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Bank Failures, Financial Restrictions, and Aggregate Fluctuations: Canada and the United States, 1870–1913*

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The belief that bank runs and failures contribute to instability in aggregate economic activity is both long-standing and widely held. Indeed, the Federal Reserve Act of 1913 and the Banking Act of 1933 and of 1935 were partly intended to correct what were thought to be inherent instabilities in the banking industry. Such legislation, it was hoped, would reduce or eliminate these inherent instabilities and thereby reduce the magnitude of fluctuations in all economic activity. This paper challenges the conventional wisdom about the historical causes of bank runs and failures and about the relationship between these runs and failures and aggregate activity. This challenge is based on a theoretical approach that explicitly models financial intermediation and monetary arrangements and on a comparative study of banking and aggregate fluctuations in the United States and Canada during the years 1870–1913.

In a previous *Quarterly Review* article (Williamson 1987b), I reviewed some recent developments in the theory of financial intermediation. 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 then analyzing how that environment generates financial intermediation. 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; possible 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, stemming from the work of Diamond and Dybvig (1983), focuses on deposit contracts, bank runs, and bank failures. In the Diamond and Dybvig model, the banking system has an inherent instability. Banks provide a form of insurance through the withdrawal provision in deposit contracts. But then banks are left 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

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(rather than banking in particular). It is also concerned 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 (1987c), Bernanke and Gertler (1989), and Greenwood and Williamson (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, thereby causing a decrease in the quantity of intermediation and in real output. Such a wealth redistribution might be associated with debt deflations. Williamson (1987c) 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 organize some historical experience and empirical evidence. Second, for those familiar with the intermediation literature, this paper shows how a model related to models of Williamson (1987c) and Greenwood and Williamson (1989) can be used to study bank runs and failures. 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 in two countries were strikingly different but when other factors affecting aggregate fluctuations were quite similar. Next, I construct a general equilibrium model with endogenous financial intermediation. The model can incorporate the financial arrangements of each 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 model fits the evidence.

The period I focus on is the 44-year span from 1870 to 1913, and the two countries are Canada and the United States. Over this period, Canada had a branch banking system with about 40 chartered banks. In contrast (in 1890), the United States had more than 8,000 banks, mostly 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 runs and failures. 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 Canadian banks acted to virtually preempt any widespread banking panics, so that disruption from financial crises was considerably smaller in Canada. In marked contrast, widespread bank runs and failures characterized U.S. history during the National Banking Era (1864–1913), as documented by Sprague (1910).

The model presented here captures the important features of Canadian and U.S. monetary and banking arrangements during 1870–1913. It is related to other models constructed by Williamson (1987c) and Greenwood and Williamson (1989) 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 here as a unit banking restriction, banks fail with positive probability. When they fail, banks experience something that can be interpreted as a bank run. In contrast, banks not subject to the unit banking restriction diversify perfectly and 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 unit banking restriction or a constraint that banks cannot issue circulating notes. The price level, bank liabilities, and output are mutually positively correlated. Two important results are

- Under the unit banking restriction, bank failures are high when output is low, but the unit banking restriction actually makes output less volatile.
- When private note issue is prohibited, output is less volatile.

These two results are consistent with the view that intermediation amplifies fluctuations: since both restrictions inhibit intermediation, 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 experience runs and fail with higher probability. In Diamond and Dybvig's model, bank runs and failures occur because of an inherent instability associated with the structure of deposit contracts, and runs can be prevented by suspending convertibility or providing deposit insurance. But the Diamond–Dybvig model cannot confront the Canadian/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 unprecedentedly large numbers. During the Depression, deposit contracts in Canada and the United States were similar, no Canadian banks suspended convertibility, and Canada had no deposit insurance. (For a study of Canadian banking in the 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.

