The Radio and Bank Distress in the Great Depression

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Abstract

I test a coordination game based model of bank runs developed by Angeletos and Werning (2004). I first show that when the fraction of people that receive the public signal increases and the signal is bad, then the number of people demanding their deposits and the probability of a successful attack should increase. I test this prediction using data on the extent of the radio during the high levels of bank distress experienced during the Great Depression. Counties with higher levels of radio penetration rates in 1930 experience higher levels of banking stress between 1930 and 1933. A 10 percentage point increase in radio penetration rates leads to a 4.3 percentage point decline in bank deposits between 1930 and 1933. This correlation remains after controlling for a variety of measures for local economic conditions as well as pre-trends from 1920 to 1930 and an instrumental variables strategy. Though the major distress subsides after 1933, the differential in deposits between counties persists through the end of the sample in 1936.

1 Introduction

At the heart of fractional reserve banking is a troublesome informational asymmetry. Whether or not depositors are worried about illiquidity or insolvency, depositors must deal with the nagging suspicion that they will be left out if others demand their deposits. Information about what other depositors are doing, then, is crucial for making a decision to one's own deposits. In the modern day, rumors swirled about the solvency of Bear Sterns and Lehman often stoked by the financial news media such as CNBC.[1] Yet it has proven very difficult to identify the causal role of those rumors, truthful or otherwise, because it is so hard to sharply identify information flows. History provides an unique setting to address this difficulty by providing major shifts in information flows due to the introduction of new communication technologies. I study one particular case in one

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[1]Some in the popular press have gone so far as to say these rumors *caused* the collapses. See for example "Bringing down Bear Stearns" by Bryan Burrough in the August 2008 issue of *Vanity Fair*.

major period of time: the radio during the Great Depression. I exploit geographic variation in the extent of the radio to identify the effect of the availability of a public signal on bank distress and test a key prediction of a theoretical model of bank runs in the process.

I consider a model developed by Angeletos and Werning (2004) (AW) applicable to a variety of coordination type phenomenon including currency crises and bank runs. The basic setting is as follows. Agents must make a decision of whether or not to "attack" some status quo policy. In the case of a policy of demandable deposits, this attack would take the form of a particular individual demanding his deposits. Whether or not the attack is "successful," in other words, deposit redemptions are suspended, depends on how many people also attack. The number of people that are required for an attack to be successful depends on some (unknown) fundamental θ, the financial position of the bank. All agents receive a private signal on θ. At the same time, agents are divided into two groups: those that own radios (late movers) and those that do not (early movers). The early movers are required to take an action solely on the basis of their private signal. The late movers, besides receiving their private signal, also receive a public signal about the number of early movers that decided to attack. On the basis of both of those signals, they decide whether or not to attack. I prove that if the public signal on the fundamental is bad, then having more people receive the public signal increases the probability of a bank run. While being a rather straightforward result, it is a key prediction from these coordination game models.

In this paper, I provide empirical support for this proposition. I show that county-level penetration rates of the radio in 1930 are a strong predictor of subsequent banking distress between 1930 and 1933 in the form of declines in deposits. The major worry in interpreting these regressions as casual is some omitted variable that drives both radio penetration rates in 1930 and subsequent banking performance. The regressions control for the most obvious alternative channel through which the radio might be correlated with subsequent banking outcomes.: the local economic environment. To this end, I include controls for conditions in agriculture as well as conditions in the non-agricultural labor market in the form of wages and unemployment. Besides these controls for economics conditions, I also include controls relating to population characteristics resulting in a final set of controls similar to that of Strömberg (2004), who studied the role of the radio in the distribution of New Deal spending.

After controlling for all of these factors including regional variation in failure rates, a 10 percentage point increase in radio penetration rates, approximately half of one standard deviation, leads to between a 2.4 and 4.3 percentage point larger decline in deposits between 1930 and 1933. Putting the results in a different perspective, the effect of the radio is about 1/7 of the effect of the unemployment rate in 1930. Eliminating the radio would not have completely staunched the bank runs during the Depression, but it would have reduced the average decline in deposits between 1/6 and 1/11 of the total declines.

I go beyond this basic set of controls to control for a second set of potential omitted variables in the form of pre-trends in economic conditions between 1920 and 1930. A variety of authors have argued that to understand the Great Depression, it is essential to understand what happened during the boom of the 1920s. For example, Field (1992) argues that the slow recovery from the trough in 1933 is due to low levels of construction, which themselves are related to an "uncontrolled" real estate boom during the 1920s. More to my case, Friedman and Schwartz (1971) (FS) emphasize the importance of agriculture in driving banking outcomes during the 1920s and the echoes of the 1920s shakeout for the Depression. Even after controlling for changes in a number of indicators related to agriculture, the basic results remain only slightly changed.

A more direct approach to the issue of lurking variables would be to look for an instrument. To that end, I have employed the instruments for radio penetration rates suggested by Strömberg (2004): ground conductivity and the share of a county's surface area covered by woodlands. In the early days of the radio with the technology still being perfected, local geographic features had large effects on the ability to pick up AM signals and, hence, affected the value of owning a radio. This suggests that these geographic variables will be significant in the first stage. Strömberg argues that they are also valid in the second stage. While it seems plausible that ground conductivity would be uncorrelated with unobservables that drive New Deal spending in his case and bank distress in my setting, it seems much less plausible to think this for the woodlands variable. For the banking case, it is easy to imagine that the share of woodlands is correlated with something like the ease of transportation in a particular county and that the ability to get from one place to another is important for how much distress a bank faces. For this reason, I choose to include woodlands as a control in my main specification. In the IV specification where I only include ground conductivity as an instrument, the coefficient on the radio becomes much larger and retains a high degree of statistical significance. If I follow Strömberg's IV specification exactly including both as instruments, then the point estimate of the effect of the radio remains roughly unchanged but the standard errors are larger and only statistically significant at the 15% level.

I also examine to what extent the effects differ across different periods of time. I find the radio to be an important predictor in the decline between 1930 and 1931 as well as from 1930 to 1932. Furthermore, the differences in banking outcomes generated by the radio during the decline persist through the end of this dataset in 1936. Now the debate over the banking crisis during the Depression has centered on the relative importance of illiquidity and insolvency. Friedman and Schwartz (1971), echoed in Wicker (1996), came down strongly on the side of illiquidity. On the other hand, Calomiris and Mason (1997, 2003b) argue that the importance of illiquidity and contagion has been exaggerated and that poor fundamentals were at the heart of the troubles in the banking sector. Now my paper does not take a stand on what the major source of the banking crisis was. However, the longer run results do suggest that by limiting public information the authorities could have "bought time" to fix up the problems in the banks whatever the source, insolvency or illiquidity.

The study of the effects of mass media has a long history in the social sciences stretching back to its inception. Writing in 1948, Lazarsfeld and Merton posed the question of what are the effects "of a Hollywood, a Radio City, and a Time-Life Fortune enterprise for our society?" Their (tentative) answer was that the effect had been "commonly overstated" though they themselves were sympathetic to the difficult identification question. "Comparisons with other societies lacking these mass media would be too crude to yield decisive results, and comparison with an earlier day in American society would still involve gross assertions rather than precise demonstrations." Since then, social scientists have made great strides in addressing this identification question. Much of this work has addressed the role of media on political outcomes like voting patterns or spending. As noted above, Strömberg (2004) studies the role of radio in changing the allocation of New Deal spending towards areas that are better informed by the presence of the radio. There is a burgeoning literature that has shown how mass media can change beliefs through explicit endorsements (DellaVigna and Kaplan, 2007; Enikolopov et al., 2011; Gentzkow, 2006; Gentzkow et al., 2011) or more subtle means such as increasing the salience of particular political candidates (James M. Snyder and Strömberg, 2010).[2] Research in related fields studies how the media affects

[2]See DellaVigna and Gentzkow (2010) for a fine review of this empirical literature.

people's perceptions of risk in general (see Wahlberg and Sjöberg (2000) for a summary) and in particular cases such as crime (see Garofalo (1981) for a summary).

Research on the effect of media on other more economic forms of behavior has focused mainly on financial markets. Not only does the media provide up to the minute reports on breaking macroeconomic news and rumors, the financial media also offers "experts" giving advice on stocks to buy and sell. For example, Tetlock (2007) finds that investor sentiment reflected in a popular column in the *Wall Street Journal* predicted future stock returns. Given the difficulty in attempting to identify information flows, many authors have identified the non-existence of information flows or information flows without the possibility of trading. In the first case, Cutler et al. (1989) have noted the non-existence of major revelations on many days of large stock price movements. In the latter case, French (1980) examines stock returns on Mondays after the market had been closed for the weekend finding unusually negative returns on those days. Koudijs (2011) studies a case from the 18th century where a particular set of British stocks were traded in both London and Amsterdam. Information regarding these stocks all originated in Britain but had to make it across the North Sea literally on packet boats to be incorporated in the price in Amsterdam.

Research tracing out the effects of information flows on depositor behavior has been more limited. The papers that I am aware of include Kelly and ÓGráda (2000) and ÓGráda and White (2003), which study a particular New York City bank, the Emigrant Industrial Savings Bank, during two runs in the 1850s. The former provides clear evidence on the role of social networks and direct social contact in spreading contagion. They use the fact that newly arrived Irish immigrants from a particular area tended to crowd in the same tenement in New York. During the Panics of 1854 and 1857, the best predictor of whether or not a depositor will withdraw his funds is what county he is originally from. This points to the role of direct communication between individuals in causing people to demand their deposits. The latter paper examines other determinants of depositor behavior finding that uninformed withdrawals were rather limited during this period of time.

2 The Sequential Model of Angeletos and Werning (2006)

I now layout the model of Angeletos and Werning (2006) and derive the theoretical prediction that I test.[3] There is a continuum of agents where each agent i can choose between two actions, either attack and demand their deposits, $a_i = 1$ or not, $a_i = 0$. The payoff from not attacking is normalized to 0 and the payoff from attacking is $1 - c$ if the bank suspends payments and $-c$ otherwise, where $c \in (0, 1)$ is the cost of attacking. The status quo of demandable deposits is abandoned if $A > \theta$ where $A = \int_0^1 a_i di$ is the total number of people that attack and θ is the exogenous fundamental representing the strength of the status quo. The payoff for agent i is then

$$U(a_i, A, \theta) = a_i(\mathbf{1}_{\mathbf{A}>\theta} - \mathbf{c})$$

where $\mathbf{1}_{\mathbf{A}>\theta}$ is an indicator for a regime change.[4]

The key feature of this setup is the existence of strategic complementarities in the sense that the payoff to an agent i attacking is increasing in the average action A. Then going back to Diamond and Dybvig (1983), when θ is common knowledge, there exists a range $\bar{\theta} > \theta > \underline{\theta}$ where both $A = 1$ and $A = 0$ are equilibria.[5] In two important works, Morris and Shin (2002, 2005) took up the question of the value of these public sources of information for coordination games. Following Morris-Shin, rather than assume common knowledge of θ, information is assumed to be imperfect, asymmetric, and private. At the beginning of the game, θ is drawn from an improper uniform prior over the real line. All agents then receive a private signal $x_i = \theta + \sigma_x \xi_i$ where ξ_i is a standard normal that is independent across agents.

In the original Morris-Shin approach, agents also received a noisy *exogenous* public signal regarding the fundamental. Here the term "exogenous" refers to the fact that the amount of information in the public signal is taken to be determined outside of the model. The key innovation in the AW setup is to link the quality of the public signal to the quality of the private signal.[6] In particular,

[3] In an appendix, I consider a different interpretation of the effects of the radio in the context of simultaneous move formulation of this model.

[4] Goldstein and Pauzner (2005) study a global games model specialized to the banking setting.

[5] Note that this range combined with some assumption about the distribution of the fundamental θ gives a way to calculate something like the probability that a run *could* occur, but the model does not require a bank run to occur in this region.

[6] They point out that this idea goes back to Atkeson (2000) commenting on Morris and Shin (2002). He noted that if prices (the public signal, in that case) were fully revealing, then the game would collapse to the Diamond-Dybvig world.

following AW, I assume that a fraction $\mu < 1$ of agents move first based on solely their private signal. Then the remaining $1-\mu$ fraction of agents observes besides their private signal, a public signal y on the aggregate action A_1 of the early movers.

$$y = \Phi^{-1}(A_1) + \sigma_\epsilon \epsilon$$

An attack is successful if and only if $\mu A_1 + (1-\mu)A_2 \geq \theta$.

AW look for a monotone equilibrium in the sense that an uninformed agent attacks if and only if $x_i < x_1^*$ and an informed agent attacks $x_i < x_2^*(y)$.To find the equilibrium, AW proceed in three steps: (1) link the signal regarding A to a public signal on θ, (2) solve the model assuming a particular exogenous public information structure and (3) sub in for the link between the informativeness of public and private signal.

