RESTRICTIONS ON FINANCIAL INTERMEDIARIES
AND IMPLICATIONS FOR AGGREGATE FLUCTUATIONS:
CANADA AND THE UNITED STATES,
1870-1913

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ABSTRACT

During the period 1870-1913, Canada had a well-diversified branch banking
system while banks in the U.S. unit banking system were less diversified.
Canadian banks could issue large-denomination notes with no restrictions on
their backing, while all U.S. currency was essentially an obligation of the
U.S. government. Also, experience in the two countries with regard to bank
failures and banking panics was quite different. A general equilibrium busi-
ness cycle model with endogenous financial intermediation is constructed that
captures these historical Canadian and American monetary and banking arrange-
ments as special cases. The predictions of the model contradict conventional
wisdom with regard to the cyclical effects of banking panics. Support for
these predictions is found in aggregate annual time series data for Canada and
the United States.

1. Introduction

Advances in the economics of information have permitted recent progress in modeling financial intermediaries. This new financial intermediation literature is somewhat diverse, but the models generally follow the approach of specifying an economic environment in terms of primitives--preferences, endowments, and technology--and analyzing how that environment generates financial intermediation as an endogenous phenomenon. Several things are gained from this type of approach: a deeper understanding of the role of financial intermediaries as institutions that diversify, transform assets, and process information; explanations for bank runs; insights into the role of financial intermediaries in aggregate fluctuations; and implications for the effects of financial regulations.

One branch of this financial intermediation literature, following on the work of Diamond and Dybvig (1983), focuses on deposit contracts, bank runs, and bank failures. In the Diamond-Dybvig model, the banking system has an inherent instability. Banks provide a form of insurance through the withdrawal provision in deposit contracts, but this leaves banks open to runs, during which the expectation of the failure of an otherwise safe bank is self-fulfilling. (This branch of the literature includes Postlewaite and Vives 1987, Wallace 1988, and Williamson 1988.)

Another branch of the financial intermediation literature, which includes work by Diamond (1984), Boyd and Prescott (1986), and Williamson (1986), is concerned with financial intermediation in general (rather than banking in particular) and with the features of economic environments (moral hazard, adverse selection, and monitoring and evaluation costs) that can lead to intermediary structures. Models of this type have been integrated into macroeconomic frameworks by Williamson (1987b), Greenwood and Williamson

(1988), and Bernanke and Gertler (1989) to study the implications of financial intermediation for aggregate fluctuations. A general conclusion of this work is that the financial intermediation sector tends to amplify fluctuations. Bernanke and Gertler (1989) show how a redistribution of wealth from borrowers to lenders increases the agency costs associated with lending, causing a decrease in the quantity of intermediation and in real output. Such a wealth redistribution might be associated with debt deflations. Williamson (1987b) shows how some kinds of aggregate technology shocks, which produce no fluctuations in an environment without the information costs that generate an intermediary structure, do cause fluctuations when these costs are present. (See Gertler 1988 for a survey of other related work.)

This paper has two purposes. First, for those unfamiliar with the recent literature on financial intermediation, it shows how an explicit general equilibrium model with endogenous financial intermediation can illuminate some central issues in banking and macroeconomics and can put order on some historical experience and empirical evidence. Second, for those familiar with the intermediation literature, this paper shows how a model related to models in Williamson (1987b) and Greenwood and Williamson (1988) can be used to study bank failures and banking panics. The model here has some novel implications for the role of financial regulations and bank failures in aggregate fluctuations, and I find some (qualified) empirical support for its predictions.

The approach I take is the following. First, I study a historical period when monetary and banking arrangements were strikingly different in two countries. In terms of what has a bearing on aggregate fluctuations, other than financial arrangements, the two countries were quite similar in this period. Next, I construct a general equilibrium model with endogenous financial intermediation which can incorporate the financial arrangements in either

country as special cases. Then I study the implications of the differences in banking and monetary arrangements for aggregate fluctuations in the two countries. Last, I go to the data and judge whether the theory fits the evidence.

The period I focus on is the 44 years from 1870 to 1913, and the two countries are Canada and the United States. Over this period, Canada had a branch banking system with, at most, 41 chartered banks, while (in 1890) the United States had more than 8,000 banks, and most were unit banks. Numerous restrictions on branching, along with other constraints absent in Canada, tended to keep U.S. banks small. Canadian banks were free to issue private circulating notes with few restrictions on their backing, but all circulating currency in the United States was effectively an obligation of the U.S. government. In addition to these differences in banking and monetary arrangements, the countries had different records of bank failures and panics. Average bank depositor losses as a fraction of deposits were roughly 60 percent larger in the United States than in Canada. Also, cooperative behavior among the Canadian banks acted to virtually preempt any widespread banking panics, so that disruption from financial crises was considerably smaller in Canada. The history of widespread bank runs and failures in the United States during the National Banking Era (1863-1914) is documented in Sprague (1910).

The model presented here captures the important features of Canadian and U.S. monetary and banking arrangements during 1870-1913. This model is related to others constructed in Williamson (1987b) and Greenwood and Williamson (1988), in that it has costly state verification (Townsend 1979) which provides a delegated monitoring role for financial intermediaries (Diamond 1984, Williamson 1986). When the model includes a restriction on diversification by financial intermediaries, interpreted as a unit banking restriction, banks fail with positive probability. When they fail, banks

experience a phenomenon which can be interpreted as a bank run. Banks not subject to the unit banking restriction diversify perfectly, and they never fail.

When subjected to aggregate technological shocks, the model yields patterns of comovement in the data that are qualitatively similar whether or not there is a diversification restriction or a constraint that banks cannot issue circulating notes. The price level, bank liabilities, and output are mutually positively correlated. Two important results:

- Despite the fact that aggregate bank failures are negatively correlated with output when there is unit banking, the unit banking restriction actually reduces the unconditional variance of output.

- Introducing a restriction that prohibits the issue of private bank notes decreases the unconditional variance of output.

These two results are consistent with the view that intermediation amplifies fluctuations. That is, both restrictions inhibit intermediation, and both reduce the magnitude of fluctuations.

Banks fail for a quite different reason in my model than in Diamond and Dybvig's (1983). Here, the unit banking restriction results in a banking system in which banks are less diversified than they would be otherwise. These banks are therefore more sensitive to idiosyncratic shocks, and they fail and experience runs with higher probability. In Diamond and Dybvig's model, bank failures and runs occur because of an inherent instability associated with the structure of deposit contracts. The Diamond-Dybvig model cannot confront the Canada/U.S. differences during 1870-1913. It also has difficulty with the Great Depression, when Canada experienced no bank failures while U.S. banks were failing in very large numbers. During the Great Depression, de-

posit contracts in the United States and Canada were similar, Canada had no deposit insurance, and no Canadian banks suspended convertibility. (For a study of Canadian banking in the Great Depression, see Haubrich 1987.)

The model's implication that the unit banking restriction reduces fluctuations contradicts conventional wisdom about the role of bank failures in the business cycle. Several studies have argued that bank failures propagated negative aggregate shocks during the Great Depression. Friedman and Schwartz (1963) see the propagation mechanism as acting through measured monetary aggregates, while Bernanke (1983) and Hamilton (1987) argue that there are additional, nonmonetary effects of intermediation on real activity.

In the model, government deposit insurance in the unit banking system acts to eliminate bank runs, but banks still fail. This arrangement is equivalent to one where banks diversify perfectly and never fail. Therefore, after World War II, when U.S. and Canadian banks face the same restrictions on private note issue and U.S. deposits are insured, the two countries should experience similar macroeconomic behavior, other things held constant.

To test this theory, I examine detrended aggregate annual data for Canada and the United States during 1870-1913 and 1954-1987. For the 1870-1913 period, new gross national product (GNP) data have recently been constructed for the United States by Romer (1989) and Balke and Gordon (1989) and for Canada by Urquhart (1986). This makes the study of this period of particular current interest. Of the aggregate data I examine, the GNP data provide the strongest support for the theory. The volatility of Canadian GNP is higher than that of U.S. GNP according to both the Romer data (56 percent) and the Balke and Gordon data (11 percent). For 1954-1987, GNP volatility in the two countries is approximately equal. Price level volatility is higher in Canada for the 1870-1913 period, but in the 1954-1987 data there are some

inconsistencies with the theory with regard to price level volatility and comovements of prices with output. In apparent contradiction to the theory, bank liabilities are less volatile in Canada than in the United States during 1870-1913. However, there are good reasons to believe that this volatility difference reflects measurement error in the U.S. data.

The paper is organized as follows. In section 2 I review Canadian and U.S. monetary and banking arrangements in 1870-1913. In section 3 I construct the model and describe its implications. In section 4 I discuss the empirical evidence. The final section is a summary and conclusion.

2. Monetary and Banking Arrangements in the United States and Canada, 1870-1913

During the 1870-1913 period, the United States had a unit banking system, as it does today. There were few barriers to entry in the banking industry, but banks faced numerous restrictions which tended to keep them small and to limit diversification. In 1890, the United States had 8,201 banks, including 3,484 national banks (U.S. Department of Commerce 1975). Circulating paper currency consisted mainly of national bank notes (in denominations of $1 and more) and notes issued directly by the U.S. Treasury. National bank notes were more than fully backed by federal government bonds at the time of issue and were guaranteed by the federal government. All banks were subject to reserve requirements.

During the National Banking Era (1863-1914), the U.S. banking system was subject to recurrent periods of widespread panic and bank failure, as is well known. Pervasive financial crises occurred in 1873, 1884, 1890, 1893, and 1907 (Sprague 1910). Figure 1 plots percentage deviations from trend (computed with a Hodrick-Prescott filter; see Prescott 1983) in GNP and in bank suspensions in the United States between 1870 and 1913. There is clearly

negative comovement between the series, with a correlation coefficient of -0.25. Friedman and Schwartz (1963) and Cagan (1965) also find that panic periods tended to be associated with declines in real output growth and with increases in the currency/deposit ratio.

At the same time, Canada's branch banking system, patterned after Scottish arrangements, consisted of, at most, 41 chartered banks. In 1890, when Canada's population was slightly less than one-tenth of the United States', Canada's 38 chartered banks had 426 branches nationwide. The granting of a bank charter required federal legislation, which created a significant barrier to entry. However, once given a charter, a bank faced few restrictions, at least compared to U.S. banks. Canadian banks could issue notes in denominations of $4 and more (raised to $5 in 1880). A bank's note issue was limited by its capital, but this constraint does not seem to have been binding on the system as a whole through most of the period.[1] There were no reserve requirements,[2] but after 1890, 5 percent of note circulation was held on deposit in a central bank circulation redemption fund. This added insurance was essentially redundant, since notes were made senior claims on a bank's assets in 1880. Most bank notes appear to have circulated at par, especially after 1890 legislation that required redemption of notes in particular cities throughout Canada.

The striking difference in the incidence of bank failure in Canada and the United States during the Great Depression has been noted by Friedman and Schwartz (1963) and Bernanke (1983) and studied by Haubrich (1987). From 1930 to 1933, more than 9,000 U.S. banks suspended operations (Friedman and Schwartz 1963), but no banks failed in Canada between 1923 and 1985. The record of bank failures in the two countries during 1870-1913, while showing less striking differences than that, also indicates that the incidence of bank

failure was lower and the disruptive effects of these failures were considerably smaller in Canada than in the United States.

