"Financial Fragility in a Monetary Economy: Positive Implications and Policy Prescriptions"*

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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 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. From a positive perspective, our model matches quite closely the qualitative changes in some 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. From a normative perspective, we argue that interventions, such as increases in the money supply, are sufficient to overcome strategic uncertainty and thus avoid financial collapse.

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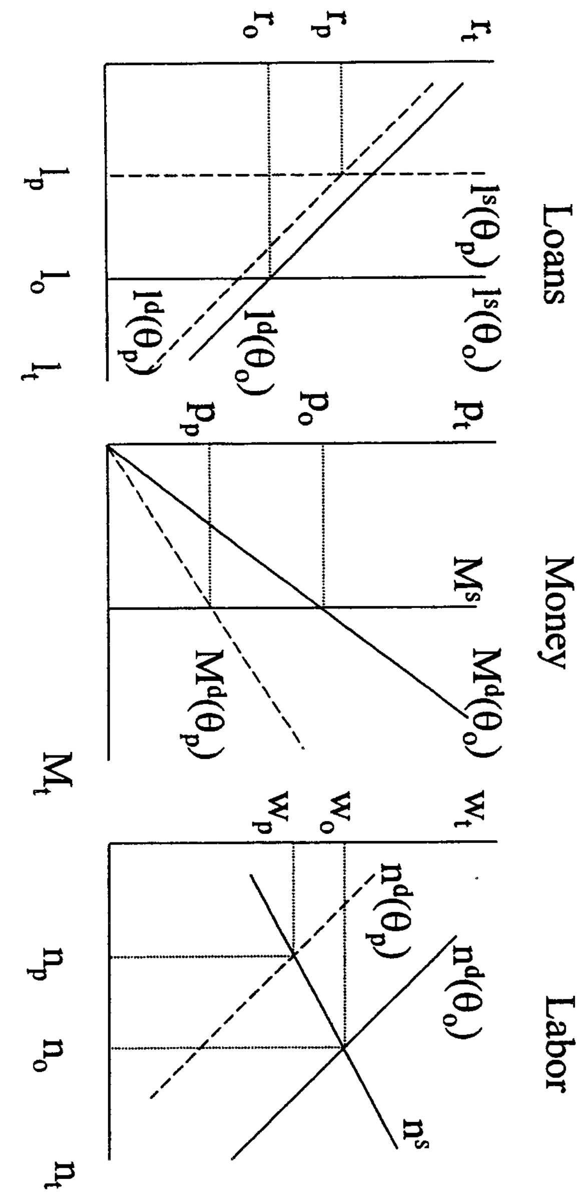
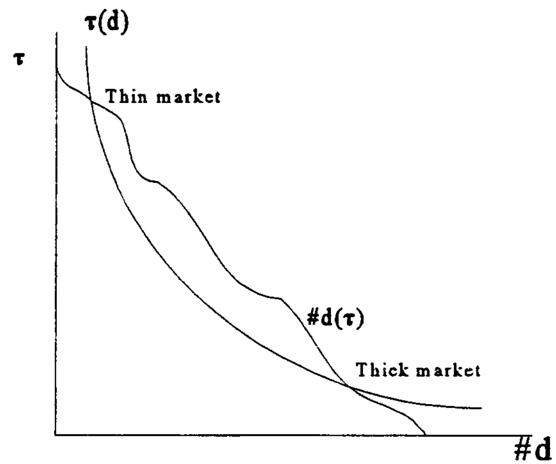


Fig. 2: Market Equilibrium

Figure 1



I. Introduction

A common element in past and recent episodes of financial crises is the collapse of the financial sector, followed by 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 among economists.

The approach of this paper is to focus on the role of shifts in expectations as a source of financial crises. While dynamic, stochastic representations of the fundamentals model are relatively widespread, the real effects of shifts in expectations are much less understood. Thus one goal of this paper is to provide a coherent framework for understanding the real effects of financial fragility and to evaluate policy remedies. Throughout the analysis, we use the U.S. Great Depression as a stark example of financial fragility though our framework is instructive for understanding the more complex financial crises observed in a number of countries over recent years.[1]

Besides providing some insights into the nature of these rather dramatic macroeconomic events, our analysis describes 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. Relatedly, one of the points of debate concerning current currency/financial crises is the nature of the intervention: tight vs. loose money.

