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FINANCIAL FRAGILITY AND THE GREAT DEPRESSION

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ABSTRACT

We analyze a financial collapse, such as the one which occurred during the Great Depression, from the perspective of a monetary model with multiple equilibria. The economy we consider contains financial fragility due to increasing returns to scale in the intermediation process. Intermediaries provide the link between savers and firms who require working capital for production. Fluctuations in the intermediation process are driven by variations in the confidence agents place in the financial system. Our model matches quite closely the qualitative movements in some financial and real variables (the currency/deposit ratio, ex-post real interest rates, the level of intermediated activity, deflation, employment and production) during the Great Depression period.

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"Financial Fragility and the Great Depression"

I. Introduction

Any study of the U.S. Great Depression must confront the collapse of both financial and real flows. The basic facts of this episode are well documented. Bernanke [1983] and Friedman and Schwartz [1963] provide a vivid description of the financial collapse during the 1930-33 period, including: the rise in the currency/deposit ratio from 0.086 in October 1929 to 0.227 in March 1933, the 29% fall in velocity from 1929 to 1933, the increased ex post real interest rate on short term government bonds from 7.4% in 1929 to 11.3 % in 1930 and 1931 and the substantial reduction in bank loans over the period. Further, there was widespread fear of bank runs throughout the 1929 to 1933 period, with actual runs occuring sporadically between October 1930 and March 1933. Coupled with the financial collapse, real output fell by approximately 36% from a peak in 1929 to a trough in 1933, the unemployment rate reached 25%, wholesale prices fell by nearly 40%, and both consumption and investment flows collapsed over the period.

This paper presents a framework in which fluctuations in economic activity reflect the confidence agents place in the productivity of financial intermediaries. Our focus on confidence partly reflects its apparent role in observed bank runs as well as the lack of a readily identifiable real cause for the Great Depression. The theme that confidence is an important element in the study of the Great Depression is not novel: Kindleberger [1996] discusses the relevance of confidence in a number of similar episodes in the U.S. and other countries. Critics of this view often point to the lack of a specific model in which confidence plays such a key role. The contribution of this paper is to propose and analyze such a model.

Our approach rests upon the the presence of strategic complementarity in the intermediation process so that endogenous variations in consumer beliefs about the extent of participation at intermediaries are self-fullfiling.[1] Throughout this paper, we use the term "financial fragility" to capture the dependence of the intermediation process on the beliefs of agents.[2] In these sunspot equilibria, fluctuations in confidence lead to variations in the efficiency of the intermediation process and ultimately large movements in output and employment. Further, there are substantial movements in households' portfolios not unlike those observed during the Great Depression period. Finally, the underlying regime shift structure of the sunspot equilibrium is supported by the nonlinearities highlighed in the empirical work of Coe [1995], who utilizes the techniques of Hamilton [1989] and argues that the financial flows during the interwar period are best described through a three state Markov process.

The model has two key components. First, intermediaries provide the link between entrepreneurs, who must borrow to finance working capital but have private information about their production opportunities, and depositors. A breakdown in the intermediation process will choke off production and can account for the collapse in output.

Following Bernanke [1983], the period of the Great Depression is viewed as arising from an increase in the costs of intermediation. In fact, Bernanke [1983, pg. 264] argues:

> "However, the rapid switch away from the banks (given the banks' accumulated expertise, information, and customer relationships) no doubt impaired financial efficiency and raised the CCI [cost of credit intermediation]."

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[1]This paper thus builds upon the earlier analyzes of Bryant [1987], Diamond and Dybvig [1983] and Weil [1989] which couple strategic complementarity and intermediation.

[2] Thus ours is a different definition of financial fragility than that used in Bernanke and Gertler [1990] who focus on the interaction between the design of incentive compatible contracts and the wealth level of borrowers.

As in Cooper and Ejarque [1995], the breakdown of the intermediation process arises from the strategic interaction of agents rather than from exogenous sources. Thus the first component of the analysis highlights the loss of confidence agents place in the productivity of financial intermediaries which represents the limited financial market participation, through reduced deposit inflows and bank runs, that occurred during this period.

The second element of the model generates a demand for money and bank loans in a general equilibrium setting due to fixed costs of intermediated activity as in Chatterjee and Corbae [1992]. In equilibrium, some savers choose to hold money while others (those with large savings) incur a fixed cost to obtain higher returns from intermediated loans. Their model highlights the store of value function of money, which is important for understanding the large movements in velocity and asset substitution that occurred during the Great Depression. In our model, the (per capita) fixed cost of intermediated activity rises endogenously during a financial collapse and generates movements in velocity and the deposit/currency ratio like those observed in the data.

The two components of strategic uncertainty and the fixed cost of intermediated activity are, in fact, directly linked in our model. The intermediation technology that we specify exhibits returns to scale due to the fixed costs of project evaluation and monitoring. These fixed costs are ultimately reflected in the costs agents bear when they save through intermediaries. Thus, our model augments the Chatterjee and Corbae formulation by providing a basis for the fixed cost from an increasing returns to scale intermediation technology.

Overall, our framework highlights the loss of confidence in the intermediation process as the source of the Great Depression. During a financial crisis, the demand for nominal money balances rises and the supply of loans to intermediaries falls. This portfolio effect reflects the increased cost of intermediated activities. As a consequence, the real interest rate will rise and the price level will fall to equilibrate the markets for loans and money. These effects are consistent with the observations over this period as is the resulting rise in the currency/deposit ratio.

The financial crisis has effects on output and employment as well. In particular, firms must finance the purchase of inputs (labor) with bank loans in our economy; intermediaries provide working capital to firms.[3] The financial crisis ultimately causes a shift back in labor demand and consequently a drop in employment, production, *and* consumption.[4]

While there is deflation in our model, it is the endogenous result of the intermediation breakdown. In contrast, Bernanke [1983] and Bernanke and Gertler [1989,1990] provide a propagation mechanism through the balance sheet effects of deflation, as suggested by Fisher [1933]. Thus deflation acts as an exogenous *source* of the increased cost of intermediation. It is interesting to note that while Fisher proposed a "logical" order for his debt-deflation theory of the Great Depression, his chronological order (p.343) begins with "Mild Gloom and Shock to Confidence."

Our model is illustrated by numerical examples of sunspot equilibria. Here, the sunspot variable proxies for the level of confidence agents have in the productivity of the intermediation process. The model's quantitative implications can account for the movements, though not necessarily magnitudes, in financial and real variables (the currency/deposit ratio, ex-post real interest rates, the level of intermediated activity, deflation, employment and production) during the Great Depression. We emphasize, however, that the numerical exercise is meant only to be

[3] Christiano and Eichenbaum [1992] also study the effects of financial shocks on firm's working capital though confidence plays no role in their analysis.

[4] This is in contrast to the negative comovement between consumption and employment found in Cooper and Ejarque [1995].

illustrative of our simple dynamic model and is not a calibration exercise.

