

**Debt Deflation and Financial Instability:
Two Historical Explorations**

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I. Introduction

Recent research, both historical and contemporary, has broadened existing analyses of the connections between financial markets and macroeconomic conditions to encompass a broader menu of debt, credit and intermediation linkages between real and nominal variables. It is useful to distinguish two categories of contributions to this literature. In the first, which we label "bank failure" explanations of cyclical fluctuations, one finds research linking bank failures, bank runs and other disturbances to the operation of financial intermediaries to fluctuations in output and employment. Ben Bernanke's 1983 article on nonmonetary effects of the financial crisis in the propagation of the Great Depression, emphasizing the role of bank failures in disrupting financial intermediation and worsening the U.S. depression, is an influential member of this school.²/ In the second category, which we label "debt deflation" theories, one finds studies seeking to establish the relevance for the business cycle of downward movements in asset and commodity prices, movements which, by affecting the

¹/ University of California at Berkeley and Wesleyan University, respectively. This paper was prepared for the City University Business School's Conference on Debt Deflation, April 14-15, 1994. Much of the work was undertaken during Eichengreen's visit to the International Monetary Fund and Grossman's sabbatical at Hebrew University. We thank both institutions for their hospitality, Charles Calomiris and Rick Mishkin for help with data, David Selover and Nathan Sussman for technical assistance, and Nick Crafts, Charles Calomiris and Anna Schwartz for comments. For financial support, Grossman thanks the German Marshall Fund of the United States, Eichengreen the Center for German and European Studies of the University of California.

²/ For our purposes, theories that link bank failures to business cycles via a contraction of the money supply, à la Friedman and Schwartz (1963), fall into a separate category ("monetary explanations") from that emphasizing debt, credit and intermediation linkages. We return to this distinction below.

net worth of nonfinancial borrowers, alter spending by households and firms. Charles Calomiris and Glenn Hubbard's 1989 article on the real effects of price-level movements in the post-bellum United States is a leading example of this genre.^{1/}

While it is useful to distinguish the effects of banking problems from those of movements in asset and commodity prices, clearly the two phenomena are related. In the pre-World War I United States, each of the episodes of financial crisis identified by Sprague (1910) was characterized by an upsurge of bank failures, a collapse of asset prices and a decline in the general price level. The temporal coincidence of these events suggests that banking panics and debt deflation may have been causally connected, although the direction of causality is unclear. Similarly, during the Depression of the 1930s the banking panics identified by Bernanke and James (1991) follow on the heels of the collapse of equity prices and a dramatic decline in the world price level. Again, historical accounts suggest that debt deflation and banking crises may have been related, although whether they were two independent responses to a common underlying shock or there were causal connections between them remains an open question.^{2/}

The possibility of such connections has not escaped previous investigators. Minsky's (1977) emphasis on financial fragility is compatible with the argument that debt deflation, by eroding the collateral against which banks lend, heightens financial institutions' vulnerability to destabilizing shocks. Gorton (1988) shows that the downturn in prices and output associated with recessions tended to provoke financial crises in the 19th century. Bernanke, while focusing on bank failures, supplements his

^{1/} The literature on cyclical fluctuations is replete with other theories, for example those that emphasize monetary and technological shocks. Our purpose here is not to provide a complete catalog, however, but simply to distinguish between two theories focusing on credit, debt and intermediation.

^{2/} While we do not comment in this paper on recent experience, we cannot resist pointing to the coincidence in recent years of banking crises and asset price collapses in countries like Sweden, Finland, Israel, Japan and the United Kingdom.

analysis of these factors with a discussion of debt deflation. Calomiris and Hubbard, in focusing on the real effects of price-level changes, cite the tendency for deflation to cause borrowers to default and banks to fail. Bernanke and James, while concentrating on banking panics, argue that the correlation between deflation and output declines in the 1930s, which survives even after controlling for other channels through which deflation operates, suggests the presence of a debt-deflation effect.

Although previous work has acknowledged the temporal coincidence of bank failures and collapses in asset and commodity prices, it has not analyzed them in ways that facilitate attempts to differentiate their effects or to draw out their connections. One would like to be able to distinguish the extent to which collapses in asset and commodity prices adversely affect output by provoking bank failures and thereby reducing the efficiency of financial intermediation, versus the extent to which they erode the credit worthiness of nonfinancial debtors, undermining the ability to borrow of agents on the other end of the transaction. One would wish to compare the importance of bank failures in depressing asset and commodity prices and thereby inducing reductions in desired levels of consumption and investment, with disruptions in access to finance which prevent agents from achieving the levels of consumption and investment they desire.

In this paper we explore two episodes on which much previous historical work has focused: the post-bellum U.S. and the global depression of the 1930s. We seek to distinguish the effects of bank failures and debt deflation and to probe the connections between them. Section II lays out some theoretical considerations and discusses problems of measurement. Section III then analyzes economic fluctuations in the post-bellum United States, Section IV cross-country evidence from the Great Depression.

