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# Financial Collapse and Active Monetary Policy: A Lesson from the Great Depression

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ABSTRACT

We analyze financial collapses, such as the one that occurred during the U.S. Great Depression, from the perspective of a monetary model with multiple equilibria. The multiplicity arises from the presence of a strategic complementarity 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. From a positive perspective, our model matches closely the qualitative changes in important financial and real variables (the currency/deposit ratio, ex-post real interest rates, the level of intermediated activity, deflation, employment and production) over the Great Depression period, an experience often attributed to financial collapse. Further, we show how adding liquidity to the banking system through increases in the money supply is sufficient to overcome strategic uncertainty and thus avoid financial collapse.

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# 1. Introduction

A common element in past and recent episodes of "financial crises" is the collapse of activity in the financial sector, along with reductions in real output, consumption, employment and other components of real activity. The source of these episodes and the nature of appropriate policy intervention remains an open area of debate. In this paper, we focus on fluctuations in confidence as a source of financial collapse.[1] Our framework provides an integrated approach to studying the link between variations in confidence and fluctuations in aggregate economic activity. Further, we consider policy remedies within this structure.

The idea that confidence is an important element in financial collapse, such as 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. Moreover, Fisher's [1933] "logical" order for his debt-deflation theory of the Great Depression begins with "Mild Gloom and Shock to Confidence" and goes on to stress the contribution of pessimism at various stages of his chronology of events. Our focus on confidence also reflects the lack of a readily identifiable real cause for the Great Depression.[2]

Our mechanism for integrating confidence into an aggregate model of intermediation builds upon the contributions of Bryant [1987], Weil [1989] and Cooper-Ejarque [1995]. These papers all consider the implications of a strategic complementarity in the banking sector. Here we are explicit about the basis of the complementarity; there is a technology that

[1] The debate on these episodes is reflected in the lack of precise terminology to describe them. In our discussion, we use the term "financial collapse" to signify a dramatic reduction in the level of economic activity within the financial sector. Thus this term captures an observed and directly measurable event. We use the term "variations in confidence" to capture variations in the beliefs of agents which, in an environment like ours, can give rise to financial collapse.

[2] See Cole-Ohanian [1999] for a recent discussion of competing models of the Great Depression. See also Boyd-Gomis-Kwak-Smith [2000] for an empirical study on the causes of banking crises. They argue (p.4), "... it is hard to dismiss a 'sunspots view' of banking crisis on the basis of existing evidence."

allows a coalition of agents to evaluate loan applications and ensure repayment at a fixed cost which is shared equally among the coalition. Thus if a single agent believes that many (few) other agents will join the coalition, then his anticipated costs of participating in the coalition are small (large), which reinforces the perceived high (low) degree of equilibrium participation. Stochastic variations in the cost of intermediation that arise out of these strategic complementarities are the source of fluctuations in confidence. Rather than focus on bank runs, which reflect ex post variations in confidence, our paper focuses on the effects of confidence on disintermediation, which reflects ex ante decisions.[3] In order to understand observed substitution between currency and deposits that characterizes financial collapse, the model integrates money into the environment as in Chatterjee-Corbae [1992].[4] Thus the disintermediation process which is central to our mechanism produces these substitution effects. Furthermore, this environment with money and banking allows us to evaluate the effects of alternative policies in a general equilibrium framework.

We use the U.S. Great Depression as a stark example of the importance of confidence though our framework is instructive for understanding the more complex financial crises observed in a number of countries over recent years.[5] We provide a coherent general equilibrium model that yields contemporaneous movements of the currency/deposit ratio, ex-post real interest rates, the level of intermediated activity, deflation, employment and production which

[3] Thus, our paper shares a similarity to one by Azariadis-Smith [1998], who study sunspot induced variations in real activity in a non-monetary economy with private information.

[4] Williamson [1987] studies the general implications of variations in the riskiness of projects and thus shares this objective of linking intermediation to real activity. He has valued fiat money that perfectly substitutes for deposit contracts. Another related paper is Azariadis-Chakraborty [1998], which uses increasing returns to generate multiple equilibria in a monetary model with banks.

[5] The model we construct is closed and hence unable to deal with the complexities created by international capital flows and the associated uncertainty over exchange rates. See Chang-Velasco [2000] for a detailed discussion of modeling financial crises in open economies.

were observed during the Great Depression.

Our analysis also considers some policy remedies. In the context of the Great Depression, it is often argued, most notably by Friedman and Schwartz [1963], that appropriate interventions might have reduced the magnitude of the reductions in output and employment. In particular, they state (p.300-301):

> "The contraction is in fact a tragic testimonial to the importance of monetary forces.... Prevention or moderation of the decline in the stock of money, let alone the substitution of monetary expansion, would have reduced the contraction's severity and almost certainly its duration."

The statement by Friedman and Schwartz is still relevant in policy discussions today. One of the points of debate concerning current financial crises is the nature of the intervention: tight vs. loose money. Our paper thus contributes to policy analysis by showing how a Central Bank can eliminate confidence driven financial collapse through liquidity provision.[6]

The paper is organized as follows. The economic environment (preferences, technologies, and information assumptions) is presented in Section 2. Section 3 describes the economic organization of the environment (market structure). Section 4 defines an equilibrium and proves certain properties of it. Section 5 provides an extended example of the model economy and relates it to certain observables from the Great Depression.

[6] Champ-Smith-Williamson [1996] evaluate how liquidity provision can prevent fundamental induced bank panics.

## 2. Environment

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 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.[7]

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

### A. Workers

One subset of agents is endowed with leisure time in youth and no time in old age. These agents are termed "workers." Workers are also endowed with an idiosyncratic amount ($\alpha$) of the consumption good in youth, which is private information. The distribution of wealth across the population is given by $H(\alpha)$. The heterogeneity in endowments generates variation in the desire to save across households. To economize on notation we associate an agent type's name with $\alpha$.[8]

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

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

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 factor.

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

[8] Note that this is simply a labeling device and implies nothing about the type-specific nature of allocations.

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

**B. Entrepreneurs**

The other subset of agents, termed "entrepreneurs," are endowed with leisure time in youth and consume in old age. Entrepreneurs are risk neutral; 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 managerial 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.[9] Let $F(k)$ denote the distribution of $k$ across the population of entrepreneurs.

With probability $\pi$, 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 and 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

[9] Again, the association of the time cost $k$ with an agent's name is made for simplification.