To capture U.S. banking arrangements after World War II, I introduce a government deposit insurance program in the model. Here, monitoring is delegated to the government in a unit banking system. The government uses its power to tax to effect transfers from depositors in healthy banks to depositors in failed banks. Essentially, the government performs the same intermediation function in the unit banking economy as does a well-diversified private financial intermediary in the economy with no financial regulations. The deposit insurance system acts to eliminate bank runs and their associated costs in the unit banking economy, though it cannot eliminate bank failures (just as some individual firms fail in the economy with perfectly diversified banks). 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 match the model's predictions with the data, I examine detrended annual gross national product (GNP) and aggregate banking data for Canada and the United States during 1870–1913 and 1954–1987. For the 1870–1913 period, new GNP data have recently been constructed for Canada by Urquhart (1986) and for the United States by Romer (1989) and Balke and Gordon (1989). These new data make the study of this period of particularly current interest. The two U.S. GNP series have similar long-run properties but quite different cyclical properties, so including both gives some idea of how the results are sensitive to measurement problems.

Of the aggregate data I examine, the GNP data provide the strongest support for the theory. For 1870–1913, 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 some inconsistencies with the model appear regarding 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 difference in volatility reflects measurement error in the U.S. data.

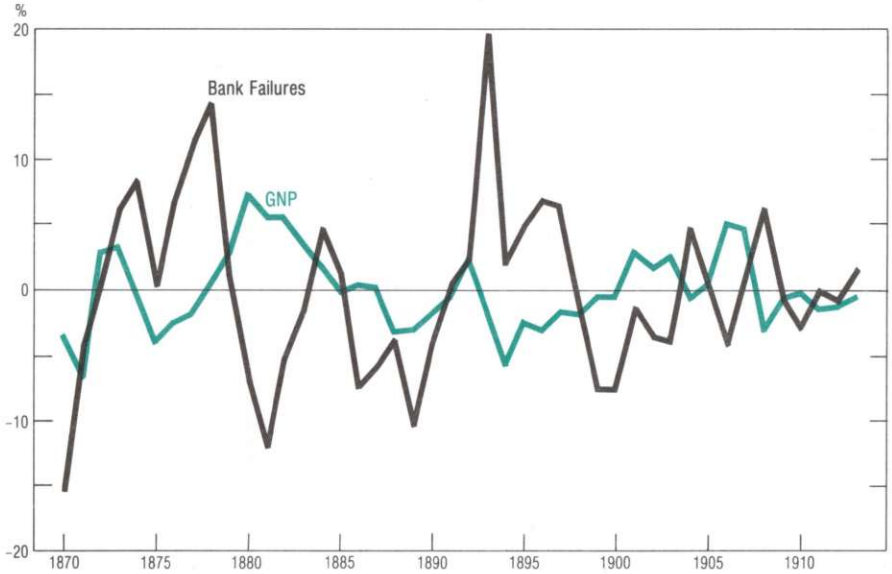
The paper is organized as follows. I begin by reviewing Canadian and U.S. monetary and banking arrangements in 1870–1913. Then I construct the model (a version of it for each country's economy) and describe its implications for aggregate fluctuations. Next I discuss the empirical evidence. Finally, I summarize how well the model fits that evidence and conclude with possible implications for policy.

Money and Banking in Canada and the United States, 1870-1913

During the 1870–1913 period, 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.

Chart 1

Percentage Deviations From Trend of U.S. Output and Bank Failures, 1870–1913*



*Computed using a Hodrick-Prescott filter (see Prescott 1983). For bank failures, the percentage deviations are divided by 10.
Sources of basic data: Romer 1989, U.S. Department of Commerce 1975

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). 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 was a limited issue of Dominion notes (federal government currency), backed 25 percent by gold and 75 percent by government securities, with additional issues backed 100 percent by gold. Legislation periodically increased the limit on the fractionally gold-backed component of government-issued currency.

There were no Canadian 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 bank assets in 1880. Most bank notes appear to have circulated at par, especially after 1890 legislation that required redemption of notes in certain cities throughout Canada.

In the same period, the United States had a unit banking system, as it still does today. There were few barriers to entry in the banking industry, but banks faced numerous restrictions, which tended to keep them small and limit diversification. In 1890, the United States had about 8,200 banks, including nearly 3,500 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, the U.S. banking system was subject to recurrences of widespread panic and bank failure, as is well known. Pervasive financial

[1]In 1907, this constraint on note issue appears to have become binding during the crop-moving season. At that time, the Canadian government instituted a temporary rediscounting arrangement with the banks. The arrangement was made permanent with 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.

crises occurred in 1873, 1884, 1890, 1893, and 1907 (Sprague 1910). Chart 1 plots percentage deviations from trend in GNP and in bank suspensions in the United States between 1870 and 1913. There is clearly negative comovement, with a correlation coefficient of −0.25, between the series. Friedman and Schwartz (1963) and Cagan (1965) also find that panic periods tend to be associated with declines in real output growth and with increases in the currency-to-deposit ratio.