We adopt an agnostic perspective on the importance of debt deflation. We do not wish to be interpreted as attempting to show that debt deflation was necessarily important in the episodes analyzed here. We think this

skeptical approach is warranted for several reasons. One is the difficulty of conceptualizing debt deflation and of distinguishing it from alternative macroeconomic mechanisms. Formalizing debt deflation as a decline in asset and commodity prices that induces reductions in desired levels of consumption and investment on the part of households and firms is surely not sufficiently refined for definitive analysis. Caution is warranted on empirical grounds as well. Any empirical difficulties that hamper attempts to measure concepts such as, say, the money supply or the incidence of bank failures are dwarfed when one considers debt deflation. How does one measure the relevant debts in light of data limitations? While this is a problem for all attempts to empirically analyze debt deflation, it poses special difficulties for historical work. Given the limitations of historical data, we therefore focus on the prices associated with the quantities that theory suggests should be relevant for debt deflation. But this renders our results contingent on a further set of assumptions, which we describe in Section II. Inevitably, ambiguity arises concerning the interpretation of our evidence. Surprisingly, however, there does not appear to exist a previous empirical study that seeks to distinguish the effects of debt deflation from those of bank failures and policy variables. We therefore think that our approach, despite the inevitable ambiguities, is useful in pushing the debate forward.

II. Theory and Measurement

Any attempt to distinguish the effects of "banking crises" and "debt deflation" is handicapped by the difficulty of conceptualizing and measuring the two concepts. In the case of the former, it is far from straightforward to identify banking "panics" or "crises" independent of their effects. Schwartz (1986) distinguishes "real" from "pseudo" financial crises, maintaining that not all instances of deposit liquidation, bank runs and bank failures necessarily constitute a crisis in the sense of exercising an

adverse impact on the real economy. While upsurges in bank failures tend to be one of the criteria investigators since Sprague have invoked when identifying distress among financial intermediaries, it is clear that not all bank failures connote a panic or crisis of a sort that is likely to significantly affect economic activity. Limiting one's attention to episodes in which bank failures are accompanied by declines in output, on the other hand, would bias one toward finding an association between banking panics and cyclical fluctuations. Grossman (1993), in analyzing U.S. experience from 1874 through 1913, experiments with a number of proxies for banking problems, including the number of bank failures and the assets of failed or suspended banks. While this approach is free of the selection bias alluded to earlier in this paragraph, it runs the risk of conflating isolated bank failures with full-fledged panics. Schwartz (1986) and Bordo (1990) focus on the currency/deposit ratio as a measure of the severity of crises. This does not eliminate the need to invoke ancillary information, however, since a judgement still must be made about the critical threshold through which a change in that ratio must pass before qualifying as a "crisis."

Investigations of debt deflation are similarly handicapped by difficulties of defining and measuring the concept. Irving Fisher (1933) when coining the term failed to provide a clear definition, instead pointing to nine aspects of indebtedness and deflation with possible implications for the business cycle. While some subsequent investigators have associated the concept with a falling aggregate price level which raises the real value of nominally-denominated debts, others have emphasized asset price deflation -- a drop not in the general price level but in the market value of financial assets -- which raises the value of net debt (gross debt net of assets).

In a single paper it is not possible to provide definitive solutions to these problems. Rather, we adopt as working conventions the following definitions and measures. By a banking crisis we mean an increase in the

incidence of distress among financial institutions which disrupts their ability to carry out their intermediation function. We measure the incidence of this distress in a number of alternative ways: as a function of the number of national bank failures and the assets of failed banks, and as binary indicator variables based on both qualitative and quantitative information. By debt deflation we mean a fall in the prices of either assets or goods and services that raises the real value of net debt, thereby worsening the net wealth position of nonfinancial borrowers and discouraging them from consuming or investing. Define the real value of net debt as $(D-A)/P$, where D is gross debt, A is assets, and P is the price of goods and services. Then the real value of net debt, which we will also refer to as the "real debt burden," can be raised by increasing indebtedness (a rise in D), by asset-price deflation (a fall in A), or by commodity price deflation (a fall in P). (An alternative measure of the debt burden that might appeal more to some readers is the net debt/income ratio $(D-A)/PY$, where Y is real income or output. In this case the debt burden can also be raised by a fall in Y .^{1/})

Measuring the debt burden poses difficulties for historical research. Time-series estimates of real net debt can be constructed for times and places like the 20th century United States on the basis of individual and corporate tax returns, but for periods preceding the adoption of personal and corporate income taxes, no comparable information is available.^{2/} While earlier information is available for public debt issues and the debts of publicly listed and traded companies, there is only scattered information on the debts of privately-held companies (which dominate earlier periods) and households (limited mainly to spotty information on mortgage debts). On the

^{1/} In the present context, this measure may be problematic, since as a matter of arithmetic, debt deflation (defined as a rise in the net debt to income ratio) can result from a fall in the level of activity, heightening simultaneity problems for debt-deflation theories of the business cycle.