They show that an observation on y is equivalent to observing z,[7] where

$$z \equiv x_1^* - \frac{1}{\sqrt{\alpha_x}} y = \theta - \sigma_x \sigma_\epsilon \epsilon$$

which is a public signal on θ with standard deviation σ_z and precision defined as $\alpha_z = \frac{1}{\sigma_z^2}$. Keep in mind that this defines a negative relationship between θ and y. So large values of y suggest low values of the fundamental θ. Now note that

$$\sigma_z = \sigma_\epsilon \sigma_x \Rightarrow \alpha_z = \alpha_\epsilon \alpha_x$$

This shows that the implied quality of the public signal on θ, $\alpha_z = \frac{1}{\sigma_z^2}$, is increasing in the quality of both the private signal α_x and the exogenous component of the public signal α_ϵ.

The aggregate attack of late agents is then $A_2(\theta, y) = \Phi(\sqrt{\alpha_x}(x_2^*(y) - \theta))$ and the overall attack is $A(\theta, y) = \mu A_1(\theta) + (1-\mu)A_2(\theta, y)$. Now we can define the level of the fundamental just larger for an attack to be successful given y, $\theta^*(y)$ as the solution to $A(\theta^*(y), y) = \theta^*(y)$. Under the assumption of monotone strategies, $x^*(y)$ will solve an indifference relationship where the expected

[7] There are some assumptions discussed in AW required on the variances of the private signal and exogenous component of the public signal that ensures this map is one-to-one.

value of attacking is equal to the cost.

$$\Pr(\theta \leq \theta^*(y)|x^*(y), y) = c$$

At the same time, early agents face a slightly more difficult problem. They have to use their private signal to not only forecast the fundamental but also to forecast the *public signal received by the late agents*. So the threshold x_1^* solves $\Pr(\theta \leq \theta^*(y)|x_1^*) = c$ where y is a random variable with a distribution conditional on x. Now since z and y have the same informational content when the mapping between the two is unique, the dependence z can be integrated out using its conditional distribution to find

$$\int \underbrace{\Phi(\sqrt{\alpha_x}(x_1^* - \theta^*(z))}_{\Pr(\theta \leq \theta^*(z)|x_1^*, z)} \underbrace{\sqrt{\alpha_1}\phi(\sqrt{\alpha_1}(x_1^* - z))}_{Pr(z|x)} dz = 1 - c \tag{1}$$

where $\alpha_1 = \frac{\alpha_x \alpha_\epsilon}{1+\alpha_\epsilon}$.

An equilibrium will be a joint solution for $\{\theta^*(z), x_1^*, x_2^*(z)\}$. AW show the system of equations defining equilibrium can be reduced to computing the solution to two equations. First the expression for x_2^* can be subbed out in the expression for $\theta^*(z)$ to obtain

$$\Gamma(\theta^*(z), x_1^*) = g(z) \tag{2}$$

where

$$\Gamma(\theta, x_1) = -\frac{\alpha_z}{\sqrt{\alpha_x}}\theta + \Phi^{-1}\left(\theta + \frac{\mu}{1-\mu}(\theta - \Phi(\sqrt{\alpha_x}(x_1 - \theta)))\right)$$

and $g(z) = \sqrt{1 + \frac{\alpha_z}{\alpha_x}}\Phi^{-1}(1-c) - \frac{\alpha_z}{\sqrt{\alpha_x}}z$. The second equation is the expression determining the cutoff of x_1^* (eqn. 1).

Now calculate the probability of a run in this setting as

$$Pr(\theta \leq \theta^*(y)|y) = \Phi(\sqrt{\alpha_\epsilon \alpha_x}(\mu\Phi(\sqrt{\alpha_x}(x_1^* - \theta^*(z))) + (1-\mu)\Phi(\sqrt{\alpha_x}(x_2^*(z) - \theta^*(z))) - z)$$

where I have chosen to write the probability on the RHS in terms of z rather than y. From the SCP, it is easy to check that

Proposition 1. *If y is large, then $\frac{\partial A}{\partial \mu} > 0$ and $\frac{\partial Pr(\theta \leq \theta^*(y)|y)}{\partial \mu} < 0$.*

This testable implication is the key prediction of the AW model and many models of bank runs based on coordination games that I will test using the innovation of the radio. The intuition for this result is rather straightforward. It simply says that when the signal on θ is bad (y is large), then if more people hear that signal, there will be a greater chance of a bank run. This proposition has nothing to say about the welfare effects of this change in μ whether or not the radio was broadcasting falsehoods. At the same time, notice that the comparative statics are driven by not just the fact that more people hear a bad signal but that they know that there are more people also hearing the bad signal. The social interaction is driven by the correlated fundamental.

Beyond just the comparative static, what is also of interest is that quantitative magnitude of changes in μ. Consider Figure 4, which shows the effect of changing μ from .02 to .98. As is quite transparent, moving from very few people (μ high) having the radio to almost ubiquitous radio ownership (μ low) has very small effects on the probability on the order of a few percentage points in either direction. This does not seem promising as a quantitative explanation for the empirical results. This issue is not essentially related to the choice of the other parameters $c, \alpha_x, \alpha_\epsilon$. In an appendix, I offer a heuristic argument for why the effects tend to be small.

3 Empirics

3.1 Data and Empirical Specification

To examine the relationship between the spread of information and bank distress, I combine data from the 1930 Census of Population and the FDIC's report on banking between 1920 and 1936 (Federal Deposit Insurance Corporation, 2001).The 1930 Census of Population provides penetration rates of the radio $Radio_i$ across counties measured as a fraction of households owning the radio. To my knowledge, this is the only year that the Census asked this question. Figure 1 shows that there is much variation in county-level penetration rates allowing for the possibility of identifying an effect. At the same time, the 1930s was a time that experienced rapid growth in the prevalence of radios so that by the onset of World War II, radio ownership was nearly ubiquitous in the U.S.

The retrospective FDIC data provide all sorts of information on banking outcomes across counties. I focus on the deposits measure in this paper since changes in this measure provide the clearest empirical analog to the model. Figure 2 shows that the distribution of (log) changes in deposits is left skewed, unsurprisingly, but that the left tail is not particularly heavy. For this reason, I choose to not trim tails in my baseline results though robustness checks suggest that eliminating some of the bigger changes would not materially change the results. Another possible measure of distress would be bank failure rates. As noted by Richardson (2008), the failure rates must be handled with care as the FDIC did not attempt to separate out such things as separate versus permanent closures as well as failed banks that were actually taken over by competitors. Figure 3 shows that an additional problem with using bank failures as the dependent variable is the mass point at no change. This makes linear models potentially unattractive. The deposits measure also has a tighter mapping to theory under the assumption that people withdraw equal amounts. For these reasons, I choose to focus on the decline in deposits in the main specification. I consider the decline in number of banks as a robustness check in an appendix.

I estimate the following regression

$$\Delta \log Dep_i = \alpha Radio_i + X_i \beta + \epsilon_i$$

where $\Delta \log Dep_i$ is the log change in deposits between 1930 and 1933 and X_i is a set of controls that include both state and Federal Reserve district fixed effects. I include both sets of fixed effects since I do not want to identify the effect of the radio off the large variation in bank failures across states stemming from potentially different bank branching restrictions (Carlson and Mitchener, 2009) nor across Fed districts stemming from different discount rates and collateral requirements (Richardson and Troost, 2009). Following Strömberg (2004), I control for a number of variables reflecting local economic conditions. These include the per capita value of agricultural crops and land, as well as unemployment and average retail wage.[8] I also control for some characteristics of the county including total population, population density, share of the population that is black, and two measures of urbanization: (1) an indicator if there are no urban areas and (2) the fraction of urbanized areas in a county. Again this follows the specification in Strömberg (2004). Standard errors are robust, in other words clustered at the level of randomization, the county. I do not weight

[8]To be clear, the "average" wage is, in reality, the per capita amount of total retail wages in a county.

the observations though I consider weighting the regressions by the number of deposits in 1930 as a robustness check later.

Note that all the control variables X_i and the penetration rate $Radio_i$ are from 1930 while the banking variables are for *subsequent* years. I use only 1930 radio data for the simple reason that it is the only year for which I have this information. Using 1930 data also has the feature of using variables that are predetermined relative to the banking distress. This lends plausibility to the claim that I am estimating a causal effect though surely does not establish it. At the same time, clearly, radio penetration rates will not be constant over this period. Instead the underlying assumption is that relative ranks of counties in terms of radio penetration rates remain the same over this period. More in line with this assumption, I will also consider a robustness check where I use the 1930 percentile in the radio penetration distribution as the dependent variable rather than the absolute level of radio penetration rates.

3.2 Main Results

The baseline results for the log change in deposits, $\Delta \log Dep_i$, as the dependent variable are presented in Table 1. As noted above, my preferred specification in column 1 does not trim tails. It shows that a 10 percentage point increase in the fraction of families in a county owning a radio leads to a 0.044 log points greater decline in deposits. This is also statistically significant at the 5% level, almost at the 1% level. To get a sense of the magnitude of this effect, moving from the 25 percentile to the 75th percentile of the radio penetration distribution would entail an approximately 27 percentage point increase in radio ownership rates. Hence, it would imply a roughly 0.12 log point larger decline in deposits relative to the mean decline in deposits of 0.58 log points. This is a fairly sizable effect. At the same time, if we compare this coefficient relative to another control such as unemployment, the effect does not seem too large. In fact, the coefficient on radios is less than 1/7 of the coefficient on unemployment in 1930. Interestingly, the coefficients on the other controls for local economic conditions are rather insignificant. The only one that appears to matter is the rural dummy, which shows that distress was lower in rural regions at least in percentage terms. Columns 2, 3, and 4 show that the result as I vary the set of fixed effects included. The fact that the estimate gets larger in magnitude as I take out fixed effects underlines the importance of controlling for these geographic differences.

Next in Column 5, I control for trends between 1920 and 1930 in the agricultural variables. Many authors writing about the Depression argue that it was in some form a "payback" for what happened in the 1920s. FS emphasize the large swings in the value of farm land due to the beginning and end of World War I and its effects on bank distress in the 1930s.[9] So while it is important to control for the current state of a local economy as I do in the baseline regressions, it may also be important to control for how a particular county got to that level in 1930. The econometric worry is that these trends would simultaneously predict banking outcomes during the Depression and levels of radio penetration at the start of the Depression. Following FS, I focus on agricultural variables and include trends in the per capita value of crops and farm buildings.[10] Even after controlling for these trends, I still find a very large effect of radios though slightly smaller than in the baseline specification in terms of economic magnitude and statistical significance. Still in line with the claims in FS, the history of a given county in terms of the growth in the value of crops and farms are important predictors of its experience during the Depression.

Turning to the trends themselves, both agricultural trends matter, statistically and economically. Somewhat strangely, they matter in opposite ways. Large run ups in the *value of crops* during the 1920s predicts *larger* declines in deposits while large run ups in the *value of farms* during this same period predicts *smaller* declines in deposits. Without direct evidence on farm mortgage debt, it is difficult to offer a definitive explanation. One possible story is as follows. In counties that experience large increases in the value of crops, this leads farmers to leverage up to reap the value of these high prices. This, however, results in greater banking stress between 1930 and 1933 when agricultural prices collapse. Conversely, when the value of farm buildings increase sharply in a given county, this, all else equal, tends to reduce the leverage ratio of farmers in that county. This, then, leads to lower levels of bank distress during the banking crisis of the Depression. It is interesting to note that these somewhat puzzling results are not driven by a multi-collinearity problem between these two variables. In fact, the correlation between the change in the value of crops and the change in the value of farm buildings is a rather minor 0.087.

A more direct approach to addressing the endogeneity question would be to employ an instru-

[9] Others such as Olney (1990, 1999) emphasize the role of "financial innovation" in the 1920s that gave consumers for the first time the opportunity to buy durable goods on credit. All of these authors in one way or another point to the roots of the 1930s in what transpired during the 1920s.

[10] I would have liked to include a trend in unemployment as well, but that data does not appear to exist for 1920.

mental variables strategy as reported. In his paper on the relation between the radio and New Deal spending, Strömberg (2004) suggests using the fraction of area covered by woodlands and ground conductivity [11] as variables that are correlated with radio penetration rates and, at least for for his case, uncorrelated with New Deal Spending. Since the initial technology of radios used AM signals, the ground itself rather than the airwaves was an important medium through which the signals were transmitted. Furthermore, woodlands and other physical impediments such as mountains would also tend to obstruct the signal. The problem, in my view, is that the woodlands variable is not a valid instrument even after controlling for, say, urbanization rates. The reason is that the extent of woodlands could serve as a proxy for the ease of transportation and road networks. This ability to travel large distances would potentially affect the ability of people to demand their deposits. Hence, the woodlands variable could potentially effect the change in deposits directly invalidating the second key requirement for a valid instrument. This is why I have chosen to include the share of woodlands as a control in the baseline specifications. With this potential worry in mind, Column 6 of Table 1 reports the result of an IV regression where I use both variables as instruments. Note that the F-statistic easily clears the level of concern for the presence of weak instruments. The point estimate for the effect of the radio is substantially larger though at the expense of a marginal level of statistical significance (p-value = 0.154). While the statistical significance is slightly less, I consider this further causal evidence for the role of the radio.[12]

One point to keep in mind is the different numbers of observations across different specifications. I lose a few hundred observations to start with because of zero values in 1930 or 1933 and to a lesser extent missing values in those variables. These may be important observations since they are potentially large declines in deposits, but they invalidate the linear model I am estimating. Furthermore, there is missing values in some of the control variables, and this is what leads to a further reduction in the number of observations moving from the regressions without any controls to those with controls. Because of this question about how to deal with zeros, Table 2 reruns the baseline specifications in level changes rather than log changes. I now include the level of deposits in 1930 as an additional control to ensure that larger changes are not simply due to larger banks. I obtain similar results with this variable. Most specifications still show large effects in economic

[11] See the original paper by Strömberg (2004) for background on where these variables come from.