II. Environment

The model economy closely follows Chatterjee and Corbae in the construction of a monetary equilibrium with borrowing and lending. However, we add endogenous labor supply and production decisions to that environment. Further, the financial flows in our model provide firms with the working capital necessary to finance production activities. A technology, which allows a coalition of agents to evaluate loan activity at a cost, is also included. Variations in the cost of intermediation which arise out of strategic complementarities, as in Cooper and Ejarque, produce financial fragility.

There is a continuum of two-period lived agents born each period t=0,1,2,... on a large number of spatially distinct locations or islands. As in Bernanke and Gertler [1989], who also use a two-period OLG framework, this allows us to abstract from complicated dynamics and should be thought of as representing the entry and exit of firms from credit markets rather than as literal generations. As each island is identical, we describe the environment on one of them. The islands generate a competitive banking environment by providing outside options for a subset of the agents in our model.[5]

There are two types of agents on each island: workers and entrepreneurs. We first describe each of these types and then discuss their interactions.

II.a. Workers

One subset of agents is endowed with leisure time in youth and no time in old age. These

[5] Island specific intermediaries are consistent with the pattern of banking created by the regulatory restrictions on branch banking in the U.S.

agents are termed "workers". Workers are also endowed with a heterogeneous amount (α) of the consumption good in youth. The distribution of endowments across the population is given by $H(\alpha)$. The heterogeneity in endowments generates variation in the desire to save across households. To save on notation we associate an agent type's name with α.

Workers have preferences over consumption in both periods of life and leisure time in youth. The preferences of worker α in generation t over consumption ($c^t_{t,\alpha}$, $c^t_{t+1,\alpha}$) and work ($n_{t,\alpha}$) on a representative island are given by:

$$u(c^t_{t,\alpha}, n_{t,\alpha}) + \beta v(c^t_{t+1,\alpha})$$

where $u(\cdot)$ is strictly increasing in its first argument, strictly decreasing in its second argument and quasi-concave, $v(\cdot)$ is strictly increasing and concave, and $\beta \in (0,1]$ is the discount rate.

Workers cannot leave their island of birth. As discussed below, this assumption limits the formation of a single intermediary in the economy.

II.b. Entrepreneurs

The other subset of agents, termed "entrepreneurs", are endowed with leisure time in youth and consume real profits in the second period of life. Their lifetime utility is the sum of leisure in youth and real profits in old age. Entrepreneurs have access to an agent specific, stochastic technology that produces output in period t+1 from period t inputs of hired labor and entrepreneurial time.

Given this production lag, entrepreneurs borrow funds to pay for labor services. Entrepreneurs can travel between islands to obtain funding for their projects but cannot transfer their own productive technology off their island.

Production requires a fixed managerial input by entrepreneurs. We assume that there are varying degrees of mangerial efficiency so less efficient entrepreneurs bear a higher time cost of operating the firm. The time cost (i.e. a disutility from work suffered in youth) for operating the firm for entrepreneur k is denoted by k and is private information. Let F(k) denoted the distribution of k across the population of entrepreneurs. While the heterogeneity generates variation in an entrepreneur's decision of whether to produce, those entrepreneurs who undertake production demand identical amounts of hired labor.

With probability π, net output from entrepreneur k's productive activity ($y_{t+1,k}$) is given by:

$$y_{t+1,k}=f(n_{t,k})$$

where $n_{t,k}$ is the level of labor input, the function $f(\cdot)$ is strictly increasing and concave. With probability $(1-\pi)$, the labor employed in period t is unproductive and the entrepreneur's output is zero. In this case, the firm cannot repay the loan. Throughout the analysis, we assume that realizations of the stochastic technology are independent across entrepreneurs and are also their private information. As formalized below, entrepreneurs operate their technology iff the expected returns to production exceed labor costs plus the time cost to the entrepreneur.

II.c Intermediation Technology

The final element in the environment is a technology which evaluates loans ex ante and monitors them ex post. Loan applications must be screened ex ante to ensure that entrepreneurs have sufficiently low fixed costs to rationalize the ex ante investment. Otherwise, those entrepreneurs with relatively high values of k (i.e. those with positive profits in the absence of loan repayment) would borrow and then claim ex post that their investment activity did not succeed. Further, ex post monitoring is necessary to again insure that entrepreneurs do not claim investment failures as a way to avoid obligations to the intermediary.[6]

Intermediation is a costly activity as resources must be devoted to evaluation and monitoring of loans. We assume there are increasing returns to these activities. Evaluation of one loan application will create information that will be useful in the evaluation of other loans in similar activities. Further, the monitoring of the outcome of one project may reduce the costs of monitoring other projects. In this sense, there may be important informational spillovers in the intermediation process. Finally, evaluation costs may themselves be largely independent of the size of a particular loan. Hughes and Mester [1997] provide evidence that banks of all sizes exhibit significant scale economies.[7]

Put differently, intermediaries accumulate stocks of knowledge from current and past activity that underlies their returns to scale. As suggested by our quote from Bernanke [1983], it is precisely this stock of capital that depreciated so rapidly during the Great Depression.

For simplicity, we consider an intermediation technology in which there is a fixed cost Γ representing the costs of obtaining and processing information relevant for loan making on any island.[8] Once this fixed cost is paid, information about *all* generation t entrepreneurs on any island is known and the marginal cost of a loan is zero. A similar assumption on the evaluation technology is made in Williamson [1986].

We chose this specification of increasing returns partly for its tractability. More general

[6] The importance of ex ante differences across borrowers forms the basis of the incentive problem in Bernanke and Gertler [1990] and Azariadis and Smith [1996] while the ex post costly state verification problem is essential in Townsend [1979] and Bernanke and Gertler[1989].

[7] Their finding of scale economies is also consistent with the large number of recent bank mergers even among the largest U.S. banks. In particular, they document that geographic restrictions on branching contributed to the large number of banks (14,000) in 1982. The bank merger wave that began in the 1980s following many states' liberalization of these restrictions lowered that number to 9,000 in 1997.

[8] Thus, Γ is the per capita cost of intermediation if all agents participate in this activity.

sources of complementarity are specified by Bryant [1987] and Weil [1989] so that the returns from intermediated activity for an individual increase with the overall level of that activity. Our model provides a source for this complementarity through fixed costs of intermediation and, coincidently, provides a basis for the underlying fixed cost of lending needed to generate an equilibrium with money and loans. [9]

III. Economic Organization

Markets are organized around the basic flows in this economy. Labor flows from workers to entrepreneurs who undertake production. This flow is accomplished through a competitive labor market between the continuum of active entrepreneurs and workers on each island. In return for supplying $n_{t,\alpha}$ units of labor, worker α receives goods $w_t n_{t,\alpha}$.

Savings can flow from workers in one of two ways. First, there is a money market on each island where workers can costlessly sell their goods at price p_t for the money holdings of the old. Second, since production occurs with a lag, savings can flow to entrepreneurs who wish to hire labor prior to selling output.