[1]The model we construct is closed and hence unable to deal adequately with the complexities created by international capital flows and the associated uncertainty over exchange rates. See Chang and Velasco [1999] for a detailed discussion of modeling financial fragility in an open economy.

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.[2] 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. Moreover, it is interesting to note that Fisher's [1933] "logical" order for his debt-deflation theory of the Great Depression begins with "Mild Gloom and Shock to Confidence."

Throughout this paper, we use the term "financial fragility" to capture the dependence of the intermediation process on the beliefs of agents.[3] The approach, outlined in Sections II and III, rests upon 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-fulfilling.[4]

In these sunspot equilibria, described in Sections IV and V, fluctuations in confidence lead to variations in the efficiency of the intermediation process. The resulting variation in the thickness of the loan market leads to relatively 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 highlighted in the empirical work of Coe [1995], who utilizes the techniques of Hamilton [1989] and argues that the financial flows during the

[2]See Cole-Ohanian [1998] for a recent discussion of competing models of the Great Depression.

[3] Our definition of financial fragility differs from certain others in the literature. Allen and Gale [1998] explore the effect of a zero probability event on an interbank insurance market . Bernanke and Gertler [1990] focus on the interaction between the design of incentive compatible contracts and the wealth level of borrowers. DenHaan, et. al. [1998] examine whether bilateral lending relationships survive when there are exogenous aggregate liquidity shocks which affect the limited liability constraint. Finally, Lagunoff and Schreft [1998] consider an environment with limited diversification which links a finite number of lenders to a project and then evaluate the effect of default within the chain.

[4]This paper thus builds upon the earlier analyzes of Bryant [1987], Diamond and Dybvig [1983] and Weil [1989] which couple strategic complementarity and intermediation. Greenwood and Jovanovic [1990] looks at the participation in intermediated activity in a growth model.

Table 1
Steady State Values

Variable	Optimistic Steady State (model,data)	Pessimistic Steady State (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	0.990,0.86	0.989,0.706

Parameters: $\Gamma=0.0055$, $[k_1=0,k_2=.06]$, $F_1=.95$, $\gamma=0.05$, $[\alpha_1=.23,\alpha_2=.25,\alpha_3=12]$,$[A_1=.36,A_2=.55,A_3=.09]$,$\beta=.9$,$\xi=.9$,$\phi=1.11$,$\pi=.995$

Table 2
% Change: Optimism to Pessimism

Variable	Model	Data
deflation	61	40
velocity	-65	-29
production	-11	-36
real wages	-0.6	16

Table 3
Welfare Gains from Stabilization Policy

worker type 1	worker type 2	worker type 3	worker avg.	firm type 1	firm type 2	firm avg
.00008	.0016	-.00004	.0009	.0013	.0196	.0022

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 $P \equiv \{(w,r) | 0 \le (w,r) \le (W,R)\}$ 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 $z: P \to P$ 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( ) 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 $\text{prob}(\theta_{t+1}=\theta_i | \theta_t=\theta_j)$ 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.

interwar period are best described through a three state Markov process.

An extended example of a sunspot equilibrium, presented in Section VI, allows us to relate our model more directly to the experience of the Great Depression and to address policy intervention. From a positive perspective, we find that our model can match many of the features observed during the Great Depression period. 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.

A final aspect of our analysis, explored in Section VII, is a role for government intervention. Following Lucas [1987, chapter 3], it is commonly argued that the value of stabilization policy is not very large. In our model, we characterize government stabilization policies that would avoid financial fragility. This can be accomplished either through active monetary intervention or through the provision of a form of deposit insurance. For instance, we show that a mild monetary expansion in pessimism, such as that suggested by Friedman and Schwartz [1963], can eliminate the low level equilibrium. We also show that the welfare gains from stabilization policies may affect diverse subsets of households differently. In general, the welfare gains are still surprisingly small.

