	21	22	22	22	28	32
B.C.	8	10	12	13	14	15	17	19	23	28	29
N.B.	4	9	11	11	12	12	12	12	12	11	11
N.S. *	4	5	13	12	12	12	12	12	12	12	12
Nfld.	1	2	2	2	2	2	2	2	3	3	3
others**	5	10	14	15	15	18	22	23	24	28	29
total	53	70	96	130	122	129	136	138	144	158	170

source : Bank of Montreal Annual Report, selected years
(Statistics are supplied by the Bank of Montreal Archives.)
Canada Yearbook

* : Branches in P.E.I. in 1905-13 are included in N.S..

** : Others are the branches in Manitoba, Saskatchewan and Alberta. Foreign
branches are not included.

Table A3.3 Bank of Commerce - Branches in Canada (III)

	1899	1902	1903	1904	1905	1909	1911	1913
Ontario	44	45	46	47	47	66	79	89
Quebec	1	1	1	1	1	3	90**	81
N.B.	--	--	--	2	2	1	4	4
N.S.	--	--	1	15	15	13	13	14
P.E.I.	--	--	--	--	--	5	5	5
B.C.	5	12	12	12	12	20	42	42
Manitoba	1	1	8	12	14	21	23	23
others*	1	2	4	11	15	70	104	118
total	52	61	74	100	106	199	360	370

source : The Monetary Times and Canada Yearbook

* : Others include the branches in the Northwest Territory (Alberta and Saskatchewan) and Newfoundland.

** : A sudden jump in the number of branches in Quebec is attributed to the takeover of Eastern Townships Bank. At the time of the take over 78 of 95 branches were located in Quebec.

Table A3.4 Bank of Nova Scotia - Branches in Canada (I)

	1862-5	1866	1867-9	1870	1871-3	1874-5	1876	1877-8	1879	1880
N.S.	3	4	5	6	7	7	8	10	11	11
N.B.	--	--	--	--	--	1	1	1	1	3
total	3	4	5	6	7	8	9	11	12	14

	1881	1882	1883	1884	1885-7	1888	1889-90	1891-3	1894	1895-6
N.S.	11	12	12	12	13	13	14	13	13	13
N.B.	4	10	10	9	9	9	9	9	9	9
P.E.I.	--	1	3	3	2	2	2	2	2	2
Quebec	--	--	--	--	--	1	1	1	1	1
Manitoba	--	1	1	1	--	--	--	--	--	--
Nfld.	--	--	--	--	--	--	--	--	1	2
total	15	24	26	25	24	25	26	25	26	27

source : Bank of Nova Scotia Archives. (compiled from various documents)
Foreign Branches are not included.

Table A3.5 Bank of Nova Scotia - Branches in Canada (II)

	1897	1898	1899	1900	1901	1902	1903	1904
N.S.	13	13	13	14	16	19	19	22
N.B.	9	9	9	9	9	10	12	12
P.E.I.	2	2	2	2	2	2	2	2
Quebec	1	2	2	2	2	2	2	2
Manitoba	--	--	1	1	1	1	1	1
Ontario	1	1	2	4	5	5	5	5
B.C.	--	--	--	--	--	--	--	1
Nfld.	2	2	2	2	2	2	2	2
Alberta	--	--	--	--	--	--	5	5
total	28	29	31	34	37	41	48	52

source : Bank of Nova Scotia Archives. (compiled from various documents)
 Foreign Branches are not included.

Table A3.6 Bank of Nova Scotia - Branches in Canada (III)

	1905	1906	1907	1908	1909	1910	1911	1912	1913
N.S.	22	24	24	24	24	27	27	26	30
N.B.	12	14	13	14	15	15	15	17	32
P.E.I.	2	2	2	2	2	2	2	2	5
Quebec	2	2	4	5	5	5	5	7	8
Manitoba	1	1	1	1	1	1	1	1	2
Ontario	7	8	9	16	16	22	21	24	25
B.C.	1	1	1	1	1	1	3	3	4
Nfld.	2	2	2	2	3	7	7	8	9
Alberta	4	2	2	2	2	2	2	4	4
Sask.	--	1	2	2	2	2	3	6	7
total	53	57	60	69	71	84	86	98	126

source : Bank of Nova Scotia Archives. (compiled from various documents)
 Foreign Branches are not included.