^{2/} Thus, U.S. Department of Commerce (1976) provides time-series estimates of the net debt of the public, corporate and household sectors for the period 1916-1970. For details on sources, see Kuvin (1936).

asset side it might be possible to assemble time series on the value of publicly traded securities and on the assets of joint-stock companies publishing balance sheets, but doing so for private companies and estimating the asset position of households would be more difficult.^{1/}

Historical data on the market prices of assets and debts is more readily available than information on their quantities. The approach we take in this paper is therefore to use information on prices and yields as indirect indicators of debt deflation. Following Calomiris and Hubbard (1989) and Mishkin (1991), we focus on the information content of interest-rate spreads. In an environment of asymmetric information, adverse selection can arise.^{2/} Consider a situation in which lenders have incomplete information about the risk characteristics of the projects that borrowers wish to undertake. As the interest rate rises, borrowers with relatively risky projects will become the likeliest to want to take out loans. This gives rise to the possibility of a backward-bending supply curve of loans and rationing in credit markets (Stiglitz and Weiss, 1981).

^{1/} Goldsmith (1985) made a heroic attempt to assemble national balance sheets for more than a dozen countries for the relevant period, but his estimates exist only for benchmark years and are disaggregated only to a limited extent.

^{2/} Asymmetric information can also give rise to moral hazard and produce the credit-market conditions we describe below. In the interest of simplicity, we concentrate in the text on the adverse-selection mechanism. Inevitably, a decision to focus on asymmetric information as the source of debt deflation is controversial. Anna J. Schwartz, in commentator's remarks on the conference version of this paper, argued that unexpected shifts in monetary policy are a more important cause of debt deflation. Borrowers and lenders predicate their investment decisions on a particular set of price forecasts, in this view; if the monetary authorities pursue unexpectedly contractionary policies, prices fall relative to expectations, and debtors and creditors become distressed. In our view, a fall in prices relative to expectations should render borrowers worse off but lenders better off. As King (1993) notes, a further element such as asymmetric information must be added to prevent the impact on the spending decisions on debtors and creditors from canceling one another out. Thus, while not questioning the importance of the monetary policies emphasized by Schwartz, we prefer to think of them as monetary disturbances rather than debt deflation shocks of the sort we are concerned with here.

Lenders can reduce adverse selection by requiring borrowers to provide collateral.^{1/} If a borrower defaults, the lender takes title to the collateral and is compensated at least partially for the loss. If the collateral is of sufficiently good quality, the danger of loss and hence the existence of asymmetric information are no longer relevant; all borrowers should be able to obtain funds at the rate on risk-free loans.^{2/} As emphasized by Greenwald and Stiglitz (1988) and Bernanke and Gertler (1990), a collapse in asset prices, due say to a stock market crash, by eroding the value of collateral, magnifies the implications of asymmetric information and adverse selection. The more the value of collateral falls, the less the compensation available to lenders in the event of default, and the larger the spread over the risk free rate that will have to be paid by prospective borrowers when information is incomplete. Similarly, a fall in the general price level increases the real value of debt (reduces the real value of collateral) for potential borrowers, requiring them to pay larger interest rate spreads.

Figure 1 displays this schedule in debt-spread space. As the value of collateral declines ($[D-A]/P$ rises), larger spreads are demanded of potential borrowers.^{3/} This suggests that, other things equal, the spread can be taken as a measure of the debt burden and hence of debt-deflation pressures.^{4/}

^{1/} Borrowers with the best reputations may be able to borrow free of collateral. Large, well-established corporations for which the asymmetric information problem is attenuated may be able to float unsecured corporate securities, for example. The borrowers on which we focus here are best thought of as those who find entry to the market for unsecured corporate securities blocked because of informational asymmetries.

^{2/} This abstracts from litigation and other fixed costs of default.

^{3/} The reader will note that here we discuss net debt and (negative net) collateral interchangeably. This is sensible if one defines D and A comprehensively, so that A includes all of the relevant collateral.

^{4/} As noted above, it is possible for the "supply of debt" schedule to bend back. If the backward-bending portion intersects with a downward sloping demand schedule, there is the possibility of two equilibria. Only the low interest rate equilibria of this pair is stable.

Importantly, other variables can shift the SS locus in debt-spread space. A banking crisis, for example, can be expected to shift the entire locus leftward from SS to S'S'. As Diamond (1984) and others emphasize, banks can engage in delegated monitoring and establish long-term relationships with borrowers in order to attenuate adverse selection and asymmetric information problems. A shock to the banking system which disrupts the ability of financial intermediaries to assemble information and screen borrowers will consequently increase the spread corresponding to any level of collateral. Thus, the impact of a change in spreads on output can be interpreted as a debt-deflation effect only if one controls for bank failures and other variables capable of shifting the SS locus in debt-spread space.

Some readers may remain uncomfortable with our use of interest rate spreads to proxy for debt deflation. They may worry, for example, that a business cycle downturn or an increase in the variance of output or prices, which increases the size of the lower tail of the wealth and income distributions at which default on liabilities occurs, may also increase observed spreads. Our point is that output and prices so low as to erode income and wealth sufficiently to provoke default by nonfinancial borrowers is precisely what should be meant by "debt deflation." Spreads capture this effect so long as one controls for other factors affecting the efficiency of financial intermediation. The addition of such controls is what distinguishes our use and interpretation of interest-rate spreads from other recent work, such as Calomiris and Hubbard (1989), Mishkin (1991), and Bordo, Rappaport, and Schwartz (1992) where they are interpreted in terms of a range of financial problems including but not limited to debt deflation.