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 output is private information.

As formalized below, entrepreneurs operate their technology if the expected returns to production exceed labor costs plus the time cost to the entrepreneur. While heterogeneity generates variation in an entrepreneur's decision of whether to produce, the independence of $f(\cdot)$ from $k$ guarantees that those entrepreneurs who undertake production demand identical amounts of hired labor.

**C. Intermediation Technology**

The final element in the environment is a technology that screens 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 ensure that entrepreneurs do not claim investment failures as a way to avoid obligations to the intermediary.[10]

Intermediation is a costly activity because resources must be devoted to evaluation and monitoring of loans. We assume there are increasing returns to these activities. Evaluation of one loan application creates information that will be useful in the evaluation of other loans in similar activities. Further, the monitoring of the outcome of one project reduces the costs of

[10] The importance of ex ante differences across borrowers forms the basis of the incentive problem in Bernanke-Gertler [1990] and Azariadis-Smith [1998], while the ex post costly state verification problem is essential in Bernanke-Gertler [1989] as well as in Boyd-Chang-Smith [1998].

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 [1998] provide evidence that banks of all sizes exhibit significant scale economies.[11]

For simplicity, we consider an intermediation technology in which there is a fixed cost $\Gamma$ representing the costs of obtaining and processing information relevant for loan making on any island.[12] Once this fixed cost is paid, information about all generation $t$ entrepreneurs (both their projects and returns) 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 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 fixed cost provides a foundation for reduced form specifications of complementarities and is consistent with the existence of a general equilibrium with loans and return-dominated money.

## 3. 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 $\alpha$ receives goods $w_t n_{t,\alpha}$.

[11] As noted however in the introduction of Hughes-Mester [1998], this contrasts with other findings of no significant scale economies. For further discussion of this controversy (and references to papers that do not find significant scale economies), see Berger-Mester [1999].

[12] Thus, $\Gamma$ is the per capita cost of intermediation if all agents participate in this activity.

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) may utilize the intermediation technology at time $t$ to provide for the screening and monitoring of loans. In fact, if a saver chooses to make a loan, he will always utilize this technology since the returns to lending would 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 technology, implies that all projects are fully evaluated and monitored.

Following Boyd and Prescott [1986, p. 216], an intermediary is a coalition of agents at a given location that publicly announces a set of rules for its members. Incurring the fixed cost $\Gamma$, 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 (Boyd-Prescott also make assumptions about the environment such that there is an absence of monopoly power). Since entrepreneurs are risk neutral, insurance markets against idiosyncratic zero output events are not considered.

Given this structure, we must address how $\Gamma$ 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.[13] 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 require information about the income levels of depositors. Since depositor types are not public information, 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.

The timing of the extensive form game associated with implementing the allocation rule is as follows. Given that the rule is anticipated, after young agents learn their type, they 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 noncooperative fashion by the simultaneous choices of all agents. In this manner, our efficient coalition is placed within a noncooperative environment in which coordination problems may emerge due to the independent choices made by agents concerning their participation in the

[13] See Moulin [1994] for a more lengthy discussion of this and related mechanisms.

coalition.[14]

Finally, a government authority injects or withdraws money within the economy via lump sum transfers or taxes. Let

(1) $\Upsilon_t = M_{t+1} - M_t$

be the injection or withdrawal of money where $M_{t+1} = (1+g_t)M_t$ is the money supply at the beginning of period $t+1$.

In summary, 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. As a consequence, we argue (and show) 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 (i.e. there is a thick loan market). In a second 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

[14] There is another industrial organization to consider in which the coalition (a singleton or group of agents) offers deposit rates to attract other agents to join. This would then produce a spread between loan and deposit rates. This alternative multi-stage formulation still must confront the issue of who pays the fixed cost of the intermediary. If it is a single agent, he must have enough resources to guarantee these rates, and we have assumed this is not feasible. If there is a measurable group that starts the institution and then gets to post borrowing and lending rates, then there may be a coordination problem within this group. Further, to the extent that the gap between loan and deposit rates is used to finance the fixed cost, there is another source of inefficiency produced. Our structure highlights the coordination problem within an internally efficient arrangement for each intermediary.

Great Depression, the theme that confidence in the intermediation process was lost during this period is certainly consistent with evidence, summarized by Bernanke [1983], of the contractions of the banking system. The nature of these interactions and the resulting sunspot equilibria are described in more detail below.

## 4. Equilibrium

In general we index a state of the economy in period $t$ by $\theta_t$ in some finite set $\Theta$.[15] We also let $\sum$ represent the transition matrix for $\theta_t$ where

$$\Sigma_{ij} = \Pr(\theta_{t+1} = \theta_i | \theta_t = \theta_j).$$

We associate $\theta_t$ with the state of confidence in the financial system. In a stationary rational expectations equilibrium, defined below, relative prices and real decisions are stationary functions of this sunspot variable.

### A. Worker Decisions

Consider a worker in generation $t$, state $\theta_t$. This agent will take the real wage $(w(\theta_t))$, the real rate of interest $(r(\theta_t))$, the real cost of intermediation $(\tau(\theta_t))$, the price level $(p(\theta_t))$, and the real monetary transfer $(h(\theta_t))$ as given in deciding on labor supply and savings. Due to the cost of participating in the intermediary coalition, a worker's portfolio decision is nontrivial.

If worker $\alpha$ chooses to save through the holding of money, then that agent's lifetime

[15] The underlying regime shift structure of the sunspot equilibrium is supported by the nonlinearities highlighted 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.

utility of $V_\alpha^M(\theta_t)$ is given by:

$$(2) \qquad V_\alpha^M(\theta_t) = \max_{n\in[0,1],m\in[0,\alpha+wn+h]} u(\alpha + w(\theta_t)n + h(\theta_t) - m, n) + \beta E[v(mp(\theta_t)/p(\theta_{t+1}))|\theta_t].$$

From this problem let $m_\alpha(\theta_t)$ denote the real money demand of worker $\alpha$ in state $\theta_t$.

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 $V_\alpha^L(\theta_t)$ and is given by

$$(3) \qquad V_\alpha^L(\theta_t) = \max_{n\in[0,1],l\in[0,\alpha+wn+h-\tau]} u(\alpha + w(\theta_t)n + h(\theta_t) - \tau(\theta_t) - l, n) + \beta v(\pi(1 + r(\theta_t)l).$$

From this problem let $l_\alpha(\theta_t)$ be the loan supply of worker $\alpha$ in state $\theta_t$.[16] The return on loans is assumed independent of the future value of $\theta_{t+1}$; risk averse depositors have no incentive to build extrinsic uncertainty or sunspots into their loan contracts. As a consequence, lending through an intermediary shields agents from uncertainty over the future value of the sunspot variable.