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). Between 1923 and 1985, no Canadian banks failed; but from 1930 to 1933, more than 9,000 U.S. banks suspended operations. The record of bank failures in the two countries during 1870–1913, while showing less striking differences than in the Depression, also indicates that the incidence of bank failure was lower and the disruptive effects of bank failures were much smaller in Canada than in the United States.

Evidence supporting these observations appears in Table 1, which 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, however, clearly overstates the difference between Canadian and U.S. bank failure rates, since Canadian banks were larger than U.S. banks and since 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 20 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. These are provided in Table 2, which displays some data on bank depositors' losses in Canada and the United States. On average, in the years under study, losses to depositors were 0.07 percent of total deposits in Canada and 0.11 percent in the United States. By this measure, the disruption from bank failures appears to have been significantly smaller—57 percent smaller—in Canada than in the United States.

Table 1

Canada's 23 Chartered Bank Liquidations, 1870–1913

Year of Suspension	Bank Liabilities at Suspension (Can. $)	% 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
	1,997,041	100.00	.00

Source: Beckhart 1929 (pp. 480–81)

Further, Canadian chartered banks had cooperative arrangements that tended to lessen 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. 124–25) is illustrative:

> On the evening of October 12 [1906] the bankers in Toronto and Montreal heard with surprise that the Bank of

Table 2

Bank Depositor Losses as a Percentage of Total Deposits

Country and Year	Annual Percentage*
Canada**	
1873	.03%
1879	.15
1881	.20
1883	.69
1887	.87
1895	.89
1899	.47
1908	.04
1910	.14
1914	.05
1867–1920	.07%
United States	
1865–1880	.19%
1881–1900	.12
1901–1920	.04
1865–1920	.11%

*For multiyear spans, average annual losses as a percentage of deposits were computed first and then averaged.

**For years not included, the annual percentage of losses to deposits was zero.

Sources: Beckhart 1929, FDIC 1941

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). Although 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 Model

I now construct a model that captures the essential features of the banking and monetary structures of Canada and the United States during the 1870–1930 period.

I have already described two important differences between Canadian and U.S. banking and monetary arrangements at that time. 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 second 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 whereas U.S. bank notes could not (to the extent that breaking 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 of the Canadian and U.S. 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 of Williamson (1987c) and Greenwood and Williamson (1989) but differs from them somewhat to capture the problem at hand. The model abstracts from reserve requirements, interest-bearing government debt, and the operation of the gold standard monetary regime.

The Canadian Economy

□ Environment

The Canadian economy is modeled as a closed economy with 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

$$E_t(\delta l_t - e_t - e_{t+1} + c_{t+1})$$

where

E_t = the expectation operator conditional on period t information

δ = an individual-specific parameter denoting the value to a lender of consuming leisure

l_t = leisure

e_t = effort expended

c_t = 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 period t to an investment project that 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 in period t, the project yields a random return $\tilde{w}$ in period $t+1$, where $\Pr[\tilde{w} \leq w] = H(w, \theta, \phi_t)$; here, $H(\cdot, \cdot, \cdot)$ is differentiable in all its arguments and is twice differentiable in its first argument. Let $h(w, \theta, \phi) \equiv D_1H(w, \theta, \phi)$ 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 that 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) which is carried out in such a way that probability mass is shifted only for lower values of w. Specifically,

$$\int_0^{\bar{w}} D_3H(x, \theta, \phi)\, dx < 0 \qquad \text{for } 0 < w < \bar{w}$$

$$D_3H(x, \theta, \phi) = 0 \qquad \text{for } w > K$$

$$\int_0^{\bar{w}} xD_3h(x, \theta, \phi)\, dx = 0.$$

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. There is costly state verification (as in Townsend 1979, 1988). 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 in the hands of a group of old agents at $t = 1$. These agents supply fiat money inelastically to maximize consumption. Claims on period $t+1$ consumption exchanged for the period t consumption good can take one of two forms: *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 incurs a cost of α units of effort. No costs are 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 differing among lenders, it is simple to obtain well-defined demand functions for intermediary liabilities. These can be obtained without explicitly specifying 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, β can be interpreted as the cost of carrying out an exchange using a check-writing technology rather than fiat currency. Similarly, α can be interpreted as the cost in inconvenience associated with holding a large-denomination bank note as opposed to perfectly divisible fiat money. 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 $\alpha = \infty$. Within any generation, the fraction of agents 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 that 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

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

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

and $\eta_4 K < \eta_2 + \eta_3$. Therefore, in 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.