Others may object that spreads, insofar as they reflect the term structure of interest rates, are picking up expectations of future price-level trends and liquidity preference effects. To minimize the contamination of spreads by these effects, we compute them from higher- and

lower-grade railroad bonds of comparable maturities for the post-bellum United States; for the interwar period we compare central bank discount rates and commercial paper rates rather than mixing bond and commercial paper rates. And insofar as spreads rise in business cycle downturns because default risk on low-quality bonds rises disproportionately, this reflects the rise in $(D-A)/PY$ (the erosion in the real value of collateral) that is at the center of debt-deflation analyses.

In the following sections we employ this model of the relationship between interest-rate spreads and debt deflation in an effort to marshal evidence on the operation of the latter.

III. Evidence from the Post-Bellum United States

The post-bellum United States is a natural laboratory for analyzing the connections between debt deflation, banking panics and business cycles. Cyclical instability was pronounced -- although how much more pronounced than in the post-World War II period remains a matter of dispute.^{1/} Wholesale prices fell steadily, by more than one per cent per annum, for fully two decades prior to the mid-1890s, which itself could have elevated the real burden of existing debts.^{2/} On a number of occasions the price level declined abruptly, telescoping the effects of general price deflation into shorter periods. The post-bellum years saw waves of bank failures, most notably in 1873, 1893 and 1907. On each occasion asset prices plummeted, eroding the value of borrowers' collateral. Influential accounts (viz. Sprague 1910, Kindleberger 1978) emphasize the importance of asset- and debt-market collapses and banking panics in the business cycles of the period.

^{1/} On this controversy see Romer (1989) and Balke and Gordon (1989).

^{2/} This is strictly true, of course, only if the deflation of the period was unanticipated and hence not incorporated into interest rates. On the debate over whether prewar inflation could be forecast, see Barsky and De Long (1991).

Two attempts to elucidate the connections between these variables are Calomiris and Hubbard (1989) and Grossman (1993). Calomiris and Hubbard use monthly data for the period 1893-1909 and a structural vector autoregression model to analyze the contribution of credit-market disruptions to business-cycle fluctuations. Their analysis focuses on the correlation between measures of credit-market distress like the spread between interest rates on high- and low-risk assets and economic activity (their preferred measure being pig iron production).^{1/} They document significant correlations between credit-market disturbances and output fluctuations.

For our purposes, their approach and results are subject to two limitations. The first, noted above, is that their formulation does not lend itself to the distinction between debt deflation and banking crises. As shown in Figure 1, an increase in the interest rate spread could result from either debt deflation or a banking crisis which shifted the relationship between real net indebtedness and observed interest rates. A second problem is that the authors find that an increase in the interest-rate spread is contemporaneously associated with increases in output and prices, seemingly inconsistent with interpretation of the spread as a measure of debt deflation.

Grossman (1993) focuses not on debt deflation but on banking crises. Using quarterly data for a longer period than Calomiris and Hubbard, he estimates a structural macroeconomic model designed to extend the IS-LM framework to incorporate monetary and nonmonetary effects of bank failures. In his model, bank failures can reduce output by prompting a shift into currency from deposits, depressing the money multiplier, reducing the money supply and shifting the LM curve to the left. Alternatively, bank failures can depress output through nonmonetary (confidence or spending) channels

^{1/} To guard against the possibility that interest rate spreads on various grades of commercial paper are imperfect indicators of the cost of credit, they also include quantity flows (the change in the real flow of loans) and the monthly percentage change in the liabilities of failed businesses. We follow this precedent in our analysis below (see Table 1).

that shift the IS curve to the left. He presents evidence consistent with the operation of both channels. For present purposes, the limitation of this approach is again that it does not enable us to distinguish the effects of banking panics from those of debt deflation, since asset and price-level collapses, whose effects are not treated explicitly, tended to coincide with upsurges in bank failures.

This correlation is plotted in Figure 2 for the period 1881-1913. Its two panels juxtapose two measures of bank failures (assets of bank failures and number of bank failures) against the percentage rate of change of the GNP deflator. All variables are expressed as four quarter moving averages. A negative correlation between the number of bank failures and the rate of inflation is apparent, consistent with the notion that deflation is conducive to financial instability.^{1/} At -0.12, however, that correlation is statistically insignificant. Figure 3 shows the analogous relationship between the interest-rate spread and the rate of inflation. This correlation is a marginally stronger though still insignificant -0.20; the sign is not inconsistent with our interpretation of the spread in terms of debt deflation. Figure 4 plots the spread and the number of bank failures. Although the two variables appear to move together during certain episodes, over the entire period they are uncorrelated.^{2/}

We also ran bivariate Granger causality tests between these pairs of variables.^{3/} The only statistically significant relationships were those between inflation and the spread. Prior declines in the price level significantly predicted subsequent increases in the spread (at the 99 per cent confidence level), again consistent with our interpretation of the spread in terms of debt deflation. In addition, increases in the spread predicted deflation, as if the process fed on itself in a vicious circle.

^{1/} And vice versa.

^{2/} The correlation coefficient between the spread and number of bank failures is 0.03.

^{3/} These used four lagged values of both variables.