As noted earlier, there is a private information problem in this latter activity. For this reason, a saver (or group of savers) will utilize the intermediation technology at time t to provide for the screening and monitoring of loans. In fact, we assume throughout the analysis that depositors will always utilize this technology since the returns to lending will be zero otherwise. Put differently, if the intermediary did not monitor, then all borrowers would claim zero output and no repayments would take place. This is dominated by monitoring which, with our simple

[9]Further, we see this model as capturing an aspect of the bank runs model put forth by Diamond and Dybvig [1983]. In their model of bank runs, the returns to leaving funds at an intermediary depend on the withdrawal decisions of others while our work emphasizes these interactions from the perspective of deposit decisions.

technology, implies that all projects are fully evaluated and monitored.[10]

Following Boyd and Prescott [1986], an intermediary is a coalition of agents at a given island that utilize this technology. Unlike Boyd and Prescott, our coalitions are created by depositors.[11] Incurring the fixed cost Γ, a coalition of depositors makes loans at rate r_t to entrepreneurs who wish to borrow. Since entrepreneurs can move freely among islands in response to loan terms, if a coalition deviated from offering a competitive rate, its demand would shift to another location. Thus, the loan market is perfectly competitive. Since entrepreneurs are risk neutral, insurance markets against idiosyncratic zero output events are not considered.

Given this structure, we must address how Γ is allocated across members of the coalition of depositors. As in Townsend [1978], we assume the allocation rule that each coalition member shares equally in the fixed cost. Specifically, the fixed cost to an agent of making a loan is given by $\tau_t=\Gamma/\#(d_t)$, where $\#(d_t)$ denotes the measure of depositors at the intermediary in period t. Once this fixed cost is covered, each coalition member receives a return per unit deposited equal to the real return on loans r_t. This rule is analogous to a two-part tariff in which all members pay the same "hook-up" fee and then enjoy the same marginal return.

As formalized in Appendix A, this allocation rule has a number of compelling properties. First, it is efficient in that it provides the appropriate marginal incentives for deposits by the members of the intermediary. Second, it is a welfare maximizing rule for the coalition in that there is no other rule that will give *all* coalition members a higher utility level. Third, it does not

[10] In contrast, Cooper and Ejarque [1995] construct their multiple equilibria by allowing regimes with and without monitoring. Azariadis and Smith [1996] also has regimes with and without incentive problems.

[11] The qualitative nature of our results are unchanged if both depositors and borrowers are included in the coalition. In our case, the interaction with borrowers is through the market. As in Diamond [1984], if individuals attempted to make loans on their own, they would have to incur these fixed costs and thus are more than willing to share them with others through the intermediary.

require information about the income levels of depositors so that if the coalition is not able to observe the income of its members (which differs across agents due to the differences in endowments), the rule will still induce efficient behavior across members (i.e. the rule is incentive compatible). Finally, no subset of depositors has an incentive to defect and form a new coalition. This last point also addresses the question of the number of coalitions at each island; it is efficient to have only one coalition per location in order to share the fixed cost among the largest possible group of depositors.

Given that these rules are anticipated, young agents *simultaneously* decide whether to hold money or join the intermediary coalition on their island. The strategic complementarity emerges from this decision; the more agents that choose to join the intermediary, the lower is the fixed cost for each and thus others have an incentive to join as well. Thus, the size of the intermediary sector is determined in a non-cooperative fashion by the simultaneous choices of all agents.

In sum, an intermediary is a coalition of agents that produce loan evaluation activities using an increasing returns to scale technology which induces the presence of a fixed cost borne by all agents who join the coalition. This sharing of the fixed cost creates a strategic complementarity in the decisions of the agents.[12] As a consequence, we argue below that there can be multiple steady state equilibria in this economy. In one equilibrium, depositors are optimistic that many other agents will deposit funds with the intermediary and thus fixed costs per depositor will be low. As a result, many agents choose to become depositors. In a second

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[12]In fact, any contract such that the fixed cost borne by one agent was a decreasing function of the number of coalition members would create a strategic complementarity.

equilibrium, this optimism is replaced by pessimism and few agents deposit funds with the intermediary, fixed costs per depositor are high and thus markets are relatively thin. Once there are multiple steady states, we can generate sunspot equilibria by randomizing between these outcomes. The sunspot variable coordinates the beliefs of the depositors. From the perspective of the Great Depression, the theme that confidence in the intermediation process was lost during this period is certainly consistent with the low flow of deposits into intermediaries. The nature of these interactions and the resulting sunspot equilibria are described in more detail below.[13]

IV. Decision Problems and Steady State Equilibria

We first consider steady states in which all relative prices are constant over time and the cost of intermediated activity, τ, is given and constant. We then consider sunspot equilibria of the more general model in the following section.

IV.a. Worker Decisions

Consider a worker in generation t. This agent will take the real wage (w), the real rate of interest (r), and the real cost of intermediation (τ) as given in deciding on labor supply and savings. Due to the cost of participating in the intermediary coalition, a worker's choice of asset is nontrivial.

If worker α chooses to save through the holding of money, then that agent's lifetime utility of $V_{\alpha}^{\$}(w)$ is given by:

[13] A second interpretation of variations in the cost of intermediation stems from fundamental sources. Bernanke [1983] argues that there was an increased cost of intermediation during the Great Depression but, as in Bernanke and Gertler [1989,1990], this is often seen as a consequence of the deterioration of the net worth of borrowers. Alternatively, any direct measures by the government to regulate intermediaries can be viewed as altering the cost of intermediation and thus the value of τ in our model. Owing to the lack of directly observed fundamental shocks around the onset of the Great Depression, our analysis picks up from Cooper and Ejarque [1995] and stresses sunspots as a source of fluctuations.

$$V_\alpha^{\$}(w) \;=\; \max_{n,m} u(\alpha + wn - m, n) + \beta v(m) \tag{1}$$

In this optimization problem, $n \in [0,1]$ and $0 \leq m \leq \alpha + wn$. From this problem, let $m_\alpha(w)$ be the money demand of worker α.

Instead of holding money, the worker could instead choose to join the intermediary coalition. The value of participating in the loan market is denoted by $V_\alpha^l(w,r,\tau)$ where

$$V_\alpha^l(w,r,\tau) \;=\; \max_{n,l} \; u(\alpha + wn - \tau - l, n) + \beta v(\pi(1+r)l) \tag{2}$$

In this optimization problem, $n \in [0,1]$ and $0 \leq l \leq \alpha + wn - \tau$. From this problem, let $l_\alpha(w,r)$ be the loan supply of worker α. Thus, $(l_\alpha(w,r)+\tau)$ would represent the total deposits of this agent.

Finally, define

$$\Delta_\alpha(w,r,\tau) \;=\; V_\alpha^l(w,r,\tau) - V_\alpha^{\$}(w) \tag{3}$$

which represents the difference in lifetime utility levels for worker α from participating in the two different markets. Thus agent α of generation t will join the intermediation coalition iff $\Delta_\alpha(w,r,\tau) \geq 0$.