[12] The IV regression not reported here where I only use ground conductivity as an instrument shows a much larger effect of the radio in terms of statistical and economic significance.

terms though there is less statistical significance.

3.3 An Accounting Exercise

To get a sense of the magnitude of the effect, I consider a counterfactual where the radio had never been invented. This exercise makes no assumption about what the fundamental source of bank runs were and should not be interpreted to suggest that radio stations were airing scurrilous stories of panicky depositors demanding their money. The results also should not be interpreted as having welfare implications. At the same time, the results also do not attempt to take into account contagion effects. What I mean by this partial and general equilibrium effects whereby the radio only directly caused a few failures but those failures had spillover effects on other banks. In this sense, my estimates would be an overestimate of the direct effect of the radio. That being said, Calomiris and Mason (2003b) suggest that contagion effects were quite small during this period. In a regression of hazard rates of individual banks on fundamentals and aggregate failure rates at the state-level, they find very little effect from the latter. They are careful to point out that the *existence* of a correlation would not necessarily imply contagion but possibly just correlated fundamentals.[13]The absence of a correlation is more difficult to explain if contagion is present though not impossible.

A further reason to believe that this estimate would be an overestimate is the reshuffling of deposits between banks that almost certainly occurred. These estimates should not necessarily be interpreted as implying that these deposits simply disappeared. Instead it may be that depositors took their funds and moved them to a different bank. If this different bank was located in a different county with, say, low radio penetration rates, then this control group of counties would be affected by the treatment leading me to overestimate the effect. Furthermore, it could be that depositors were actually able to withdraw their funds and put the cash under the mattress. By revealed preference, this is a less preferred situation to the one *ex ante* with a household's wealth on deposit and earning a return, but it would be drastic of overstatement of these losses if the estimate of the radio was interpreted to mean that these declines in deposits were complete losses.

In any case, even with those provisos in mind, I would argue that this accounting exercise provides a useful reference point for interpreting the magnitude of the effects. Taking the baseline

[13]This is the famous reflection problem noted by Manski (1993) in identifying social effects.

OLS effect from Table 1, moving from the average radio penetration rate in 1930 (22%) to no radios would have reduced the decline in deposits by .097 (-.44*.22) log points in the baseline. With an average decline in deposits of .59 log points, eliminating the radio would have not eliminated banking failures, but it would have substantially ameliorated the decline in deposits by a little less than 1/6 of the whole decline. As a lower bound, eliminating the radio would have limited the decline in deposits by something closer to 1/11 of the total decline. Whether or not one interprets this amount as large or small depends on how one interprets the differential impact of the radio on people's level of informativeness. In particular, the question is whether the radio provided a truly new source of information or "filled out" the information set of individuals. The answer to this question depends on the existence of other sources such as newspapers or just other people to talk to, which suggests a split between rural and urban areas in the effects and mechanism of the radio that I explore role. Even in the most limited case, there are potentially other effects of the radio beyond only new information. In particular, scholarly work from the 1940s such as Lazarsfeld and Merton (1948) argued that the medium itself rather than solely the content mattered.

3.4 Effects Over Time

I focus on the total decline from 1930 to 1933 period for the simple reason that this is where the vast majority of the decline in deposits during the Depression is concentrated. Hence, the estimate provides a convenient summary of the effects of the radio. Banking panics, more or less, stopped in March 1933 with FDR's bank holiday and the "stress tests" imposed by the legislation authorizing the FDIC. That being said, the work of Friedman and Schwartz (1971) argued that the collapse in the banking sector during the first half of the Great Depression really came from 4 separate episodes in Fall 1930, Spring 1931, Fall 1931, and Winter 1933. FS believed that all of these panics were liquidity driven rather than related to insolvency and that they were national in scope. The debate since then has turned around these two central claims.

I attempt to examine whether the radio had similar effects across these different subperiods. I defer the discussion of what differences or similarities would mean for the major debates in the literature until later. Unfortunately, because the data are annual, it is impossible to separate the data into the four FS episodes.Instead I estimate the effect between 1930 and 1931 and from 1930 to 1932. At the same time, the FDIC data run all the way through 1936. So I can consider "longer run" effects of the radio, in particular, after the major stresses of the Depression subside. Table 3 reports the results for these three separate periods. For each period, I estimate the baseline specification and another trimming the 1% tails.[14] I find that the vast majority of the total effect between 1930 and 1933 comes from the period between 1930 and 1932 with declines in deposits during both 1930 to 1931 and 1931 to 1932. The relative magnitudes of these two periods appears to depend on the degree of tail trimming.

The fact that the overall effect is mainly in place by 1932 provides some supporting evidence for the my interpretation. Almost no one disagrees with the claim that the 1933 panic was widespread and national in scope. Everyone all across the country was demanding their deposits. In an environment like this, the role for information provided by the radio to foment further panic appears limited. By this point, everyone already knew that banks were suffering severe distress from withdrawals during earlier panic periods and depressed asset pricing. There was very little differential information that the radio could provide. A skeptical interpretation of the limited effect between 1932 and 1933 would be that as we move further away from 1930, the radio penetration rate from that year becomes a worse and worse predictor of radio penetration for the year in question. This leads to a classical error in variables setting where estimates are biased towards 0 as observed in the results. What gives me pause in this interpretation is the fact that many of the other coefficients for the controls, which are also from 1930 and presumably affected by attenuation bias as well, do not change or tend to be larger in absolute value. For example, the effect of the unemployment becomes larger in magnitude. This leads me to believe that the different results for the two subperiods reflect something about the character of the panics.

Columns 5 and 6 show the results for 1930 to 1936. What is evident is that the total effect of the radio through 1936 is basically unchanged from the 1930 to 1933. This means that counties with high radio penetration rates in 1930 still have differentially lower levels of deposits in 1936, three years after the panics have subsided. Due to data limitations, I cannot answer the question of when, if ever, this differential closes though that is of some interest. The question then is how should we interpret these "long-run" results. What they suggest in this case is that whatever the basic source of bank failures, illiquidity or insolvency, reducing information flows during crisis periods can have

[14] Do note that the set of counties used in each of these regressions differs slightly as some counties have zero deposits in some years but not in others. Restricting attention to a consistent minimal set of counties would not appreciably change the results.

relatively long lasting impacts. The logic for why this might be the case even when illiquidity is the main source of failures is quite obvious. In this case, the problem is not with the banks but the people coordinating their actions. Making that more difficult to do through limiting what people know about other people's actions will be beneficial.

The question is why should this matter in the case of insolvency. If a bank is truly insolvent, then limiting what people know about it or what other people are doing should only delay the inevitable. This might lead to smaller declines in deposits now, but eventually the information will be revealed and declines in deposits should then increase. This pay back effect is simply not present in the data. The absence of this phenomenon is suggestive of the elasticity of the meaning of the word "insolvency" during times of crisis. It is also highlights the potential of "buying time," even in the case of insolvency, for recapitalization, as happened under the emergency banking act of 1933. Unfortunately, taken together, all of this discussion suggests that comparing short versus long term effects will not be helpful in disentangling the relative importance of illiquidity versus insolvency.

3.5 Effects across Space

Table 4 reports the effects of radio across counties with different levels of urbanization. I interact the share of urban population with the share of households that own a radio. Columns 1 and 2 show the results for no tail trimming and the 1% tails trimmed. What the results for both show is that the effect of the radio was smaller in more urbanized areas. Note that this is conditional on there being any urban areas in a particular county. The baseline effect is still strongly negative, to be sure, and a county would have to be above the 95th percentile in urbanization rates before the overall effect of the radio was positive. At the same time, there does not seem to be much effect when we use population density in a county. So it seems that

These regressions provide a hint at the mechanism by which the radio mattered. A question that naturally arises is why exactly would the radio matter in big cities with daily or even bi-daily newspapers? It would seem that in these areas that the marginal improvement in the speed of information from the radio would be just that, marginal. The results here are consistent with that view. In completely urban counties, the radio would have had no effect. While, at the same time, the results make clear that the radio was a major improvement in communication technologies for those in rural areas where it would be difficult to obtain up to the minute information from daily local newspapers. The radio here apparently served to coordinate individuals' actions by providing them a truly new means of learning about what was happening around them.

Next in light of the large differences across Federal Reserve districts in terms of discount policy, I examine whether there are differences in the effect of the radio. Figure 5 shows that there are not large differences across districts. In fact, I cannot reject the null that there is no heterogeneity in the effect across districts. This is true in a statistical sense but also in an economic sense with 8 of the effects almost exactly the same as the main effect. The biggest outliers are districts 3 (Philadelphia), 6 (Atlanta), 7 (Chicago), and 12 (San Francisco) where the effects are slightly positive. I have not been able to come up with a commonality to these 4 regions that would explain the differences. Atlanta and Chicago in fact are somewhat of polar opposites in terms of how aggressively they used discount lending to prevent runs. California was one prominent state that actually allowed for branch banking. One of the narrative examples I discuss below actually comes from Philadelphia, and it was a situation where authorities used the radio to plead for calm.

3.6 Placebo Tests

Given the timespan covered by the FDIC data, it is possible to estimate the effect of the radio in periods other than the Great Depression. I would argue that these estimates serve as a falsification test for my hypothesis that the radio spread bad news during the Great Depression. While the 1920s were not a period of complete quiescence, the times of trouble in banking and the broader economy such as the Depression of 1921 never reached the scale and scope of the events that transpired during the Great Depression. One could estimate these effects for a number of different periods during the 1920s and the results are roughly similar across different time spans. Table 5 reports the same six specifications that I used to estimate the effect of the radio for the baseline results where now the dependent variable is the log change in deposits between 1920 and 1923. Now in my preferred specification in column 1, the point estimate is smaller small in magnitude with a very small level of statistical significance. Possibly providing stronger evidence against an effect for this period is the fact that the estimate of the effect is very unstable across specifications. The unconditional correlations with only Federal Reserve district fixed effects in Columns 3. Only with the IV do we see a strongly negative relationship.

Figure 7 shows the results for all 3 year periods that end before 1929. Two thirds of the estimates are statistically insignificant and all are larger than the main specifications. In fact, most of them show a positive relationship with the radio in 1930. This could perhaps be evidence of reverse causality with counties exhibiting the fastest growth in deposits purchasing more radios by 1930. Taken as a whole, I would interpret these results along with the timing results suggesting that the radio and the spread of information is only relevant at certain times. More information is not always and everywhere “bad.” Instead it is only in times of severe stress that “ignorance is bliss.”

3.7 Robustness Checks

Here I consider some robustness checks. Columns 3 and 4 in Table 6 run a weighted regression where I weight counties by the amount of deposits in the county in 1930. This method attaches more importance to what happens in the counties with the biggest amount of deposits in 1930. The coefficient is very little changed in terms of economic magnitude though the statistical significance is slightly decreased. The last two columns use 1929 as a base instead of 1930. Again there are strong effects though mitigated relative to the baseline specification in terms of magnitude and statistical significance. I conclude that these three modifications make minor differences to the baseline effects. In addition, Figure 6 shows the results varying the percentage of the tails trimmed for the dependent variable, the log change in deposits between 1930 and 1933. The red line is the estimate from Column 1 in my main specification and it is clear that we cannot reject the null that all of these different estimates are the same as the main estimate.

In the body of the text, I focus on the effects of the radio on total deposits rather than on, say, the number of banks operating. As noted above, I do this for the main reason that it is much more difficult to interpret the changes in number of banks. A particular bank may disappear for any number of reasons not always related to distress in the form of depositors. In addition, there were all sorts of have way measures instituted during this period of time to slow down deposits such as partial suspensions or bank holidays. These too make it challenging to interpret changes in the number of banks. Finally, the change in deposits provides a tighter link to the theory and the size of the attack. This is related to the issue that there is a mass point at 0 change in the number of banks (see Figure 3). Now these counties almost surely experienced some type of distress during the Depression, just not enough to apparently shut down any banks. By using deposits as a dependent variable, I can still separate out differences in these counties' experiences. Having a mass point at 0 would also be inconsistent with the basic linear specification I employ.