There was no bivariate relationship, in contrast, between the interest rate spread and the number or assets of failed banks. We found no support, in other words, for the idea that debt deflation heightened the fragility of the banking system or that bank failures were conducive to debt deflation.

One way of more precisely distinguishing the various effects is to augment Calomiris and Hubbard's vector autoregressions to incorporate the effects of bank failures. Holding constant shocks to the bank failure equation, we can interpret the effects of shocks to the interest-rate-spread equation in terms of debt deflation, in the spirit of Figure 1 above.^{1/} Holding shocks to the spread constant, we can interpret shocks to the bank-failure equation in terms of financial-market disruptions narrowly defined.

The data used in this analysis are described in the appendix. We consider the same variables as Calomiris and Hubbard, augmenting their specification to include bank failures. Our implementation differs slightly. Rather than monthly data spanning the 1890s and 1900s, we use quarterly observations for the period 1881.I-1914.I. This enables us to utilize a more comprehensive measure of output, Balke and Gordon's quarterly estimates of real GNP. Rather than the structural VAR approach, we use the Choleski decomposition, considering different orderings to test the sensitivity of our results.

The F-statistics for the joint significance of four lagged values of the explanatory variables in the various equations are reported in Table 1.^{2/} An increase in the number of bank failures and in the spread both have negative impacts on subsequent output movements. The coefficient on bank failures differs significantly from zero at standard confidence levels,

^{1/} Readers concerned that variables like output, prices and interest rates might also shift the SS curve should be reassured by the fact that we hold these variables constant as well when interpreting the effects of the spread in terms of debt deflation.

^{2/} In addition, we included a constant, a time trend and quarterly dummies in the regressions. To allay confusion, note that these are **not** the results of bivariate Granger causality tests like those discussed above; rather, the F-statistics test the joint significance of all lags on a particular variable in the multivariate regressions that make up our VARs.

while that on the spread approaches but does not quite achieve significance. These results are not inconsistent with financial instability and debt-deflation theories. In addition, output responds negatively to lagged values of the interest rate and the price level, although only the coefficients on the first of these variables are jointly significant at standard confidence levels.^{1/}

The variables considered here have less explanatory power in the other equations. Bank failures, in addition to showing considerable persistence, rise when output falls, when prices decline, when business failures increase, and when there is a prior disruption to the flow of loans. But only prices and output, in addition to lagged failures, have a statistically significant effect on failures in a single-equation setting.^{2/} The spread is most strongly affected by lagged prices and business failures. Commercial paper rates depend significantly on lagged output and bank failures. While their positive response to output is intuitive, their negative response to bank failures is not; we return to this point below.^{3/} Business failures respond positively, as expected, to interest rates; surprisingly, they increase when prices rise. The real flow of loans responds negatively to increases in the price level, perhaps reflecting the tendency of price increases to raise the deflator rather than to reduce the nominal flow of loans.

Impulse-response functions based on a moving average representation of these regressions provide a more comprehensive picture of the interaction of these variables. We summarize the results in two ways: in the form of plots of the responses to disturbances of variables of interest, and in the form

^{1/} An anomaly is the positive response of output to lagged business failures.

^{2/} A surprise here is that increases in the commercial paper rate tended to be followed by a decline in bank failures. This is in contrast to Gorton (1988), who finds, using an entirely different methodology, that interest rates are not useful for predicting financial panics during this period.

^{3/} Grossman (1993) explores the possibility that the response of interest rates to bank failures may be nonlinear.

of variance decompositions which measure the share of the forecast-error variance attributable to each innovation. Consider the responses to innovations to bank failures and the spread.^{1/} The spread, when shocked, takes a considerable period to decline back toward initial levels (Figure 5); in comparison, bank failures decline rapidly following a shock to their number (Figure 6).^{2/} Output falls on impact in response to both shocks (Figure 7), for the reasons described above. In response to an increase in the spread, output takes four quarters to recover; in the case of bank failures that recovery is immediate. Prices also fall in response to both shocks. Their reaction to a bank-failure shock is short and sharp, that to a spread shock shallower but more persistent, mirroring the response of output. Interest rates fall in response to both shocks, bottoming out after two quarters (Figure 8). This reflects both the direct negative effect of bank failures and the spread that was noted above and the indirect effect operating through output (which declines in response to the shocks, further depressing interest rates).

Especially interesting from the present point of view is the response of the spread and bank failures to one another. An increase in bank failures causes, on impact, a small uptick in the spread, but the response is minimal (Figure 5). Table 1 showed that the direct effect of bank failures on the spread was negligible; the impulse-response function shows that the absence of a link remains after incorporating indirect effects operating through prices, output and interest rates.^{3/} An interpretation is that spillovers from financial instability to debt deflation were insignificant in this period. Similarly, we find a very small response of the number of bank failures to a positive shock to the spread (Figure 6).

^{1/} Confidence intervals grow quite large after the initial quarters; this makes it prudent to focus mainly on the impact effects of a shock.

^{2/} This last result is also evident in Grossman (1993). The general tendency is emphasized by Schwartz (1986).

^{3/} These results are also consistent with the bivariate Granger causality tests reported above.