Denote the labor supply of worker $\alpha$ by $n_\alpha^s(\theta_t)$. We assume that preferences are such that labor supply is increasing in the wage and the interest rate and decreasing in the initial endowment. Further, assume that consumption in youth is increasing in income and decreasing in the interest rate.

Finally, define

$$\Delta_\alpha(\theta_t) = V_\alpha^L(\theta_t) - V_\alpha^M(\theta_t)$$

which represents the difference in lifetime utility levels for worker $\alpha$ from participating in the two different markets. Thus agent $\alpha$ of generation $t$ will join the intermediation coalition iff $\Delta_\alpha(\theta_t) > 0$. Let $\alpha^*(\theta_t)$ satisfy

$$(4) \qquad \Delta_{\alpha^*}(\theta_t) = 0.$$

[16] Thus, $(l_\alpha(\theta_t) + \tau(\theta_t))$ would represent the total deposits of this agent.

Under our above assumptions, Appendix B (Proof of Proposition 1) shows that there is a unique $\alpha^*(\theta_t)$, given state contingent prices and the cost of joining the intermediary coalition. Worker $\alpha$ will thus participate in the money market if $\alpha \leq \alpha^*(\theta_t)$ and make loans through intermediaries otherwise. 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 $\alpha^*(\theta_t)$ consistent with the observation on the currency/deposit ratio during the Great Depression.

**B. Entrepreneur Decisions**

Entrepreneur $k$ of generation $t$ will take the real wage and the real rate of interest 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 $w(\theta_t)n$ units of the consumption good to pay workers. Thus the entrepreneur would borrow $w(\theta_t)n$ from the intermediary, owe $(1 + r(\theta_t))w(\theta_t)n$ in the following period and have a real profit of $f(n) - (1 + r(\theta_t))w(\theta_t)n$ 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:

$$V_k^B(\theta_t) = \max_n \beta\pi \left[f(n) - (1 + r(\theta_t))w(\theta_t)n\right] - k. \tag{5}$$

The optimizing level of labor demand $n_k^d(\theta_t)$ is given implicitly by:

$$f'(n_k^d) = (1 + r(\theta_t))w(\theta_t)$$

which is independent of both the entrepreneur's fixed cost and the success probability (i.e. $n_k^d = n^d$ for all $k$). Thus, lenders cannot use the demand for labor by firms as a way to sort entrepreneurs.

Entrepreneur $k$ chooses to produce iff $V_k^B(\theta_t) > 0$ or $k < k^*(\theta_t)$ where $k^*(\theta_t)$ satisfies

$$V_{k^*}^B(\theta_t) = 0. \tag{6}$$

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

**C. Market Clearing**

Using the above critical values of $\alpha^*(\theta_t)$ and $k^*(\theta_t)$, we can state precisely the conditions for market clearing in the money, bond and labor markets. Money market clearing requires

$$\int_{\underline{\alpha}}^{\alpha^*(\theta_t)} m_\alpha(\theta_t) dH(\alpha) = \frac{M(\theta_t)}{p(\theta_t)} \tag{7}$$

where $M(\theta_t)$ is the stock of nominal money balances in state $\theta_t$.

The loan market clearing condition is

$$\int_{\alpha^*(\theta_t)}^{\bar{\alpha}} l_\alpha(\theta_t) dH(\alpha) = \int_{\underline{k}}^{k^*(\theta_t)} w(\theta_t) n_k^d(\theta_t) dF(k). \tag{8}$$

Loan supply incorporates the savings decision of those workers with high endowments and loan demand incorporates the extensive margin of producers in that not all entrepreneurs will be active.

The condition for labor market equilibrium is

$$\int_{\underline{\alpha}}^{\bar{\alpha}} n_\alpha^s(\theta_t) dH(\alpha) = \int_{\underline{k}}^{k^*(\theta_t)} n_k^d(\theta_t) dF(k). \tag{9}$$

In general, both labor supply and labor demand will depend on the interest rate $r(\theta_t)$.

**D. Stationary Sunspot Equilibria**

We now define a stationary sunspot equilibrium.

DEFINITION 1. *A* stationary sunspot equilibrium *is characterized by* $\{p(\theta), r(\theta), w(\theta), h(\theta), n(\theta), m(\theta), l(\theta), \tau(\theta), k^*(\theta), \alpha^*(\theta)\}$ *for all* $\theta$ *such that: (i) all agents optimize (i.e. (2)-(6)), (ii) all markets clear (i.e. (7)-(9)), (iii) the government budget constraint is satisfied (1), and (iv)* $\tau(\theta) = \Gamma/\#d(\theta)$ *where* $d(\theta) \equiv (\bar{\alpha} - \alpha^*(\theta))$.

We characterize stationary sunspot equilibria in several steps. First we show that given $\tau$ a steady state equilibrium exists and that ($\alpha^*$, $k^*$) is unique. Second we provide a sufficient condition for the economy to have multiple steady states. Third, we prove that if there are multiple interior steady states, there exists a stationary sunspot equilibrium. Finally, we show that the degree of financial institution participation is increasing in the money growth rate.

A steady state equilibrium is a stationary sunspot equilibrium in which variations in confidence do not matter (i.e. $\Pr(\theta_{t+1} = \theta_i | \theta_t = \theta_i) = 1$). We consider steady state equilibria with passive monetary policy (i.e. $g_t = 0, \forall t$) so that all relative prices and the cost of intermediation are constant. Then,

PROPOSITION 1. *Given* $\tau$*, there exists a steady state equilibrium.*

**Proof.** See Appendix B.

We characterize multiple steady states as a fixed point problem in ($\tau$,$\#d$) space, as in Figure 1. Here $\tau$ determines the participation rate in the intermediation coalition ($\#d$) through the choices of agents, and participation determines $\tau$ through the sharing of the fixed cost ($\tau = \Gamma/\#d$). Note that variations in $\tau$ have a direct effect on the participation decision of agents as well as an indirect effect through the dependence of the equilibrium prices on $\tau$.[17] Multiple steady states correspond to multiple values of $\tau$ satisfying $\tau = \Gamma/\#d(\tau)$, where $\#d(\tau)$ denotes the fraction of agents in the intermediary coalition given $\tau$.