I also consider the effects of the radio on the number of banks. Table 7 reports the results with all of the same controls as the basic specification with deposits as the dependent variable. Overall, the negative effects are still present in similar magnitudes to the deposits case, but there is less statistical significance in the main specifications. I take this at least suggesting that there is nothing inconsistent between these results and the ones using deposits. I would argue that the log change in deposits is a more natural variable to map into the model since it can be though of as whether depositors "run" for their deposits. Whether a bank closes also depends on the fundamental making the relationship a little less tight.

Finally in Table 8, I replace the actual share of households owning a radio with the percentile of a given county in the radio penetration rate distribution. This attempts to address the worry that radio penetration rates obviously change over this period of time while it is more plausible that ranks of counties in terms of radio ownership rates remain constant over this period of time. In this specification as well, the radio has a similar effect to the baseline specification with a move from the 25th to 75th percentile leading to an approximately 0.12 log point greater decline, very close to the baseline result.

4 Narrative Evidence

The effectiveness of the radio in shaping people's actions was studied and understood almost immediately. The Radio Project funded by the Rockefeller Foundation starting in 1937 and led by Paul Lazarsfeld produced a number of studies on effects of mass media. For example, in *The Psychology of Radio*, Cantril and Allport (1935) reported the results of a number of psychology experiments. These showed that actually hearing a piece of news broadcast was more effective in promoting action than reading the same piece of news. Taken together, the studies highlighted the ability of mass media to operate in novel and powerful ways. So it should not be surprising that "by 1937, 70 percent of the American public reportedly depended on the radio for their daily news[, and radio] was also considered a credible media: 88 percent of the American public thought that radio news commentators made truthful reports." (Strömberg, 2004)

In terms of actual examples of the radio's power, there were Roosevelt's famous fireside chats, which in the eyes of many observers at the time, had major effects. I would argue that the power of these chats was mainly to coordinate people's actions. The fact that everyone knew everyone else was listening to them made them that much more powerful than, solely, the content. A more direct example with regards to banks comes from Philadelphia during 1931 where prominent members of the community went out the air to call for calm. "Rabbi Fineshriber made a radio address urging the wisdom of leaving deposits in the banks." (Dewsbury, 1933) The Governor of the Philadelphia Federal Reserve, George Norris, also got on the radio "pleading with the depositors to allow their funds to remain in the local banks." (Dewsbury, 1933) The fact that the radio was used to calm tensions suggest that it would have the power to inflame those tensions as well. Maybe the most famous example of that inflammatory power was Orson Welles' 1938 broadcast of an adaptation of H.G. Wells' *The War of the Worlds*. Reports differed over to what extent people actually believed the report and panicked. However, there were a number of confirmed cases of overloaded circuit boards at police stations and newspapers with some people fleeing their homes in terror. The book by Cantril (1940), another result of the Radio Project, argued that what gave the broadcast its power was not so much the content as it was how it was said.

More broadly, the Great Depression saw a number of incidents that pointed to the role of rumors, sometimes malicious, in exacerbating bank distress. Though not coming from a radio, a classic example of this comes from the *Daily Workers* newspaper that printed a number of articles predicting more bank failures. In response to this, the Fish Committee, tasked to investigate the possible support of communism by people in the United States, noted that there were no laws in place to prevent the spreading of false rumors. In response to this, the House Banking and Currency Committee in February 1931 considered a bill that would have made it unlawful to "circulate false rumors causing the runs on member banks of the Federal Reserve System." This bill was endorsed both by the Treasury and the Federal Reserve Board.

In fact, the Comptroller of the Currency John W. Pole in 1930 had already gone on the record as supporting legislation penalizing the spread false and malicious rumors on the insolvency of particular banks. In a related move in July of 1932, the House and Senate passed legislation amending the Federal Home Act. Under the "Unlawful Acts, and Penalties"subsection 21, an addendum was included specifying penalties and possible jail time for those who made willful false statements regarding the health or value of securities issued by the Federal Home Loan Bank. At the same time, legislation covering all national and Federal Reserve system banks outlawing rumor mongering, satisfactory to the Treasury Department, was passed out of the Banking and Currency Committee but failed in the full House. These issues over information generated much attention in popular press, besides Congressional discussion. Just to give two examples: "Bill Against False Rumors Supported; Capital Bankers Point Out Laxity in Present Laws Over Country: 1930 Life Policies Gain" in the *New York Times* on February 17, 1931; "US to Probe Talk Causing Bank Runs" in the *Washington Post* on April 27, 1933.

Another example from the time on the sometimes pernicious effect of information came from the Reconstruction Finance Corporation. This was setup by the Hoover administration to provide funding to banks, railroads, and other businesses. In the beginning, like borrowing from the discount window, loans from the RFC were confidential. Butkiewicz (1995) argues that these loans initially were very effective in reducing bank failure rates. However, in August of 1932, the Speaker of the House John Nance Garner inserted an amendment into an emergency relief act requiring that the list of loan recipients be made available to the Secretary of the Senate and Clerk of the House. Congress assured Hoover that these lists would be kept confidential, and, of course, they were not. The first list was published by the *New York Times* in that same month. Butkiewicz (1995) provides evidence that this publicity destroyed the effectiveness of the program as it made borrowers most likely to benefit from the funds reluctant to apply for funds.

Examples of the potentially destabilizing role of mass media still appear today. In an article published in the *New York Times* on March 16, 2013 it was reported, "In Nicosia, [Cyprus] a crowd of around 150 demonstrators gathered in front of the presidential palace late in the afternoon after calls went out on *social media* [emphasis added] to protest the abrupt decision [to tax deposits], which came with almost no warning at the beginning of a three-day religious holiday on the island." The effects of new media has not gone unnoticed by regulators. An article in the *New York Times* from April 28, 2013 titled"Twitter Speaks, Markets Listen and Fears Rise" said it all. It discussed the effects on markets of a hoax on Twitter that claimed that President Obama was injured in a bombing of the White house which wiped out $136 in market value of the Dow Jones Industrial Average in instants before recovering. The parallels between the RFC case and the demands for publicity of borrowers from the discount window by Congress and news outlets in the most recent crisis are striking as well. So it seems that even in a time with seemingly ubiquitous information, new sources and slightly faster access to that information can be quite valuable.

5 Conclusion

As noted by Holmström (2012). there are many instances in the history of economic crises where information has been intentionally suppressed. During the Scandinavian banking crisis of 1991 and 1992, toxic assets were placed in better capitalized banks, thereby obscuring the overall quality of the struggling banks. He also relates the prosaic example of De Beers' which forbids purchasers to examine diamonds one at a time. Instead possible purchasers are presented with an opaque bag of diamonds and they must either take it or leave it. Gorton (1985) discusses how clearinghouses before the existence of Federal Reserve often "pooled" groups of banks in times of crisis as a way to obscure the quality of individual banks. On the other hand, in the words of the familiar trope, "Information wants to be free," and this paper has highlighted one innovation that served to free up the flow of information: the radio.

I use this innovation to test an important prediction of a workhorse model of bank runs based on coordination games. In line with the theory, my results suggest that this freer flow of information from the radio did not help stabilize the banking system, but rather exacerbated the banking distress during the Great Depression. The results are quite striking with a 10 percentage point increase in radio penetration rates leading to an approximately 4.4 percentage point greater decline in deposits. Putting it in a different perspective, eliminating the radio would have mitigated the fall in deposits by approximately 1/11 of the total decline between 1930 and 1933 using the lower end of the estimates.

In terms of future research, a useful extension would be to more carefully trace out the role of the radio in informational flows over space and time. So far the work has not specified in detail how the radio mattered and, in particular, what type of information was broadcast. I hinted at one possibility where the radio broadcasts information on bank failures in neighboring counties, and this is what leads people to demand their own deposits. These geographic links could be explored by examining how the spatial correlation across counties varies with the degree of radio penetration. This analysis would extend that of Calomiris and Mason (2003b) who also looked at effects of local overall failure rates on individual banks. Second, the role of the radio in providing up to the minute information is necessarily a high frequency phenomenon. I have had to look for those effects at a lower frequency due to data constraints. However, attempting to exploit higher frequency information on banking distress such as suspension dates from state banking regulator reports would be of some interest.

A second avenue for future research would exploit the fact that the radio is such a strong predictor of banking outcomes *even after controlling for coincident economic conditions.* This suggests that it would provide an excellent instrument for estimating the relationship between economic outcomes and bank failures during this time period. The difficulty is always in identifying the direction of causality. Cole and Ohanian (2004) report that there is no correlation at the state-level between the number of bank failures and subsequent changes in income. However, subsequent work by Calomiris and Mason (2003a) using instrumental variables found large negative effects on economic activity of bank failures.[15] A county-level analysis of the relationship between economic activity and banking outcomes with the use of radio penetration rates as an instrument would potentially provide additional evidence on this crucial question.

Information flows are seemingly at the heart of financial decisions and even more so in times of crisis. Identifying this link has proven difficult with so much information all around us. The slower times of the not so distant past provide a rich set of discrete jumps in communication technology, and those jumps provide a useful lens through which to study this important question.

[15]Ziebarth (2013) considers a particular natural experiment and, too, finds large negative effects.

6 Appendix: The Simultaneous Move Game of Angeletos and Werning (2006)

In this section, I consider interpreting the effects of radio as coming mainly through an increase in the quality of the public signal. This section closely follows AW in deriving the equilibrium outcome. First, equilibrium is defined as

$$a(x,y) \in \text{ argmax } \mathrm{E}[U(a, A(\theta,y),\theta)|I]$$

$$A(\theta,y) = \mathrm{E}[a(x,y)|\theta,y]$$

$$y = \Phi^{-1}(A) + \sigma_\epsilon \epsilon$$

where I denotes the information set of a given agent. For this case, it includes both the private signal x and the public signal y. AW look for a monotone equilibrium meaning agent i attacks if and only if $x_i < x^*(y)$. Then the status quo is abandoned if $\theta \leq \theta^*(y)$ where $\theta^*(y)$ is an object to be determined in equilibrium.

In this case, agents receive a public signal y on the overall attack A, given by

$$y = \Phi^{-1}(A) + \sigma_\epsilon \epsilon$$

As Angeletos and Werning (2006) point out, taken literally this clashes with the simultaneous move structure of the game, but they show that it can be rationalized as the limit of the sequential move game discussed in the body of this paper and the working paper version of their paper (Angeletos and Werning, 2004).[16]

So in a monotone equilibrium, the size of the attack will be given by

$$A(\theta,y) = Pr(x < x^*(y)|\theta) = \Phi(\sqrt{\alpha_x}(x^*(y) - \theta))$$

[16] A richer setup would incorporate the fact that presumably those who move later, in the case of a run, would experience lower payoffs as a result of an assumption of sequential filling of demands for deposits. This, then, would introduce a tradeoff where those that own the radio could either decide to run to the bank early on the basis of a private signal or wait for the public signal on the radio at the expense of potentially being late to arrive at the bank though more certain of what is occurring.

i.e. the fraction of agents who receive a private signal less than $x^*(y)$ given a realized (though unobserved to the agent) value of θ and the public signal y. Now substituting this expression into the expression for the public signal,

$$x^*(y) - \sigma_x y = \theta - \sigma_x \sigma_\epsilon \epsilon$$

where, by definition, $\sqrt{\alpha_x} = \frac{1}{\sigma_x}$. We will return to the question of the uniqueness of this correspondence later.

Under the assumption of monotone strategies, $x^*(y)$ will solve an indifference relationship where the expected value of attacking is equal to the cost.

$$\Pr(\theta \leq \theta^*(y) | x^*(y), y) = c$$

The expected value of attacking is equal to probability that the status quo is abandoned, which happens when $\theta \leq \theta^*(y)$. At the threshold $x^*(y)$, then the expected benefits will be equal to the costs c. In turn, $\theta^*(y)$ is defined as the solution to $A(\theta, y) = \theta$, which is the level of the fundamental θ where given a particular public signal y, the attack is just successful.

The expression for the public signal can be rewritten as

$$\theta = Z(y) + \sigma_x \sigma_\epsilon \epsilon$$

Hence, the posterior for θ given x and $Z(y)$ will be normal with mean $\frac{\alpha_x}{\alpha_x+\alpha_z} x + \frac{\alpha_z}{\alpha_x+\alpha_z} Z(y)$ with precision $\alpha_x + \alpha_z$.[17] Hence,

$$\Pr(\theta \leq \theta^*(y) | x, y) = \Phi \left(\sqrt{\alpha_x + \alpha_z} \left(\theta^*(y) - \frac{\alpha_x}{\alpha_x + \alpha_z} x - \frac{\alpha_z}{\alpha_x + \alpha_z} Z(y) \right) \right)$$

So the indifference relationship reads

$$\Phi \left(\sqrt{\alpha_x + \alpha_z} \left(\theta^*(y) - \frac{\alpha_x}{\alpha_x + \alpha_z} x^*(y) - \frac{\alpha_z}{\alpha_x + \alpha_z} Z(y) \right) \right) = c$$

[17] Remember that AW has assumed that the prior for θ is the improper uniform on the real line. So the posterior simply equals the likelihood.