In the discussion that follows, denote the labor supply of worker α by $n^s_\alpha(w,r,\tau)$. We assume that preferences are such that labor supply is increasing in the wage, the interest rate and decreasing in income. Further, assume that consumption in youth is increasing in income and decreasing in the interest rate.[14]

[14] Thus consumption in youth is non-increasing in τ and labor supply is non-decreasing in τ.

IV.b. Entrepreneurs

Entrepreneur k of generation t will take the real wage (w_t) and the real rate of interest (r_t) as given in deciding whether or not to undertake production. Since production occurs with a lag, the entrepreneur must fund labor services prior to selling output. To accomplish this, the entrepreneur borrows funds from the intermediary. An entrepreneur wishing to hire n workers would need $w_t n$ units of the consumption good to pay workers. Thus the entrepreneur would borrow wn from the intermediary, owe $(1+r_t)w_t n$ in the following period and have a real profit of $f(n)-(1+r_t)w_t n$ if the investment succeeds. In addition, the entrepreneur would suffer a disutility of managerial effort of k in youth. In the event of zero production, profits are zero. An entrepreneur that decides not to produce (since the effort cost is too high) simply does not consume.

If entrepreneur k chooses to produce, then her lifetime utility is given by:

$$V_k^b(w,r) = \beta\pi[\max_n f(n) - w_t n(1+r_t)] - k. \quad (4)$$

The optimizing level of labor demand n(w,r) is given implicitly by:

$$f'(n^d)=w(1+r)$$

which is independent of both the entrepreneur's fixed cost and the success probability. Entrepreneur k chooses to produce iff $V_k^b(w,r) \geq 0$.

IV.c. Steady State Equilibria

A steady state equilibrium is (w,r,p) such that the plans of optimizing agents given these prices implies that the markets for labor, goods, money and loans all clear. The optimization problems of agents has both intensive and extensive margins. Throughout we focus on monetary equilibria with active intermediaries.

Entrepreneur k will participate in the product market as a seller if $k \leq k^*(w,r)$ where $k^*(w,r)$ is given by:

$$k^*(w,r)=[f(n^d(w,r))-wn^d(w,r)(1+r)]\beta\pi$$

That is, firms with high fixed costs of operation (e.g. small firms in terms of net output) will not participate.

Worker α will participate in the money market if $\alpha < \alpha^*(w,r,\tau)$ and make loans through intermediaries otherwise, where $\alpha^*(w,r,\tau)$ is given by $\Delta_\alpha(w,r,\tau)=0$.[15] Since workers with low endowments save relatively little, they are unwilling to pay the fixed cost to participate in the loan market. It will be shown that an increase in intermediation costs raises α^* consistent with the observation on the currency/deposit ratio during the Great Depression.

Using these critical values of k and α, the conditions for market clearing in the money, bond and labor markets can be precisely stated. Money market clearing requires:

$$\int_{\underline{\alpha}}^{\alpha^*} m_\alpha(w)dH(\alpha) = M/p \tag{5}$$

where M is the fixed stock of nominal money balances in the economy.

The loan market clearing condition is:

$$\int_{\alpha^*}^{\bar{\alpha}} l_\alpha(w,r,\tau)dH(\alpha) = \int_{\underline{k}}^{k^*} wn_k^d(w,r)dF(k) \ . \tag{6}$$

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[15]The proof of Proposition 1 argues that the equilibrium is characterized by cutoff rules for firms and households.

The loan supply incorporates the savings decision of those workers with high endowments and the integral on the right side incorporates the extensive margin of producers in that not all entrepreneurs will be active.

The condition for labor market equilibrium is:

$$\int_{\underline{\alpha}}^{\alpha^*} n_\alpha^s(w)dH(\alpha) + \int_{\alpha^*}^{\bar{\alpha}} n_\alpha^s(w,r,\tau)dH(\alpha) = \int_{\underline{k}}^{k^*} n_k^d(w,r)dF(k) \ . \tag{7}$$

Note that, in general, both labor supply and labor demand depend on the interest rate r.

For this economy, one can prove

Proposition 1: Given τ, there exists a steady state equilibrium.

Proof: See Appendix B.

V. Sunspot Equilibria

Now we re-consider the possibility of multiple steady states and sunspot equilibria due to the increasing returns to intermediated activity described by the specific technology we have assumed in IIc.[16] Our approach is to argue that multiple steady states may be possible and then construct sunspot equilibrium by randomizing across the neighborhoods of these two steady state equilibria as in Cooper and Ejarque [1995] and Chatterjee, Cooper and Ravikumar [1993].[17]

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[16] The conclusions of this paper would remain intact for many other, more general, intermediation technologies. For instance, Bryant and Weil provide models in which there are social returns to scale in the intermediation process. If these social returns are sufficiently strong, there may exist multiple steady states. They consider economies in which the level of savings at the individual level (s) is an increasing function of the net return on savings, (R). Further, through the external returns to scale, R is itself an increasing function of the aggregate level of savings, S. Thus, we have s(R(S)) so that s is an increasing function of S, a situation of strategic complementarity stressed by Cooper and John [1988].

[17] In recent work on indeterminacy, Farmer and Guo [1994] construct sunspots in the neighborhood of a unique steady state equilibrium.

For each given value of τ, Proposition 1 tells us that there will exist a steady state equilibrium. Multiple steady states are fixed points of $\tau = \Gamma/\#(d(\tau))$ where $\#(d(\tau))$ is the measure of depositors in the equilibrium given τ. Figure 1 illustrates this fixed point problem in $(\tau, \#d)$ space. As shown, there exists one steady state which satisfies the fixed point problem where $\tau_L = \Gamma/\#(d(\tau_L))$ and another where $\tau_H = \Gamma/\#(d(\tau_H))$, with $\tau_L < \tau_H$. The low (high) value of the intermediation cost is associated with a thick (thin) market. Note that the multiple equilibria shown in the figure are robust in that small variations in the $\#(d(\tau))$ function do not alter the number of equilibria. These multiple fixed points are possible since the level of intermediated activity $\#(d(\tau))$ ultimately falls as τ rises and gets large as τ approaches zero.[18]

Given multiple steady states, we discuss the construction of sunspot equilibria. Not all economies will possess sunspot equilibria. As in Chatterjee, Cooper and Ravikumar [1993], a necessary condition for sunspot equilibria is the multiplicity of steady states.

We let θ represent the sunspot variable and assume that $\theta \in \{\theta_o, \theta_p\}$ where the subscript "o" means optimism and "p" denotes pessimism. Associated with each value of θ is a cost of intermediated activity, $\tau(\theta) = \Gamma/\#(d(\theta))$, with $\tau(\theta_o) < \tau(\theta_p)$. That is, when there is a confidence crisis, θ_p is realized and costs of intermediation are higher. This is possible iff the number of depositors during a period of crisis are lower since then the low level of intermediated activity will translate into higher intermediation costs through the thick markets

[18]Finding multiple steady states and hence, from Proposition 2, sunspot equilibria is more immediate in a related economy where $\tau(d)$ is a decreasing step function. That is, suppose we do not require $\tau = \Gamma/\#(d)$, but instead approximate the continuously decreasing cost case by two exogenously given values, $\tau_L < \tau_H$. Then as long as $\#(d(\tau_L)) > \#(d(\tau_H))$, we can find a $\#(d^*)$ between these values and assume that the fixed cost per depositor is τ_L iff the number of depositors exceeds $\#(d^*)$. In this case, the multiplicity of steady states and thus sunspot equilibria is immediate since the more difficult fixed point problem brought about by assuming $\tau = \Gamma/\#(d(\theta))$ is no longer present.