II. Environment

The model economy closely follows Chatterjee and Corbae [1992] 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 [1995], 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 agents are termed "workers". Workers are also endowed with a heterogeneous amount (α) of the consumption good in youth. We assume that a workers' type is private information. 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.[6]

Workers have preferences over consumption in both periods of life and leisure time in

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

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

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.

More generally, suppose that the mechanism design problem sets a menu (r_α, τ_α) 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.

Lagunoff, R. and S. Schreft, "A Model of Financial Fragility", mimeo, July 1998.

Lucas, R., Models of Business Cycles, New York: Basil Blackwell, 1987.

Margo, R. "Employment and Unemployment in the 1930s," Journal of Economic Perspectives, 7 (1993),41-60.

Moulin, H. "Serial Cost Sharing of Excludable Public Goods", Review of Economic Studies, 61 (1994), 305-25.

Townsend, R., "Optimal Contracts and Competitive Markets with Costly State Verification," Journal of Economic Theory, 21 (1979),265-93.

__________"Intermediation with Costly Bilateral Exchange", Review of Economic Studies, 55 (1978), 417-425.

Weil, P., "Increasing Returns and Animal Spirits," American Economic Review, 79 (1989), 889-94.

Williamson, S., "Increasing Returns to Scale in Financial Intermediation and the Non-Neutrality of Government Policy", Review of Economic Studies, 53 (1986), 863-875.

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 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.[7] Let F(k) denote the distribution of k across the population of entrepreneurs. While the heterogeneity generates

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

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 that 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.[8]

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

[8] The importance of ex ante differences across borrowers forms the basis of the incentive problem in Bernanke and Gertler [1990] and Azariadis and Smith [1998] while the ex post costly state verification problem is essential in Townsend [1979] and Bernanke and Gertler[1989].

43 (1995), 285-323.

Cooper, R. and A. John, "Coordinating Coordination Failures in Keynesian Models," Quarterly Journal of Economics , 103 (1988), 441-64.

DenHaan, W., G. Ramey, J. Watson, "Liquidity Flows and Fragility of Business Enterprise", mimeo, December 1998.

Diamond, D. "Financial Intermediation and Delegated Monitoring," Review of Economic Studies, 51 (1984), 393-414.

Diamond, D. and P. Dybvig, "Bank Runs, Deposit Insurance and Liquidity," Journal of Political Economy, 91 (1983), 401-19.

Farmer, R. and J.T. Guo, "Real Business Cycles and the Animal Spirits Hypothesis," Journal of Economic Theory, 63 (1994), 42-72.

Fisher, I., "The Debt-Deflation Theory of Great Depressions," Econometrica, 1 (1933), 337-57.

Freeman, S., "Banking as the Provision of Liquidity," Journal of Business, 61 (1988), 45-64.

Friedman, M. and A. Schwartz, A Monetary History of the United States, 1867-1960. Princeton University Press: Princeton, N.J., 1963.

Fulghieri, P. and R. Rovelli, "Capital Markets, Financial Intermediaries and Liquidity Supply," mimeo, Kellog Graduate School of Management and IGIER, 1995.

Greenwood, J. and B. Jovanovic, "Financial Development, Growth and the Distribution of Income," Journal of Political Economy, 1990,1076-1107.

Hamilton, J., "Monetary Factors in the Great Depression," Journal of Monetary Economics, 19 (1987), 145-69.

__________, "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle," Econometrica, 57 (1989), 357-84.

Hodrick, R., N. Kocherlakota, and D. Lucas, "The Variability of Velocity in Cash-In-Advance Models", Journal of Political Economy, 99 (1991), 358-84.

Kindleberger, C. Manias Panics and Crashes: A History of Financial Crises, John Wiley and Sons: New York, 1996.

References

Allen, F. and D. Gale "Financial Contagion", mimeo, October 1998.

Azariadis, C. and B. Smith, "Financial Intermediation and Regime Switching in Business Cycles," American Economic Review, 88 (1998), 516-36.

Bernanke, B., "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression," American Economic Review, 73 (1983), 257-76.

Bernanke, B. and M. Gertler, "Agency Cost, New Worth and Business Fluctuations," American Economic Review, 79 (1989), 14-31.