The next proposition establishes a sufficient condition for multiple equilibria.

PROPOSITION 2. *If there exists a steady state with active intermediaries, then there exist multiple steady states with active intermediaries.*

**Proof.** See Appendix B.

The proof rests on one of two elements: the existence of an equilibrium without intermediation and the continuity of the $\#d(\tau)$ function. Note that in this result, one of the equilibria may be nonmonetary in that all agents join the intermediary coalition.

Figure 1 illustrates an example with two interior steady states. One satisfies the fixed point problem where $\tau(\theta_o) = \Gamma/\#d(\tau(\theta_o))$ and another where $\tau(\theta_p) = \Gamma/\#d(\tau(\theta_p))$, with $\tau(\theta_o) < \tau(\theta_p)$. 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 $\#d$ function do not alter the number of equilibria. These multiple fixed points are possible since the level of intermediated activity $\#d$ ultimately falls as $\tau$ rises and gets large as $\tau$ approaches zero.

Given the potential of multiple steady states, it is relatively straightforward to construct sunspot equilibria by randomizing across the neighborhoods of these two steady state

[17] The direct effect is easy to characterize: holding $w$ and $r$ constant, $\Delta_\alpha$ is decreasing in $\tau$ since $V_\alpha^M$ is independent of $\tau$ and by the envelope condition $\frac{dV_\alpha^L}{d\tau} = -u_c(c^L, n^L) < 0$. However, the indirect effects through the equilibrium prices are not easy to determine.

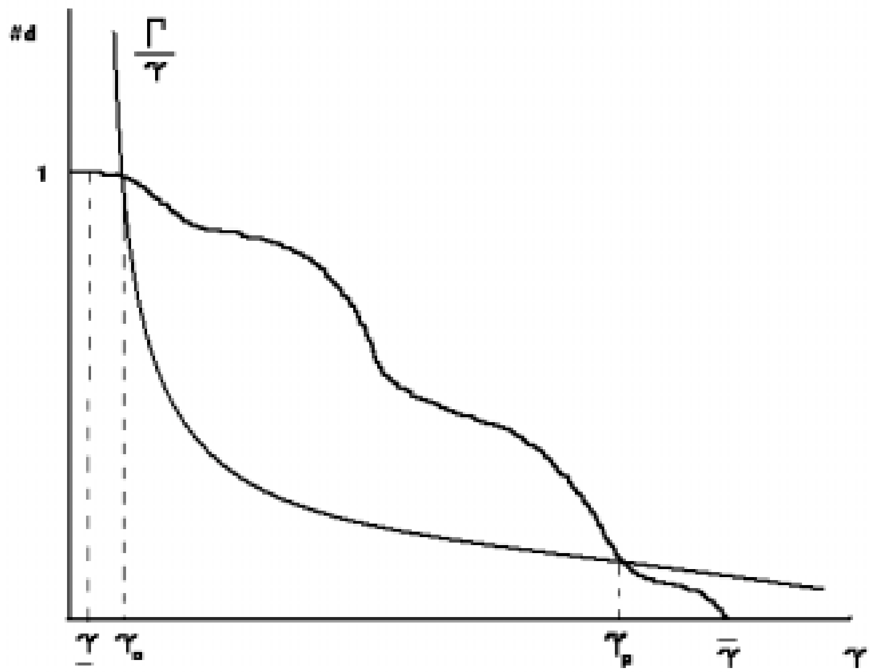


Figure 1: Multiple Steady State Equilibria

equilibria as in Cooper-Ejarque [1995] and Chatterjee-Cooper-Ravikumar [1993]. We find

Proposition 3. *If there are multiple interior steady states, then there exists a stationary sunspot equilibrium.*

**Proof.** See Appendix B.

Next, we turn to the effects of policy on participation. It is simple to show that the direct effect of a rise in the money growth rate (fall in the return to money) induces agents to join the financial coalition, holding general equilibrium effects of money growth on wages and interest rates fixed.

Lemma 1. Holding $w$ and $r$ fixed, $\#d$ is increasing in $g$ for a given $\tau$.

**Proof.** See Appendix B.

The general equilibrium effects are less straightforward because participation in the financial coalition induces variations in both interest rates and wages. In order to isolate the effects of monetary policy on financial markets, in the next proposition we provide a sufficient condition on preferences which eliminates wage variation. In this case, the proposition shows that government provision of liquidity induces households to enter the financial coalition.

Proposition 4. *With preferences such that labor supply is sufficiently elastic with respect to the wage rate and inelastic with respect to the interest rate, financial coalition participation ($\#d$) is increasing in the money growth rate ($g$) for a given $\tau$.*

**Proof.** See Appendix B.

As we show in Figure 1, this proposition implies that the $\#d(\tau)$ shifts out as $g$ increases so that the set of equilibria depends on government policy. However, this proposition suggests an intriguing question: does there exist a sunspot contingent monetary policy which eliminates financial fragility? In the next section, we present an extended example of an economy with multiple steady states and thus sunspot equilibria. The example rests upon preferences that fall in the class of Proposition 4. Here we find that indeed expansionary policy can support an equilibrium with thick financial markets and high real activity.

## 5. Confronting the Great Depression: An extended example

The basic facts of the Great Depression during the 1930-33 period are well documented: the rise in the currency/deposit ratio from 0.086 in October 1929 to 0.227 in March 1933 (see Table B3 in Friedman-Schwartz [1963]), the 35% fall in velocity from 1929 to 1933 (see Table A5 in Friedman-Schwartz [1963]), the increased ex post real interest rate on short term government bonds from 7.4% in 1929 to 11.3% in 1930 and 1931 (see Table 2 in Hamilton [1987]), the reduction in bank loans/output of 10% from January 1930 to February 1933 (see Table 1 in Bernanke [1983]), and the drop in the loan/deposit ratio from 0.86 in September 1929 to 0.73 over the period from January 1930 to February 1933 (see Table 1 in Bernanke [1983]). Coupled with the financial collapse, real output fell by approximately 36% from a peak in 1929 to a trough in 1933, and employment fell by nearly 25% (see Cole-Ohanian [1999] for a thorough review of the business cycle facts during the 1929-39 period). Finally, wholesale prices fell by nearly 33% (see Friedman-Schwartz [1963], p. 300).