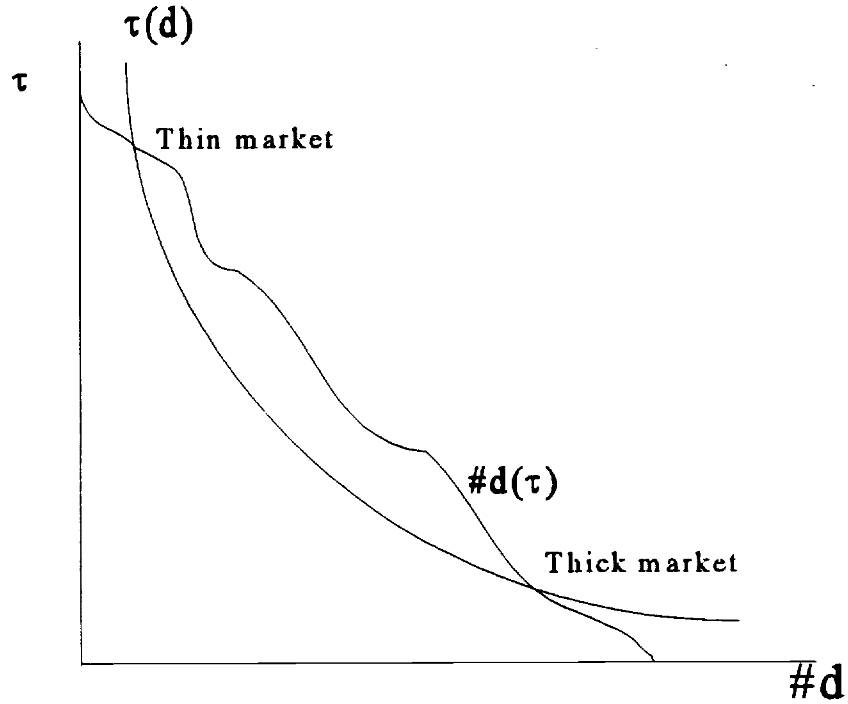

Figure 1

externality. Likewise, during periods of optimism, the increased number of depositors implies that each pays a lower fixed cost.

We model the sunspot process as Markovian and let Σ represent the transition matrix for the sunspot variable with

$$\Sigma_{ij}=\Sigma(\theta_i,\theta_j) = \text{Prob}(\theta_{t+1}=\theta_i \mid \theta_t=\theta_j) \tag{8}$$

In this way, we can allow for some persistence in the state of financial confidence.[19]

To construct a sunspot equilibrium, we need to return to the individual optimization problems and allow for choices to be dependent on the current realization of the sunspot variable. If worker α chooses to save through the holding of money and the current state of the sunspot is θ, then his lifetime utility is given by:

$$V_\alpha^{\$}(\theta) = \max_{n,m} u(\alpha + w(\theta)n - m, n) + \beta E_{\theta'} \, v(mp(\theta)/p(\theta')) \; . \tag{9}$$

Note that in this optimization problem, we allow the price of goods in terms of money to be dependent on the realized value of θ. This reflects the fact, emphasized below, that variations in the cost of intermediation influence the demand for money and thus the money price of goods. Further, the wage is dependent on the current value of θ. This dependence of prices on the sunspot variable is a defining characteristic of a sunspot equilibrium.

The value of participating in the loan market is denoted by $V_\alpha^l(\theta)$ where

[19] We chose the two state sunspot process for simplicity only. For instance, we would have constructed a three state model with optimism, mild pessimism and strong pessimism (as in Fisher's chronological order of events and Coe's findings).

$$V^l_\alpha(\theta) \;=\; \max_{n,l} \; u(\alpha + w(\theta)n - \tau(\theta) - l, n) + \beta v(\pi l(1 + r(\theta))) \; . \qquad \textbf{(10)}$$

Here, wages and the interest rate are contingent on the current value of θ. However, the return on loans is assumed to be independent of the sunspot variable: risk averse depositors have no incentive to build extrinsic uncertainty into their loan contracts. As a consequence, lending through an intermediary shields agents from uncertainty over the future value of the sunspot variable. In the discussion that follows, we denote the labor supply of a type α agent in state θ by $n^s(\alpha,\theta)$. As in the steady state analysis, there will exist a cut-off level of α for each θ, denoted $\alpha^*(\theta)$ such that workers hold money in state θ iff $\alpha < \alpha^*(\theta)$.

If entrepreneur k undertakes production, utility in state θ is given by:

$$\max_n \quad \pi\beta[f(n) - w(\theta)(1 + r(\theta))n] \; - k \qquad \textbf{(11)}$$

Let $n^d(\theta)$ represent the state contingent level of labor demand. As in the steady state analysis, there will exist a cut-off level of the fixed cost, contingent on θ, denoted $k^*(\theta)$, such that a entrepreneur will participate in state θ iff $k < k^*(\theta)$.

With these modifications to the individual optimization problems, a stationary sunspot equilibrium is characterized by $\{p(\theta), r(\theta), w(\theta), n(\theta), m(\theta), l(\theta), k^*(\theta), \alpha^*(\theta)\}$ for all θ such that: (i) all workers and entrepreneurs optimize, (ii) all markets clear, and (iii) $\tau(\theta) = \Gamma/\#(d(\theta))$.

<u>Proposition 2:</u> If there are multiple interior steady states, then there exists a stationary sunspot equilibrium.

Proof: See Appendix B.

VI. Examples

To illustrate the workings of the model, here we consider equilibria for a particular version of our economy. The presentation begins with an example of multiple steady state equilibria and then constructs a sunspot equilibrium around the steady states.

VI.a. Multiple Steady States

For this example, suppose that there are two types of firms. Let type j have fixed costs of production k_j and let F_j be the fraction of firms with costs equal to or less than k_j, where $k_1 < k_2$. Further, assume that the production function for a representative firm is $f(n) = \psi n^{\xi}$. Hence labor demand is

$$n_t^d = \left[\frac{\xi \Psi}{w_t(1+r_t)}\right]^{\frac{1}{1-\xi}}. \tag{12}$$

Finally, since firms must borrow to finance wage payments, their loan demand is $w_t n^d_t$. The equilibria will involve cutoff rules so that only firms with sufficiently low costs will produce.