Appendix D : Clearing Statistics by Banks

In the tables provided in this appendix (Tables A3.7-10), clearing statistics (by banks) of the Montreal Clearinghouse and the Toronto Clearinghouse are presented. While the Montreal Clearinghouse clearing statistics by banks are available in *members-only-circulation* documents, the clearing statistics of the Toronto Clearinghouse are summarized from the handwritten registers of daily clearings.

Table A3.7 Montreal Clearinghouse - Clearings by Banks (I)

	1902	1903	1904	1905	1906	1907
Montreal	191.9	205.7	199.9	257.3	302.1	332.7
Commerce	79.5	85.7	82.0	111.8	121.5	125.4
Merchants B.	94.9	94.9	89.4	106.8	120.4	127.9
British N.A.	39.9	46.5	42.6	53.3	63.8	58.5
Quebec	64.2	56.6	58.1	76.0	83.5	71.9
Molsons	148.1	129.1	107.0	143.1	154.9	134.4
Toronto	77.5	81.8	84.6	95.6	90.4	90.4
Ontario	13.2	15.4	14.6	15.6	---	---
Union	21.4	25.7	24.7	27.8	32.9	38.4
Imperial	45.5	41.0	35.2	41.6	49.3	51.7
Nova Scotia	39.5	37.4	32.7	39.6	49.4	54.6
Nationale	19.4	21.7	20.8	23.1	26.5	31.2
Royal	54.2	43.5	36.8	49.8	91.7	93.4
D'Hochelaga	82.5	78.3	73.2	90.5	101.5	109.5
E. Townships	29.5	34.7	36.1	42.5	46.7	52.3
Sovereign	9.1	23.9	32.5	44.2	54.6	39.9

	1902	1903	1904	1905	1906	1907
Dominion	41.4	41.5	42.9	51.3	66.4	62.9
Ottawa	46.8	50.3	51.6	54.3	64.9	74.3
total	1098.9	1113.9	1065.1	1324.3	1533.6	1555.7

unit : \$ million

Table A3.8 Montreal Clearinghouse - Clearings by Banks (II)

	1908	1909	1910	1911	1912	1913
Montreal	320.7	359.6	381.7	422.1	515.2	564.5
Commerce	107.8	139.4	146.4	164.0	249.1	263.5
Merchant B.	138.2	194.9	165.9	217.0	263.9	231.8
British N.A.	53.3	63.1	72.3	79.3	88.3	91.8
Quebec	63.8	83.2	76.1	83.8	98.2	89.1
Molson	135.2	201.3	215.6	239.2	272.5	248.3
Toronto	84.7	110.9	123.0	132.9	151.9	146.8
Sterling	7.2	10.6	11.6	8.6	11.1	12.5
Union	44.3	51.1	55.0	67.5	78.3	103.5
Imperial	53.5	73.1	71.5	77.9	83.9	84.8
Nova Scotia	47.4	63.9	69.1	80.7	102.3	112.3
Nationale	31.3	37.4	39.2	50.2	60.6	60.3
Royal	94.7	133.6	156.1	178.5	257.6	306.8
D'Hochelaga	98.9	124.8	135.0	146.9	163.5	175.3
E. Townships	50.7	57.7	61.0	70.5	---	---

	1908	1909	1910	1911	1912	1913
Dominion	57.8	68.7	76.0	78.2	103.9	113.4
Ottawa	70.6	77.2	92.9	97.5	111.1	115.4
District	---	13.7	44.2	56.1	64.9	59.6
Traders	---	---	36.9	56.9	64.9	---
Provincial	---	---	45.4	51.5	62.8	68.8
New Brunswick	---	---	---	1.7	9.4	1.5
Home	---	---	---	6.7	41.2	30.5
total	1467.3	1866.7	2088.5	2368.5	2845.5	2879.1

unit : \$ million

source : Bank of Montreal Archives.