□ *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, 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 1987c and Greenwood and Williamson 1989) 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

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

or, integrating by parts,

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

The optimal contract between an intermediary and an entrepreneur is a *debt contract* (as in Gale and Hellwig 1985 and Williamson 1987a). That is, a fixed payment is promised; 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 for two reasons: First, incentive compatibility requires that the payment be noncontingent if verification does not occur. Second, since risk neutrality implies that risk sharing is not a factor here, 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 $\sigma(\theta, \phi_t)$ such that $\pi(x, \theta, \phi_t)$

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

reaches a maximum for $x = \sigma(\theta, \phi_t)$ with fixed θ and ϕ_t and $\sigma(\theta, \phi_t) \in (0, \bar{w})$. Entrepreneurs for whom $\pi(\sigma(\theta, \phi_t), \theta, \phi_t) \geq r_t K$ receive loans, while those with $\pi(\sigma(\theta, \phi_t), \theta, \phi_t) < r_t K$ do not. For the entrepreneurs receiving loans, the promised payment x_t satisfies

$$(3) \qquad \pi(x_t, \theta, \phi_t) = r_t K.$$

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 can 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 never need to monitor the intermediary.

This optimal arrangement captures some important features of financial intermediation arrangements observed in the real world. In the model, intermediaries diversify, transform assets, process information, and hold debt in their portfolios.

□ *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, $x_t' = \sigma(\theta_t', \phi_t)$. Then

$$(4) \qquad \pi(x_t', \theta_t', \phi_t) = r_t K$$

$$(5) \qquad D_1 \pi(x_t', \theta_t', \phi_t) = 0.$$

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

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

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

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, 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, 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

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

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

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

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

$$(10) \qquad E_t p_{t+1} = q_i p_1 + (1 - q_i) p_2$$

for $\phi_t = \phi_i$ and $i = 1, 2$. Let $s \equiv p_1/p_2$. Then from (8), (9), and (10) come

$$(11) \qquad \eta_1 A(q_1 + (1-q_1)/s) + \eta_2[1 - B(r_1 - q_1 - (1-q_1)/s)] + \eta_3[1 - F(r_1 - q_1 - (1-q_1)/s)] - s\{\eta_1 A(q_2 s + 1 - q_2) + \eta_2[1 - B(r_2 - q_2 s - 1 + q_2)] + \eta_3[1 - F(r_2 - q_2 s - 1 + q_2)]\} = 0$$

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

$$\eta_2 B(r_1 - q_1 - (1-q_1)/s) + \eta_3 F(r_1 - q_1 - (1-q_1)/s) = \eta_4 K[1 - G(\theta_1')] \tag{12}$$

$$\eta_2 B(r_2 - q_2 s - 1 + q_2) + \eta_3 F(r_2 - q_2 s - 1 + q_2) = \eta_4 K[1 - G(\theta_2')]. \tag{13}$$

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 s, r_i, θ_i', and x_i' for i=1, 2.

The U.S. Economy

Here I treat the U.S. economy as simply a larger-scale version of the Canadian economy. Note that in the model summarized by equations (11)–(15), the measure of the Canadian population N is irrelevant for determining equilibrium interest rates and prices. Let N^* denote the measure of the U.S. population, which is on the order of $10N$ for the 1870–1930 period.

Recall that at the time, there were two key differences between U.S. and Canadian monetary and banking arrangements:

- U.S. banks were mostly unit banks that could not diversify to the extent of their Canadian counterparts.
- Restrictions on private note issue in the United States implied that bank notes could not be backed by private assets.

An extreme version of the first (unit banking) restriction 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; instead, 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), then for the U.S. economy (14) and (15) become

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

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

for $i = 1, 2$.