To illustrate the workings of the model and to link it to the Great Depression, we consider sunspot 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 in the absence of government intervention in the money market. We then relate the properties of our example to observations from the Depression and find that our simple framework is able to capture a number of important aspects of this episode. Finally, we end with an analysis of active monetary policy.

**A. Parametric Assumptions**

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

$$(10) \quad n_t^d = \left[\frac{\xi\Psi}{w_t(1+r_t)}\right]^{\frac{1}{1-\xi}}.$$

Finally, since firms must borrow to finance wage payments, their loan demand is $w_t n_t^d$. 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

$$(11) \quad \ln\left(c_t^t - \frac{n_t^{1+\gamma}}{1+\gamma}\right) + \beta E_t \ln\left(c_{t+1}^t\right)$$

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

$$(12) \quad n_t^s = w_t^{\frac{1}{\gamma}}.$$

Note that the elasticity of labor supply with respect to the real wage is given by $1/\gamma$ and that labor supply is independent of $r_t$.

Given a real wage ($w_t$) and a real return on savings ($r_t$), if a household joins the intermediation coalition, its loans are[18]

$$(13) \quad l_t = \frac{\beta(\alpha - \tau_t)}{1+\beta} + \phi w_t^{\frac{1+\gamma}{\gamma}}$$

where $\phi = \beta\gamma/[(1+\beta)(1+\gamma)]$ and $\alpha$ is the endowment. In this expression, $\tau_t$ 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 (12) and money demand is given by

$$(14) \quad m_t = \frac{\beta\alpha}{1+\beta} + \phi w_t^{\frac{1+\gamma}{\gamma}}.$$

For this example, suppose there are three types of households. Let type $i$ have endowment level $\alpha_i$, 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 only households with sufficiently high endowment levels will join the intermediary. To characterize these equilibria, let $H_i$ be the fraction of households with an endowment level equal to or bigger than $\alpha_i$, and let $\mu(\alpha_i)$ be the mean endowment level for these households.[19]

## B. Multiple Steady States

For our example, there are multiple steady states thus illustrating a version of Proposition 2.[20] The first is an optimistic ($\theta_o$) equilibrium: type 1 households hold money while types 2 and 3 join the intermediary, and all firms produce. The second is a pessimistic ($\theta_p$) equilibrium: only type 3 households join the intermediary, and only type 1 firms produce.

[18] In subsections (5.B)-(5.C), $h_t = 0$, $\forall t$.

[19] For example, $H_2 = A_2 + A_3$ and $\mu(\alpha_2) = A_2\alpha_2 + A_3\alpha_3$.

[20] Interestingly, this example has discrete types, and thus the continuity we used in Proposition 2 does not hold here. Still, there is a fixed point argument by Tarski [1955] which relies on monotonicity rather than continuity. In our application, the key is that as $\tau$ increases, there may be jumps in the participation rate, but these are always downward. Thus these jumps do not prevent intersections with the $\tau = \Gamma/\#d$ relationship.

When there is a confidence crisis, $\theta_p$ is realized and costs of intermediation are higher. This is possible iff the number of depositors during a period of crisis is lower since then the low level of intermediated activity will translate into higher intermediation costs through the thick markets externality. Likewise, during periods of optimism, the increased number of depositors implies that each pays a lower fixed cost.

While these steady states differ in terms of participation decisions (where $(\alpha^*(\theta), k^*(\theta))$ induce proportions of the population who participate in the loan market $(H_{\alpha^*}(\theta), F_{k^*}(\theta))$), the equilibrium interest rates and wages (as functions of $(H_{\alpha^*}(\theta), F_{k^*}(\theta))$) satisfy

$$(15) \quad 1 + r(\theta) = \Psi\xi(F_{k^*}(\theta))^{1-\xi} \left[ \frac{\left(\frac{1+\beta}{\beta}\right)(1 - \phi H_{\alpha^*}(\theta))}{\mu(\alpha^*(\theta)) - \Gamma} \right]^{\frac{\gamma+1-\xi}{1+\gamma}}$$

and

$$(16) \quad w(\theta) = \left[ \frac{\Psi\xi(F_{k^*}(\theta))^{1-\xi}}{1 + r(\theta)} \right]^{\frac{\gamma}{1+\gamma-\xi}}.$$

It is thus easy to see that an equilibrium with high household participation at intermediaries will imply, from (15), low interest rates because the fraction of agents participating in loan activity $(H_{\alpha^*})$ and the flow of loans $(\mu(\alpha^*))$ will both be large. The effect on interest rates may be offset by higher firm participation $(F_{k^*})$. From (16), 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 $\Delta(\theta)$ is the difference in utility between making loans and holding money. For this example,

$$(17) \quad \Delta(\theta) = (1 + \beta) \ln \left( 1 - \frac{\tau(\theta)}{\alpha + \omega(\theta)} \right) + \beta \ln (1 + r(\theta))$$

where

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

and $\tau(\theta) = \Gamma/H_{\alpha^*}(\theta)$. From (17), we again see the cutoff property: given $(w(\theta), r(\theta), \tau(\theta))$, only agents with sufficiently large endowments will join the intermediary since the utility differential is increasing in $\alpha$.

The optimistic equilibrium with household types 2 and 3 joining the intermediary coalition arises if (17) is positive for endowment levels $\alpha_2$ and $\alpha_3$. This condition is evaluated with $\tau = \Gamma/H_{\alpha_2}$, using $H_{\alpha_2}$ 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.[21] 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 0.079 to 0.233. As noted above, it rose from 0.086 to 0.227 in U.S. data. The model overpredicts the drop in velocity (65% in the model versus 35% in the data). Further, for our model, the interest rate on loans rises from 8.6% to 10.1%, 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% by 1933. While the model does not include government debt, we use this return as measuring the opportunity cost of intermediated bank loans to

[21] The values used for the wealth distribution and the verification cost were chosen to minimize a weighted difference between simulated and actual moments. The moments chosen, under optimism and pessimism, were real interest rates, currency/deposit ratios, deflation, output growth, and velocity growth.

firms, given that the default risk, $(1-\pi)$, in our example is essentially zero. The model also predicts a gap between loan and deposit rates (average across all depositors) of about 1.05% in the optimistic steady state and 1.22% in the pessimistic steady state.[22]

Table 1

Steady State Values

| Variable | Optimism (model,data) | Pessimism (model,data) |
|---|---|---|
| real interest rate % | $(8.6, 7.4)$ | $(10.1, 11.3)$ |
| currency/deposit | $(0.079, 0.086)$ | $(0.233, 0.227)$ |
| loan/deposit | $(0.990, 0.860)$ | $(0.989, 0.706)$ |

**Parameters:** $\Gamma = 0.0055$, $[k_1 = 0, k_2 = 0.06]$, $F_1 = 0.95$, $\gamma = 0.05$, $\pi = 0.995$, $[\alpha_1 = 0.23, \alpha_2 = 0.25, \alpha_3 = 12]$, $[A_1 = 0.36, A_2 = 0.55]$, $\beta = 0.9$, $\xi = 0.9$, $\phi = 1.11$.