For a representative household of generation t, let preferences be given by:

$$\ln\left(c_t^t - \frac{n_t^{(1+\gamma)}}{(1+\gamma)}\right) + \beta \ln(c_{t+1}^t) \tag{13}$$

where $\gamma > 0$ parameterizes the disutility from work. A simplifying feature of these preferences is that the labor supply decision is independent of the return on savings and income. The labor supply decision of a household, regardless of its asset market participation decision, is

$$n_t^s = w_t^{\frac{1}{\gamma}}. \tag{14}$$

If a household joins the intermediation coalition, loans, given a real wage (w_t) and a real return on savings (r_t), are:

$$l_t = \frac{\beta(\alpha - \tau)}{1+\beta} + \phi w_t^{\frac{1+\gamma}{\gamma}} \tag{15}$$

where $\phi \equiv \beta\gamma/[(1+\beta)(1+\gamma)]$ and α is the endowment. In this expression, τ is the per capita cost of intermediated activity and is determined in equilibrium. If a household holds money, then labor supply is again given by (14) and money demand is:

$$m_t = \frac{\beta\alpha}{1+\beta} + \phi w_t^{\frac{1+\gamma}{\gamma}} \tag{16}$$

For this example, suppose that there are three types of households. Let type i have endowment level α_i and let A_i be the fraction of this type where $\alpha_1 < \alpha_2 < \alpha_3$. As we shall see, the equilibria will involve cutoff rules so that only households with sufficiently high endowment levels will join the intermediary. To characterize these equilibria, let H_i be the fraction of households with endowment level equal to or bigger than α_i and let $\mu(\alpha_i)$ be the mean endowment level for these households.[20]

We construct two steady states. The first is an optimistic equilibrium: type 1 households hold money while types 2 and 3 join the intermediary and all firms produce. The second is a pessimistic equilibrium: only type 3 households join the intermediary and only type 1 firms produce.

While these steady states differ in terms of participation decisions, the equilibrium interest rates and wages satisfy:

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[20]For example, $H_2=A_2+A_3$ and $\mu(\alpha_2)=A_2\alpha_2+A_3\alpha_3$. Note the slight change in notation for the cumulative distribution of agent's endowments.

$$(1+r) = \Psi\xi F_j^{1-\xi}\left[\frac{\left(\frac{1+\beta}{\beta}\right)(1-\phi H_i)}{\mu(\alpha_i)-\Gamma}\right]^{\frac{\gamma+1-\xi}{1+\gamma}} \tag{17}$$

and

$$w = \left(\frac{\Psi\xi F_j^{1-\xi}}{(1+r)}\right)^{\frac{\gamma}{1+\gamma-\xi}}. \tag{18}$$

It is thus easy to see that an equilibrium with high household participation at intermediaries will imply, from (17), low interest rates because the fraction of agents partipating in loan activity (H_i) and the flow of loans ($\mu(\alpha_i)$) will both be large. The effect on interest rates may be offset by higher firm participation. From (18), wages will rise from the increased labor demand induced by the fall in interest rates and higher firm participation.

To characterize the equilibria requires a check on the participation decisions of the different households and firms. The expressions for interest rates and wages can be used to solve for the equilibrium choices of households and hence their expected lifetime utility. Recall that $\Delta_\alpha(w,r,\tau)$ is the difference in utility between making loans and holding money. For this example,

$$\Delta_\alpha(w,r,\tau) = (1+\beta)\ln\left(1-\frac{\tau}{\alpha+\omega}\right) + \beta\ln(1+r) \tag{19}$$

where

$$\omega = \left(\frac{\gamma}{1+\gamma}\right)w^{\frac{(1+\gamma)}{\gamma}}$$

and $\tau = \Gamma/H_i$ if H_i is the fraction of households in the intermediary. From (19), we again see the cutoff property: given (w,r,τ) only agents with sufficiently large endowments will join the intermediary since the utility differential is increasing in α.

The optimistic equilibrium with household types 2 and 3 joining the intermediary coalition arises if (19) is positive for endowment levels α_2 and α_3. This condition is evaluated with $\tau = \Gamma/H_2$, using H_2 and $\mu(\alpha_2)$ to determine interest rates and wages. In an optimistic equilibrium, we must also check that both firm types make positive profits. Similarly,the conditions for the pessimistic equilibrium can be checked as well.

Tables 1 and 2 present the predictions of a specific numerical example of this economy based upon the particular parameter values given there. Note that at least qualitatively, the comparison of the steady states is similar to observations before (optimism) and during (pessimism) the Great Depression. In particular, the currency/deposit ratio is higher in the pessimistic steady state, rising from .085 to .26. As noted in our introduction, it rose from .086 to .227 in U.S. data. Further, for our model, the interest rate rises from 8 to 11% while in U.S. data Hamilton [1987] reports that the real ex post return on short term government debt increased from 7.4% in 1929 to 11.3% in 1937. The model overpredicts the drop in velocity (72% in the model versus 29% in the data). The model also predicts a gap between loan and deposit rates (average across all depositors) of about 1.9% in the optimistic steady state and 2.3% in the pessimistic steady state.[21] This gap is not as large as reported by Bernanke [1983] between corporate and government bonds.

[21] The gap between loan and deposit rates is given by $r(\theta)-r^d(\theta)=[\Gamma/\Sigma_i A_i l_i](1+r^d(\theta))$.

Associated with these financial market changes are movements in prices and output. In our example, real output is about 15.5% lower in the pessimistic steady state while output fell by about 36% during the Great Depression. This is perhaps not surprising given that we have no factors such as real investment and inventory changes that may have magnified these effects. Given that the model understates the output effects, the model also predicts a deflation of 67% which exceeds that of about 40% observed in the U.S.

Finally, given the specification of technology and preferences, wages do not vary much in our example relative to observation: i.e. they fall by -0.1%. According to Margo [1993], real wages rose by 16% from 1929 to 1932. For our firms, the real cost of labor is $w(1+r)$ and this did increase under pessimism but only by about 2%. Also, 5% of the firms (in particular "small" firms with high fixed costs of operation) choose not to finance production opportunities that were profitable in the optimistic steady state.

One very interesting element in the example is that the fixed cost is actually not very large. From the intermediation technology, the ratio of loans to total deposits (D) is simply $1-\Gamma/D$ where Γ is the fixed cost of operating the intermediary. For our equilibria, the loan deposit ratio is about .98.[22] Thus the fixed cost is actually a very small part of the flow of deposits: only about 2% of deposits are used to finance the operations of the intermediary.

Why can this small fixed cost produce multiple equilibria? The key is the large middle income class whose asset holdings change across the two steady states and thus cause the large variations in the currency/deposit ratio. The intermediation process is largely financed by a

[22] This ratio is higher than that reported by Bernanke [1983]. Note though that our model does not include any government debt and thus excludes the substitution between loans and the holding of government securities.

small fraction of the population with high income.

VI.b.Sunspot Equilibria

While the above discussion indicates that the steady states for this specific example mimic some of the features of the Great Depression, our ultimate interest is in studying sunspot equilibria constructed from the multiple steady states. This gives content to the theme that in late 1929, the U.S. economy experienced a loss of confidence and moved from optimism to pessimism. In general, the possibility of this switch and its realization will have effects on equilibrium behavior. We now investigate these effects in our example.