Table 1 displays statistics on bank liquidations in Canada during 1870-1913. In total, Canada had 23 bank liquidations while, at the same time, the United States had 3,208. This evidence clearly overstates the difference between Canadian and U.S. bank failure rates, since Canadian banks were larger than U.S. banks and Canadian GNP and population were less than one-tenth of the corresponding quantities in the United States over the period. Thus, the failure of an average-sized Canadian bank would potentially have had a much larger effect on the Canadian economy than the failure of an average-sized U.S. bank would have had on the U.S. economy.

According to Table 1, noteholders of failed banks received 100 percent of the face value of their liabilities in 21 of the 23 Canadian bank liquidations, and depositors received 100 percent in 12 of the 23. This might indicate relatively little economic disruption from Canadian bank failures, but that conclusion requires comparable statistics for the United States. Table 2 displays some data on bank depositor losses in the United States. These are 16- and 20-year averages of annual losses to depositors as a percentage of total deposits. For the years in which bank failures occurred in Canada, similar Canadian statistics are also provided in Table 2. Thus, on average in the years under study, losses to depositors were 0.11 percent of total deposits in the United States and 0.07 percent in Canada. By this measure, the disruption from bank failures appears to have been significantly smaller--57 percent smaller--in Canada than in the United States.

Further, Canadian chartered banks had cooperative arrangements that tended to mitigate the adverse effects of bank failures. Canadian banks were mainly self-regulated, with a formal organization, the Canadian Bankers'

Association, established in 1891 and given special powers through legislation in 1900. The largest banks, particularly the Bank of Montreal, appear to have been willing to act as informal lenders of last resort and to step in to help reorganize troubled banks. This excerpt from Johnson (1910, pp. 124-125) is illustrative:

> On the evening of October 12 [1906] the bankers in Toronto and Montreal heard with surprise that the Bank of Ontario had got beyond its depth and would not open its doors the next morning . . . . The leading bankers in the Dominion dreaded the effect which the failure of such a bank might have. The Bank of Montreal agreed to take over the assets and pay all the liabilities, provided a number of other banks would agree to share with it any losses. Its offer was accepted and a representative of the Bank of Montreal took the night train for Toronto. Going breakfastless to the office of the Bank of Ontario he found the directors at the end of an all-night session and laid before them resolutions officially transferring the business and accounts of the bank to the Bank of Montreal. They adopted the resolution before 9 a.m. and the bank opened business for the day with the following notice over the door: "This is the Bank of Montreal."
>
> Before 1 o'clock the same notice, painted on a board or penciled on brown wrapping paper, was over the door of the 31 branches in different parts of the Dominion. Its customers were astonished that day when they went to the bank, but none of them took alarm and many of them were well pleased with the change.

The collective behavior of Canadian banks not only served to minimize the costs of liquidating insolvent institutions; it also appears to have prevented widespread banking panics. Any bank runs seem to have been confined to individual banks or branches (U.S. Congress 1910). While U.S. banks had cooperative arrangements during the National Banking Era, particularly clearinghouses (Gorton 1985), the ability of U.S. banks to act as a single coalition could not approach that of their Canadian counterparts.

The government of Canada had a monopoly on the issue of small-denomination notes during 1870-1913, but circulating currency in large denominations consisted mostly of bank notes (Johnson 1910). There was a limited issue of Dominion notes, backed 25 percent by gold and 75 percent by govern-

ment securities, with additional issues backed 100 percent by gold. Legislation periodically increased the limit on the fractionally gold-backed component of government-issued currency.

3. The Theory

The purpose of this section is two-fold. First I will construct a model which captures the essential features of the banking and monetary structures of Canada and the United States during the period of interest. Then I will explore the implications of this theory for the interaction between financial structure and macroeconomic fluctuations.

Section 2 described two important differences between Canadian and U.S. banking and monetary arrangements in 1870-1913. One is that Canadian bank liabilities were much less subject to idiosyncratic risk than were U.S. bank liabilities. The Canadian system let Canadian banks become larger than U.S. banks, and branch banking allowed greater geographical diversification. Further, the cooperative behavior among Canadian banks helped to insure depositors against losses. The other important difference is related to the fact that Canadian banks could issue circulating notes in large denominations and back them with private assets. In the United States, only national banks could issue notes, and these notes had to be backed 111 percent by U.S. government bonds. Thus, Canadian bank notes could perform an intermediation function while U.S. bank notes could not (to the extent that breaking up government bonds into small denominations is an insignificant function compared to the intermediation normally done by banks).

The model should be able to replicate the differences in the U.S. and Canadian experiences with regard to bank failures. That is, bank failures should be negatively correlated with aggregate activity, and the incidence of bank failure should be higher in the model U.S. economy than in the model Canadian economy.

The model constructed here is related to the models in Williamson (1987b) and Greenwood and Williamson (1988), with some differences designed to capture the problem at hand. This model abstracts from reserve requirements, interest-bearing government debt, and the operation of the gold standard monetary regime.

3.1. The Model Canadian Economy

3.1.1. Environment

This is a model of a closed economy which has a continuum of two-period-lived agents born in each period $t = 1, 2, 3, \ldots$. The measure of a generation is N. Each generation has two types of economic agents, lenders and entrepreneurs. Lenders each receive an indivisible endowment of one unit of time when young and maximize $E_t(\delta \ell_t - e_t - e_{t+1} + c_{t+1})$, where E_t is the expectation operator conditional on period t information, δ is an individual-specific parameter denoting the value to a lender of consuming leisure, ℓ_t is leisure, e_t is effort expended, and c_t is consumption. Lenders can use their single unit of time in period t either to produce one unit of the period t consumption good or to consume one unit of leisure. Entrepreneurs have no endowments of time, the consumption good, or effort in either period of life. A generation t entrepreneur has access at time t to an investment project which requires K units of the time t consumption good as input in order to operate, where K is an integer greater than 1. If funded, the project yields a random return $\tilde{w}$, for which $\Pr[\tilde{w} \leq w] = H(w, \theta, \phi_t)$; here, $H(\cdot, \cdot, \cdot)$ is differentiable in all its arguments and is twice differentiable in its first argument. Let $h(w, \theta, \phi) \equiv D_1 H(w, \theta, \phi)$ denote the probability density function, which is positive on $[0, w]$. The variable ϕ_t affects the investment projects of all entrepreneurs, and θ is an entrepreneur-specific parameter which orders probability distributions according to first-order stochastic dominance. That is,

$D_2H(w,\theta,\phi_t) < 0$ for $0 < w < \bar{w}$. Project quality strictly improves as θ increases. For fixed θ, an increase in ϕ produces an increase in the riskiness of the project return without changing its expected value. That is, an increase in ϕ is a mean-preserving spread (Rothschild and Stiglitz 1970), though this is carried out in such a way that probability mass is shifted only for lower values of w. Specifically, $\int_0^{\bar{w}} D_3H(x,\theta,\phi)\, dx < 0$ for $0 < w < \bar{w}$, $D_3H(x,\theta,\phi) = 0$ for $w > K$, and $\int_0^{\bar{w}} x D_3 h(x,\theta,\phi)\, dx = 0$.

Assume that the aggregate shock ϕ_t follows a two-state Markov process. That is, $\phi_t = \phi_i$ for $i = 1, 2$, and $\Pr[\phi_{t+1}=\phi_1 | \phi_t=\phi_i] = q_i$ for $i = 1, 2$, where $0 < q_i < 1$ and $\phi_2 > \phi_1$ for $i = 1, 2$ and $q_1 \geq q_2$. Aggregate shocks are therefore nonnegatively serially correlated, and all project returns are riskier in state 2 than in state 1.

Project returns are independently distributed across entrepreneurs. As in Townsend (1979), (1988), there is costly state verification. That is, entrepreneurs can observe the return on their own project, w, but any other agent expends γ units of effort to observe w.

Lenders who choose to produce the consumption good in period t save the entire amount, by acquiring fiat money or investing (directly or indirectly) in an entrepreneur's project. There is a fixed quantity of M_0 units of perfectly divisible fiat money which is in the hands of a group of old agents at $t = 1$. These agents supply fiat money inelastically so as to maximize consumption. Claims on period $t + 1$ consumption exchanged for the period t consumption good can take one of two forms; they are either deposit claims or notes. Deposits and notes are identical from the point of view of the issuer, but a lender who holds a deposit incurs a cost of β units of effort and a noteholder, a cost of α units of effort. There are no costs associated with holding fiat money. The parameters α and β are lender-specific, as is δ.

The fact that asset claims are named _deposits_ and _notes_ at this stage in the analysis is premature, since I have not yet established that arrangements corresponding to real-world banking institutions might arise here. However, to look ahead, my aim is to generate demand functions for two types of intermediary liabilities, deposits and notes, which are both backed by the same portfolio of loans to entrepreneurs. With costs of holding the two liabilities and the costs differing among lenders, it is simple to obtain well-defined demand functions for intermediary liabilities, without having to explicitly specify the spatial and informational features that cause some agents to prefer one type of intermediary liability to another, even if their returns are identical. In terms of the ultimate optimal financial arrangement, the cost α can be interpreted as the cost in inconvenience associated with holding a large-denomination bank note as opposed to perfectly divisible fiat money. Similarly, β can be interpreted as the cost of carrying out an exchange using a check-writing technology rather than fiat currency. These costs might plausibly be thought to differ among individuals or types of transactions.

To obtain simple demand functions for intermediary liabilities, assume there are three types of lenders. _Type 1_ lenders have $\alpha = \beta = \infty$, _type 2_ lenders have $\delta = 0$ and $\beta = \infty$, and _type 3_ lenders have $\delta = 0$ and $\alpha = \beta = \infty$. The fraction of agents in any generation who are type i lenders is η_i. The measure of agents in a generation with $\delta \leq \delta'$ is $\eta_1 A(\delta')$, the measure with $\alpha \leq \alpha'$ is $\eta_2 B(\alpha')$, and the measure with $\beta \leq \beta'$ is $\eta_3 F(\beta')$. Here, $A(\cdot)$, $B(\cdot)$, and $F(\cdot)$ are distribution functions which give the distribution of parameter values across each lender type. Let $a(\delta) \equiv DA(\delta)$, $b(\alpha) \equiv DB(\alpha)$, and $f(\beta) \equiv DF(\beta)$, where $a(\cdot)$, $b(\cdot)$, and $f(\cdot)$ are positive on R_+. In equilibrium, type 1 lenders will substitute as a group between consuming leisure and holding fiat

money, type 2 lenders will substitute between fiat money and notes, and type 3 lenders will substitute between fiat money and deposits.

Let η_4 denote the fraction of agents who are entrepreneurs, with $\eta_4 G(\theta')$ being the fraction of agents who are entrepreneurs with $\theta \leq \theta'$. Let $g(\theta) \equiv DG(\theta)$, with $g(\cdot)$ positive on $[\underline{\theta}, \bar{\theta}]$ for $\bar{\theta} > \underline{\theta}$. Assume that

$$\int_0^{\bar{w}} xh(x, \bar{\theta}, \phi_1) \, dx > K$$

$$\int_0^{\bar{w}} xh(x, \underline{\theta}, \phi_1) \, dx < K$$

and $\eta_4 K < \eta_2 + \eta_3$. Therefore, for the equilibrium to be examined, there will always be some projects funded, some projects not funded, and some lenders of each type holding fiat money.