The interpretation is the same: the direct effect of the spread on bank failures in Table 1 is small, negative and statistically insignificant; in the impulse-response functions this effect is not significantly modified by indirect effects operating through output, prices or interest rates. Again, it would seem that spillovers from debt deflation to financial instability were not noticeable during this period.

Another perspective on the impulse-responses can be obtained from the associated variance decompositions. Table 2 summarizes these after 12 quarters. The column for output shows that more than half of forecast-error variance for output at this horizon is attributable to output innovations themselves, not surprisingly given the persistence in this variable (which shows up in the output equation in Table 1 in the form of a large F-statistic on lagged output).^{1/} But the next most important determinant of output variance is innovations to the spread, which account for 15 per cent of the total. The contribution of bank failures, in contrast, is only a third as large, comparable to that of interest rates and price level changes and larger than that of business failures and the flow of loans.

The variance decompositions also support our findings concerning the interaction of bank failures and the spread. Bank failure shocks account for less than two per cent in the forecast-error variance of the spread after 12 quarters.^{2/} Shocks to the spread account for less than five per cent of the analogous variance of bank failures.^{3/}

To test the robustness of the results, we deflated the assets of business failures by the price level (those assets are in nominal terms in the regressions discussed above); this had minimal effect. Following Bordo, Rappoport and Schwartz (1982), we added the money supply to our vector of

^{1/} This same finding is reported by Bordo, Rappoport and Schwartz using monthly data.

^{2/} Aside from own lagged values, the price level explains the largest share of the variance, consistent with our debt-deflation interpretation.

^{3/} Here interest rates are the most important explanatory variable aside from own lags.

regressors.^{1/} The response of the other variables to bank-failure and spread shocks remained essentially unchanged.^{2/} In addition, the money supply fell in response to both spread and bank-failure shocks.^{3/} Different orderings did not alter impact effects and only modestly affected the contours of the subsequent response. One change that made a difference was to substitute the assets of bank failures for the number of bank failures. Lagged values of this variable somewhat implausibly have a positive impact on output in regressions like those of Table 1; in the associated impulse-response functions as well, output rises on impact in reaction to a bank failure shock. The spread and the commercial paper rate behave as before.

What are the implications of these findings? Controlling for bank failures and several additional variables that might plausibly shift the SS curve in Figure 1, we find a negative impact on output of interest rate

^{1/} These authors criticize Calomiris and Hubbard for omitting monetary variables from their vector autoregression. Our basic specification, designed to follow Calomiris and Hubbard as closely as possible, also omitted this variable. Clearly, a large historical literature, of which Friedman and Schwartz (1963) is the definitive statement, suggests that bank failures may matter by reducing the money supply, and that monetary shocks may be important for both bank failure rates and spreads. See also Cagan (1965).

^{2/} After 12 quarters, monetary shocks account for 10 per cent of the forecast-error variance of output, while the spread accounts for 11 per cent and bank failures account for 4 per cent. The shares accounted for by the spread and bank failures are little different than in Table 2. Thus, the inference we drew from that table, that debt-deflation effects exercised a noticeable effect on output, appears to survive the addition of money. Note that when we add money, our approach continues to differ from that of Bordo, Rappoport and Schwartz by our inclusion of bank failures and the distinction this permits between debt deflation and financial instability effects. The main difference between our results and theirs appears to lie in the even smaller effect of the loan flow in our specification, much of the effect of which appears to be captured by variations in the number of bank failures.

^{3/} We refer to the impact effect. In both cases, the behavior of the money supply mirrors the responses of output and (especially) prices: a brief fall and a quick recovery in the case of bank failure shocks, a more extended decline in the case of spread shocks. Prices account for 28 per cent of the forecast-error variance of money after 12 months, more than any other variable than money itself. It is tempting to follow Calomiris and Hubbard in interpreting these money stock variations as reflecting endogenous responses to changes in the determinants of money demand, presumably operating from the operation of the gold standard.

spreads, which we interpret as the effect of debt deflation.^{1/} This fall in output is short-lived: it reaches its maximum after one quarter, and output has fully recovered after four quarters, although it continues to cycle. The impact effect on output of a one standard deviation shock to the spread is almost exactly the same as that of a one standard deviation shock to the number of bank failures, but the recovery of output from a bank failure shock is faster. A plausible interpretation of these results is that both financial instability and debt deflation mattered for output movements in the United States prior to 1913, but that neither helps greatly in explaining the persistence of business cycle fluctuations.

Finally, we find no evidence of connections between bank failures and debt deflation. There is scant indication of causality running in either direction. Insofar as historical accounts suggest a temporal coincidence of financial instability and debt deflation, this is most likely to have reflected the response of bank failures and asset/debt positions to common underlying shocks.

IV. Evidence from the Great Depression

Another episode in which the effects of debt deflation may be evident is the global slump of the 1930s. This was, after all, the experience that led Irving Fisher to develop his debt deflation theory of Great Depressions. The period was characterized by the collapse of asset prices, most prominently in the United States following the Great Crash on Wall Street but in other countries as well. It featured a dramatic decline in the general price level in a range of countries linked together by the international gold standard. If the effects of debt deflation are hard to discern in this period, it is difficult to imagine another in which they might more plausibly operate.