The second 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. In contrast, Canadian residents had the option of holding large-denomination private circulating notes backed by private loans. Given the restriction on private note issue, instead of (11)–(13) the U.S. economy has

$$\eta_1 A(q_1 + (1-q_1)/s^*) + \eta_2 + \eta_3[1 - F(r_1^* - q_1 - (1-q_1)/s^*)] - s^*\{\eta_1 A(q_2 s^* + 1 - q_2) + \eta_2 + \eta_3[1 - F(r_2^* - q_2 s^* - 1 + q_2)]\} = 0 \tag{19}$$

$$\eta_3 F(r_1^* - q_1 - (1-q_1)/s^*) = \eta_4[1 - G(\theta_1'^*)] \tag{20}$$

$$\eta_3 F(r_2^* - q_2 s^* - 1 + q_2) = \eta_4[1 - G(\theta_2'^*)]. \tag{21}$$

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

For the U.S. economy, (16)–(21) determine s^* 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 $\Pr[w < x_t^*(\theta)]$. Here, $x_t^*(\theta)$ is the payment promised by the entrepreneur that satisfies

$$(22) \quad \pi^*(x_t^*(\theta), \theta, \phi_t) = r_t^* K.$$

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

$$(23) \quad \Psi_{t+1}^* = N^* \int_{\theta_t'^*}^{\bar{\theta}} H(x_t^*(\theta), \theta, \phi_t) g(\theta)\, d\theta.$$

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 each depositor of getting to the bank early to withdraw a 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 when banks are perfectly diversified, because then depositors would never need to verify the return on the bank's portfolio.

With this interpretation of bank runs and failures, 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 the U.S. and Canadian banking systems unexplained.

Model Implications

I now explore some of the model's implications for the interaction between financial structure and macroeconomic fluctuations.

For Aggregate Fluctuations

Having characterized an equilibrium in equations (11)–(15) for the Canadian economy and in (16)–(21) for the U.S. economy, I proceed to analyze aggregate fluctuations in the two economies. This analysis is carried out by determining the qualitative comovements among key aggregate variables in each economy and making quantitative comparisons across the two. (The methods used to do this are detailed in Williamson 1989.)

I use the following approach: For each economy, start with a benchmark equilibrium in which there are no fluctuations—that is, where there are no shocks ($\phi_t = \phi$ for all t) with $s=1$, $r_1 = r_2 = r$, and $\theta_1' = \theta_2' = \theta'$ in the Canadian economy, and similarly for the U.S. economy. Then, subject the two parallel economies to a small perturbation around the benchmark equilibrium. We now have $\phi_1 = \phi$ and $\phi_2 > \phi$, where $\phi_2 - \phi_1$ is small. The perturbations to the benchmark equilibrium are small, the economy can be only in one of two states, and the underlying disturbance (ϕ) evolves in an analytically convenient way (as a Markov process). As a result it is easy, using calculus, to derive algebraic formulas for the variances and covariances of key variables.