3.1.2. Financial Arrangements

For investment projects to be financed, lenders and entrepreneurs need to make contractual arrangements. As in the costly state verification setups of Townsend (1979), Gale and Hellwig (1985), and Williamson (1986) and (1987a), assume the following commitment technology and sequence of moves by the contracting parties. In any period t, the lenders jointly funding investment projects agree among themselves on rules for dividing the period $t + 1$ payments from entrepreneurs. No lender can observe payments made to other lenders by the entrepreneur. Lenders make commitments in period t about how they will respond to declarations by an entrepreneur at $t + 1$ about the project outcome, and payment schedules are set. In period $t + 1$, an entrepreneur declares a particular project outcome, w^d, and a lender then incurs the verification cost if $w^d \in S$ or does not incur the cost if $w^d \notin S$, where S is the verification set. Note that stochastic verification is ruled out.[3] Payments from the entrepreneur to lenders depend on the entrepreneur's declaration and on the results of the lenders' state verification, if it occurs.

Let r_t denote the market expected return per unit of the consumption good invested by lenders in entrepreneurs' projects, and let $R_t(w)$ denote the payment to the lenders in a given project by an entrepreneur. Then, from Williamson (1987b) and Greenwood and Williamson (1988), the following is an optimal arrangement. Lenders delegate monitoring to a financial intermediary (as in Diamond 1984 and Williamson 1986). The entrepreneur makes a noncontingent payment of x_t to the intermediary if $w \geq x_t$ and pays the intermediary w if $w < x_t$. The expected return to the intermediary is then

$$\pi(x_t, \theta, \phi_t) = \int_0^{x_t} (w - \gamma) h(w, \theta, \phi_t) \, dw + x_t [1 - H(x_t, \theta, \phi_t)] \qquad (1)$$

or, integrating by parts,

$$\pi(x_t, \theta, \phi_t) = x_t - \int_0^{x_t} H(w, \theta, \phi_t) \, dw - \gamma H(x_t, \theta, \phi_t). \qquad (2)$$

The optimal contract between an intermediary and an entrepreneur is a debt contract, as in Gale and Hellwig (1985) and Williamson (1987a). That is, there is a fixed promised payment, and if the entrepreneur cannot meet it, then bankruptcy occurs and the entrepreneur consumes zero. The verification cost, γ, can be interpreted as a cost of bankruptcy.

Intuitively, this contract is optimal since, first, incentive compatibility requires that the payment be noncontingent in the event that verification does not occur. Second, since risk sharing is not a factor here, with risk-neutral agents, maximizing the payment in verification states minimizes the probability of verification and therefore minimizes expected verification costs.

Assume that $\pi(x, \theta, \phi_t)$ is strictly concave in its first argument for $\theta \in [\underline{\theta}, \bar{\theta}]$ and $\phi_t = \phi_i$ for $i = 1, 2$. Then there is a unique $\hat{x}(\theta, \phi_t)$ such that $\pi(x, \theta, \phi_t)$ reaches a maximum for $x = \hat{x}(\theta, \phi_t)$ with fixed θ and ϕ_t and

$\hat{x}(\theta,\phi_t) \in (0,\bar{w})$. Entrepreneurs for whom $\pi\left(\hat{x}(\theta,\phi_t),\theta,\phi_t\right) \geq r_t K$ receive loans, while those with $\pi\left(\hat{x}(\theta,\phi_t),\theta,\phi_t\right) < r_t K$ do not. For the entrepreneurs receiving loans, the promised payment x_t satisfies

$$\pi(x_t,\theta,\phi_t) = r_t K. \tag{3}$$

Note that x_t decreases with θ; that is, the loan interest rate is lower for higher-quality projects.

Financial intermediaries are those type 3 lenders with $\beta = 0$. These intermediaries are able to commit to making noncontingent payments of r_t to each of their depositors and noteholders by holding large portfolios and achieving perfect diversification.[4] Since each of an intermediary's depositors and noteholders receives r_t with certainty, the liability holders need never monitor the intermediary.

This optimal arrangement captures some important features of financial intermediation arrangements observed in the real world, including asset transformation, diversification, information processing, and the fact that intermediaries hold debt in their portfolios.

3.1.3. Equilibrium

In equilibrium, there is some θ'_t such that entrepreneurs with $\theta \geq \theta'_t$ receive loans while those with $\theta < \theta'_t$ do not. Let x'_t denote the promised payment for the marginal borrower; that is, $x'_t = \hat{x}(\theta'_t,\phi_t)$. Then

$$\pi(x'_t,\theta'_t,\phi_t) = r_t K \tag{4}$$

and

$$D_1\pi(x'_t,\theta'_t,\phi_t) = 0. \tag{5}$$

Since $\pi(\cdot,\cdot,\cdot)$ is concave in its first argument, equations (4) and (5) solve for x_t' and θ_t' given r_t. Using (2) to substitute in (4) and (5) gives (6) and (7):

$$x_t' - \int_0^{x_t'} H(w,\theta_t',\phi_t) \, dw - \gamma H(x_t',\theta_t',\phi_t) = r_t K \qquad (6)$$

$$1 - H(x_t',\theta_t',\phi_t) - \gamma h(x_t',\theta_t',\phi_t) = 0. \qquad (7)$$

Given the market expected return r_t, (6) and (7) determine x_t' and θ_t'.

Let p_t denote the price of fiat money in period t, in terms of the consumption good. The expected return on fiat money in period t is then $E_t p_{t+1}/p_t$. The type 1 lender who is indifferent between consuming leisure and producing the consumption good to exchange for fiat money has $\delta = E_t p_{t+1}/p_t$. Similarly, the type 2 lender who is indifferent between holding intermediary notes and holding fiat money has $r_t - \alpha = E_t p_{t+1}/p_t$. And the type 3 lender who is indifferent between holding intermediary deposits and holding fiat money has $r_t - \beta = E_t p_{t+1}/p_t$. Equilibrium in the market for fiat money therefore implies that

$$\eta_1 A(E_t p_{t+1}/p_t) + \eta_2[1-B(r_t-E_t p_{t+1}/p_t)] + \eta_3[1-F(r_t-E_t p_{t+1}/p_t)] = p_t M_0 \qquad (8)$$

where the left side of (8) is the demand for fiat money (with the three terms representing the demand for fiat money by type 1, type 2, and type 3 lenders, respectively) and the right side of (8) is the supply of fiat money. In the credit market, equilibrium implies that

$$\eta_2 B(r_t-E_t p_{t+1}/p_t) + \eta_3 F(r_t-E_t p_{t+1}/p_t) = \eta_4 K[1-G(\theta_t')] \qquad (9)$$

where the first term on the left side of (9) is credit supplied (through financial intermediaries) by noteholders, the second term on the left side is credit supplied by intermediary depositors, and the right side is credit demanded by entrepreneurs.

Now restrict attention to the stationary monetary equilibrium, where $p_t > 0$ for all t and quantities and prices depend only on the state, ϕ_t. Let subscripts denote the state. Then

$$E_t p_{t+1} = q_i p_1 + (1-q_i)p_2, \quad \phi_t = \phi_i, \quad i = 1, 2. \tag{10}$$

Let $\hat{p} \equiv p_1/p_2$. Then from (8), (9), and (10) come (11), (12), and (13):

$$n_1 A(q_1 + (1-q_1)/\hat{p}) + n_2[1-B(r_1-q_1-(1-q_1)/\hat{p})] + n_3[1-F(r_1-q_1-(1-q_1)/\hat{p})]$$

$$- \hat{p}\{n_1 A(q_2\hat{p}+1-q_2) + n_2[1-B(r_2-q_2\hat{p}-1+q_2)] + n_3[1-F(r_2-q_2\hat{p}-1+q_2)]\} = 0 \tag{11}$$

$$n_2 B(r_1-q_1-(1-q_1)/\hat{p}) + n_3 F(r_1-q_1-(1-q_1)/\hat{p}) = n_4 K[1-G(\theta_1')] \tag{12}$$

$$n_2 B(r_2-q_2\hat{p}-1+q_2) + n_3 F(r_2-q_2\hat{p}-1+q_2) = n_4 K[1-G(\theta_2')]. \tag{13}$$

Also, from (6) and (7), for $i = 1, 2$,

$$x_i' - \int_0^{x_i'} H(w,\theta_i',\phi_i) \, dw - \gamma H(x_i',\theta_i',\phi_i) = r_i K \tag{14}$$

$$1 - H(x_i',\theta_i',\phi_i) - \gamma h(x_i',\theta_i',\phi_i) = 0. \tag{15}$$

Equations (11)-(15) solve for $\hat{p}$, r_i, θ_i', and x_i' for $i = 1, 2$.

3.2. The Model U.S. Economy

Here I will treat the U.S. economy as simply a scaled-up version of the Canadian economy. Note that in the model summarized by (11)-(15) the measure of the Canadian population, N, is irrelevant for the determination of equilibrium interest rates and prices. Let N^* denote the measure of the U.S. population, which is on the order of 10N for the period under study.

Recall that two important differences between U.S. and Canadian monetary and banking arrangements during 1870-1913 are that (1) restrictions on private note issue in the United States implied that bank notes could not

be backed by private assets, and (2) U.S. banks were for the most part unit banks, which could not diversify to the extent that their Canadian counterparts could.

The first restriction can be captured in the model by simply closing off the issue of notes by private agents. Type 2 lenders are then forced to hold fiat money, just as U.S. residents who wished to hold circulating notes could either hold U.S. Treasury notes or national bank notes backed by U.S. government bonds, while Canadian residents had the option of holding large-denomination private circulating notes backed by private loans.

An extreme version of the second restriction, unit banking, is a prohibition on all diversification. Assume that no agent can hold claims on more than one investment project. With this restriction, financial intermediaries have no role in the model; all lending and borrowing is done directly between type 3 lenders and entrepreneurs. However, this outcome can be interpreted as a banking arrangement where, for every funded project, there is one bank with K depositors. Optimal contracts with entrepreneurs are debt contracts, as in the case without the unit banking restriction (Williamson 1986), but there is now no delegated monitoring. If the entrepreneur (bank) defaults, all K depositors incur the verification cost; that is, the depositors incur collective verification costs of $K\gamma$ with unit banking and γ with perfect diversification. Therefore, for the unit banking system, the expected return to a bank's depositors is

$$\pi^*(x_t^*, \theta, \phi_t) = x_t^* - \int_0^{x_t^*} H(w, \theta, \phi_t) \, dw - \gamma K H(x_t^*, \theta, \phi_t) \tag{16}$$

where the asterisk (*) superscripts denote variables and functions for the U.S. economy. Given (16), (14) and (15) become, for the U.S. economy, (17) and (18): For $i = 1, 2,$

$$x_i^{!*} - \int_0^{x_i^{!*}} H(w,\theta_i^{!*},\phi_i) \; dw - \gamma K H(x_i^{!*},\theta_i^{!*},\phi_i) = r_i^* K \qquad (17)$$

$$1 - H(x_i^{!*},\theta_i^{!*},\phi_i) - \gamma K h(x_i^{!*},\theta_i^{!*},\phi_i) = 0. \qquad (18)$$

Given the restriction on private note issue, instead of (11), (12), and (13) the U.S. economy has (19), (20), and (21):

$$\eta_1 A\big(q_1 + (1-q_1)/\hat{p}^*\big) + \eta_2 + \eta_3 \big[1 - F(r_1^* - q_1 - (1-q_1))/\hat{p}^*\big]$$

$$- \hat{p}^* \{\eta_1 A(q_2\hat{p}^* + 1 - q_2) + \eta_2 + \eta_3[1 - F(r_2^* - q_2\hat{p}^* - 1 + q_2)]\} = 0 \qquad (19)$$

$$\eta_3 F\big(r_1^* - q_1 - (1-q_1)/\hat{p}^*\big) = \eta_4\big[1 - G(\theta_1^{!*})\big] \qquad (20)$$

$$\eta_3 F(r_2^* - q_2\hat{p}^* - 1 + q_2) = \eta_4\big[1 - G(\theta_2^{!*})\big]. \qquad (21)$$

The differences between (11), (12), and (13), on the one hand, and (19), (20), and (21), on the other, arise because under the U.S. regime all type 2 lenders hold fiat money and none of them contribute to the supply of credit to entrepreneurs.