Now using the definition of $\theta^*(y)$, they find

$$A(\theta^*(y), y) = \theta^*(y) \Rightarrow \Phi\left(\sqrt{\alpha_x}\left(x^*(y) - \theta^*(y)\right)\right) = \theta^*(y)$$

This can be solved for $x^*(y)$ to find

$$x^*(y) = \theta^*(y) + \frac{1}{\sqrt{\alpha_x}}\Phi^{-1}\left(\theta^*(y)\right)$$

Now subbing this expression into the indifference relationship as well as the definition of $Z(y)$, it follows that

$$\theta^*(y) = \Phi\left(\sqrt{\frac{\alpha_x}{\alpha_x + \alpha_z}}\Phi^{-1}(1-c) + \frac{\alpha_z}{\alpha_z + \alpha_x}y\right)$$

Given this value for $\theta^*(y)$, it follows that

$$x^*(y) = \Phi\left(\sqrt{\frac{\alpha_x}{\alpha_x + \alpha_z}}\Phi^{-1}(1-c) + \frac{\alpha_z}{\alpha_z + \alpha_x}y\right) + \sqrt{\frac{1}{\alpha_x + \alpha_z}}\Phi^{-1}(1-c) + \frac{1}{\sqrt{\alpha_x}}\frac{\alpha_z}{\alpha_z + \alpha_x}y$$

We have used the following fact $-\Phi^{-1}(c) = \Phi^{-1}(1-c)$. Summing up, given a value of y, it is trivial to compute the threshold cutoff $x^*(y)$ from the previous expression and in turn to calculate, $\theta^*(y)$. For any value of θ, it is then easy to calculate the size of the attack $A(\theta, y)$. Then given the attack size $A(\theta, y)$, it is possible to calculate the probability of a run as a function of θ by integrating out the random variable y.

6.1 Indeterminacy

Whether or not there exist multiple equilibria depends on whether the mapping between y and z is one to one. As AW show, this question is equivalent to studying the mapping $F(y) = z$ where

$$F(y) = \Phi\left(\frac{\alpha_z}{\alpha_z + \alpha_x}y + q\right) + \frac{1}{\sqrt{\alpha_x}}\left(-\frac{\alpha_x}{\alpha_x + \alpha_z}y + q\right)$$

with $q = \sqrt{\frac{\alpha_x}{\alpha_x+\alpha_z}}\Phi^{-1}(1-c)$. This comes from substituting out for x^* in terms of θ^*. It is clear that $F(y)$ is continuous in y and $F(y) \to -\infty$ as $y \to \infty$ and $F(y) \to \infty$ as $y \to -\infty$. Hence, there must exist a solution and, therefore, an equilibrium. Differentiating the function, AW show that

$$\text{sign}(F'(y)) = -\text{sign}\left(1 - \frac{\alpha_z}{\sqrt{\alpha_x}}\phi\left(\frac{\alpha_z}{\alpha_x + \alpha_z}y - q\right)\right)$$

Now the maximum value that ϕ can take on is $\sqrt{2\pi}$. So if $\frac{\alpha_z}{\sqrt{\alpha_x}} \leq \sqrt{2\pi}$, then F is strictly decreasing and, hence, the solution of $F(y) = z$ is unique. If this condition fails, then there exists an interval $(\underline{z}, \bar{z})$ where there are multiple solutions and, therefore, multiple equilibria depending on the selection rule. It is important to emphasize that the size of the attack will still be uniquely defined. It is only in terms of what agents infer from the signal about the fundamental that is undetermined.

6.2 Non-Fundamental Volatility

Now, this model introduces non-fundamental volatility driven by variation in the public signal unrelated to the fundamental. The information structure dictates how agents will respond to noise shocks, ϵ. AW define non-fundamental volatility in the region of determinacy as $\frac{\partial\hat{\theta}}{\partial\epsilon}$ where $\hat{\theta}(\epsilon) = \theta^*(y(\epsilon))$. Now recall that

$$y = \Phi^{-1}(A) + \sigma_\epsilon\epsilon$$

Parallel to AW, it is easy to check that

$$\frac{\partial\hat{\theta}}{\partial\epsilon} = \frac{\sigma_z}{\sigma_x}\phi\left(\Phi^{-1}(\hat{\theta})\right) = \sigma_\epsilon\phi\left(\Phi^{-1}(\hat{\theta})\right)$$

It follows that $\hat{\theta}$ satisfies a single crossing property[18] with respect to σ_ϵ. Note that in this setting, sensitivity (in the SCP sense) to non-fundamental shocks does not depend on the informativeness of the private shock since θ^* is independent of σ_x. Furthermore, *for a given value of* $\hat{\theta}$, the sensitivity is increasing with the quality of exogenous component of the public signal σ_x.

[18] To be more specific, let ϵ_0 be the unique value for which $\frac{\partial\hat{\theta}}{\partial\sigma_\epsilon} = 0$, then for any ϵ_1, ϵ_2 such that $\epsilon_1 < \epsilon_0 < \epsilon_2$, then $\frac{\partial|\hat{\theta}(\epsilon_2) - \hat{\theta}(\epsilon_1)|}{\partial\sigma_\epsilon} < 0$.

6.3 The Probability of a Run and the Role of the Radio

I can also calculate the probability of a run conditional on a public signal y as

$$Pr(\theta \leq \theta^*(y)|y)$$

where, as before, $\theta|y$ is distributed normal with mean $Z(y)$ and standard deviation $1/\sqrt{\alpha_\epsilon \alpha_x}$. Hence,

$$Pr(\theta \leq \theta^*(y)|y) = \Phi(\sqrt{\alpha_\epsilon \alpha_x}(\theta^*(y) - Z(y)))$$

Now it is straightforward to check that

$$\text{sign}\left(\frac{\partial Pr(\theta \leq \theta^*(y)|y)}{\partial \alpha_\epsilon}\right) = \text{sign}\left[\frac{1}{2}\sqrt{\frac{\alpha_\epsilon}{\alpha_x}}(\theta^*(y) - Z(y)) + \sqrt{\alpha_\epsilon \alpha_x}\left(\frac{\partial \theta^*}{\partial \alpha_\epsilon} - \frac{\partial Z}{\partial \alpha_\epsilon}\right)\right]$$

The behavior of this derivative can be summarized as follows.

Proposition 2. *In the region of determinacy, if y is large enough, then* $\frac{\partial Pr(\theta \leq \theta^*(y)|y)}{\partial \alpha_\epsilon} \geq 0$.

Proof. First, it is easy to check that

$$\frac{\partial Z}{\partial \alpha_\epsilon} = \frac{\partial x^*}{\partial \alpha_\epsilon} = \frac{\partial \theta^*}{\partial \alpha_\epsilon} + \frac{\partial \Phi^{-1}(\theta^*(y))}{\partial \alpha_\epsilon}$$

and

$$\theta^*(y) - Z(y) = \frac{y}{\sqrt{\alpha_x}} - \frac{1}{\sqrt{\alpha_x}}\Phi^{-1}(\theta^*(y))$$

So it remains to check the sign of

$$\frac{1}{2\alpha_\epsilon}[y - \Phi^{-1}(\theta^*(y))] - \sqrt{\alpha_x \alpha_\epsilon}\frac{\partial \Phi^{-1}(\theta^*(y))}{\partial \alpha_\epsilon}$$

Note two more facts

$$y - \Phi^{-1}(\theta^*(y)) = \frac{1}{1+\alpha_\epsilon}y - \sqrt{\frac{1}{1+\alpha_\epsilon}}\Phi^{-1}(1-c)$$

and

$$\frac{\partial \Phi^{-1}(\theta^*(y))}{\partial \alpha_\epsilon} = \frac{1}{2\sqrt{\alpha_\epsilon + 1}}\Phi^{-1}(1-c) + \frac{1}{(1+\alpha_\epsilon)^2}y$$

Putting everything together,

$$\frac{1}{2}\sqrt{\frac{1}{\alpha_\epsilon}}\left(\frac{1}{1+\alpha_\epsilon}y-\sqrt{\frac{1}{1+\alpha_\epsilon}}\Phi^{-1}(1-c)\right)-\sqrt{\alpha_\epsilon\alpha_x}\left[\frac{1}{2\sqrt{1+\alpha_\epsilon}}\Phi^{-1}(1-c)+\frac{1}{(1+\alpha_\epsilon)^2}\right]$$

Then collecting like terms, I have

$$-\frac{1}{2}\Phi^{-1}(1-c)\left[\frac{1}{2}\sqrt{\frac{1}{\alpha_\epsilon(1+\alpha_\epsilon)}}+\sqrt{\frac{\alpha_\epsilon\alpha_x}{1+\alpha_\epsilon}}\right]+y\left[\frac{1}{2\sqrt{\alpha_\epsilon}(1+\alpha_\epsilon)}-\frac{\sqrt{\alpha_\epsilon\alpha_x}}{(1+\alpha_\epsilon)^2}\right]$$

It is easy to see that if $c \geq .5$, then the constant terms is weakly larger than 0 since $\Phi^{-1}(1-c) \leq 0$. Now consider the term multiplying y, the bound on $\alpha_\epsilon, \alpha_x$ for determinacy implies that

$$-\sqrt{\alpha_\epsilon\alpha_x} \geq \frac{1}{\sqrt{\alpha_\epsilon 2\pi}}$$

Hence,

$$\frac{1}{2\sqrt{\alpha_\epsilon}(1+\alpha_\epsilon)}-\frac{\sqrt{\alpha_\epsilon\alpha_x}}{(1+\alpha_\epsilon)^2} \geq 0 \Leftrightarrow \alpha_\epsilon \geq \frac{2}{\sqrt{2\pi}}-1$$

But $\frac{2}{\sqrt{2\pi}}-1<0$ and $\alpha_\epsilon>0$ by definition. Since that term is positive, for y large enough, the second term will be greater than the first term in absolute value. The result is established. $\square$

This result provides one rationale for interpreting the empirical results. The radio increased the quality of the public signal and during the Depression when y was high, the radio exacerbated the problem of bank runs. This echoes the intuition in Dang et al. (2012) where public information is most dangerous when the situation is most dire. The logic for this is the asymmetry in payoffs. When an agent knows that many people are already running, this greatly increases the incentive to run as well. The same incentive does not hold when few people are running, and the strength of this incentive is increasing in the quality of the public signal, α_ϵ. While rationalizing the empirical results, this approach does not exactly fit with the cross-sectional regressions where I really look for the effects of changing the number of people who own the radio. For this reason, I consider the sequential form of the game in the body of the text.

7 Appendix: A Heuristic Argument for the Small Quantitative Effect of the Share Informed μ

The heuristic reason for this comes from the single crossing property of Γ with respect to μ. Consider taking a first order Taylor approximation to θ^* in terms of z about $\tilde{z}$ such that $\theta^*(\tilde{z}) = \tilde{\theta}$.[19] Then $\frac{\partial \theta^*}{\partial z}$ is implicitly defined as

$$-\frac{\alpha_z}{\sqrt{\alpha_x}}\frac{\partial \theta^*}{\partial z} + \frac{1}{\phi(\tilde{\theta})}\left(\frac{\partial \theta^*}{\partial z} + \frac{\mu}{1-\mu}\left[\frac{\partial \theta^*}{\partial z} + \phi(\sqrt{\alpha_x}(x_1 - \tilde{\theta}))\sqrt{\alpha_x}\frac{\partial \theta^*}{\partial z}\right]\right) = -\frac{\alpha_z}{\sqrt{\alpha_x}}$$

which implies that

$$\frac{\partial \theta^*}{\partial z} = \frac{1}{1 - \frac{\sqrt{\alpha_x}}{(1-\mu)\alpha_z \phi(\tilde{\theta})}(1 + \mu\sqrt{\alpha_x}\phi(\sqrt{\alpha_x}(x_1 - \tilde{\theta}))} \equiv \gamma(\mu)$$

Another important property is that $\theta^*(\cdot;\mu,x_1) : \mathbb{R} \to (\theta^L(\mu), \theta^H(\mu)) \subseteq [0,1]$ where

$$\theta^L(\mu) + \frac{\mu}{1-\mu}(\theta^L(\mu) - \Phi(\sqrt{\alpha_x}(x_1 - \theta^L(\mu)) = 0$$

and

$$\theta^H(\mu) + \frac{\mu}{1-\mu}(\theta^H(\mu) - \Phi(\sqrt{\alpha_x}(x_1 - \theta^H(\mu)) = 1$$

It is easy to check that $\frac{\partial \theta^L}{\partial \mu} > 0$, $\frac{\partial \theta^H}{\partial \mu} < 0$ and $\theta^L(0) = 0, \theta^H(0) = 1$.