Table 2

% Change: Optimism to Pessimism

| Variable | (model,data) |
|---|---|
| deflation | $(61, 33)$ |
| velocity | $(-65, -35)$ |
| $\Delta$loans/output | $(-12, -10)$ |
| production | $(-11, -36)$ |
| real wages | $(-0.6, -9)$ |

[22] The gap between loan and deposit rates is given by $r(\theta) - r^d(\theta) = \left[\frac{\Gamma}{\sum_i A_i l_i}\right](1 + r^d(\theta))$. This gap is not as large as reported by Bernanke [1983] between corporate and government bonds, though our model does not include large default risk ($\pi = .995$).

Associated with these financial market changes are movements in prices and output. In our example, real output is about 11% 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 61%, which exceeds that of about 33% observed in the U.S. In fact, the deflation that arises in our model could be added to a Fisher/Bernanke-Gertler "debt-deflation" structure in order to obtain larger impacts on output. We note however, that unlike the Bernanke-Gertler [1989] paper, which takes an exogenous fall in nominal prices as the starting point, our model delivers endogenous price movements.

The model produces a 12% decline in loans relative to output in the pessimistic state.[23] Bernanke [1983, Table 1] shows that the average change in loans relative to personal income fell by 10% between September 1929 and February 1933. Further, despite the financial collapse in the model, the ratio of loans to output generated by our simulation is essentially independent of the sunspot variable, consistent with the evidence reported by Cole-Ohanian [1999, Table 10] from 1929 to 1933. Evidently, this aspect of their evidence is consistent with a model of financial collapse driven by expectations.

Finally, given the specification of technology and preferences, wages do not vary much in our example relative to observation: i.e. they fall by 6/10 of 1%. For our firms, the real cost of labor is $w(\theta)(1 + r(\theta))$, and this did increase under pessimism, but less than 1%. Cole-Ohanian [1999, Table 11] report that while real wages in manufacturing rose between

[23] Specifically, $(L_p - L_o)/Y_p$ where $L_s$ denotes total loans in state $s \in \{o, p\}$ and $Y_p$ denotes output in the pessimistic state.

1929 and 1932, those in nonmanufacturing actually fell and that economywide, the real wage was about 9% below its 1929 level in 1933. Also, 5% of the firms (in particular "small" firms with high fixed costs of operation) chose 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 (i.e. $\Gamma = 0.0055$). From the intermediation technology, the ratio of loans to total deposits ($D$) is simply $1 - \Gamma/D$ where $\Gamma$ is the fixed cost of operating the intermediary. For our equilibria, the loan deposit ratio is about 0.99. Thus the fixed cost is actually a very small part of the flow of deposits: only about 1% of deposits are used to finance the operations of the intermediary.

How can this small fixed cost produce multiple equilibria? The key is the middle 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 small fraction of the population with high income.

**C. 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.

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).[24] 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 3.

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 $\Sigma_{oo} \geq 0.99$ while $\Sigma_{pp} \geq 0.5$. Thus the pessimistic state need not be very persistent, though the optimistic state is fairly persistent, and thus switches to pessimism (such as a Great Depression episode) are relatively infrequent.

It is simple to explain the impact of the sunspot variable in terms of simple supply and demand curves. In the pessimistic state, loan supply is lower than under optimism because the per capita fixed cost of intermediation rises so that households substitute into currency.

[24] This is a crude way to model variations in expectations. See Lagunoff and Schreft [1998] for a forward looking model of expectations formation that admits fragility.

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. 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 are given in 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.

### D. Active Policy Intervention

Given the presence of sunspot equilibria, it is quite natural to think about the design of stabilization policy. The question we address is whether there exists an active monetary policy that would have eliminated the pessimistic equilibrium.[25] In the context of the debate over the Great Depression, this analysis can be viewed as an evaluation of the argument, attributed to Friedman and Schwartz [1963], that active monetary intervention would have curtailed the loss of output associated with the Great Depression.

[25] In contrast, there are also stabilization policies that work through agents' expectations to eliminate certain undesirable equilibria. The well-known example of deposit insurance falls into this class of policies. In our case, the government could promise to cover a part of the cost of operating the intermediary. For example, the government could offer to reimburse agents for any payment of the fixed cost of intermediation above $\tau(\theta_o)$. This is essentially a promise to add liquidity to the banking system in the event that deposit flows are low. Suppose that the government has the ability to commit to this policy and can either print money or raise the required tax revenues from taxes on workers. The policy is feasible, in our example, since the minimal endowment exceeds the cost of intermediation. Then starting from a candidate equilibrium of pessimism, a representative agent will want to deviate and accept the better terms offered by the government. This will destroy the pessimistic equilibrium. Of course, in equilibrium, the government policy is never utilized.

A monetary expansion leading to positive nominal transfers influences the relative gains to participating in the two different markets in our model. Clearly, the money creation enhances the utility of agents participating in the loan market since they bear none of the current or future inflation tax. However, for agents using money as a store of value, this policy represents a tax and thus creates an incentive to save through the intermediary. In the specific example of the previous section, we show that a modest rate of money creation would have been sufficient to overcome the pessimistic sunspot equilibrium.[26]

In particular, we suppose that the monetary authority injects/withdraws money into the economy as a function of the sunspot variable. The resulting lump sum real transfer/tax, denoted by $h(\theta)$, is distributed to young workers before their portfolio choice (i.e. these transfers are made to all agents regardless of their market participation).[27] It is convenient to describe the government policy in terms of the growth rate of the money supply (denoted $g(\theta)$). This growth rate and the lump sum transfer are linked:

$$h(\theta) = \frac{g(\theta)M}{p(\theta)}$$

where $M$ denotes the money supply at the start of a period.