As described above, creating a sunspot equilibrium amounts to introducing a random variable that coordinates agents on either high asset market participation rates (optimism) or low participation rates (pessimism). With the preferences assumed in the example, the resulting randomness in the value of holding money will not influence any of the labor supply decisions nor the asset choices except possibly for asset market participation decisions. Recall, that sunspots influence the return to holding money. Thus, in the optimistic state, agents may want to hold money since the expected return to this asset is increased by the prospect of pessimism and the consequent deflation. Similarly, the return to money holding is reduced in the pessimistic state by the prospect of returning to optimism.

In the equilibria we constructed, all of the asset market participation decisions are represented by strict inequalities. Therefore, it is straightforward to introduce a small probability of switching from the neighborhood of one steady state to the other without disturbing the basic structure of the equilibria. This is an application of Proposition 2.

In fact, we can calculate how much persistence in each state is necessary to have a sunspot equilibrium. This is of interest since one suspects that pessimism is not close to a permanent state. For our example, we can support a sunspot equilibrium in which $\Sigma_{oo} \geq .95$ while $\Sigma_{pp} \geq .5$. Thus the pessimistic state need not be very persistent though the optimistic state is fairly persistent and thus switches to pessimism relatively infrequent.

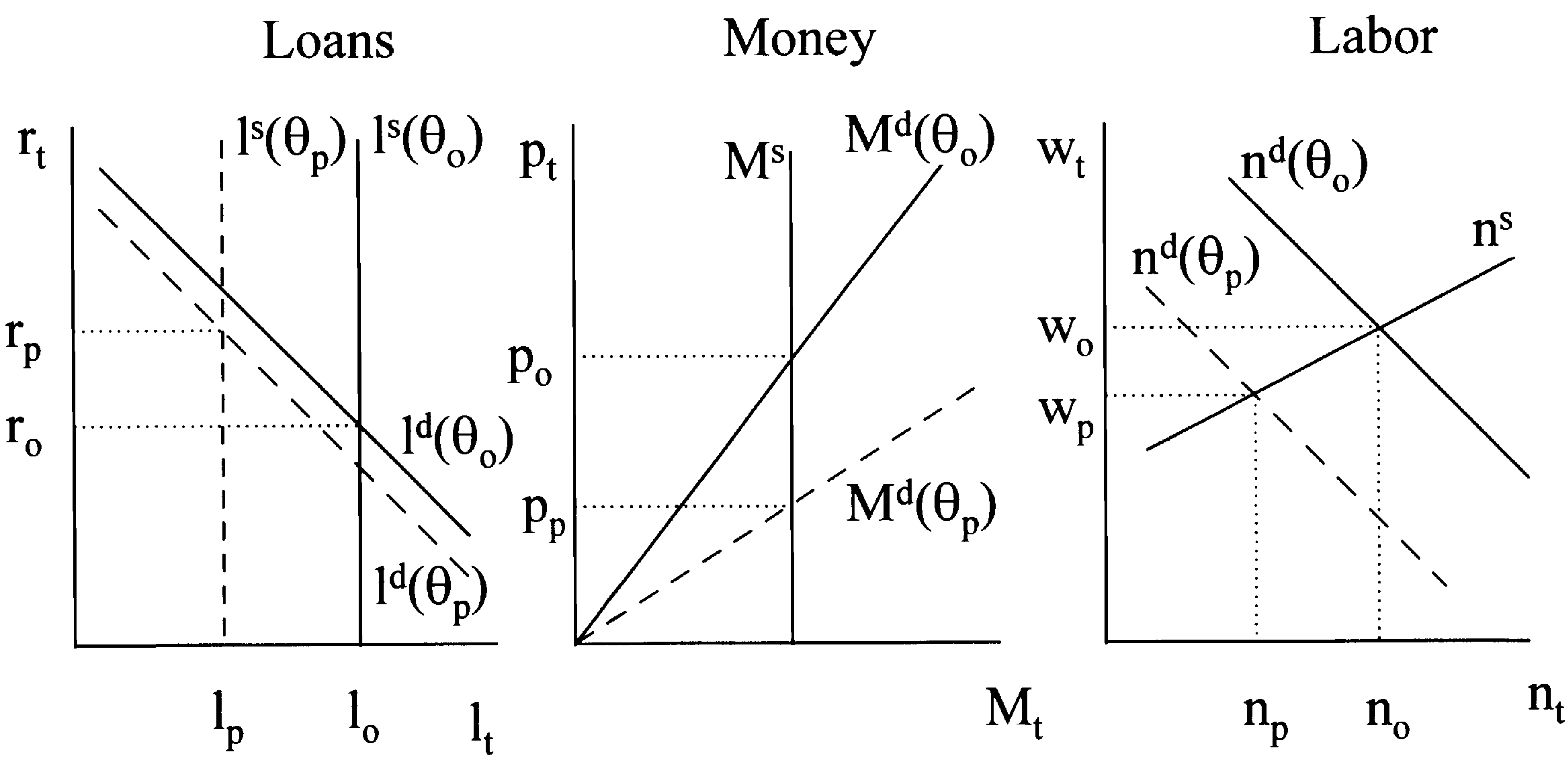
Figure 2 shows the impact of the sunspot variable in terms of supply and demand curves. In the pessimistic state, loan supply is lower than under optimism as the per capita fixed cost of intermediation rises so that households substitute into currency. The consequent increase in the interest rate reduces labor demand leading to a reduction in real wages. Since the real costs of hiring labor are higher, some firms may choose not to produce (which explains the lower demand for loans in Figure 2). Finally, real money demand is much higher in the pessimistic state so that prices must be lower to equilibrate the money market.

Qualitatively, the model matches the actual behavior of the economy prior to and during the Great Depression. In a sunspot equilibrium constructed by randomizing in the neighborhood of the two steady states, the movements of the variables across the states will be given by Tables 1 and 2. As noted earlier, the model produces many of the basic elements of the Great Depression period though the output movements are a bit too small and the wage movements not large enough.

VII. Conclusions

The goal of this paper was to assess the ability of a monetary model with multiple equilibria to match some of the observations during the Great Depression. The model's predictions qualitatively match the movements of a number of key variables. Undoubtedly there are other factors contributing to these movements but we find the success of the sunspot driven

Fig. 2: Market Equilibrium



fluctuations quite compelling

The key to the analysis is a strategic complementarity associated with the intermediation process. The presence of the complementarity reflects the existence of an underlying non-convexity in the screening and monitoring technology. Interestingly, the model does not require a large degree of non-convexity to generate these results: in our example, the cost of intermediation is only about 1.5% of production, which is below the valued added of financial services in U.S. GNP.

Costly intermediation also provides the basis for money demand in contrast to other frameworks, such as the cash-in-advance model. In its simplest form, the cash-in-advance model would predict unitary velocity, a prediction grossly violated by the observed large movements in velocity during the Great Depression.[23] In contrast, we are able to generate sizeable swings in velocity within our costly intermediation framework.