Now consider

$$\int (\Phi(\sqrt{\alpha_x}(x_1 - \theta(z;\mu_H,x_1)) - \Phi(\sqrt{\alpha_x}(x_1 - \theta(z;\mu_L,x_1)))\sqrt{\alpha_1}\phi(\sqrt{\alpha_1}(x_1 - z))dz$$

Then taking a first order Taylor approximation to $\Phi(\sqrt{\alpha_x}(x_1 - \theta(z;\mu,x_1))$ about $\tilde{z}$, we have two parts to consider. First,

$$\int_{z\in(z^L(\mu^H),z^H(\mu^H))} \frac{1}{\sqrt{\alpha_x}\phi(\sqrt{\alpha_x}(\tilde{\theta} - x_1)}(\gamma(\mu_H) - \gamma(\mu_L))(z - \tilde{z})\phi(\sqrt{\alpha_1}(x_1 - z))dz$$

[19] This $\tilde{z}$ is implicitly defined as $g(\tilde{z}) = -\frac{\alpha_z}{\sqrt{\alpha_x}}\tilde{\theta} + \Phi^{-1}(\tilde{\theta})$ where I have defined the value for $\tilde{\theta}$ above.

and, second,

$$\int_{z \notin (z^L(\mu^H), z^H(\mu^H))} (\Phi(\sqrt{\alpha_x}(x_1 - \theta(z;\mu_H,x_1)) - \Phi(\sqrt{\alpha_x}(x_1 - \theta(z;\mu_L,x_1)))\sqrt{\alpha_1}\phi(\sqrt{\alpha_1}(x_1 - z))dz$$

where $z^H(\mu^H)$ solves $\theta^*(z^H, \mu_L) = \theta^H(\mu^H)$ and $z^L(\mu^H)$ solves $\theta^*(z^L, \mu_L) = \theta^L(\mu^H)$. The first integral is then equal to 0 when $\tilde{z} = x_1$ and $z^H(\mu^H) - z = z - z^L(\mu^H)$. Roughly speaking in this region, because of the SCP, the differences between $\theta^*(z;\mu^H)$ and $\theta^*(z;\mu^L)$ cancel out. For the second integral, note that the difference between $\Phi(\sqrt{\alpha_x}(x_1 - \theta(z;\mu_H,x_1)) - \Phi(\sqrt{\alpha_x}(x_1 - \theta(z;\mu_L,x_1))$ can always be bounded by 1. So that the second integral can be bounded by the probability that $z \notin (z^L(\mu^H), z^H(\mu^H))$. These are tail events so with the thin tails assumption of the normal, this probability will be quite small. Taken altogether, this implies that the integral defining x_1^* is basically unrelated to μ since it only matters through the dependence of θ^* on μ. Then given this, the effect of changes in μ on the probability of a run will be negligible since, in effect, we can redefine the fundamental by subtracting off the fixed size of the attack of the early movers.

References

Angeletos, G.-M. and I. Werning (2004). Crises and prices: Information aggregation, multiplicity, and volatility. NBER WP 11015.

Angeletos, G.-M. and I. Werning (2006). Crises and prices: information aggregation, multiplicity, and volatility. *American Economic Review 96*, 1721–1737.

Atkeson, A. (2000). Discussion of Morris and Shin. *NBER Macro Annual 13*.

Butkiewicz, J. (1995). The impact of a lender of last resort during the Great Depression: The case of the Reconstruction Finance Corporation. *Explorations in Economic History 32*, 197–216.

Calomiris, C. and J. R. Mason (1997). Contagion and bank failures during the Great Depression: The June 1932 Chicago banking panic. *American Economic Review 87*, 863–883.

Calomiris, C. and J. R. Mason (2003a). Consequences of bank distress during the Great Depression. *American Economic Review 93*, 937–947.

Calomiris, C. and J. R. Mason (2003b). Fundamentals, panics, and bank distress during the Depression. *American Economic Review 93*, 1615–1647.

Cantril, H. (1940). *The Invasion from Mars: A Study in the Psychology of Panic*. Transaction Publishers.

Cantril, H. and G. Allport (1935). *The Psychology of Radio*. Harper.

Carlson, M. and K. Mitchener (2009). Branch banking as a device for discipline: Competition and bank survivorship during the Great Depression. *Journal of Political Economy 117*, 165–210.

Cole, H. L. and L. Ohanian (2004). New Deal policies and the persistence of the Great Depression: A general equilibrium analysis. *Journal of Political Economy 112*, 779–816.

Cutler, D. M., J. M. Poterba, and L. H. Summers (1989). What moves stock prices? *Journal of Portfolio Management 15*, 4–12.

Dang, T. V., G. Gorton, and B. Holmström (2012). Ignorance, debt and financial crises. Unpublished, Yale SOM.

DellaVigna, S. and M. Gentzkow (2010). Persuasion: Empirical evidence. *Annual Review of Economics 2*, 643–669.

DellaVigna, S. and E. Kaplan (2007). The Fox News effect: Media bias and voting. *Quarterly Journal of Economics 122*, 1187–1234.

Dewsbury, E. (1932 - 1933). Control of community opinion: A case study of a means of averting bank failures. *Social Forces 11*, 385–391.

Diamond, D. W. and P. H. Dybvig (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy 91*, 401–419.

Enikolopov, R., M. Petrova, and E. Zhuravskaya (2011). Media and political persuasion: Evidence from Russia. *American Economic Review 101*, 3253–3285.

Federal Deposit Insurance Corporation (2001). Federal Deposit Insurance Corporation data on banks in the United States, 1920-1936. ICPSR ed.

Field, A. J. (1992). Uncontrolled Land Development and the Duration of the Depression in the United States. *Journal of Economic History 52*, 785–805.

French, K. R. (1980). Stock returns and the weekend effect. *Journal of Financial Economics 8*, 55–69.

Friedman, M. and A. J. Schwartz (1971). *A Monetary History of the United States: 1867-1960*. Princeton University Press.

Garofalo, J. (1981). NCCD Research Review: Crime and the Mass Media: A Selective Review of the Literature. *Journal of Research in Crime and Delinquency 18*, 319–349.

Gentzkow, M. (2006). Television and voter turnout. *Quarterly Journal of Economics 121*, 931–972.

Gentzkow, M., J. M. Shapiro, and M. Sinkinson (2011). The effect of newspaper entry and exit on electoral politics. *American Economic Review 101*, 2980–3018.

Goldstein, I. and A. Pauzner (2005). Demand-deposit contracts the probability of bank runs. *Journal of Finance 60*, 1293–1327.

Gorton, G. (1985). Clearinghouses and the original of central banking in the United States. *Journal of Economic History 45*, 277–283.

Holmström, B. (2012). The nature of liquidity provision: When ignorance is bliss. Presidential Address, Econometric Society.

James M. Snyder, J. and D. Strömberg (2010). Press coverage and political accountability. *Journal of Political Economy 118*, 355–408.

Kelly, M. and C. ÓGráda (2000). Market contagion: Evidence from the Panics of 1854 and 1857. *American Economic Review 90*, 1110–1124.

Koudijs, P. (2011). The boats that did not sail: News and asset price volatility in a natural experiment. Unpublished, Stanford GSB.

Lazarsfeld, P. F. and R. K. Merton (1948). Mass communication, popular taste, and organized social action. In L. Bryson (Ed.), *The Communication of Ideas*. Harper and Bros.

Manski, C. (1993). Identification of endogenous social effects: The reflection problem. *Review of Economic Studies 60*, 531–542.

Morris, S. and H. S. Shin (2002). Social value of public information. *American Economic Review 92*, 1521–1534.

Morris, S. and H. S. Shin (2005). Central bank transparency and the signal value of prices. *Brooking Papers on Economic Activity 2*, 1–66.

ÓGráda, C. and E. White (2003). The Panics of 1854 and 1857: A view from the Emigrant Industrial Savings Bank. *Journal of Economic History 63*, 213–240.

Olney, M. (1990). Demand for consumer durable goods in 20th century America. *Explorations in Economic History 27*, 322–349.

Olney, M. (1999). Avoiding default: The role of credit in the consumption collapse of 1930. *Quarterly Journal of Economics 114*, 319–335.

Richardson, G. (2008). Quarterly data on the categories and causes of bank distress during the Great Depression. *Research in Economic History 25*, 37–115.

Richardson, G. and W. Troost (2009). Monetary intervention mitigated banking panics during the Great Depression: Quasi-experimental evidence from a Federal Reserve district border, 1929-1933. *Journal of Political Economy 117*, 1031–1073.

Strömberg, D. (2004). Radio's impact on public spending. *Quarterly Journal of Economics 119*, 189–221.

Tetlock, P. (2007). Giving content to investor sentiment: The role of media in the stock market. *Journal of Finance 62*, 1139–1168.

Wahlberg, A. and L. Sjöberg (2000). Risk perception and the media. *Journal of Risk Research 3*, 31–50.

Wicker, E. (1996). *The Banking Panics of the Great Depression.* Princeton University Press.

Ziebarth, N. L. (2013). Identifying the effects of bank failures from a natural experiment in Mississippi during the Great Depression. *AEJ: Macroeconomics 5*, 81–101.

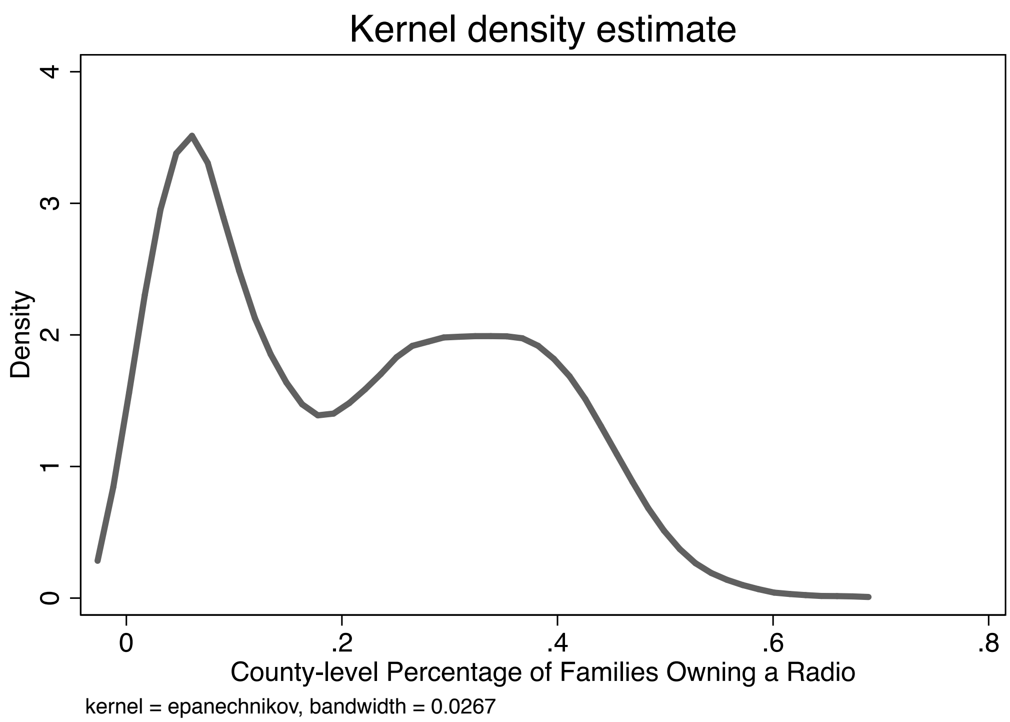

Figure 1: Kernel density of fraction of households that own a radio within a county in 1930.

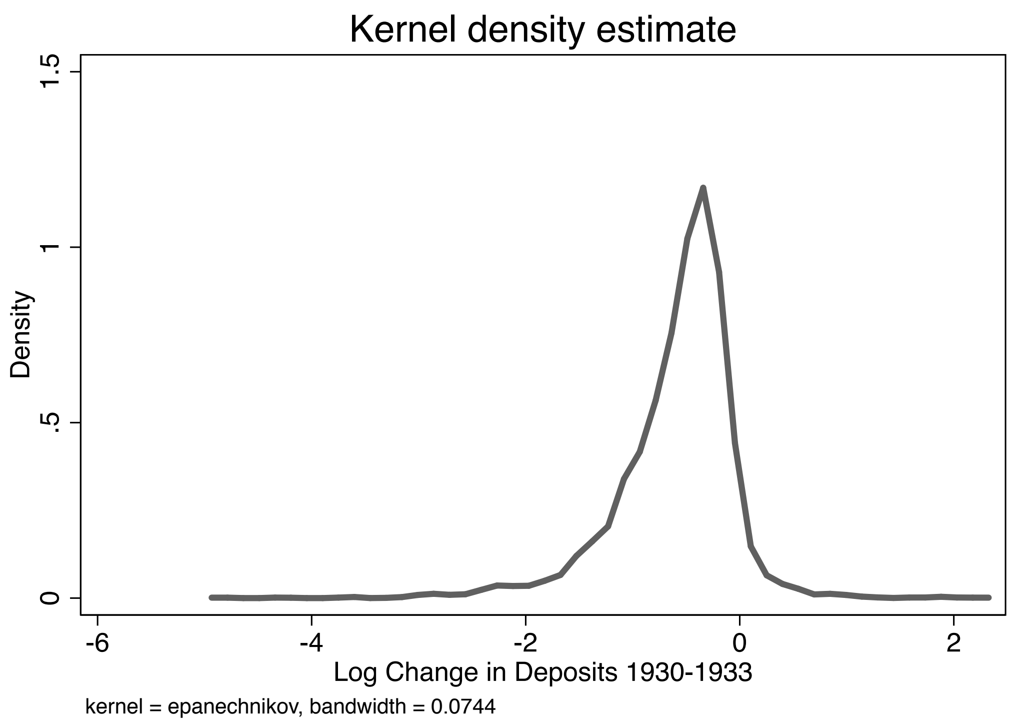

Figure 2: Kernel density of log change in deposits between 1930 and 1933 within a county.