^{1/} The reader should bear in mind the caveats raised at the end of Section 2.

A problem for empirical analysis is that debt deflation is only one of several transmission mechanisms running from monetary deflation to output. Bernanke and James enumerate several possible channels. One is the tendency of declining producer prices to put upward pressure on real wages and reduce profitability, a pattern which was evident in all the industrial countries. If money wages adjust incompletely to the fall in the price level, firms should be induced to move down their upward-sloping supply curves to lower levels of production. This is a mechanism stressed by Eichengreen and Sachs (1985), Newell and Symons (1988), and Sumner (1994), among others. Problems with this explanation include the possibility that the rise in real wages was simply a corollary rather than an independent cause of the Depression and the fact that the sluggishness of money wages was apparently so persistent.

A second channel is real interest rates. If the post-1929 deflation was largely unanticipated, deflation would have raised real interest rates, discouraging consumption and investment. Recent research on the United States (viz. Cecchetti 1992, Hamilton 1992) suggests that the deflation was at least partly unanticipated. Moreover, even a fully anticipated deflation of the magnitude of that of the early 1930s could have raised real interest rates because of the zero floor on the nominal interest rate. For how long and for how many countries this constraint was binding is unclear, however, because some nominal interest rates in gold standard countries rose rather than falling after 1932.

A third conceivable channel is the direct effect on expenditure of declining money supplies. Schwartz (1981) and others argue, most prominently for the United States but by implication for other countries, that the contraction of the money supply contributed to the severity of the Depression by depressing spending. Authors adopting this perspective emphasize the impact of monetary contraction on demand operating through channels other than the interest rate.

A fourth channel, emphasized by Bernanke (1983) and Bernanke and James (1991), is banking crises. These authors stress the tendency for deflation to undermine the stability of financial institutions. The consequent banking crises disrupted the ability of financial institutions to undertake their intermediation function, cutting the access to external finance of even credit-worthy borrowers and depressing demand.

In comparison with banking crises, "much less has been written" on debt deflation.^{1/} Debts are difficult to measure, notwithstanding the work of Mishkin (1978) on the household sector in the United States and Goldsmith's efforts (described above).^{2/} Bernanke and James suggest that the residual effects of price level movements -- once real wages, real interest rates and real exchange rates have been controlled for -- may be attributable to debt deflation. The problem with this approach, as the authors are aware, is that the residual effect of prices is a catch-all for omitted price-level effects and measurement errors.

The obvious way of dealing with the existence of a multiplicity of explanations is multivariate analysis. Thus, Bernanke and James estimate multiple regressions using pooled time-series and cross-section data for 24 countries over the period 1930-1936. They estimate their equations by ordinary least squares on the grounds that the deflation driving the movement of the independent variables was imposed by exogenous monetary forces associated with the operation of the international gold standard.

We extend their approach, building on their data and specification, but adding a measure of the interest rate spread in an attempt to directly estimate debt deflation effects. Insofar as their measure of banking panics adequately controls for events in financial markets that shift the

^{1/} Bernanke and James (1991), p.56.

^{2/} For example, bankruptcy procedures changed at different times in different countries, often as a function of the severity of the slump and the extent of bankruptcy problems.

relationship between spreads and the real debt burden, we can interpret the coefficient on the spread as a measure of the importance of debt deflation.

We measure spreads as the difference between rates on commercial paper and central bank discount rates. Commercial paper rates are available only for a subset of countries, necessarily reducing the size of the sample.^{1/} We experimented with the difference between the rate of interest on government bonds and a non-governmental bond rate; this did not produce consistent results, which we attribute to the especially small sample for which long-term rates were available (70 observations) and the fact that the 1930s was characterized by problems of sovereign default, rendering the yield on government bonds a highly imperfect measure of the risk-free rate.^{2/}

Figures 9-11 juxtapose this measure of the spread against the change in industrial production relative to 1929. There is no robust bivariate relationship between the two variables.^{3/}

Table 3 reports the basic regression estimates. The dependent variable is the change in the log of industrial production; the independent variables are proxies for the various channels of transmission discussed above. We come close to replicating Bernanke and James's results. The change in output is positively related to the change in the wholesale price level, positively related to the rate of exchange rate depreciation, and negatively

^{1/} From 167 to 98 observations. The countries for which we have data are Belgium, Bulgaria, Czechoslovakia, Denmark, France, Germany, Hungary, Italy, Japan, the Netherlands, Poland, Romania, Sweden, Switzerland, the U.K. and the U.S. This change in sample size had little impact on the coefficients on other variables, since we obtained essentially the same results when we estimated equations excluding the spread on the larger sample.

^{2/} Of the countries for which we have long-term rates, the default problem is likely to be particularly severe for Germany and Poland. In addition, Bernanke and James note fears of sovereign debt problems in France in the 1930s. On the experience of other countries, see Eichengreen and Portes (1987).