Table A3.9 Toronto Clearinghouse - Clearings by Banks (I)

	1898	1899	1900	1901	1902	1903	1904	1905
Montreal	41.2	42.9	47.9	52.6	61.4	68.6	74.9	80.3
Commerce	57.8	68.1	75.5	96.6	125.3	106.3	99.1	119.3
Merchants	25.8	30.1	35.3	39.4	41.5	40.0	39.8	45.5
British N.A.	14.6	16.1	16.1	18.2	24.7	24.9	23.5	28.1
Nova Scotia	2.7	10.6	15.1	21.5	29.1	22.1	23.4	38.4
Molson	17.1	20.7	23.8	26.3	31.1	30.2	31.0	34.1
Toronto	26.5	28.8	33.5	41.1	53.5	54.2	58.2	75.3
Ontario	19.8	22.6	29.3	35.0	41.7	43.3	46.0	49.2
Dominion	61.3	70.3	79.9	105.3	151.4	136.3	129.8	167.6
Imperial	40.2	56.1	52.8	64.0	93.0	86.6	86.1	102.5
Standard	27.9	27.9	32.0	37.0	43.3	47.2	49.3	56.9
Union	7.3	6.7	8.6	82.6	114.4	13.3	16.9	21.0
Traders	17.8	21.1	23.8	29.0	32.7	39.4	45.3	59.2
Hamilton	24.2	28.7	30.2	34.3	39.6	41.9	43.4	50.0
Ottawa	4.7	5.9	7.7	8.5	10.1	10.0	11.1	13.9
Quebec	---	---	---	7.8	9.9	9.4	10.7	12.3

	1898	1899	1900	1901	1902	1903	1904	1905
Sovereign	---	---	---	---	7.3	14.3	20.8	30.9
Metropolitan	---	---	---	---	1.7	15.4	22.8	42.7
Royal	---	---	---	---	---	4.9	6.2	8.7
Crown	---	---	---	---	---	---	3.5	11.1
total	427.6	457.8	513.7	625.3	809.1	808.7	842.1	1047.5

unit : \$ million

source : Canadian Bankers Association Archives. Tables are compiled from
handwritten register of Toronto Clearinghouse.

Table A3.10 Toronto Clearinghouse - Clearings by Banks (II)

	1906	1907	1908	1909	1910	1911	1912	1913
Montreal	98.5	126.2	112.2	131.6	153.8	177.4	198.8	211.6
Commerce	131.7	131.2	126.3	163.2	176.8	217.8	258.0	254.8
Merchants	50.1	54.6	61.8	71.3	74.0	87.8	101.4	90.3
British N.A.	30.2	31.4	33.0	46.0	50.6	53.3	63.1	60.5
Nova Scotia	38.8	35.6	39.3	53.6	56.1	69.4	82.2	72.2
Molsons	37.6	36.9	34.7	39.8	43.4	51.2	58.9	62.1
Toronto	80.7	82.9	81.1	94.4	106.9	126.2	144.1	152.5
Ontario	49.2	1.7*	---	---	---	---	---	---
Dominion	180.2	177.3	159.4	191.4	212.8	225.4	266.0	261.4
Imperial	116.5	112.9	106.1	126.9	142.6	167.5	204.7	200.2
Standard	68.1	78.8	82.6	107.2	124.5	144.7	172.8	186.2
Union	30.8	29.2	30.3	41.3	38.1	64.4	86.4	113.6
Traders	69.7	77.1	71.4	84.9	99.6	116.6	84.1	---
Hamilton	55.3	55.5	52.5	62.6	66.5	74.8	73.4	79.4
Ottawa	24.2	23.6	25.0	29.0	29.3	37.3	41.9	42.6

	1906	1907	1908	1909	1910	1911	1912	1913
Quebec	10.5	10.2	9.1	10.5	10.4	14.4	18.1	14.8
Sovereign	43.1	41.3	14.7	0.6	---	---	---	---
Metropolitan	46.7	40.9	42.2	58.1	57.4	71.0	83.0	79.9
Royal	10.6	16.9	21.9	31.4	45.2	60.6	113.9	178.3
Crown	17.1	20.2	18.2	19.6	20.4	20.8	30.9	24.1
Home	18.9	18.7	21.2	29.1	31.1	32.7	35.3	35.3
Sterling	10.4	22.9	26.5	36.7	40.8	39.0	42.7	51.1
Farmers	---	3.8	6.6	7.9	6.9	---	---	---
total	1219.1	1228.9	1166.9	1437.7	1593.9	1852.4	2170.2	2181.3

unit : \$ million

* : Bank of Ontario recorded 1.7 million in January, 1907. It failed in 1907.

source : Canadian Bankers Association Archives. Tables are compiled from handwritten register of Toronto Clearinghouse.