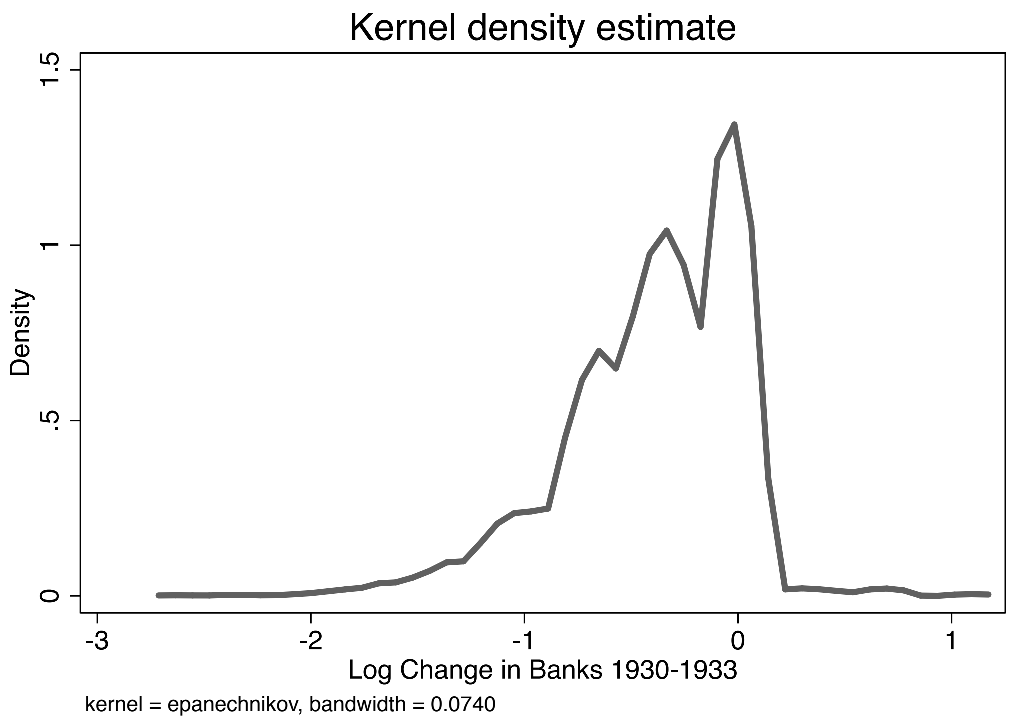

Figure 3: Kernel density of log change in number of banks operating between 1930 and 1933 within a county.

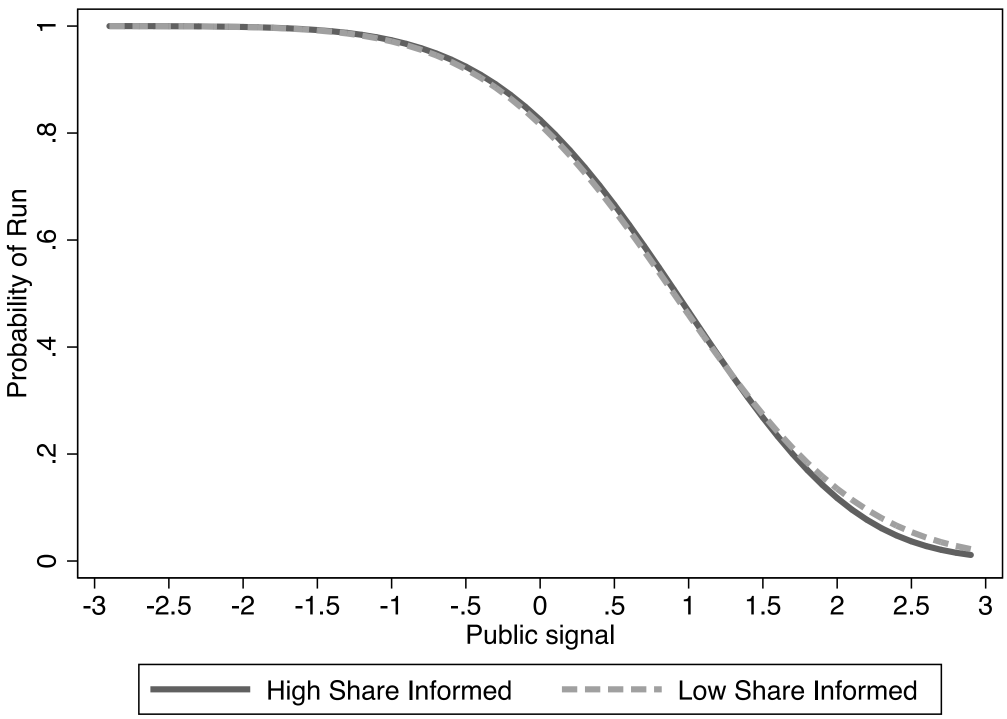

Figure 4: Effects of changing fraction informed μ on the probability of a bank run as a function of the public signal z. For both lines, $c = .2, \alpha_X = .2, \alpha_\epsilon = .2$.

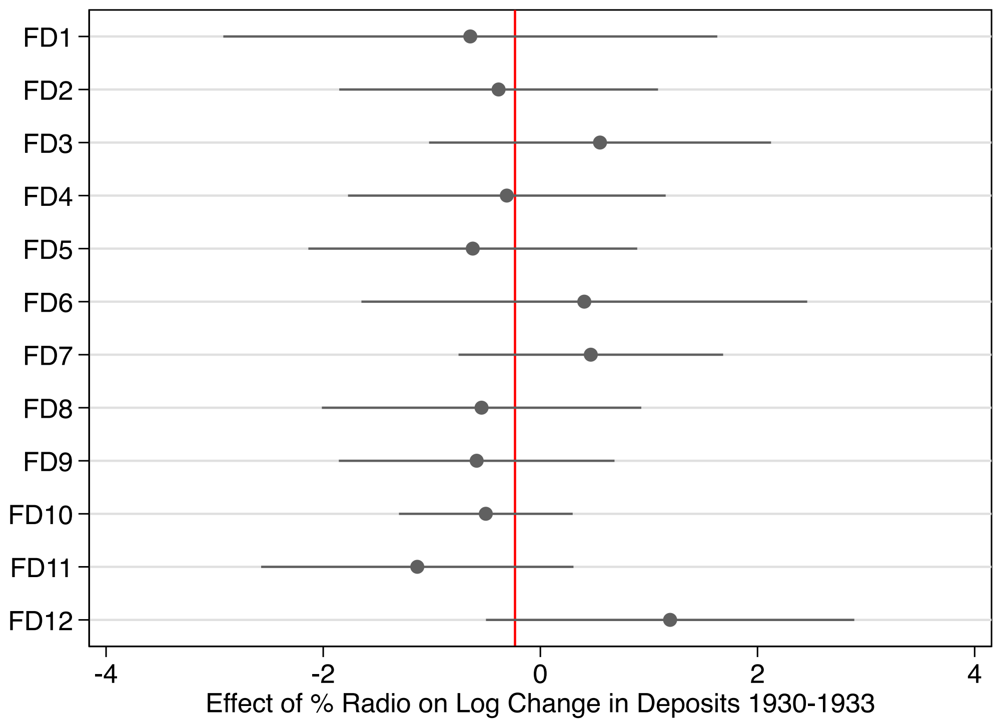

Figure 5: Effects by Federal Reserve district. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. All regressions include state fixed effects.

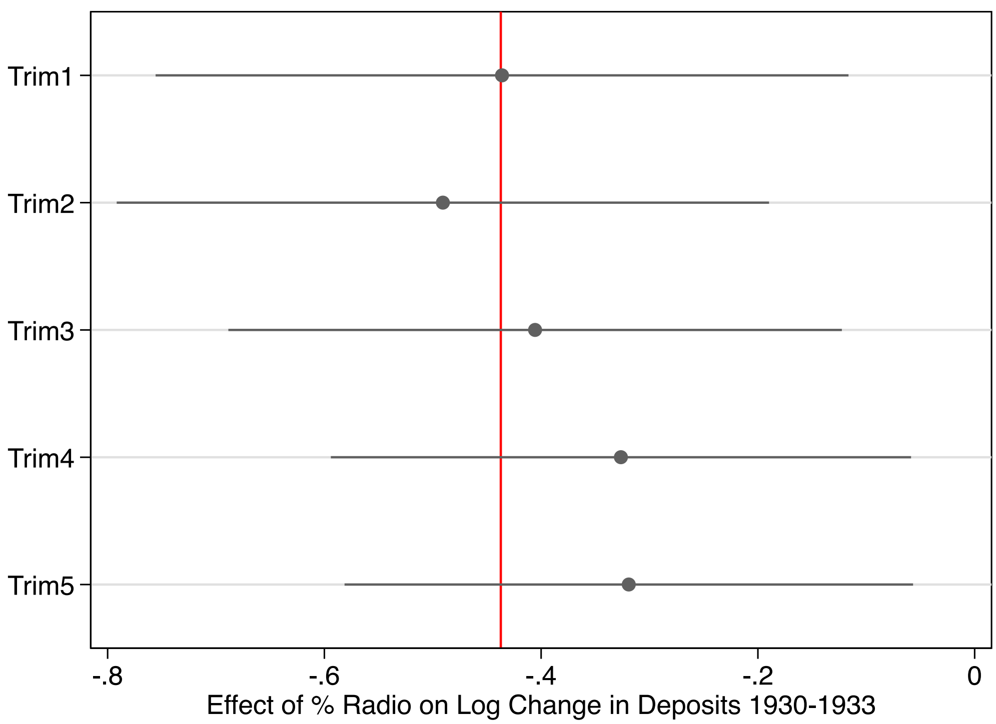

Figure 6: Effect of radio by % of the tails trimmed for log change in deposits, 1930-1933. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. All regressions include state and Federal Reserve district fixed effects.

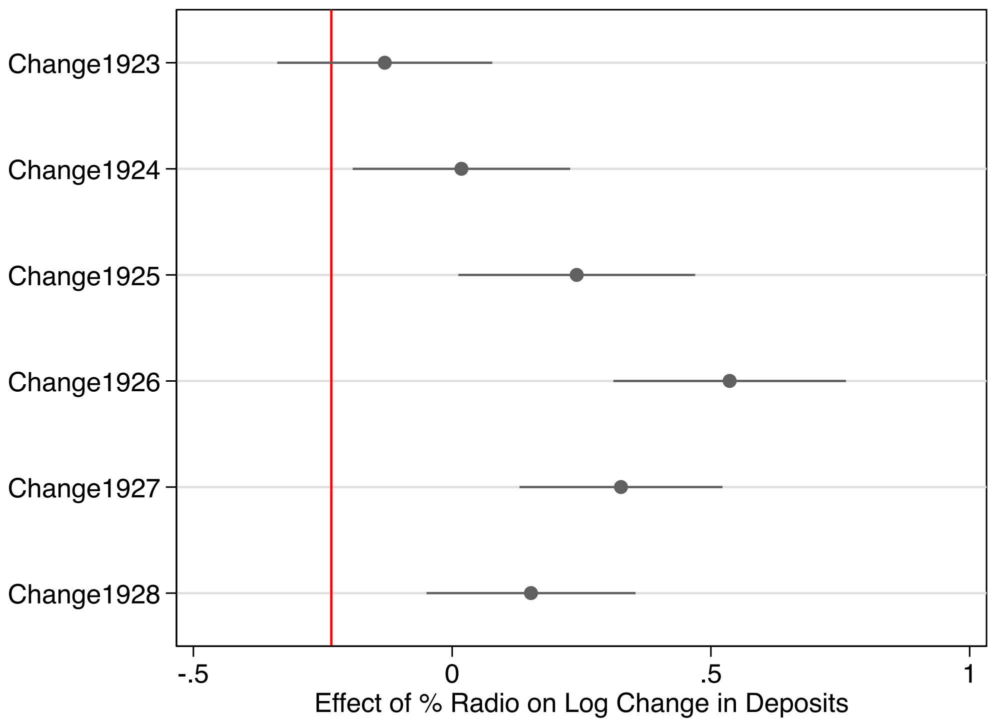

Figure 7: Effect of radio on log change in deposits between year t and $t-3$. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. All regressions include state and Federal Reserve district fixed effects.