It is easy to see how this policy would affect the asset market participation decision of agents. Consider the difference in utility levels between joining the intermediary and holding

[26] In a sample consisting only of crisis countries, Boyd-Gomis-Kwak-Smith [2000] provide evidence that inflation increases in at least one of the 3 years preceding the crisis, then falls during and after the crisis. Our model is not inconsistent with the possibility of multiple equilibria in an inflationary environment where money growth is positive in all states; for simplicity of exposition we simply chose to set $h(\theta) = 0$ in the baseline.

[27] A more realistic policy, akin to increasing bank reserves, would make the transfers contingent on coalition participation. Such a policy, however, may not be informationally feasible (as endowments are private information, transfers would have to be incentive compatible). Furthermore, even if feasible, it would only strengthen our results (i.e. imply an even smaller rate of money creation is necessary).

money given pessimism. For the preferences given in the previous example, the differential is

$$
\begin{aligned}
\Delta(\theta_p) &= (1+\beta)\ln\left(1-\frac{\tau(\theta_p)}{\alpha+h(\theta_p)+\omega(\theta_p)}\right) \\
&\quad +\beta\ln\left(\frac{p'(\theta_p)^{\Sigma_{\theta_p\theta_p}}p'(\theta_o)^{\Sigma_{\theta_o\theta_p}}}{p(\theta_p)}\right)+\beta\ln\left(1+r(\theta_p)\right)
\end{aligned}
$$

where $p'(\theta)$ denotes next period's price level in state $\theta$.

A positive monetary transfer of $h(\theta_p)$ increases this differential for two reasons. First, the leading term rises since costs of participating relative to real wealth fall as $h(\theta_p)$ rises. Second, there is a policy induced inflation even if the sunspot state does not change:

$$
\frac{p'(\theta_p)}{p(\theta_p)} = 1 + g(\theta_p) > 1.
$$

This inflation tax makes the holding of currency less attractive. Together then, the income and substitution effects of a monetary transfer will increase the gains to joining the intermediary relative to holding money. Thus the effects of money growth on participation reflect the direct effects of money growth highlighted in the lemma as well as general equilibrium responses highlighted in Proposition 4.

In the example of the previous section, the monetary authority can avoid the pessimistic output with only a small amount of intervention. If the monetary authority injects a small amount of currency into the system during a downturn (e.g. $g(\theta_p) = 0.01$) while maintaining a fixed money supply during optimistic times (e.g. $g(\theta_o) = 0$), it can eliminate the pessimistic equilibrium since the middle class households switch from holding money to joining the intermediary.

This is a much stronger result than that given in Proposition 4 because here the number of equilibria changes due to monetary policy, illustrated in Figure 2. With zero monetary growth, there are multiple steady states as indicated by the multiple crossings ($\tau_o$ and $\tau_p$) of the $\tau = \Gamma/\#d$ and $\#d(\tau)$ curves. The latter relationship is represented by a piecewise continuous step function given the discrete number of household types. When there is positive money growth, the low participation rate equilibrium disappears as indicated in the figure. The only remaining crossing is $(\tau_o, \#d(\tau_o))$.

## 6. 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 given the lack of a readily identifiable cause for the Great Depression, we find the success of the belief driven fluctuations in the intermediation process compelling.

Besides providing a perspective of the Great Depression through an explicit model of multiple equilibria, the paper contributes to the ongoing debate over interventions during such episodes.[28] Our results are supportive of the view that adding liquidity to the monetary system is stabilizing. In our model, relatively modest expansions of the money supply are sufficient to avoid pessimistic equilibria.

The key to the analysis is a strategic complementarity associated with the intermediation process.[29] The presence of the complementarity reflects the existence of an underlying non-convexity in the screening and monitoring technology. Interestingly, the model does not

[28] In fact, to our knowledge, it is the first to introduce active monetary policy into such a framework.

[29] The conclusions of this paper would remain intact for many other intermediation technologies (e.g. Bryant [1987]) provided the strategic complementarities stressed in Cooper-John [1988] are sufficiently strong.

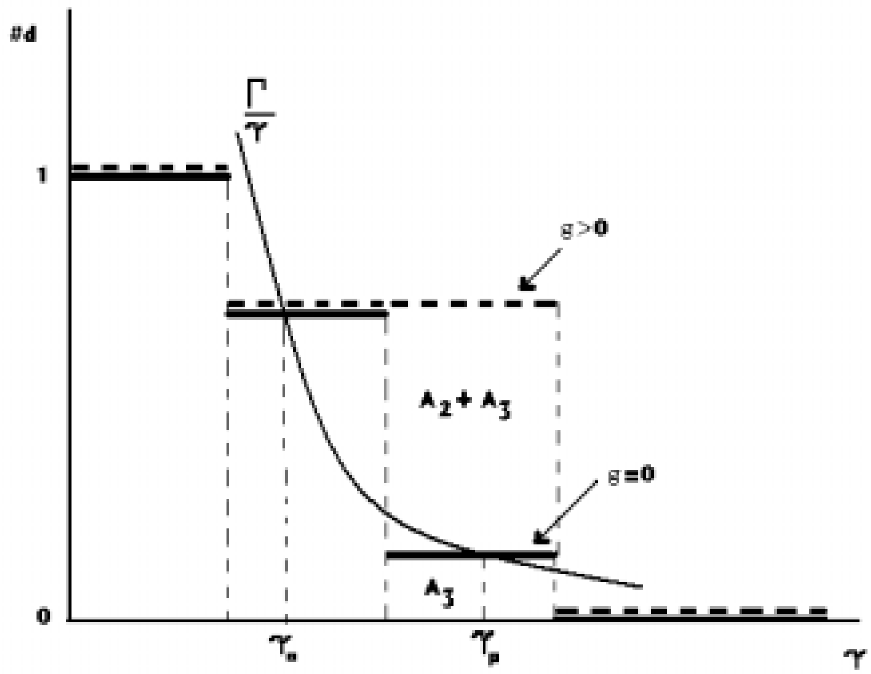


Figure 2: Equilibrium Effects of Active Monetary Policy

require a large degree of increasing returns to generate these results: in our example, the cost of intermediation is less than 1% of production, which is below the value 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. In contrast, we are able to generate sizeable swings in velocity within our costly intermediation framework.[30]

Our approach is to view the intermediary as a coalition which efficiently shares the fixed cost across its members. With this structure, the source of the coordination problem lies in the existence of the fixed cost of intermediation and not in arbitrary restrictions placed on deposit arrangements. An alternative would be to think of the intermediary as offering deposit rates and charging 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.