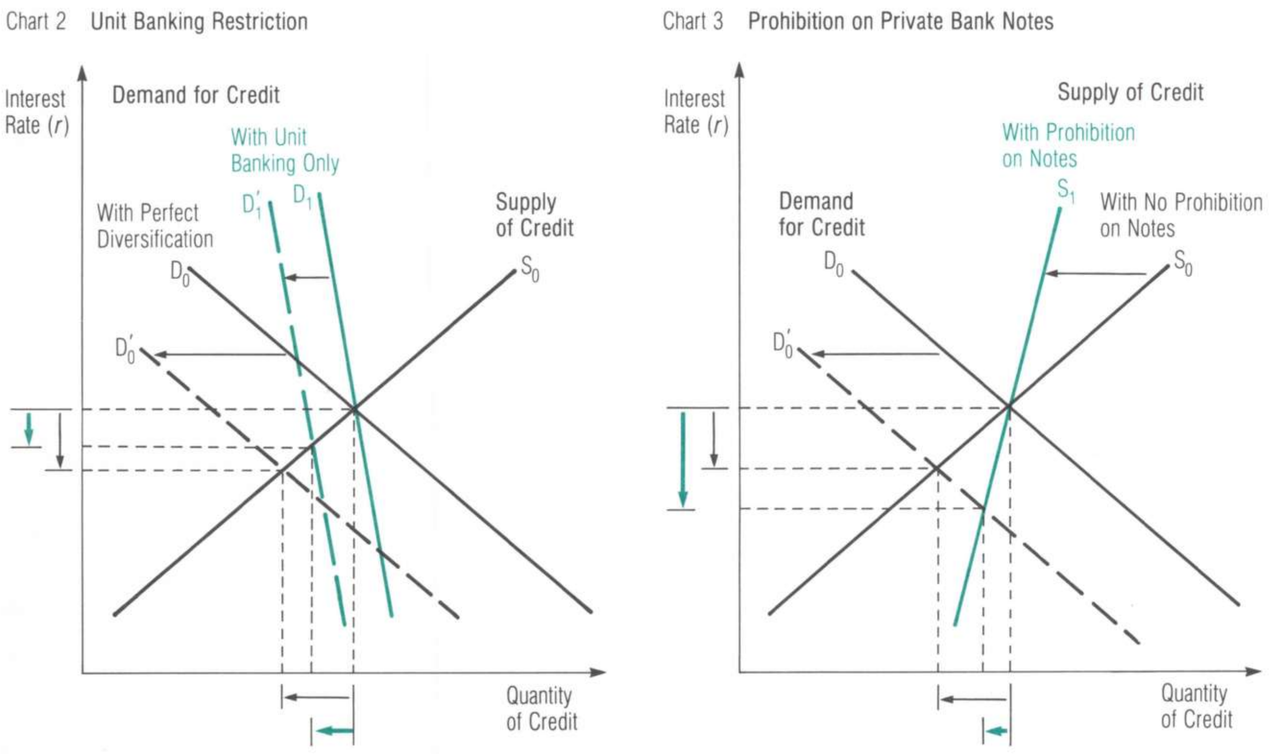
As shown rigorously in Williamson 1989, fluctuations in the two economies are qualitatively similar. In both countries, bank liabilities (bank notes plus deposits) and the price level (the inverse of the price of fiat money) are procyclical. That is, each of these variables and output are mutually positively correlated. 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 investment project returns 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 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 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 tends to be higher in state 1 than in state 2.

The perturbation has two effects on the volatility of U.S. bank failures. First, the number of failures tends to be larger in state 2 because entrepreneurs with the same characteristics (the same θ) and who receive loans in states 1 and 2 face a higher promised payment $x_t^*(\theta)$ in state 2 (the state where investment projects are riskier). In state 2, therefore, banks that fund projects of the same quality have a higher probability of failing than in state 1. 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, 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. (Again, the details appear in Williamson 1989.) The effect of the unit banking restriction and of the prohibition on private bank note issue (each considered separately) is to make

Charts 2 and 3

How Two Restrictions Affect Fluctuations Induced by Project Risk in the Credit Market



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 Chart 2, the credit demand curve D_0 is determined by the number of investment projects that, 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 branch banking 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 the interest rate, 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, if an entrepreneur defaults, the verification costs incurred by lenders are now γK rather than K, so 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 the interest rate and the quantity of projects financed is smaller than with perfect diversification.

The effect of a prohibition on private bank notes is shown in Chart 3. As the supply of credit becomes less elastic (S_0 shifts to S_1), agents who would otherwise hold 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 private 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 private bank note issue is permitted, 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, countercyclical bank failures are observed. Relaxing this restriction in the model makes bank failures a constant (that is, zero). Thus, intuition might suggest that aggregate volatility should be smaller in the model Canadian economy with perfectly diversified banks. But the model contradicts this intuition.

The model 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 Depression, a role they think operated through reductions in measured monetary aggregates. Bernanke and Hamilton argue that bank failures in the Depression had effects other than those reflected in monetary aggregates. However, note that both Bernanke (1983, pp. 266–67) and Friedman and Schwartz (1963, pp. 352–53) have difficulty reconciling their views with Canadian experience in the Depression. During this time, Canada and the United States experienced comparable declines in output, but no Canadian banks failed (Haubrich 1987).

With Deposit Insurance

Government deposit insurance programs have played an important role in discussions of banking instability—for example, in Diamond and Dybvig 1983. Such a program can be introduced into the model's unit banking system as follows. Assume 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. The taxes 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. With the establishment of the Bank of Canada in 1935, private bank note issue was prohibited in Canada, and Canadian banks were, if anything, larger and better 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.