For the U.S. economy, (16)-(21) determine $\hat{p}^*$ and $x_i^{!*}$, $\theta_i^{!*}$, r_i^* for $i = 1, 2$. Note that with the unit banking system banks fail with positive probability. For a bank that lends to an entrepreneur with parameter θ in period t, the probability of failure is $\Pr\big[w < x_t^*(\theta)\big]$, where $x_t^*(\theta)$ is the promised payment by the entrepreneur which satisfies

$$\Pi^*\big(x_t^*(\theta),\theta,\phi_t\big) = r_t^* K. \qquad (22)$$

The number of banks that fail in period $t + 1$ is, then,

$$\Psi_{t+1}^* = N^* \int_{\theta_t^{!*}}^{\bar{\theta}} H\big(x_t^*(\theta),\theta,\phi_t\big) g(\theta) \; d\theta. \qquad (23)$$

The contractual arrangement with unit banking can be interpreted as involving a bank run when a bank failure occurs. That is, the verification cost, γ, could represent the cost to a depositor of getting to the bank early to withdraw her deposit. On receiving a signal at the beginning of period $t + 1$ that failure is imminent, each depositor incurs the cost of running to the bank, each receives less than the promised return, and the bank fails. Runs are never observed with perfect diversification by banks, since then depositors would never need to verify the return on the bank's portfolio.

With this interpretation of bank failures and runs, this model seems better able to confront U.S. and Canadian experience than the bank runs model of Diamond and Dybvig (1983) or the related model of Postlewaite and Vives (1987). These other models rely on inherent features of the deposit contract to explain runs, which leaves the very different behavior of U.S. and Canadian banking systems unexplained.

3.3. Aggregate Fluctuations

To analyze fluctuations in the two model economies summarized by (11)-(15) and (16)-(21), I take as a benchmark a stationary monetary equilibrium with no fluctuations. That is, let $\phi_t = \phi$ for all t. Then, for the Canadian economy, $\hat{p} = 1$, $r_1 = r_2 = r$, and $\theta_1' = \theta_2' = \theta'$. Similarly, for the U.S. economy, $\hat{p}^* = 1$, $r_1^* = r_2^* = r^*$, and $\theta_1'^* = \theta_2'^* = \theta'^*$.

The two parallel economies are subjected to the same shocks, with $\phi_1 = \phi$ and $\phi_2 > \phi$. I study the behavior of the two economies for small perturbations; that is, I totally differentiate (11)-(15) and (16)-(21) around the benchmark equilibrium. In particular, I am interested in deriving expressions for unconditional variances and covariances of key variables. As in Greenwood and Williamson (1988), for two time series z_t^1 and z_t^2, for which $z_t^j = z_i^j$ when $\phi_t = \phi_i$ for i, j = 1, 2, to find the covariance for a *small*

perturbation to the benchmark equilibrium, a second-order Taylor expansion of the standard covariance formula gives

$$\text{cov}(a_t, b_t) \approx [(1-q_1)q_2/2(1-q_1+q_2)^2][\partial z_1^1/\partial\phi_2 - \partial z_2^1/\partial\phi_2][\partial z_1^2/\partial\phi_2 - \partial z_2^2/\phi_2]. \qquad (24)$$

Matters are somewhat more complicated for covariances of output with other key variables. Output, y_t, for the Canadian economy consists of two components. The first component, denoted y_t^1, consists of output produced in period t by lenders:

$$y_t^1 = N[\eta_1 A(E_t p_{t+1}/p_t) + \eta_2 + \eta_3]. \qquad (25)$$

The second component, y_{t-1}^2, is the output produced in period t from investment projects funded in period t − 1. Let μ denote the expected return on these projects (which is invariant to changes in ϕ). Then

$$y_{t-1}^2 = N\mu\{\eta_2 B(r_t - E_t p_{t+1}/p_t) + \eta_3 F(r_t - E_t p_{t+1}/p_t)\}. \qquad (26)$$

Then, for some variable z_t for which $z_t = z_i$ when $\phi_t = \phi_i$,

$$\text{cov}(z_t, y_t) \approx [(1-q_1)q_2/2(1-q_1+q_2)^2][\partial z_1/\partial\phi_2 - \partial z_2/\partial\phi_2]$$

$$\times [\partial y_1^1/\partial\phi_2 - \partial y_2^1/\partial\phi_2 + (q_1-q_2)(\partial y_1^2/\partial\phi_2 - \partial y_2^2/\partial\phi_2)]. \qquad (27)$$

The unconditional variance of output is

$$\text{var}(y_t) \approx [(1-q_1)q_2/2(1-q_1+q_2)^2]$$

$$\times [(\partial y_1^1/\partial\phi_2 - \partial y_2^1/\partial\phi_2)^2 + 2(q_1-q_2)(\partial y_1^1/\partial\phi_2 - \partial y_2^1/\partial\phi_2)$$

$$\times (\partial y_1^2/\partial\phi_2 - \partial y_2^2/\partial\phi_2) + (\partial y_1^2/\partial\phi_2 - \partial y_2^2/\partial\phi_2)^2]. \qquad (28)$$

The U.S. economy has similar expressions corresponding to (25), (26), (27), and (28).

Now, for the Canadian economy, totally differentiate (11)-(15) and solve to get the following, where d_t denotes bank deposits and n_t the stock of private bank notes.

$$\partial d_1/\partial \phi_2 - \partial d_2/\partial \phi_2 > 0$$

$$\partial n_1/\partial \phi_2 - \partial n_2/\partial \phi_2 > 0$$

$$\partial \hat{p}/\partial \phi_2 < 0$$

$$\partial y_1^1/\partial \phi_2 - \partial y_2^1/\partial \phi_2 > 0$$

$$\partial y_1^2/\partial \phi_2 - \partial y_2^2/\partial \phi_2 > 0.$$

Similarly, for the U.S. economy:

$$\partial d_1^*/\partial \phi_2 - \partial d_2^*/\partial \phi_2 > 0$$

$$\partial \hat{p}^*/\partial \phi_2 < 0$$

$$\partial y_1^1{}^*/\partial \phi_1 - \partial y_2^1{}^*/\partial \phi_2 > 0$$

$$\partial y_1^2{}^*/\partial \phi_2 - \partial y_2^2{}^*/\partial \phi_2 > 0.$$

(For the details of these derivations, see Appendix A.)

Fluctuations in the two economies are, therefore, qualitatively similar. In both countries, bank liabilities (bank notes plus deposits) and the price level (the inverse of the price of fiat money) are procyclical. Thus, if both economies are subjected to the same real disturbances, they experience business cycles that move in phase. The mean-preserving spread in the distribution of returns on investment projects that occurs in state 2 can

be thought of as a decrease in the demand for credit. This disturbance causes the real interest rate, r, and the quantity of credit extended by intermediaries to fall in state 2 relative to state 1. This credit decrease is matched by a decrease in the quantity of bank liabilities, so that the demand for fiat money rises and the price level falls. Output tends to be higher in state 1 than in state 2 for two reasons. One is that the expected real rate of return on fiat money is higher in state 1, so lenders work more and consume less leisure. The other reason for higher output in state 1 is that, since the shock ϕ_t is positively serially correlated, a period with a high quantity of credit extended is followed by state 1 with higher probability than by state 2. Thus, output from the previous period's investment, y_t^2, tends to be higher in state 1 than in state 2.

From (23), there are two effects on fluctuations in bank failures. First, the number of failures tends to be larger in state 2 because entrepreneurs with the same characteristics (the same θ) who receive loans in state 1 and state 2 face a higher promised payment, $x_t^*(\theta)$, in state 2, the state where investment projects are riskier. Therefore, the probability of failure for banks funding projects of the same quality is higher in state 2. Second, since $\theta_t^{!*}$ is higher in state 1 than in state 2, the average quality of projects (without taking account of the change in riskiness) is lower in state 1. This tends to make the number of failures larger in state 1 than in state 2. The first effect tends to induce countercyclical bank failures; the second effect, procyclical bank failures. It seems reasonable to assume that the first effect dominates, so that bank failures are countercyclical, as is true in the U.S. data for this period.

The next step is to make a quantitative comparison of fluctuations in the two economies. For this purpose, consider economies where $\gamma = 0$ and

$\eta_2 = 0$, that is, where verification is costless, making intermediation irrelevant, and where there is zero demand for private bank notes. Therefore, the two restrictions that make the two economies different are not binding. The two economies then produce the same benchmark steady-state equilibrium and the same unconditional variances and covariances of key variables (in per capita terms). In Appendix A, let $a = a^*$, $b = b^*$, $f = f^*$, $g = g^*$, $\lambda = \lambda^*$, $B = B^*$, $F = F^*$, $\Sigma_\theta = \Sigma_\theta^*$, and $\Sigma_\phi = \Sigma_\phi^*$. Further, assume that $B(r-1) = 0$ in the steady-state equilibrium with $\gamma = 0$ and $\eta_2 = 0$.

Now, to see what effects the unit banking restriction and the prohibition of private bank notes have on unconditional variances and covariances, differentiate equations (A1)-(A9) in Appendix A with respect to K and η_2 and evaluate at $\gamma = 0$ and $\eta_2 = 0$. This results in the following (which is detailed in Appendix B):

$$\frac{\partial}{\partial K} \left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N - (\partial d_1^*/\partial \phi_2)/N^* + (\partial d_2^*/\partial \phi_2)/N^* \right] > 0$$

$$\frac{\partial}{\partial \eta_2} \left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N - (\partial d_1^*/\partial \phi_2)/N^* + (\partial d_2^*/\partial \phi_2)/N^* \right] < 0$$

$$\frac{\partial}{\partial K} \left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N + (\partial n_1/\partial \phi_2)/N - (\partial n_2/\partial \phi_2)/N \right.$$

$$\left. - (\partial d_1^*/\partial \phi_2)/N^* + (\partial d_2^*/\partial \phi_2)/N^* \right] > 0$$

$$\frac{\partial}{\partial \eta_2} \left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N + (\partial n_1/\partial \phi_2)/N - (\partial n_2/\partial \phi_2)/N \right.$$

$$\left. - (\partial d_1^*/\partial \phi_2)/N^* + (\partial d_2^*/\partial \phi_2)/N^* \right] > 0$$

$$\frac{\partial}{\partial K} \left[(\partial y_1^2/\partial \phi_2)/N - (\partial y_2^2/\partial \phi_2)/N - (\partial y_1^2{}^*/\partial \phi_2)/N^* + (\partial y_2^2{}^*/\partial \phi_2)/N^* \right] > 0$$

$$\frac{\partial}{\partial n_2} \left[(\partial y_1^2/\partial \phi_2)/N - (\partial y_2^2/\partial \phi_2)/N - (\partial y_1^2*/\partial \phi_2)/N* + (\partial y_2^2*/\partial \phi_2)/N* \right] > 0$$

$$\frac{\partial}{\partial K} \left(|\partial \hat{p}/\partial \phi_2| - |\partial \hat{p}*/\partial \phi_2| \right) > 0$$

$$\frac{\partial}{\partial n_2} \left(|\partial \hat{p}/\partial \phi_2| - |\partial \hat{p}*/\partial \phi_2| \right) > 0$$

$$\frac{\partial}{\partial K} \left[(\partial y_1^1/\partial \phi_2)/N - (\partial y_2^1/\partial \phi_2)/N - (\partial y_1^1*/\partial \phi_2)/N* + (\partial y_2^1*/\partial \phi_2)/N* \right] > 0$$

$$\frac{\partial}{\partial n_2} \left[(\partial y_1^1/\partial \phi_2)/N - (\partial y_2^1/\partial \phi_2)/N - (\partial y_1^1*/\partial \phi_2)/N* + (\partial y_2^1*/\partial \phi_2)/N* \right] > 0.$$

Therefore, the effect of each restriction (considered separately) is to make per capita bank liabilities, per capita output, and the price level less variable. Though the unit banking restriction makes bank deposits less variable, deposits become more variable with a prohibition on private note issue.