Further, the model is unable to match some financial observations such as the reduction in the loan/deposit ratio from .86 in September 1929 to .576 in January 1933 and the increased gap between yields on Baa corporate bonds and government debt reported by Bernanke [1983, Table 1]. Because the model lacks government debt and bank reserves, the loan/deposit ratio in our model does not reflect a bank's decision to hold government debt and/or to hold

[30] Hodrick-Kocherlakota-Lucas [1991] show that more general cash-in-advance models are unable to generate realistic predictions about the sample moments of other key endogenous variables when parameters are set to match variability in velocity in post-WWII data.

excess reserves. Moreover, while the model has default risk, it is not linked to real activity. These extensions of the model might be useful in bringing its implications even closer to observations.

Finally, a dynamic version of the Diamond-Dybvig [1983] bank runs model would provide another source of strategic complementarity that could be used to examine the effects of bank runs on the behavior of economic aggregates such as output, employment, consumption, and investment. 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 or disintermediation. This is consistent with Bernanke's [1983, p. 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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## 7. Appendix A

Consider the optimization problem of a given group of depositors utilizing an intermediation technology with a fixed cost of $\Gamma$ 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

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

$$\begin{aligned} s.t. \int_{\alpha\in A} c_{t,\alpha} dH(\alpha) &= Y - \Gamma - L \\ \int_{\alpha\in A} c_{t+1,\alpha} dH(\alpha) &= (1+r)L. \end{aligned}$$

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 $\lambda_\alpha$. 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.

More generally, suppose that the mechanism design problem sets a menu $(r_\alpha, \tau_\alpha)$ such that agents with private information about their endowments self-select. If we restrict $r_\alpha = r$ for efficiency, 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.

## 8. Appendix B

PROPOSITION 1. *Given $\tau$, there exists a steady state equilibrium.*

**Proof.** To prove this proposition, find $(w, r)$ such that loan markets and labor markets clear, (8) and (9), respectively. Given these, there exists a price level clearing the money market, (7). In (8) and (9), 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 the firm's optimal decisions have this cutoff property, note from (5) 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 (2)-(4), $\Delta_\alpha(w, r, \tau)$ is increasing in $\alpha$ as long as the first period consumption for type $\alpha$ holding money exceeds that if $\alpha$ 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 $\alpha$, 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 pair $(W, R)$ 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 $z : P \to P$ 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 $z(\cdot)$ 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, $z(\cdot)$ has a fixed point. Given this $(w^*, r^*)$ pair that satisfies (8) and (9), the left side of the money market clearing condition (7) is determined, and thus the price level $p$ can be chosen to satisfy (7). ■

PROPOSITION 2. *If there exists a steady state with active intermediaries, then there exist multiple steady states with active intermediaries.*

**Proof.** It is clear that with bounded prices, it is always possible to find a large enough value of $\tau$ such that it is not worthwhile for any worker to join the intermediary coalition, in which case the economy collapses to pure monetary exchange with constant real endowments given by $\alpha$. Let $\bar{\tau}= \inf\{\tau : \#d(\tau) = 0\}$ denote the greatest lower bound of the set of costs which result in such monetary equilibria. That is, the pair $(\bar{\tau}, 0)$ is a steady state monetary equilibrium where the intermediaries do not operate since a single agent, acting independently, has no incentive to establish an intermediary coalition.

Next, it is always possible to find a small enough value of $\tau$ such that all workers join the intermediary, in which case the economy collapses to a non-monetary steady state. Obviously, when $\tau = 0$ there is no reason to hold money in our model so that the set of $\tau$ such that all workers join the intermediary is non-empty. Let $\underline{\tau}= \sup\{\tau : \#d(\tau) = 1\}$ denote the least upper bound of the set of costs which result in such non-monetary equilibria.

The proof rests on the continuity of the $\#d(\tau)$ function, which follows from the continuity of the distribution of agents in our economy and the continuity of the value functions (the latter follows from the continuity of preferences). Suppose there exists a steady state with active intermediation where the cost of joining the intermediary is $\tau_p$. The participation function ($\#d(\tau)$) must lie above the cost of the intermediation function ($\tau = \Gamma/\#d$) for $\tau$ near $\tau_p$. Then there are two cases. First, if $\underline{\tau} \geq \Gamma$, then there will exist another non-monetary equilibrium in which all agents participate. Else, $\underline{\tau} < \Gamma$, and while there is no equilibrium with full participation, the continuity of $\#d(\tau)$ implies that there is another crossing of the two curves. ■

PROPOSITION 3. *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 $\Sigma$, where

$$\Sigma_{ij} = \Pr(\theta_{t+1} = \theta_i | \theta_t = \theta_j)$$

for $i, j = o, p$. The optimization conditions by firms and households are taken for a fixed $\Sigma$, 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 $\Sigma_{ii}$ close to 1, for $i = o, p$, there will exist stationary sunspot equilibria. ■

**Lemma 1.** Holding $w$ and $r$ fixed, $\#d$ is increasing in $g$ for a given $\tau$.

**Proof.** $V_\alpha^M$ is decreasing in $g$ by an application of the envelope theorem ($\frac{dV_\alpha^M}{dg} = -\beta v_c m/(1+g)^2 \leq 0$). Since $V_\alpha^L$ is increasing in $h$, $\Delta$ (and hence $\#d$) is increasing in $g$. ■

PROPOSITION 4. *With preferences such that labor supply is sufficiently elastic with respect to* *the wage rate and inelastic with respect to the interest rate, financial coalition participation ($\#d$) is increasing in the money growth rate ($g$) for a given $\tau$.*

**Proof.** First, suppose that labor supply is perfectly elastic with respect to the wage rate and completely inelastic with respect to the interest rate so that $w$ is fixed. By the above lemma, the direct effect of an increase in $g$ leads to an excess supply of loans, putting downward pressure on $r$. The indirect effect of a decrease in $r$, however, offsets the direct effect of an increase in $g$ on $\#d$. Suppose the indirect effects weakly outweigh the direct effects. This is inconsistent with an equilibrium, however, since this contradicts the worker's optimal participation decision. Hence participation must increase with $g$. Second, by continuity, it is always possible to find preferences so that labor supply is sufficiently elastic with respect to the wage and sufficiently inelastic with respect to the interest rate that the above argument holds. ■