________________, "Financial Fragility and Economic Performance," Quarterly Journal of Economics, 105 (1990), 87-114.

Boyd, J. and E. Prescott, "Financial Intermediary Coalitions," Journal of Economic Theory, 38 (1986), 211-232.

Bryant, J. "The Paradox of Thrift, Liquidity Preference and Animal Spirits," Econometrica, 55 (1987), 1231-36.

Chang, R. and A. Velasco,"Illiquidity and Crises in Emerging Markets: Theory and Practice," NBER Macroeconomics Annual, 1999.

Chatterjee, S., Cooper, R. and B. Ravikumar, "Strategic Complementarity in Business Formation: Aggregate Fluctuations and Sunspot Equilibria," Review of Economic Studies, 60 (1993), 795-811.

Chatterjee, S. and D. Corbae, "Endogenous Market Participation and the General Equilibrium Value of Money," Journal of Political Economy, 100 (1992), 615-46.

Christiano, L. and M. Eichenbaum, "Liquidity Effects and the Monetary Transmission Mechanism," American Economic Review, 82 (1992), 344-53.

Coe, P., "Financial Crisis and New Deal Financial Reform During the Great Depression,"mimeo, University of British Columbia, 1995.

Cole, H. and L. Ohanian, "The Great Depression in the United States from the Neoclassical Perspective", (1998), mimeo.

Cooper, R. and J. Ejarque, "Financial Intermediation and the Great Depression: A Multiple Equilibrium Interpretation," Carnegie-Rochester Conference Series on Public Policy,

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.[9]

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.[10] 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 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.[11]

III. Economic Organization

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[9] 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.

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

[11] Further, we see this model as capturing a complementary 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.

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) 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.[12]

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.[13] 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

[12] In contrast, Cooper and Ejarque [1995] construct their multiple equilibria by allowing regimes with and without monitoring. Azariadis and Smith [1998] also has regimes with and without incentive problems.

[13] 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.

investment.[33] 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.

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

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 less than 1% 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.[32] 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 allocation mechanisms within the financial coalition. 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 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

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

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.[14] 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.

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

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

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.[15] 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 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

[15] 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.

Since these are ex ante welfare calculations, they are certainly dependent upon the transition matrix used to describe the sunspot process. For the above welfare calculations, we used the transition matrix assumed for the example in Tables 1 and 2 characterized by infrequent and quick episodes of pessimism (i.e. Σ_{oo}=.99 and Σ_{pp}=.5). If we raise Σ_{pp}, then the welfare gains to stabilization can be made larger. Another reason for the surprisingly small welfare gains is that while consumption falls in pessimism, leisure rises.

Note also that if the population was to vote on monetary policy they would choose to expand the money supply. Again this reflects the relatively small fraction of type 3 households.

VIII. 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 belief driven fluctuations in the intermediation process quite 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.[31] 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.

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

states. These utility levels are then compared against the utility levels in the optimistic equilibrium.[29] Based on these differences, we determine the compensating differential in consumption such that each type of worker and firm would be indifferent between the optimistic steady state and the ex ante lottery over optimism and pessimism.[30] The results are summarized in Table 3, where an entry is the fraction of steady state consumption that an agent would pay to eliminate pessimism.

Both low income type workers are willing to pay to avoid the sunspot equilibrium. Under pessimism, these households consume less and face the prospect of an inflation in the event the sunspot state changes. Middle income households, which switch from loans to money holding as the economy goes into pessimism, certainly prefer to avoid this outcome since they enjoy higher returns to their savings through the intermediary. Further, once in pessimism, they face inflation risk. Finally, type 3 households actually have to be compensated to stay in the optimistic equilibrium: while their individual costs of participation rise in pessimism, the increase in interest rates more than compensates them. Since type 3 agents comprise less than 10% of the population, a weighted measure of what a "representative" agent would be willing to pay is positive.

For the firms, the type 1 firm is always operating and clearly prefers the low real interest rates prevailing under optimism. Type 2 firms clearly are better off under optimism: this is reflected in their decision to drop out under pessimism.