Appendix E : A Sketch of the Current Clearing System

Here I will briefly sketch the current cheque clearing process in Canada. As discussed before, the clearing process of a cheque involves two stages. First, a cheque has to be physically dealt by a branch of a bank (once it is presented by a payee as a deposit item) in order to be traced back to its origination (i.e., the bank it is drawn on). And then any difference in debit entries and credit entries created by cheques between two banks has to be settled with the transfer of a medium of reserves held in central authorities.

To formalize the discussion, it will start with the observation of a cheque deposited to the branch of a direct clearer.²⁵⁶ [Internal clearing among branches of a same bank and clearing between a direct clearer and other deposit taking institutions are not considered.] And this paper will use the example of the current paper based cheque

²⁵⁶ See Bank for International Settlements (1989), p.51. "Direct clearers represent themselves directly in the clearing and settlement process" [and] "... those institutions which are not direct clearers maintain a clearing settlement account with an agent direct clearer for payment of their clearing items." Direct clearers use settlement account at the Bank of Canada to achieve net clearing balances. Also see CPA Forum (Sept. 1987).

clearing²⁵⁷ under the direction of the CPA (Canadian Payment Association) for illustration.

Once a cheque is deposited in a bank, it will be sorted with other items by midday. Then they are "bundled" and "totalled"; the batches of cheques (usually 300 items in each batch unless they are large amount exceeding 50,000 dollars) are collected by courier and delivered to the institution's nearest processing centre. Currently there are eight regional settlement locations across Canada, in which fifteen direct clearers participate. Prior to November 1983, clerks representing financial institutions had to present "due-to" and "due-from" items to the clearing houses. It is obvious that CPA has intended to gain efficiency in collecting cheques by exclusively dealing with fifteen direct clearers. When cheques arrive a processing centre, they are encoded and microfilmed for tracing and security. Items drawn on other direct clearers are re-bundled and delivered by courier to the processing centres of other direct clearers.

The exchange of these items delivered to other processing centres starts about 6 p.m. in each banking day. Since any unprocessed clearing items represent lost

²⁵⁷ Earlier study of Canadian clearing system is illustrated in Galbraith (1970). See Galbraith (1970), chapter 39 for the detailed description of the cheque arrangements for paper based clearing under the guidance of CBA.

interest revenue,²⁵⁸ direct clearers are trying to handle cheques as speedily as possible. In fact, for high speed clearing processing, most of the direct clearers are equipped with IBM 3890 document processors which can handle 1700 to 2400 cheques per minute. The exchange of cheques by courier (often involving air courier) usually peaks around midnight and slows down afterward. When these physical exchanges (deliveries) of cheques are all completed,²⁵⁹ the settlement process begins.

The financial settlement of the items exchanged starts at about 8.30 a.m. (Ottawa time) on the following day. By 9.30 a.m., the preliminary net clearing gain or loss of each direct clearer is available from Automated Clearing Settlement System (ACSS). For the next one and a half hours (10 - 11.30 a.m.), bilateral adjustments amongst direct clearers can take place through ACSS. And at 1.30 p.m., the Bank of Canada receives each direct clearer's net gain or loss and balances of these clearers are adjusted through transfer of funds between their accounts at the Bank of Canada. The Bank of Canada, eventually, announces the

²⁵⁸ CPA (1987), p.2.

²⁵⁹ See Bank for International Settlements (1989). There is a cut-off time for the exchange of cheques for each regional settlement point (generally around midnight local time). Items exchanged between direct clearers after cut-off time are not included until the next clearing cycle starts.

closing balance of each direct clearer as at the end of the previous banking day around 4 p.m.. Figure A3.2 shows the summary of cheque clearing process under the current CPA system in Canada. In the figure, it is assumed that person a writes a cheque (ba) on his deposits in bank A and person b, who receives this cheque, deposits it to his bank, bank B.

Figure A3.2

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