The Empirical Evidence

Comparing Canadian and U.S. Data

I now examine annual aggregate data for Canada and the United States for the periods 1870–1913 and 1954–1987. I attempt to discover whether the evidence is consistent with the model and its implications.

The aggregate data come from several sources. For Canada from 1870–1913, Urquhart (1986) constructed series for constant dollar GNP and the implicit price deflator. He used a value-added method to assemble the GNP data, and the resulting series seems to be considerably better than the U.S. data available 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). They used similar regression methods but different underlying data. These series seem to be the best existing measures of U.S. GNP for this period. They 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). Data on U.S. commercial bank deposits are from Friedman and Schwartz (1970), but these are inferior to the Canadian data, since the U.S. series was constructed from national banks' infrequent call reports and from scant 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 years).

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 that are percentage deviations from trend. The model 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 matrixes for percentage deviations from trend of the Canadian and U.S. data in 1870–1913. Table 5 shows cross-country correlations. Also see Chart 4. Tables 3 and 4 are generally consistent with the model, 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 Chart 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 model's predictions 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

[5]Here I set λ, the parameter that governs the smoothness in the trend, to 400. An increase in λ makes the trend smoother. Prescott (1983) uses $\lambda = 1{,}600$ for quarterly data.

Tables 3–5

Correlations of Percentage Deviations From Trend in 1870–1913 Data

Table 3 **Canadian Matrix**

	(1) Gross National Product	(2) Implicit Price Deflator	(3) Bank Deposits (deflated)	(4) Bank Notes (deflated)	(3)+(4) 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) GNP (Romer's Data)	(2) GNP (Balke & Gordon's Data)	(3) Implicit Price Deflator (standard)	(4) 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**

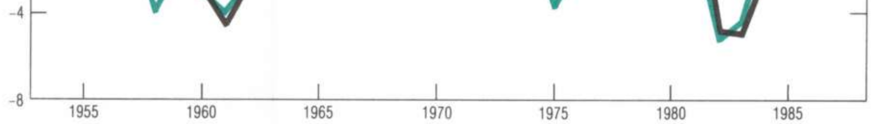
Indicator	U.S./Canada Correlation
GNP	
With Romer's Data	.395
With Balke & Gordon's Data	.678
Implicit Price Deflator	.677
U.S. Bank Deposits/Canadian Bank Notes + Deposits (all deflated)	.518

Charts 4 and 5

Percentage Deviations From Trend of U.S. and Canadian Output (GNP)

Chart 4 In 1870–1913

Chart 5 In 1954–1987



Sources of basic data: Urquhart 1986, Romer 1989, CANSIM data base, Federal Reserve Board data base

Tables 6–8

Correlations of Percentage Deviations From Trend in 1954 –1987 Data

Table 6 Canadian Matrix

	(1) GNP	(2) Implicit Price Deflator	(3) 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) GNP	(2) Implicit Price Deflator	(3) 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./Canadian Correlation
GNP	.607
Implicit Price Deflator	.935
Bank Deposits (deflated)	–.133

model predicts. See also Charts 4 and 5 for a visual representation.

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

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 implicit price deflator or Balke and Gordon's). This is not inconsistent with the model, since the prohibition on bank notes makes deposits more volatile. 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. deflator and by 21 percent using Balke and Gordon's deflator. In the 1870–1913 period, this is where the model 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, by approximately 2 percent using the standard deflator or 12 percent using Balke and Gordon's deflator. Additionally, the model could be reconciled with the data if the U.S. bank deposit data for 1870–1913 contained much more measurement error than the corresponding Canadian data. As noted earlier, this possibility seems likely.

Comparing the Industrial Composition of Canadian and U.S. Output

Another possible explanation for the differences in the volatility of Canadian and U.S. GNP in 1870–1913 is that Canadian production was more concentrated in industries with high volatility. For example, it might be the case that a larger share of Canadian GNP consisted of production of primary commodities. Production of these commodities would tend to be more cyclically sensitive than production in other industries. To see whether the empirical evidence supports this alternative hypothesis, I 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 overlapping the 1870–1913 period 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

Table 9

Volatility of Percentage Deviations From Trend in Two Countries and Two Periods

Country and Indicator	Standard Deviation (1) 1870–1913	Standard Deviation (2) 1954–1987	(1)÷(2)
Canada			
Gross National Product	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			
Gross National Product			
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			
Gross National Product			
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

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 did the United States, and this difference persists through the sample period. 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.