[29] The calculation is in the spirit of Lucas' upper bound figure (neglecting the costs of implementation).In our case, however, the calculation yields the exact welfare gain from the elimination of the pessimistic sunspot equilibrium in the case of introducing deposit insurance. The calculation does not, however, include the (small) welfare loss from the expansionary monetary policy needed to avoid the pessimistic outcome as described in Section VII.a.

[30] This is similar to the exercise undertaken by Lucas [1987] for a representative agent economy.

described in more detail below.[16]

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 portfolio decision 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:

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

In this optimization problem, $n \in [0,1]$ and $0 \le m \le \alpha + wn$. 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

[16] 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.

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

In this optimization problem, $n \in [0,1]$ and $0 \le l \le \alpha + wn - \tau$. 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

$$\Delta_\alpha(w,r,\tau) = V^l_\alpha(w,r,\tau) - V^{\$}_\alpha(w) \quad (3)$$

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 $\Delta_\alpha(w,r,\tau) \ge 0$.

In the discussion that follows, denote the labor supply of worker α by $n^*_\alpha(w,r,\tau)$. 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.[17]

IV.b. Entrepreneurs.

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 wn units of the consumption good to pay workers. Thus the entrepreneur would

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

actually observed. What is crucial is that the policies be clearly specified, so that agents' can correctly anticipate government intervention, and be credible. The well-known example of deposit insurance falls into this class of policies.

For our purposes, we consider a form of deposit insurance in which the government promises to cover a part of the cost of operating the intermediary. This is a form of deposit insurance insofar as the government is guaranteeing that private agents will not have to absorb too much of the fixed cost of operating the intermediary. In this way, the government creates a floor for the return on deposits.

For example, assume that the government offers to reimburse agents for any payment of the fixed cost of intermediation above $\tau(\theta_o)$. Suppose that the government has the ability to commit to this policy and can raise the required tax revenues from taxes on workers.[28] 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.

VII.c. Gains to Stabilization

Given the stabilizing role of monetary policy and/or deposit insurance, we turn to a discussion of its welfare implications. In particular, we calculate what agents would be willing to pay (as a fraction of their consumption in the optimistic steady state) each period of their life to eliminate the possibility of the pessimistic equilibrium. To do so, we compute the expected utility for households and firms using the stationary probabilities of the two sunspot

[28] The policy is feasible, in our example, since the minimal endowment exceeds the cost of intermediation. Hence, the government can introduce a lump sum tax to cover the entire fixed cost of intermediation.

agents. Consider the difference in utility levels between joining the intermediary and holding money given pessimism. For the preferences given in the previous example, the differential is:

$$\Delta_a(w(\theta_p),r(\theta_p),\tau(\theta_p)) = (1+\beta)\ln\left(1-\frac{\tau(\theta_p)}{\alpha+h(\theta_p)+\omega(\theta_p)}\right)+ \beta\ln\left(\frac{p'(\theta_p)^{\Sigma_{\theta_p\theta_p}}p'(\theta_o)^{\Sigma_{\theta_o\theta_p}}}{p(\theta_p)}\right).$$

The 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 (i.e., $p'(\theta_p)/p(\theta_p)=1+g(\theta_p)>1$). 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.

In the example of the previous section, the monetary authority can avoid the pessimistic output with only a small amount of intervention. In particular, if the monetary authority injects a small amount of currency into the system during a downturn (eg. $g(\theta_p)=0.01$) while maintaining a fixed money supply during optimistic times (eg. $g(\theta_o)=0$), they can eliminate the pessimistic equilibrium.

VII.b. Deposit Insurance

The intervention described above requires an active monetary authority. In contrast, there are also stabilization policies that work through agents' expectations to eliminate certain undesirable equilibria. A key aspect of these policies is that, in equilibrium, no intervention is

borrow wn from the intermediary, owe (1+r)wn in the following period and have a real profit of f(n)-(1+r)wn 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:

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

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 $\Delta_\alpha(w,r,\tau)=0$.[18] 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:

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

where M is the fixed stock of nominal money balances in the economy.[19]

The loan market clearing condition is:

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

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:

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

[19] While we are ultimately interested in the effects of variations in the stock of money, we assume for now that the money stock is constant and evaluate alternative monetary policies in the context of sunspot equilibria.

equilibrium. 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. 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.

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.