Some partial equilibrium intuition may clarify the forces that produce these results. Ignoring the dynamic effects from movements in the price level, think of the model in terms of credit supply and demand, where the competitively determined price is the interest rate r. In Figure 2, the credit demand curve, D_0, is determined by the number of investment projects which, if funded, will yield a return per lender of at least r. Credit supply is determined by the number of lenders who hold intermediary liabilities for each r. With perfectly diversified banks and no prohibition on bank note issue, an increase in the riskiness of investment projects shifts the demand curve to D_0', since fewer projects are now creditworthy for each r. As a result, r, the quantity of projects financed, and output (in the subsequent period) fall. With the imposition of a unit banking system, the credit demand curve becomes less elastic. That is, in the event of default by an entrepre-

neur, verification costs incurred by lenders are now γK rather than K, so that expected verification costs increase more rapidly as the quality of investment projects (θ) decreases. An increase in riskiness for all projects thus shifts D_1 to D_1', and the change in quantity and price is smaller than with perfect diversification.

Figure 3 shows the effect of a prohibition on private bank notes. The supply of credit becomes less elastic, and S_0 shifts to S_1, since agents who would otherwise be holding intermediated assets instead hold unproductive fiat currency. When risk increases for all projects, shifting D_0 to D_0', the quantity of credit falls less than it would have otherwise. Thus, credit, bank liabilities, and output are more volatile when bank note issue is permitted.

In the model, disturbances that make credit more volatile also tend to make prices more volatile since, with a fixed nominal stock of currency, the price level equates the supply of and the demand for fiat money. When bank note issue is permitted, bank deposits tend to be less volatile because the interest rate is less volatile and because price movements induce more substitution into fiat currency from deposits.

The fact that the unit banking restriction induces less volatility in aggregate activity is perhaps surprising. In the model U.S. unit banking economy, we observe countercyclical bank failures, and relaxing this restriction in the model makes bank failures a constant (that is, zero). Thus, intuition might tell us that aggregate volatility should be smaller in the economy with perfectly diversified banks. The model contradicts this intuition, and it also seems at odds with the views of Friedman and Schwartz (1963), Bernanke (1983), and Hamilton (1987). Friedman and Schwartz assign an important macroeconomic role to bank failures in the United States during the

Great Depression, a role they think operated through reductions in measured monetary aggregates. Bernanke and Hamilton argue that bank failures in the Great Depression had effects other than those reflected in monetary aggregates. However, note that both Bernanke (1983, pp. 266-267) and Friedman and Schwartz (1963, pp. 352-353) have difficulty reconciling their views with Canadian experience in the Great Depression. During this time, Canada and the United States experienced comparable declines in output, but no Canadian banks failed (Haubrich 1987).

3.4. Deposit Insurance

Government deposit insurance programs have played an important role in discussions of banking instability, for example, in Diamond and Dybvig (1983), and such a program can be introduced into the unit banking system as follows. Assume that the government is an agent that can supply effort to monitor entrepreneurs. The government guarantees all bank depositors a certain return in each period. If a bank fails, the government verifies the return on the bank's portfolio. Lump-sum taxes are levied, either on banks or on depositors, which are just sufficient to compensate depositors in failed banks and to compensate the government for effort expended in monitoring banks. This arrangement yields an equilibrium allocation identical to the one achieved with perfectly diversified banks.

Canadian and U.S. banking and monetary arrangements since World War II can be viewed as equivalent. In 1935, private bank note issue was prohibited in Canada, with the establishment of the Bank of Canada, and Canadian banks were, if anything, larger and more well-diversified after the war than before. The U.S. deposit insurance system can be seen as accomplishing a function similar to that of a well-diversified banking system; the only difference is that in the U.S. system monitoring is delegated partly to the

government rather than entirely to private financial intermediaries. The model constructed here, then, predicts that, other things held constant, aggregate fluctuations should have similar properties across the two countries in the postwar period.

4. The Evidence

4.1. Comparison of Canadian and U.S. Aggregate Data

Now let's examine annual aggregate data for Canada and the United States for the periods 1870-1913 and 1954-1987 and look for evidence consistent or inconsistent with the theory in section 3.

The aggregate data come from several sources. Urquhart (1986) constructed constant dollar Canadian GNP and implicit price deflator series for 1870-1913. Urquhart used a value-added method to assemble the GNP data, and the resulting series seems to be of considerably better quality than anything available for the United States for this period. For U.S. constant dollar GNP in 1870-1913, I use two alternative series, constructed by Romer (1989) and Balke and Gordon (1989) using similar regression methods, but different underlying data. These series seem to be the best existing measures of U.S. GNP for this period. The two series have similar low frequency properties, but their cyclical properties are different. For implicit price deflators for 1870-1913, I use a standard historical series from Balke and Gordon (1986) and an updated series from Balke and Gordon (1989). Data on chartered bank deposits and bank notes in circulation in Canada in 1870-1913 come from monthly statements by the chartered banks, published in the Canada Year Book (1915). U.S. commercial bank deposit data are from Friedman and Schwartz (1970). The U.S. banking data are also inferior to the Canadian data, since the U.S. series was constructed from national banks' infrequent call reports and from very poor state bank data. For 1954-1987, data come

from the CANSIM data base, the Federal Reserve Board data base, and the FDIC Annual Report (various issues).

All time series were subjected to a log transformation and were detrended using a Hodrick-Prescott filter (Prescott 1983), which essentially fits a smooth, time-varying trend to the data.[5] Multiplying the resulting series by 100 gives time series which are percentage deviations from trend. The theory yields predictions about unconditional variances and covariances of per capita aggregates in economies that do not grow. Thus, the data transformations account as well as seems possible for differences between the two countries in long-run growth, scale, and population.

Tables 3 and 4 show correlation matrices for percentage deviations from trend of the Canadian and U.S. data in 1870-1913. Table 5 shows cross-country correlations. Also see Figure 4. Tables 3 and 4 are generally consistent with the theory in that all but one of the series are mutually positively correlated in both countries. In addition, Table 5 shows a high degree of correlation between corresponding variables in the two countries. This is consistent with the assumption that real disturbances common to both countries dominate over this period.

Tables 6, 7, and 8 show correlations for the period 1954-1987 and correspond to Tables 3, 4, and 5. Also see Figure 5. Tables 6 and 7 indicate some inconsistencies with the model: In the Canadian data, there is essentially no correlation between GNP and the price level, and in the U.S. data, the GNP/price level and price level/bank deposit correlations are negative. Also, in Table 8, U.S. and Canadian bank deposits are negatively correlated. There thus appear to be important factors affecting aggregate fluctuations in Canada and the United States in the later period that are not captured in the model. Care is needed, therefore, in interpreting the 1954-1987 data and in comparing the later period with the earlier one.

Table 9 shows standard deviations of the transformed series for each time period, ratios of these volatility measures for Canada and the United States for each period, and volatility ratios for the two periods. Perhaps the strongest evidence supporting the predictions of the model is in the volatility measures for the GNP data from both periods. From column (1), Canadian GNP is considerably more volatile than U.S. GNP for the period 1870-1913. Volatility is 56 percent greater using Romer's GNP data, and 11 percent greater using Balke and Gordon's. For 1954-1987, GNP volatility is virtually identical in the two countries, as the theory predicts. See also Figures 4 and 5 for a visual representation.

In column (1) of Table 9, as is consistent with the model, Canadian prices are more volatile than U.S. prices for 1870-1913, by 9 percent using the standard U.S. GNP deflator and by 54 percent using Balke and Gordon's. However, in column (2) of Table 9, the Canadian GNP deflator is 21 percent more volatile than the U.S. GNP deflator in 1954-1987, which is inconsistent with the theory.

Returning again to column (1), note that in the early period Canadian bank deposits are less volatile than U.S. bank deposits (deflated using either the standard GNP deflator or Balke and Gordon's). This is not inconsistent with the theory since the prohibition of bank notes makes deposits more volatile in the model. Canada's bank note circulation is considerably more volatile than its bank deposits. But bank note and deposit liabilities in Canada are less volatile than bank deposits in the United States--by approximately 12 percent using the standard U.S. GNP deflator and by 21 percent using Balke and Gordon's deflator. In the 1870-1913 period, this is where the theory has the most trouble explaining the data. However, note that, in column (2), U.S. bank deposits are also more volatile than Canadian bank

deposits in the 1954-1987 period. Column (3) shows ratios for the two periods of the Canada/U.S. bank liability volatility ratios, that is, the relative volatility between the two periods. This relative volatility measure is higher for U.S. bank liabilities, approximately 2 percent using the standard GNP deflator or 12 percent using Balke and Gordon's deflator. Additionally, the theory could be reconciled with the data if the U.S. bank deposit data for 1870-1913 contained considerably more measurement error than the corresponding Canadian data. As noted earlier, this seems a good possibility.

4.2.   Industrial Composition of Canadian and U.S. Output for 1870-1913

A possible alternative explanation for the difference in the volatility of GNP in Canada and the United States in 1870-1913 is that production in Canada was more concentrated in industries which had high volatility. For example, one might suppose that a larger fraction of Canadian GNP consisted of production of primary commodities which would tend to be more cyclically sensitive than production in other industries. To see whether the empirical evidence supports this alternative hypothesis, let's examine comparable value-added data for selected U.S. and Canadian industries.

Gallman (1960) has constructed value-added measures for four U.S. industries, at five-year intervals, which overlap with our sample for the years 1874, 1879, ..., 1899. Urquhart (1986) provides comparable annual data for Canada. The four industries are agriculture, mining, manufacturing, and construction, and the value-added measures are in current dollars. For Canada, these four industries accounted for 60 percent of gross domestic product in 1889. Table 10 shows the percentage of value added in each of the four industries in Canada and the United States for the selected years. As anticipated, Canada had a larger portion of output in agriculture and a smaller portion in manufacturing than the United States did, and this dif-

ference persists through the sample. The portion of value added in mining was smaller in Canada than in the United States through most of the period, but Canada's portion was slightly larger than the United States' in 1894 and much larger in 1899. However, this 1899 number was temporarily enlarged by the Klondike gold rush (Urquhart 1986). The portion of value added in construction was consistently much smaller in Canada than in the United States.