One avenue for further work is to investigate alternative structures for the sharing of these fixed costs. Our approach is to view the intermediary as a coalition which efficiently shares the fixed cost across its members. An alternative would be to think of the intermediary as an ongoing entity that offers deposit rates and charges loan rates. The fixed costs of operation would be financed by the gap between these rates which would, in turn, be sensitive to the level of economic activity. Though this structure may not have the efficiency properties of our intermediary coalition, understanding the robustness of our results to alternative decentralizations is of interest.

Finally, a dynamic version of the Diamond-Dybvig bank runs model would provide

[23] Hodrick et al. [1991] show that more general cash-in-advance models cannot generate realistic predictions about variability in velocity.

another source of strategic complementarity that could be used to examine the effects of bank runs on the behavior of economy aggregates such as output, employment, consumption and investment.[24] It should be recognized though that the inclusion of return dominated money in a bank runs model will again require some basis (such as costly intermediation) for money demand. In fact, we view our model as complementary to the study of belief induced withdrawal decisions (as in Diamond-Dybvig) by focusing on belief induced deposit decisions. This is consistent with Bernanke's [1983,pg. 264] suggestion that it was not only *actual* bank runs that mattered in the Great Depression but also the *fear* of runs that contributed to the contraction of the banking system's role in the intermediation of credit.

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[24] Freeman [1987] and Fulghieri and Rovelli [1995] both start on this problem.

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Appendix A

Consider the optimization problem of a given group of depositors utilizing an intermediation technology with a fixed cost of Γ and a fixed marginal return of $(1+r)$. The coalition chooses the consumption profile for each agent $(c_{t,\alpha}, c_{t+1,\alpha})$ and total loans L to solve:

$$Max \int_{\alpha \in A} \lambda_\alpha U_\alpha(c_{t,\alpha}, c_{t+1,\alpha}) dG(\alpha)$$

$$s.t. \quad \int_{\alpha \in A} c_{t,\alpha} dG(\alpha) = Y - \Gamma - L$$

$$\int_{\alpha \in A} c_{t+1,\alpha} dG(\alpha) = (1+r)L \ .$$

The first-order conditions for this problem will equate the marginal rate of substitution for consumption across the two periods to $(1+r)$, independent of the welfare weights λ_α. Thus the optimal allocation will distribute the fixed costs across agents without distorting the marginal returns from investment activities. Of course, the allocation of fixed costs will reflect the welfare weights attached to each agent. One such allocation treats all depositors equally.

Further, suppose that depositors have private information about their level of income. The mechanism design problem sets a menu (r_α, τ_α) such that agents self-select. If we restricted $r_\alpha = r$ for efficiency and if agent income is unobservable, incentive compatibility requires $\tau_\alpha = \tau$ independent of type. Otherwise, all agents would claim to be of type $\min_\alpha \tau_\alpha$.

Finally, no subset of depositors could ever break off and form a new intermediation coalition which is welfare improving for them. To do so would require them to share the same fixed cost across a smaller set of agents and this would never be welfare improving for all.

Thus a rule for the intermediary in which all depositors pay the same fixed costs and earn the same marginal return is efficient, incentive compatible and in the core. These results thus motivate the coalition rules whose implications we explore in our model. Note that the optimization problem given above pertains to the choices of a given set of agents: the coordination problem in our economy concerns the determination of the size of the coalition taking these rules as given.

Appendix B

Proposition 1: Given τ, there exists a steady state equilibrium.

Proof: To prove this proposition,find (w,r) such that loan markets and labor markets clear, (6) and (7) respectively. Given these, there exists a price level clearing the money market, (5). In (6) and (7), the supply and demand functions as well as the cutoffs for firms and households are continuous functions of (w,r) given the continuity of the objective functions.

To see that firm's optimal decisions have this cutoff property, note from (4) that the returns from being active are independent of k. Thus given (w,r), there is a unique value of the fixed cost such that only firms with costs k below this critical value are active.

From (1)-(3),$\Delta_\alpha(w,r,\tau)$ is increasing in α as long as the first period consumption for type α holding money exceeds that if α engages in loan activity. Recall our assumption that consumption in youth is weakly increasing in income and weakly decreasing in the interest rate and that labor supply falls with income and weakly increases with the interest rate. Hence consumption in youth will be higher for a household that saves through the holding of money than through loans due to the payment of the fixed cost and the higher return from intermediated activity. Thus $\Delta_\alpha(w,r,\tau)$ is increasing in α and the cutoff property holds.

Consider a set $P \equiv \{(w,r) | 0 \leq (w,r) \leq (W,R)\}$ where (W,R) are sufficiently large wages and interest rates such that at (W,R) there is an excess supply of labor and loans. Since firm profits fall as (w,r) increase, there will exist a (W,R) such that the firm with the lowest fixed cost will not find it profitable to operate. Hence, at this (W,R) there will be an excess supply of loans and labor. Note that P is convex and compact.

Let $z:P \rightarrow P$ where $z(w,r)=(w',r')$ such that w' clears the labor market given r and r' clears the loan market given w. Clearly a fixed point of z( ) clears both the labor and loan markets. With the assumptions we have placed on preferences and technology, for each (w,r) there will exist a unique (w',r') pair such that markets clear: z(w,r) is a function. Thus, using Brower's fixed point theorem, z( ) has a fixed point. Given this (w*,r*) pair that satisfies (6) and (7), the left side of the money market clearing condition (5) is determined and thus the price level p can be chosen to satisfy (5). QED.

Proposition 2: If there are multiple interior steady states, then there exists a stationary sunspot equilibrium.

Proof: Consider a sunspot equilibrium in which the transition matrix across sunspot states is given by Σ, where Σ_{ij} is prob($\theta_{t+1}=\theta_i | \theta_t=\theta_j$) for i,j=o,p. The optimization conditions by firms and households are taken for a fixed Σ and decisions are continuous functions of the elements of this matrix. When $\Sigma_{ii}=1$ for i=o,p, then we have two interior steady states that do not communicate. By continuity, for Σ_{ii} close to 1, for i=o,p, there will exist stationary sunspot equilibria. QED.

Table 1
Steady State Values

Variable	Optimistic Steady State (model,data)	Pessimistic Steady State (model,data)
real interest rate (%)	8.3,7.4	10.8,11.3
currency/deposit	0.085,0.086	0.262,0.227
loan/deposit	0.982,0.86	0.979,0.706

Table 2
% Change: Optimism to Pessimism

Variable	Model	Data
deflation	67	40
velocity	-72	-29
production	-16	-36
real wages	-0.1	16

Parameters: Γ=0.01, [k_1=0,k_2=.06], F_1=.95, γ=0.05, [α_1=.2,α_2=.45,α_3=10],[A_1= .45,A_2=.45,A_3=.1],β=.9,ξ=.9,ϕ=1.11,π=.995