Again using the Hodrick–Prescott detrending procedure, I computed standard deviations of percentage deviations from trend for current Canadian dollar value-added measures for the four Canadian industries

Table 10

Percentage of Value Added in Four Canadian and U.S. Industries

Based on Current Canadian and U.S. 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 Canadian Dollar Data

Industry	Standard Deviation
Agriculture	8.2
Mining	13.8
Manufacturing	11.7
Construction	18.4
All Four Industries	9.0

Source of basic data: Urquhart 1986

in 1870–1913. These statistics are displayed in Table 11. Surprisingly, volatility was lowest in agriculture, followed by manufacturing and mining; the highest volatility was 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 of the alternative hypothesis, I constructed a counterfactual nominal GNP series for Canada for 1870–1913. This was done as follows. Let Y_t denote nominal GNP and y_{it} denote nominal value added in industry i, where $i = 1, 2, 3, 4$ for agriculture, mining, manufacturing, and construction, respectively. Again, an asterisk (*) superscript denotes a U.S. variable. Then, counterfactual Canadian nominal GNP (what Canadian GNP would have been with the same relative composition of output as the United States in agriculture, mining, manufacturing, and construction), denoted Y_t^c, is computed as

$$Y_t^c = Y_t - \sum_{i=1}^{4} y_{it} + \sum_{i=1}^{4} \psi_{it} y_{it}.$$

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

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

where $s = 1874$ for $t = 1870, \ldots, 1876$; $s = 1879$ for $t = 1877, \ldots, 1881$; $s = 1884$ for $t = 1882, \ldots, 1886$; $s = 1889$ for $t = 1887, \ldots, 1891$; $s = 1894$ for $t = 1892, \ldots, 1896$; and $s = 1899$ for $t = 1897, \ldots, 1913$. The standard deviation of percentage deviations from trend in Y_t is 7.53 and in Y_t^c 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 indexes over this period, then agricultural output would tend to be relatively less volatile than in Table 11.

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 Canada and the United States 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 Canadian banking panics were virtually nonexistent.

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 runs and failures are countercyclical in the unit banking economy and the fact that there would be no such runs and failures 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 output, prices, and bank liabilities. 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 Canadian and U.S. GNP in the two periods are the most supportive of the model. Canadian GNP is 56 percent or 11 percent more volatile than U.S. GNP in 1870–1913, depending on the U.S. GNP measure used. 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 that period, 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 Canadian bank liabilities coupled with greater measurement error in U.S. bank liabilities. This possibility seems likely, since Canadian bank liabilities were measured with greater frequency and accuracy for the 1870–1913 period.

What message does this paper have with regard to policy? The model tells us that instability in the banking system has less to do with inherent features of banking contracts and more to do with the way the banking system is regulated. Also, somewhat paradoxically, the elimination of some regulations may make banking more stable while causing more volatility in aggregate economic activity. Though the swings in aggregate activity are wider without these regulations, that does not mean that economic welfare is lower. In the model, some agents are better off and some are worse off in the unregulated economy than in the regulated economy while, in a sense, the economy as a whole is better off in the unregulated case (the allocation is Pareto optimal).

Does this mean that the United States would have been better off if government deposit insurance had not been introduced in the 1930s and impediments to branch banking had been eliminated instead? Would it be advisable to drop these impediments today and possibly eliminate deposit insurance? In the context of the model constructed in the paper, the answer to both questions is yes. However, the model does not capture some of the detrimental effects from having a banking industry with a small number of large firms—that is, the well-known efficiency losses from monopoly power. Thus, the optimal design of a banking system involves a careful assessment of the relative costs of bank failures, collusion in the banking industry (implicit or explicit), and the costs of regulatory programs such as deposit insurance. Note also that recent developments in the financial industry, such as securitization (the holding of securities—for example, mortgage loans—by institutions in which the securities do not originate), make regulations inhibiting branch banking less important in the United States. However, to the extent that securitization allows greater diversification by banks, it weakens the case for government-provided deposit insurance.

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