Using the same detrending method as described above, I computed standard deviations of percentage deviations from trend for current dollar value-added measures for the four Canadian industries in 1870-1913. These statistics are displayed in Table 11. Surprisingly, volatility was lowest in agriculture, followed by manufacturing and mining, with the highest volatility in construction. Given the evidence from Table 10, the differences in the composition of output in Canada and the United States would tend to make Canadian output less volatile in the 1870-1913 period. As an additional check, a counterfactual nominal GNP series for Canada for 1870-1913 was constructed. This was done as follows. Let Y_t denote nominal GNP, y_{it} nominal value added in industry i, where i = 1, 2, 3, 4 for agriculture, mining, manufacturing, and construction, respectively. An asterisk (*) superscript denotes a U.S. variable. Then, counterfactual Canadian nominal GNP, $\hat{Y}_t$ (what Canadian GNP would have been if Canada had had the same relative composition of output as the United States in agriculture, mining, manufacturing, and construction), is computed as

$$\hat{Y}_t = Y_t - \sum_{i=1}^{4} y_{it} + \sum_{i=1}^{4} \alpha_{it} y_{it}.$$

The weights, α_i for i = 1, 2, 3, 4, were constructed as follows:

$$\alpha_{it} = (y_{is}^* / \sum_{i=1}^{4} y_{is}^*)/(y_{is} / \sum_{i=1}^{4} y_{is})$$

where s = 1874 for t = 1870, ..., 1876; s = 1879 for t = 1877, ..., 1881; s = 1884 for t = 1882, ..., 1886; s = 1889 for t = 1887, ..., 1891; s = 1894 for t = 1892, ..., 1896; and s = 1899 for t = 1897, ..., 1913. The standard deviation of percentage deviations from trend in Y_t is 7.53, and for $\hat{Y}_t$ it is 7.54. This evidence provides no support for the alternative hypothesis that historical cross-country differences in volatility can be explained by differences in the composition of output.

The relative industry volatilities in Table 11 would probably not be very different if the value-added measures were based on constant dollar data. (Urquhart 1986 uses an aggregate price index to deflate his aggregate current dollar GNP measures.) For example, if agricultural prices were more volatile than other prices, and if these prices were procyclical, as was true for aggregate price indices over this period, then agricultural output would tend to be relatively less volatile than in Table 11.

5. Summary and Conclusions

The aim of this paper was to adapt a macroeconomic model with an explicit financial intermediation structure to capture financial and monetary arrangements in the United States and Canada in the period 1870-1913, to analyze the model's implications for aggregate fluctuations in the two countries, and to see whether these implications appear to fit the facts. Over this period, Canada had a branch banking system, with few banks compared to the U.S. unit banking system. Canadian banks could issue circulating notes with no restrictions on their backing, while U.S. banks could not issue notes backed by private assets. Canada also experienced considerably less disruption due to bank failures than the United States did, and banking panics were virtually nonexistent in Canada.

The model predicts that, with a unit banking restriction, output, the price level, and bank liabilities become less volatile than they would be otherwise, because the restriction causes the demand for credit to become less elastic in the face of technological shocks affecting credit demand. This occurs despite the fact that bank failures and bank runs are countercyclical in the unit banking economy and the fact that there would be no such failures and runs in an economy where banks could diversify perfectly, as in a branch banking system in a large economy. The model also predicts that a prohibition on circulating bank notes reduces volatility in bank liabilities, output, and prices. Deposit insurance in the unit banking system is an equivalent arrangement to a perfectly diversified banking system, so that Canada and the United States should experience similar fluctuations after World War II, everything else held constant.

With regard to its qualitative predictions for comovements, the model is consistent with aggregate annual data for the 1870-1913 period for Canada and the United States. However, the model runs into some problems in 1954-1987: U.S. and Canadian prices are countercyclical rather than procyclical as the model predicts.

Relative volatilities in U.S. and Canadian GNP in the two periods are most supportive of the model. Depending on the U.S. GNP measure used, Canadian GNP is 56 percent or 11 percent more volatile than U.S. GNP in 1870-1913. Volatility is virtually equal in the two countries in 1954-1987. Also consistent with the model is the greater volatility in Canadian prices for 1870-1913. However, for 1870-1913, Canadian bank liabilities are less volatile than U.S. bank liabilities, in contrast to what the model predicts. This result is consistent with greater volatility in true Canadian bank liabilities coupled with greater measurement error in measured U.S. bank liabilities.

This possibility seems likely, since Canadian bank liabilities were measured with greater frequency and accuracy for the 1870-1913 period.

NOTES

1. In 1907, the constraint on note issue appears to have become binding during the crop-moving season. At that time, the federal government instituted a temporary rediscounting arrangement with the banks. It was made permanent with the passing of the Finance Act of 1914.

2. If reserves were held, one-third (40 percent after 1880) had to be held in the form of Dominion notes.

3. As Townsend (1988) shows, allowing for stochastic verification in more general setups yields an optimal arrangement which in general bears little resemblance to a simple debt contract. Restricting attention to non-stochastic monitoring in my context lends considerable tractability to the analysis. Bernanke and Gertler (1989), in a model with some similar features, show how some of their results remain intact with stochastic verification. This suggests that the operating characteristics of this model may not change if the restriction on verification were relaxed.

4. Formal arguments rely on the law of large numbers (Williamson 1986,1987b), though there are some subtleties here because of the continuum of agents.

5. Here I set λ, the parameter which governs the smoothness in the trend, to 400. An increase in λ makes the trend smoother. Prescott (1983) uses $\lambda = 1600$ for quarterly data.

APPENDIX A

Derivation of Variances and Covariances With Fluctuations

For the Canadian economy, totally differentiate (11)-(15) and solve to get

$$\partial d_1/\partial \phi_2 - \partial d_2/\partial \theta_2 = N\eta_3 f \eta_4 Kg\Sigma_\phi[(1-q_1+q_2)\eta_1 a+\eta_1 A+\eta_2(1-B)+\eta_3(1-F)]/\nabla \qquad (A1)$$

$$\partial n_1/\partial \phi_2 - \partial n_2/\partial \phi_2 = \eta_2 b(\partial d_1/\partial \phi_2 - \partial d_2/\partial \phi_2)/\eta_3 f \qquad (A2)$$

$$\partial \hat{p}/\partial \phi_2 = -(\eta_2 b+\eta_3 f)\eta_4 Kg\Sigma_\phi/\nabla \qquad (A3)$$

$$\partial y_1^1/\partial \phi_2 - \partial y_2^1/\partial \phi_2 = -N\eta_1 a(1-q_1+q_2)\partial \hat{p}/\partial \phi_2 \qquad (A4)$$

$$\partial y_1^2/\partial \phi_2 - \partial y_2^2/\partial \phi_2 = N\mu(\partial d_1/\partial \phi_2 - \partial d_2/\partial \phi_2 + \partial n_1/\partial \phi_2 - \partial n_2/\partial \phi_2) \qquad (A5)$$

$$\nabla \equiv \Sigma_\theta(\eta_2 b+\eta_3 f)[(1-q_1+q_2)\eta_1 a+\eta_1 A+\eta_2(1-B)+\eta_3(1-F)]$$

$$+ \eta_4 K^2 g[(1-q_1+q_2)(\eta_1 a+\eta_2 b+\eta_3 f)+\eta_1 A+\eta_2(1-B)+\eta_3(1-F)] > 0$$

$$\Sigma_\theta = -\int_0^{x'} D_2 H(\phi,\theta',\phi) \, dw - \gamma D_2 H(x',\theta',\phi) > 0$$

$$\Sigma_\phi \equiv \int_0^{x'} D_3 H(w,\theta',\phi) \, dw > 0$$

$$g \equiv g(\theta'), \quad a \equiv a(1), \quad b \equiv b(r-1), \quad f \equiv f(r-1),$$

$$A \equiv A(1), \quad B \equiv B(r-1), \quad F \equiv F(r-1).$$

Similarly, for the U.S. economy:

$$\partial d_1^*/\partial \phi_2 - \partial d_2^*/\partial \phi_2 = N^*\eta_3 f^*\eta_4 Kg^*\Sigma_\phi^*[(1-q_1+q_2)\eta_1 a^*+\eta_1 A+\eta_2+\eta_3(1-F)]/\nabla^* \qquad (A6)$$

$$\partial \hat{p}^*/\partial \phi_2 = -\eta_3 f^*\eta_4 Kg^*\Sigma_\phi^*/\nabla^* \qquad (A7)$$

$$\partial y_1^1*/\partial \phi_2 - \partial y_2^1*/\partial \phi_2 = -N^*\eta_1 a^*(1-q_1+q_2)\partial \hat{p}^*/\partial \phi_2 \qquad (A8)$$

$$\partial y_1^2*/\partial \phi_2 - \partial y_2^2*/\partial \phi_2 = N^*\mu[\partial d_1^*/\partial \phi_2 - \partial d_2^*/\partial \phi_2] \qquad (A9)$$

$$\nabla^* \equiv \Sigma_\phi^* \eta_3 f^* \left[(1-q_1+q_2)\eta_1 a^* + \eta_1 A^* + \eta_2 + \eta_3(1-F^*) \right]$$

$$+ \eta_4 K^2 g^* \left[(1-q_1+q_2)(\eta_1 a^* + \eta_3 f^*) + \eta_1 A^* + \eta_2 + \eta_3(1-F^*) \right] > 0$$

$$\Sigma_\theta^* \equiv - \int_0^{x'} D_2 H(w, \theta'^*, \phi) \, dw - \gamma K D_2 H(x'^*, \theta'^*, \phi) > 0$$

$$\Sigma_\phi^* \equiv \int_0^{x'^*} D_3 H(w_1, \theta'^*, \phi) \, dw > 0.$$

APPENDIX B

Comparison of Variances and Covariances Across Countries

Differentiating (A1)-(A9) with respect to γ and η_2 and evaluating at $\gamma = 0$, $\eta_2 = 0$ gives

$$\frac{\partial}{\partial K}\left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N - (\partial d_1^*/\partial \phi_2)/N^* + (\partial d_2^*/\partial \phi_2)/N^*\right]$$

$$= \eta_3 f \eta_4 K g \Sigma_\phi D_2 H(x',\theta',\phi)(1-K)\left[\eta_1 a(1-q_1+q_2)+\eta_1 A+\eta_3(1-F)\right]^2/v^2 > 0 \qquad (B1)$$

$$\frac{\partial}{\partial \eta_2}\left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N - (\partial d_1^*/\partial \phi_2)/N^* - (\partial d_2^*/\partial \phi_2)/N^*\right]$$

$$= -\eta_3 f \eta_4 K g \Sigma_\phi b\{[(1-q_1+q_2)\eta_1 a+\eta_1 A+\eta_3(1-F)]\Sigma_\theta+\eta_4 K^2 g(1-q_1+q_2)\}/v^2$$

$$< 0 \qquad (B2)$$

$$\frac{\partial}{\partial K}\left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N + (\partial n_1/\partial \phi_2)/N - (\partial n_2/\partial \phi_2)/N\right.$$

$$\left. -(\partial d_1^*/\partial \phi_2)/N^* + (\partial d_2^*/\partial \phi_2)/N^*\right]$$

$$= \eta_3 f \eta_4 K g \Sigma_\phi D_2 H(x',\theta',\phi)(1-K)\left[\eta_1 a(1-q_1+q_2)+\eta_1 A+\eta_3(1-F)\right]^2/v^2 > 0 \qquad (B3)$$

$$\frac{\partial}{\partial \eta_2}\left[(\partial d_1/\partial \phi_2)/N - (\partial d_2/\partial \phi_2)/N + (\partial n_1/\partial \phi_2)/N - (\partial n_2/\partial \phi_2)/N\right.$$