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 the young before their portfolio choice. In particular, any agent's resources in youth are now given by $\alpha + w(\theta)n + h(\theta)$. Hence we assume these transfers are made to all agents regardless of their market participation.

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 sump transfer are linked: $Mg(\theta)/[1+g(\theta)]=h(\theta)$, 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 is fairly persistent and thus switches to pessimism (such as a Great Depression episode) are 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 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.

VII. Policy Intervention

Given the presence of sunspot equilibria, it is quite natural to think about the design of stabilization policy. This section discusses two such policies: active monetary intervention and a form of deposit insurance.

VII.a. Monetary Policy

First, we consider the active intervention of monetary authorities. The question we address is whether there exists a monetary policy that would have eliminated the pessimistic

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

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.[20] Given the possibility of multiple steady states, we 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].[21] As in the previous section, we continue to assume that the monetary authority is passive and does not alter the stock of money over time or state.

For each given value of τ, a steady state equilibrium exists from Proposition 1. 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 $(\tau,\#d)$

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[20] 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].

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

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.[22]

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 sufficient 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 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

[22]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. While there are certainly strategic complementarities brought about by the sharing of the fixed cost, the effects of market participation on equilibrium wages and, more importantly, interest rates contains some congestion effects which makes a general statement of multiple equilibria much more difficult. The example in the following section provides an explicit analysis of a sunspot equilibrium.

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 $\Sigma_{oo}\geq.99$ while $\Sigma_{pp}\geq.5$. Thus the pessimistic state need not be very persistent though the optimistic state

Given that the model understates the output effects, the model also predicts a deflation of 61% 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 6/10 of 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 less than 1%. 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 (i.e. $\Gamma=.0055$). 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 0.99.[27] 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.

Why can this small fixed cost produce multiple equilibria? The key is the 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 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

[27] 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.

for the sunspot variable with

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

In this way, we can allow for some persistence in the state of financial confidence.[23]

To construct a sunspot equilibrium, we 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:

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

where θ' is the future value of the sunspot variable. 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

$$V_\alpha^l(\theta) = \max_{n,l}\ u(\alpha+w(\theta)n-\tau(\theta)-l,n)+\beta v(\pi l(1+r(\theta))) \ . \quad (10)$$

Here, wages and the interest rate are contingent on the current value of θ. However, the

[23] We chose the two state sunspot process for simplicity only. For instance, we could 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).

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:

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

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 $\{p(\theta), r(\theta), w(\theta), n(\theta), m(\theta), l(\theta), k^*(\theta), \alpha^*(\theta), h(\theta)\}$ for all θ such that: (i) all workers and entrepreneurs optimize, (ii) all markets clear, and (iii) $\tau(\theta)= \Gamma/\#(d(\theta))$.

Proposition 2: If there are multiple interior steady states and $g(\theta)=0$ for all θ, then there exists a stationary sunspot equilibrium.

Proof: See Appendix B.

Note that this proposition assumes an inactive monetary authority. This is important since the sunspot equilibria are constructed in the neighborhood of the multiple steady states which, in turn, arose in the absence of an active monetary policy. In Section VII, we will turn

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.[25] 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 .079 to .233. As noted in our introduction, it rose from .086 to .227 in U.S. data. Further, for our model, the interest rate rises from 8.6 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% in 1937. The model over predicts the drop in velocity (65% 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 1.05% in the optimistic steady state and 1.22% in the pessimistic steady state.[26] This gap is not as large as reported by Bernanke [1983] between corporate and government bonds.

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.

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[25] The values used for the income 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.

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

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

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 participating 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,

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

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

to the implications of active policy for the existence of sunspot equilibria first in general and then in the context of a specific example.

VI. Confronting the Great Depression: An extended example

The basic facts of the Great Depression 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 occurring 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.

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. 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.

VI.a. Multiple Steady States

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

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

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:

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

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

$$n_t^s = w_t^{\frac{1}{\gamma}}. \quad (14)$$

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

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

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:

$$m_t = \frac{\beta\alpha}{1+\beta} + \varphi w_t^{\frac{1+\gamma}{\gamma}}. \quad (16)$$

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.[24]

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:

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

and

[24] 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.