	Log Change in Deposits 1930-1933					
	(1)	(2)	(3)	(4)	(5)	(6)
% Radio	-0.44**	-0.47***	-0.80***	-0.90***	-0.31	-0.97
	(0.18)	(0.18)	(0.15)	(0.13)	(0.19)	(0.68)
Share Woodlands	-0.12	-0.12	0.06	0.01	-0.28	
	(0.25)	(0.25)	(0.22)	(0.18)	(0.26)	
Log of Crop Value	-0.03	-0.02	-0.03*	-0.04**	0.03	-0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log of Value of Buildings	0.02	0.01	0.03	-0.01	-0.06*	0.05
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)
Unemployment Rate	-3.53*	-3.66**	-2.97*	-4.88***	-4.33**	-3.33*
	(1.89)	(1.86)	(1.75)	(1.78)	(1.92)	(1.87)
Log Manufacturing Wages	-0.08	-0.08	-0.01	0.05	-0.07	-0.02
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.12)
All Rural Dummy	-0.06*	-0.05*	-0.03	-0.02	-0.05	-0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Log of Population	-0.01	-0.01	-0.01	0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log of Population Density	0.02	0.02	0.03*	0.01	0.00	0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Share Urban	0.13	0.14*	0.20**	0.21**	0.15*	0.19*
	(0.09)	(0.09)	(0.08)	(0.09)	(0.09)	(0.10)
Share Black	0.13	0.15	0.05	0.00	0.11	0.11
	(0.11)	(0.11)	(0.08)	(0.08)	(0.11)	(0.11)
Log Change in Building Values					0.09***	
					(0.03)	
Log Change in Crop Values					-0.09***	
					(0.03)	
Fixed Effects	State, FD	State	FD	None	State, FD	State, FD
IV F-stat	-	-	-	-	-	115.45
Observations	2798	2798	2798	2798	2780	2795
Adjusted R^2	0.171	0.171	0.125	0.077	0.175	-0.015

Table 1: Effect of radio on log change in deposits between 1930 and 1933. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. Fixed effects included are indicated in the table.

	Level Change in Deposits 1930-1933 (10000s)					
	(1)	(2)	(3)	(4)	(5)	(6)
% Radio	-0.85	-0.87	-0.58	-0.08	-0.72	0.78
	(0.60)	(0.58)	(0.50)	(0.43)	(0.50)	(1.23)
Deposits in 1930	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Share Woodlands	-0.76*	-0.77*	-0.75*	-0.35	-0.88**	
	(0.42)	(0.43)	(0.43)	(0.26)	(0.43)	
Log of Crop Value	0.07	0.07	0.05	0.09	0.01	0.09*
	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)
Log of Value of Buildings	-0.18	-0.19*	-0.14	-0.22**	-0.14	-0.26*
	(0.12)	(0.12)	(0.10)	(0.11)	(0.09)	(0.15)
Unemployment Rate	-9.08*	-8.77*	-8.43*	-7.83**	-8.79	-9.53*
	(5.33)	(5.09)	(4.38)	(3.88)	(5.53)	(5.37)
Log Manufacturing Wages	-0.13	-0.14	-0.12	0.09	-0.09	-0.25*
	(0.09)	(0.08)	(0.10)	(0.16)	(0.11)	(0.14)
All Rural Dummy	-0.14	-0.14	-0.11	-0.08	-0.16	-0.18
	(0.15)	(0.15)	(0.15)	(0.15)	(0.16)	(0.14)
Log of Population	-0.33	-0.33	-0.27	-0.20	-0.32	-0.32
	(0.23)	(0.23)	(0.19)	(0.17)	(0.23)	(0.23)
Log of Population Density	0.31*	0.30*	0.26*	0.11	0.30*	0.26
	(0.17)	(0.17)	(0.13)	(0.08)	(0.17)	(0.17)
Share Urban	-0.10	-0.10	-0.04	0.04	-0.15	-0.26
	(0.20)	(0.20)	(0.21)	(0.20)	(0.20)	(0.21)
Share Black	-0.22	-0.21	-0.28*	-0.30*	-0.23	-0.10
	(0.17)	(0.16)	(0.17)	(0.18)	(0.17)	(0.16)
Log Change in Building Values					0.09	
					(0.12)	
Log Change in Crop Values					0.18*	
					(0.10)	
Fixed Effects	State, FD	State	FD	None	State, FD	State, FD
IV F-stat	-	-	-	-	-	117.14
Observations	3008	3008	3008	3008	2982	3004
Adjusted R^2	0.848	0.848	0.847	0.845	0.848	0.839

Table 2: Effect of radio on level change in deposits in units of 10000 between 1930 and 1933. The level of deposits in 1930 is included as an extra control relative to the previous specification. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. Fixed effects included are indicated in the table.

	Log Change in Deposits					
	1930-1931		1930-1932		1930-1936	
	(1)	(2)	(3)	(4)	(5)	(6)
% Radio	-0.30***	-0.17**	-0.40***	-0.33***	-0.47***	-0.33**
	(0.10)	(0.08)	(0.13)	(0.11)	(0.16)	(0.14)
Trim	0	1	0	1	0	1
Observations	2898	2840	2873	2817	2830	2774
Adjusted R^2	0.077	0.098	0.147	0.195	0.201	0.241

Table 3: Comparing the effects of the radio over different time periods, roughly corresponding to the Friedman-Schwartz episodes. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. All regressions include state and Federal Reserve district fixed effects.

	Log Change Deposits, 1930-1933			
	(1)	(2)	(3)	(4)
% Radio	-0.61***	-0.56***	-0.35	-0.36
	(0.20)	(0.19)	(0.47)	(0.50)
Urban * % Radio	0.85***	0.92***		
	(0.30)	(0.31)		
Density * % Radio			-0.01	-0.00
			(0.07)	(0.08)
Trim %	0	1	0	1
Observations	2798	2740	2798	2740
Adjusted R^2	0.172	0.174	0.170	0.171

Table 4: Effect of the radio by urbanization and population density rates. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. All regressions include state and Federal Reserve district fixed effects.

	Log Change in Deposits 1920-1923					
	(1)	(2)	(3)	(4)	(5)	(6)
% Radio	-0.13	-0.12	0.02	-0.17**	-0.03	-1.24***
	(0.11)	(0.10)	(0.08)	(0.08)	(0.11)	(0.37)
Share Woodlands	0.28**	0.28**	0.24*	0.20*	0.18	
	(0.12)	(0.12)	(0.13)	(0.10)	(0.12)	
Log of Crop Value	-0.06***	-0.06***	-0.08***	-0.09***	-0.06***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Log of Value of Buildings	0.04**	0.04**	0.07***	0.08***	0.02	0.10***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Unemployment Rate	1.56	1.54	1.62	1.33	0.67	1.72
	(1.14)	(1.13)	(1.07)	(1.07)	(1.13)	(1.15)
Log Manufacturing Wages	0.06	0.06	0.07	0.07*	0.06	0.16**
	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.06)
All Rural Dummy	-0.02	-0.02	-0.01	-0.02	-0.02*	0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
Log of Population	0.01	0.01	0.01	0.01	0.01	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log of Population Density	0.03***	0.03***	0.04***	0.06***	0.02*	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Share Urban	-0.05	-0.06	-0.08*	-0.07*	-0.06	0.05
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)
Share Black	0.04	0.05	0.07*	0.06	0.03	-0.03
	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)
Log Change in Building Values					0.07***	
					(0.02)	
Log Change in Crop Values					0.01	
					(0.03)	
Fixed Effects	State, FD	State	FD	None	State, FD	State, FD
IV F-stat	-	-	-	-	-	115.13
Observations	2950	2950	2950	2950	2928	2946
Adjusted R^2	0.244	0.244	0.152	0.130	0.250	-0.017

Table 5: A Placebo Test estimating the effects of the radio for the 1920-1923 period. Standard errors are robust and all regressions include state and Federal Reserve district fixed effects. All other control variables are the same as before.

	Log Change in Deposits			
	1930-1933		1929-1933	
	(1)	(2)	(3)	(4)
% Radio	-0.44	-0.11	-0.28	-0.34**
	(0.27)	(0.28)	(0.18)	(0.17)
Trim %	0	1	0	1
Weights	Deposits 1930	Deposits 1930	-	-
Observations	2798	2740	2800	2743
Adjusted R^2	0.410	0.330	0.191	0.214

Table 6: Some robustness checks for the effect of the radio. These include weighting counties by the amount of deposits in 1930. Specification 3 considers the change starting in 1929. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. All regressions include state and Federal Reserve district fixed effects.

	Log Change in Banks 1930-1933					
	(1)	(2)	(3)	(4)	(5)	(6)
% Radio	-0.09	-0.15	-0.27**	-0.19*	-0.03	-0.62
	(0.14)	(0.13)	(0.12)	(0.10)	(0.14)	(0.46)
Share Woodlands	-0.09	-0.09	0.02	0.32**	-0.13	
	(0.16)	(0.16)	(0.16)	(0.13)	(0.16)	
Log of Crop Value	-0.03***	-0.03**	-0.01	-0.03**	-0.03**	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log of Value of Buildings	-0.02	-0.02	-0.04**	-0.07***	-0.02	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Unemployment Rate	-3.17**	-3.23**	-2.33*	-3.52***	-2.84**	-2.95**
	(1.27)	(1.26)	(1.22)	(1.26)	(1.29)	(1.26)
Log Manufacturing Wages	0.02	0.02	0.06	0.08	0.03	0.08
	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.07)
All Rural Dummy	-0.02	-0.02	-0.01	-0.01	-0.02	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Log of Population	-0.05***	-0.05***	-0.06***	-0.05***	-0.05***	-0.06***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log of Population Density	-0.02	-0.02	0.00	-0.01	-0.03*	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Share Urban	0.01	0.02	0.02	0.01	0.00	0.07
	(0.06)	(0.06)	(0.06)	(0.07)	(0.06)	(0.08)
Share Black	0.01	0.03	0.13**	0.14***	0.01	-0.01
	(0.06)	(0.06)	(0.05)	(0.05)	(0.07)	(0.07)
Log Change in Building Values					0.04*	
					(0.02)	
Log Change in Crop Values					0.02	
					(0.02)	
Fixed Effects	State, FD	State	FD	None	State, FD	State, FD
IV F-stat	-	-	-	-	-	115.60
Observations	2803	2803	2803	2803	2785	2800
Adjusted R^2	0.216	0.216	0.151	0.085	0.216	-0.007

Table 7: Effect of radio on log change in number of banks. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. All regressions include state and Federal Reserve district fixed effects.

	Log Change in Deposits 1930-1933					
	(1)	(2)	(3)	(4)	(5)	(6)
Percentile Radio	-0.23**	-0.25***	-0.41***	-0.46***	-0.18*	-0.43
	(0.10)	(0.10)	(0.08)	(0.08)	(0.10)	(0.34)
Share Woodlands	-0.14	-0.13	0.04	0.01	-0.30	
	(0.25)	(0.25)	(0.22)	(0.18)	(0.26)	
Log of Crop Value	-0.03	-0.02	-0.03*	-0.04***	0.03	-0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log of Value of Buildings	0.02	0.01	0.03	-0.01	-0.05*	0.05
	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)
Unemployment Rate	-3.32*	-3.42*	-2.64	-4.61**	-4.17**	-2.96
	(1.89)	(1.87)	(1.75)	(1.79)	(1.93)	(1.93)
Log Manufacturing Wages	-0.08	-0.08	-0.01	0.04	-0.06	-0.03
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.12)
All Rural Dummy	-0.06*	-0.06*	-0.04	-0.04	-0.05	-0.05*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Log of Population	-0.01	-0.01	-0.01	0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Log of Population Density	0.02	0.02	0.03*	0.01	0.01	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Share Urban	0.13	0.14*	0.19**	0.20**	0.15*	0.17*
	(0.09)	(0.09)	(0.08)	(0.09)	(0.09)	(0.10)
Share Black	0.12	0.14	0.02	-0.02	0.10	0.10
	(0.11)	(0.11)	(0.08)	(0.08)	(0.11)	(0.12)
Log Change in Building Values					0.09***	
					(0.03)	
Log Change in Crop Values					-0.09***	
					(0.03)	
Fixed Effects	State, FD	State	FD	None	State, FD	State, FD
IV F-stat	-	-	-	-	-	124.12
Observations	2798	2798	2798	2798	2780	2795
Adjusted R^2	0.171	0.171	0.124	0.075	0.175	-0.014

Table 8: Effect of radio on log change in deposits between 1930 and 1933. Standard errors are robust. All regressions include share covered by woodlands, of population in urban areas, of population that is black as well as a rural dummy, population, population density, unemployment rate, value of buildings and crops. Log changes in value of buildings and crops is for the period 1920 to 1930. All these variables are from 1930. Fixed effects included are indicated in the table.