$$\left. -(\partial d_1^*/\partial \phi_2)/N^* + (\partial d_2^*/\partial \phi_2)/N^*\right]$$

$$= \eta_4 K^3 g^2 \Sigma_\phi b\eta_1 a(1-q_1+q_2)\left[\eta_1 a(1-q_1+q_2)+\eta_1 A+\eta_3(1-F)\right] > 0 \qquad (B4)$$

$$\frac{\partial}{\partial K}\left[(\partial y_1^2/\partial \phi_2)/N - (\partial y_2^2/\partial \phi_2)/N - (\partial y_1^{2*}/\partial \phi_2)/N^* + (\partial y_2^{2*}/\partial \phi_2)/N^*\right]$$

$$= \mu\eta_3 f \eta_4 K g \Sigma_\phi D_2 H(x',\theta',\phi)(1-K)\left[\eta_1 a(1-q_1+q_2)+\eta_1 A+\eta_3(1-F)\right]^2/v^2 > 0 \qquad (B5)$$

$$\frac{\partial}{\partial \eta_2} \left[(\partial y_1^2/\partial \phi_2)/N - (\partial y_2^2/\partial \phi_2)/N - (\partial y_1^2{}^*/\partial \phi_2)/N^* + (\partial y_2^2{}^*/\partial \phi_2)/N^* \right]$$

$$= \mu \eta_4^2 K^3 g^2 \Sigma_\phi b \eta_1 a (1-q_1+q_2) \left[\eta_1 a (1-q_1+q_2) + \eta_1 A + \eta_3 (1-F) \right] > 0 \tag{B6}$$

$$\frac{\partial}{\partial K} \left(|\partial \hat{p}/\partial \phi_2| - |\partial \hat{p}^*/\partial \phi_2| \right)$$

$$= \eta_4 K g \Sigma_\phi (\eta_3 f)^2 D_2 H(x',\theta',\phi)(1-K) \left[\eta_1 a (1-q_1+q_2) + \eta_1 A + \eta_3 (1-F) \right]/v^2 > 0 \tag{B7}$$

$$\frac{\partial}{\partial \eta_2} \left(|\partial \hat{p}/\partial \phi_2| - |\partial \hat{p}^*/\partial \phi_2| \right)$$

$$= \eta_4 K g \Sigma_\phi b \left[\eta_1 a (1-q_1+q_2) + \eta_1 A + \eta_3 (1-F) \right]/v^2 > 0 \tag{B8}$$

$$\frac{\partial}{\partial K} \left[(\partial y_1^1/\partial \phi_2)/N - (\partial y_2^1/\partial \phi_2)/N - (\partial y_1^1{}^*/\partial \phi_2)/N^* + (\partial y_2^1{}^*/\partial \phi_2)/N^* \right]$$

$$= \eta_1 a (1-q_1+q_2) \eta_4 K g \Sigma_\phi (\eta_3 f)^2 D_2 H(x',\theta',\phi)(1-K)$$

$$\times \left[\eta_1 a (1-q_1+q_2) + \eta_1 A + \eta_3 (1-F) \right]/v^2 > 0 \tag{B9}$$

$$\frac{\partial}{\partial \eta_2} \left[(\partial y_1^1/\partial \phi_2)/N - (\partial y_2^1/\partial \phi_2)/N - (\partial y_1^1{}^*/\partial \phi_2)/N^* + (\partial y_2^1{}^*/\partial \phi_2)/N^* \right]$$

$$= \eta_1 a (1-q_1+q_2) \eta_4 K g \Sigma_\phi b \left[\eta_1 a (1-q_1+q_2) + \eta_1 A + \eta_3 (1-F) \right]/v^2 > 0. \tag{B10}$$

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Table 1   THE 23 CHARTERED BANK LIQUIDATIONS
IN CANADA IN 1870-1913

Year of Suspension	Bank Liabilities at Suspension ($)	% of Face Value of Bank Liabilities Paid to	
		Noteholders	Depositors
1873	106,914	.00	.00
1876	293,379	100.00	100.00
1879	547,238	57.50	57.50
	136,480	100.00	96.35
	1,794,249	100.00	100.00
	340,500	100.00	100.00
1881	1,108,000	59.50	59.50
1883	2,868,884	100.00	66.38
1887	1,409,482	100.00	10.66
	74,364	100.00	100.00
	1,031,280	100.00	100.00
	2,631,378	100.00	99.66
1888	3,449,499	100.00	100.00
1893	1,341,251	100.00	100.00
1895	7,761,209	100.00	75.25
1899	1,766,841	100.00	17.50
1905	388,660	100.00	100.00
1906	15,272,271	100.00	100.00
1908	16,174,408	100.00	100.00
	560,781	100.00	30.27
	1,172,630	100.00	100.00
1910	549,830	100.00	100.00
	1,314,016	100.00	.00

Source: Beckhart (1929, pp. 480-81)

Table 2 BANK DEPOSITOR LOSSES
         AS A PERCENTAGE OF TOTAL DEPOSITS

Country	Year	Annual Percentage*
United States	1865-1890	.19%
	1881-1900	.12
	1901-1920	.04
	1865-1920	.11%
Canada**	1873	.03%
	1879	.15
	1881	.20
	1883	.69
	1887	.87
	1895	.89
	1899	.47
	1908	.04
	1910	.14
	1914	.05
	1867-1920	.07%

*For multi-year spans, average annual percentage.

**For years not included, the annual percentage was zero.

Sources: FDIC (1941), Beckhart (1929)

Tables 3-5 CORRELATIONS OF PERCENTAGE
DEVIATIONS FROM TREND
IN 1870-1913 DATA

Table 3 CANADIAN MATRIX

	(1)	(2)	(3)	(4)	(3)+(4)
	Gross National Product	Implicit Price Deflator	Bank Deposits (deflated)	Bank Notes (deflated)	Bank Liabilities (deflated)
(1)	1.000	.475	.433	.717	.588
(2)		1.000	-.026	.522	.182
(3)			1.000	.491	.941
(4)				1.000	.748
(3)+(4)					1.000

Table 4 U.S. MATRIX

	(1)	(2)	(3)	(4)
	GNP (Romer)	GNP (Balke & Gordon)	Implicit Price Deflator (standard)	Bank Deposits (deflated)
(1)	1.000	.691	.183	.217
(2)		1.000	.502	.523
(3)			1.000	.494
(4)				1.000

Table 5 CROSS-COUNTRY CORRELATIONS

Indicator	U.S./Canada Correlation
GNP With Romer's Data	.395
With Balke & Gordon's Data	.678
Implicit Price Deflator	.677
U.S. Bank Deposits/Canadian Bank Notes + Deposits (all deflated)	.518

Tables 6-8 CORRELATIONS OF PERCENTAGE
          DEVIATIONS FROM TREND
          IN 1954-1987 DATA

Table 6 CANADIAN MATRIX

	(1)	(2)	(3)
	GNP	Implicit Price Deflator	Bank Deposits (deflated)
(1) GNP	1.000	-.023	.320
(2) Implicit Price Deflator		1.000	.594
(3) Bank Deposits (deflated)			1.000

Table 7 U.S. MATRIX

	(1)	(2)	(3)
	GNP	Implicit Price Deflator	Bank Deposits (Deflated)
(1) GNP	1.000	-.528	.483
(2) Implicit Price Deflator		1.000	-.588
(3) Bank Deposits (deflated)			1.000

Table 8 CROSS-COUNTRY CORRELATIONS

Indicator	U.S./Canada Correlation
GNP	.607
Implicit Price Deflator	.935
Bank Deposits (deflated)	-.133

Table 9   VOLATILITY OF PERCENTAGE DEVIATIONS FROM TREND
IN TWO COUNTRIES AND TWO PERIODS

Country and Indicator	Standard Deviation		
	(1) 1870-1913	(2) 1954-1987	(1)÷(2)
Canada			
GNP	4.87	2.51	1.94
Implicit Price Deflator	3.84	4.42	.87
Bank Notes	9.22	--	--
Deposits	4.96	4.69	1.06
Liabilities (Notes + Deposits)	5.26	4.69	1.12
United States			
GNP (Romer)	3.13	2.57	1.22
(Balke & Gordon)	4.37	2.57	1.70
Implicit Price Deflator (standard)	3.53	3.66	.96
(Balke & Gordon)	2.49	3.66	.68
Bank Deposits (standard deflator)	5.96	5.20	1.15
(Balke & Gordon deflator)	6.64	5.20	1.28
Canada ÷ United States			
GNP (Romer)	1.56	.98	1.59
(Balke & Gordon)	1.11	.98	1.13
Implicit Price Deflator (standard)	1.09	1.21	.90
(Balke & Gordon)	1.54	1.21	1.27
Bank Liabilities (standard deflator)	.88	.90	.98
(Balke & Gordon deflator)	.79	.90	.88

Table 10 PERCENTAGE OF VALUE ADDED
IN FOUR CANADIAN AND U.S INDUSTRIES

(Based on current dollar data)

| | Industry and Country | | | | | | | |
| | Agriculture | | Mining | | Manufacturing | | Construction | |
Year	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.
1874	51.6	46.9	1.6	2.8	36.1	38.4	10.7	12.0
1879	59.1	49.0	2.0	2.9	32.4	37.0	6.5	11.1
1884	49.5	40.0	1.7	2.8	37.9	43.0	10.9	14.2
1889	46.8	35.1	2.7	3.6	41.5	47.4	9.0	13.9
1894	48.9	33.8	4.1	3.7	41.1	46.0	6.0	16.6
1899	44.9	33.3	8.2	4.6	40.2	49.5	6.8	12.6

Sources: Urquhart (1986), Gallman (1960)

Table 11 VOLATILITY OF PERCENTAGE
DEVIATIONS FROM TREND OF VALUE ADDED
IN FOUR CANADIAN INDUSTRIES,
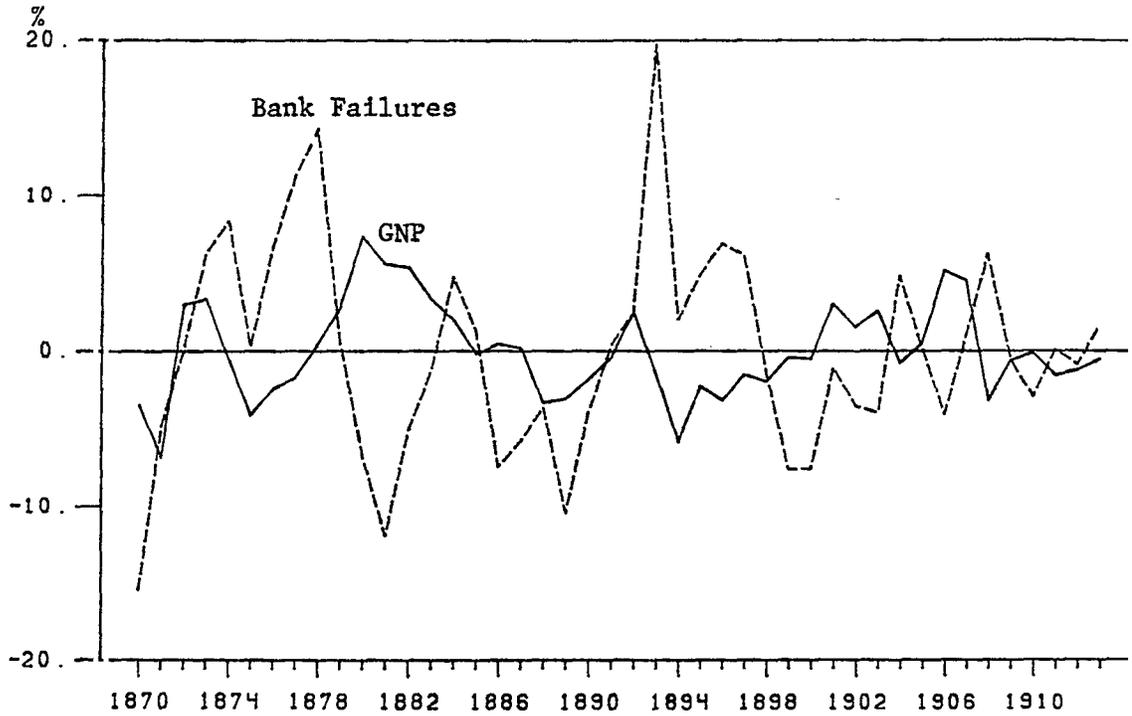1870-1913

(Based on current dollar data)

Industry	Standard Deviation
Agriculture	8.2
Mining	13.8
Manufacturing	11.7
Construction	18.4
Sum of Above Four Industries	9.0

Source of raw data: Urquhart (1986)

Figure 1 PERCENTAGE DEVIATIONS FROM TREND
OF U.S. OUTPUT AND BANK FAILURES IN 1870-1913*

*For bank failures, divided by 10.

Sources: U.S. Department of Commerce (1975),
Romer (1989)

Figures 2 and 3   THE EFFECTS OF TWO RESTRICTIONS
ON PROJECT RISK-INDUCED FLUCTUATIONS IN THE CREDIT MARKET
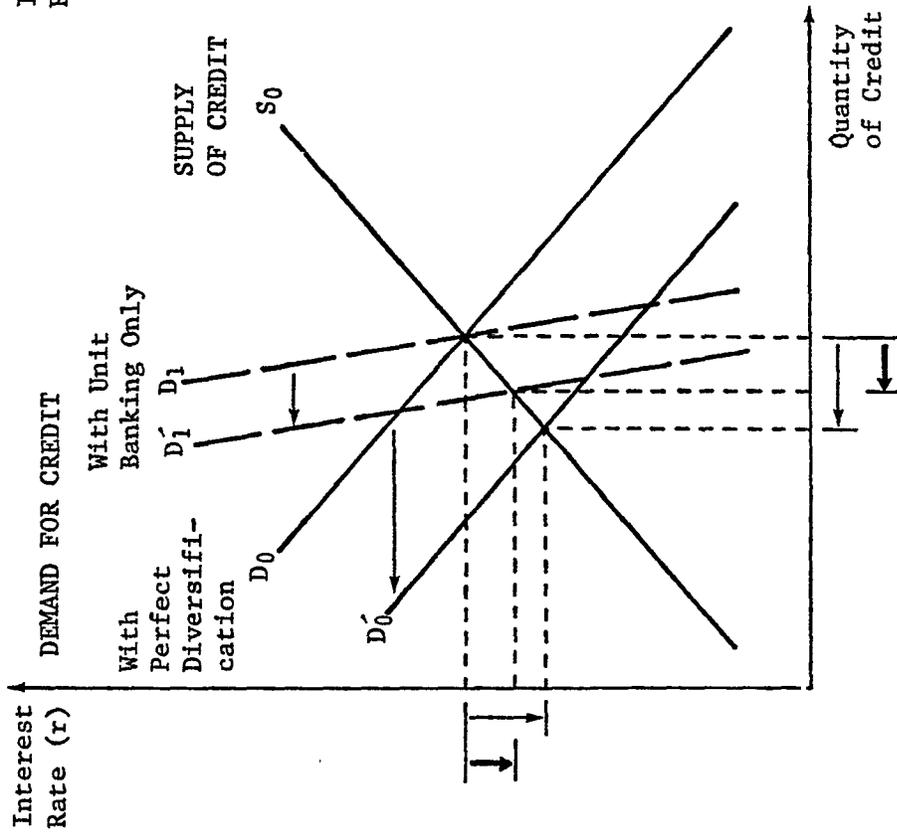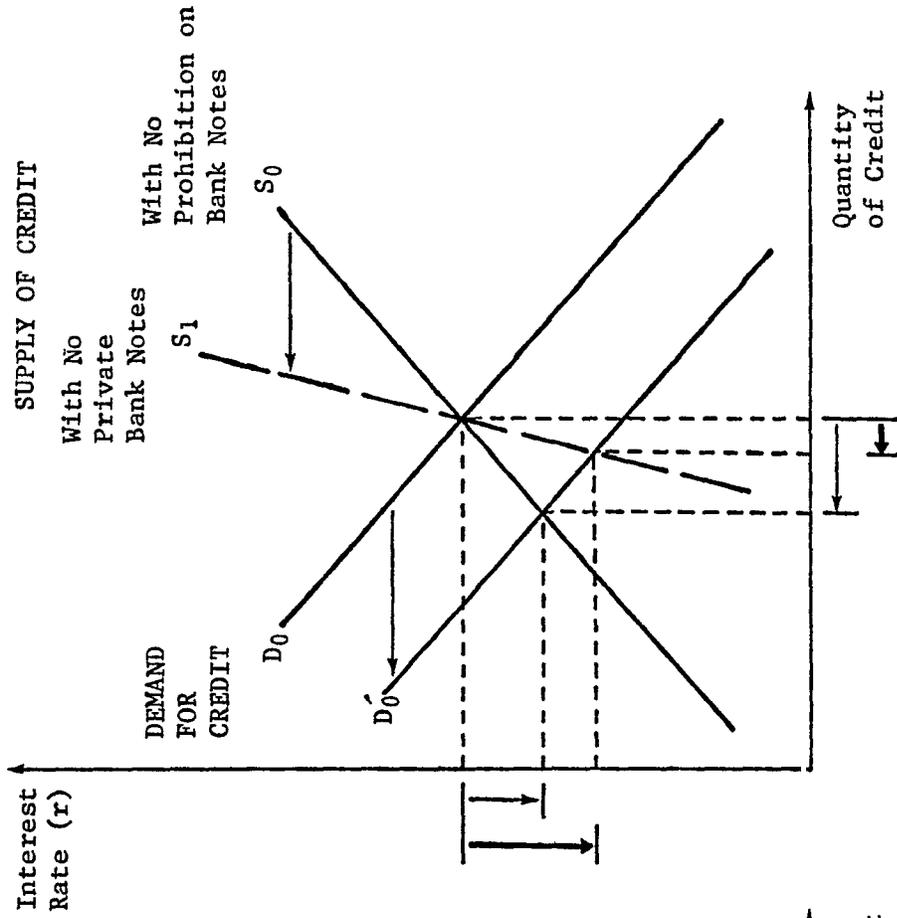
Figure 2   UNIT BANKING RESTRICTION

Figure 3   PROHIBITION ON PRIVATE BANK NOTES

Figures 4 and 5

PERCENTAGE DEVIATIONS FROM TREND
OF U.S. AND CANADIAN GNP

Figure 4   IN 1870-1913
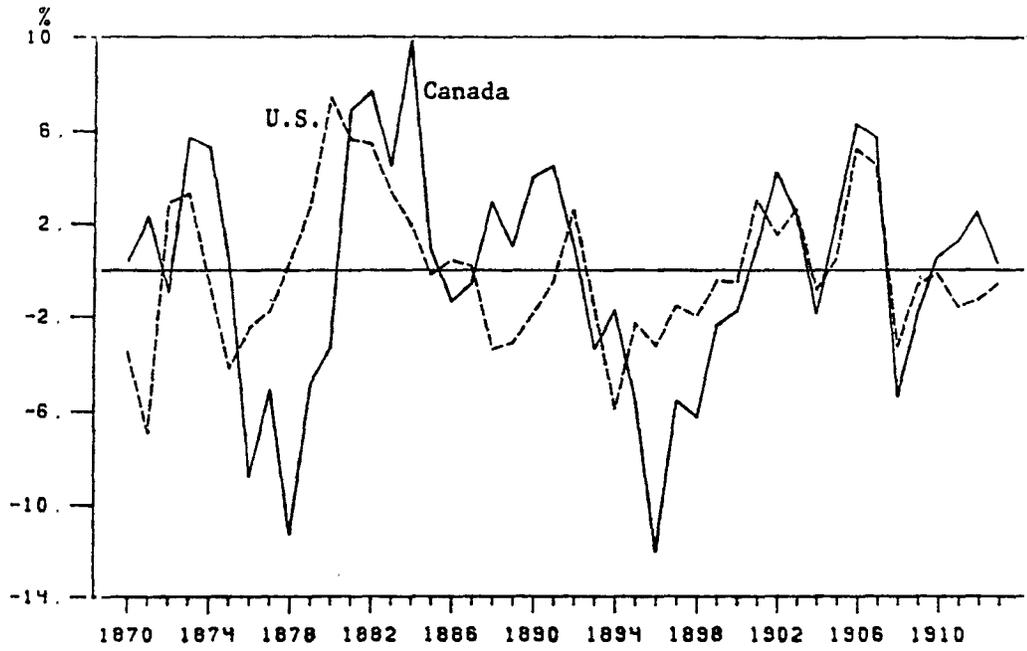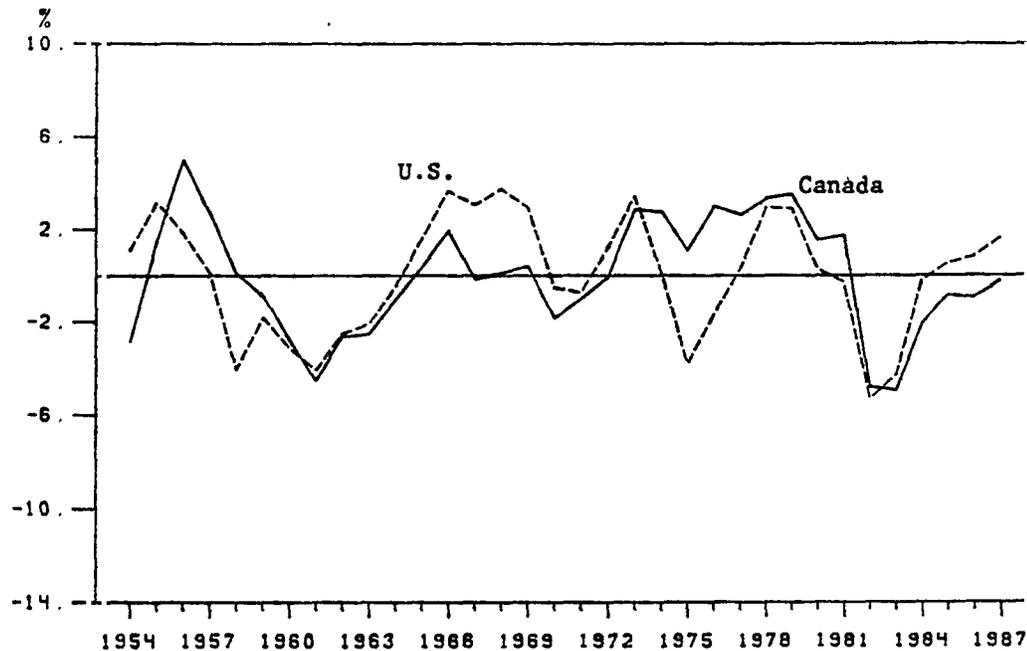

Figure 5   IN 1954-1987

Sources: Romer (1989), Urquhart (1986)
          Federal Reserve Board data base,
          CANSIM data base