^{3/} For 1931, a regression of the change in the log of industrial production (since 1929) on the spread produces a positive coefficient with a t-statistic of 1.97; for 1932 and 1933, however, the analogous coefficients are zero (with t-statistics of 0.27 and 0.66). A constant is included in each regression.

related to the change in the central bank discount rate, although the statistical significance of some of these effects varies across specifications. The sign of the coefficient on money wages seems particularly sensitive to the inclusion of the dummy for financial panics. The panic variable -- Bernanke and James's dummy variable for number of months in the year in which a country experienced a financial panic, based on the incidence on bank failures and bank runs -- is negative, statistically significant at standard confidence levels, and has an economically important effect. The change in the log of the money supply has a significant effect on output even after controlling for financial panics, interest rates and the price level.

We then added the spread to these equations. We ran the final two equations from Table 2 on three samples of countries: the full sample, the full sample minus Romania (since the scatter plots indicated Romania to be a consistent outlier), and the full sample minus France and Italy (since, as Bernanke and James observe, there is some uncertainty about whether they are properly classified as crisis countries). Evidence of a debt deflation effect, as captured by the coefficient on the spread, is inconsistent. While this coefficient is negative more often than not, it varies in sign and often differs insignificantly from zero at standard confidence levels. Only when money supply is included among the independent variables, as in Table 4, is the coefficient on the spread consistently negative, as predicted by debt-deflation theories, and does it approach statistical significance at standard confidence levels.^{1/} If these results are to be believed, they suggest that both monetary and financial (debt-deflation and panic-related disintermediation) shocks, and not just one or the other, were important for the propagation of the Great Depression. Were one forced to choose, however, the coefficients on money and panics are considerably more robust than those on the spread.

^{1/} The t-statistics on the spread in Table 3 range from 1.43 to 2.03.

Is it plausible that our spread variable is capturing the (seemingly weak) effects of debt deflation? This will be the case only if the regressions control adequately for disruptions to the financial system that shift our SS curve (the relationship between the spread and real net debt). The danger is that Bernanke and James's dummy variable for financial panics does so imperfectly. Although this variable is based on precisely the factor which we argue is the most likely candidate to shift the SS curve, namely serious banking problems, it is derived from a subjective judgement of years and nations in which banking problems were "serious." Clearly, there is scope for error here.^{1/}

Bernanke and James point out that in a model which controls adequately for debt deflation, the coefficient on the change in the log price level should be equal and opposite in sign to the sum of the coefficients on the change in the log exchange rate, the change in the log money wage, and the change in the central bank discount rate.^{2/} This is not the case of Bernanke and James's results, even when they include their financial panic measure. It is true, however, when we also control for the interest rate spread, supporting our belief that we have succeeded in capturing effects of debt deflation.

A proponent of the null hypothesis would say that we have found some evidence, especially after controlling for the effects of monetary shocks, that debt deflation mattered in the Great Depression. The evidence supporting that view is far from conclusive, however. In comparison, the evidence that alternative channels, including monetary effects, interest rate effects, exchange rate policy and financial panics, played an important role in the propagation of the Depression is considerably more robust.

^{1/} Grossman (1994) constructs a different measure of the incidence of banking panics for this period, which we intend to use in future work.

^{2/} This is because theory suggests that it is the real exchange rate, real wage and real interest rate that matter, whereas the nominal values appear in the basic specification.

V. Summary and Implications

Our ambition in this paper has been to advance the discussion of the role of debt deflation in two historical periods: the post-bellum United States and the global depression of the 1930s. Given the difficulty of assembling historical data on the net debts of households and firms, we have focused on the asset prices that should be associated with the relevant quantities and sought to control for other factors also likely to affect those prices. The results reinforce the skeptical perspective with which we approached the question. While we find in the data for the post-bellum United States some evidence of a negative impact of our measure of debt deflation on real GDP, that impact is short-lived; it can hardly account for the persistence of prewar business cycles. Strikingly, we find little evidence of connections between debt deflation and the incidence of bank failures. Our analysis of cross-section data for a range of countries in the Great Depression similarly provides some evidence consistent with the debt-deflation thesis, but this finding is sensitive to changes in specification; in particular, it hinges on controlling for monetary shocks. And even then the evidence of a distinct debt-deflation effect is far from robust.

Does this mean that debt deflation should be purged from the agenda of macroeconomic historians, who are better advised to concentrate on other transmission mechanisms? Inevitably, it is possible for true believers in debt deflation as well as skeptics to draw support from our results. Resolving this debate will ultimately require the development of better historical data.

Data Appendix

For our analysis of the post-bellum United States, we attempted to replicate and extend the data set of Calomiris and Hubbard. The authors provided us with their data on the monthly change in loans outstanding for banks in New York City, Philadelphia and Boston. These were assembled on a monthly basis from weekly reports in the Commercial and Financial Chronicle. We use the figure for the last month of each quarter. We deflate the change in loans by the current period's price index. The commercial paper rate, also using end-of-quarter months, is taken from Macaulay (1938). Data on interest rates spreads was provided by Frederick Mishkin. The Mishkin measure is the spread between high and lower grade railway bonds, calculated from data in Macaulay (1938); for details see Mishkin (1991). Again, end-of-quarter months were used. Quarterly data on the change in the GNP deflator and real GNP are from Balke and Gordon (1986). The change in the assets of business failures are from U.S. Department of Commerce (1949), Appendix 30. The number and assets of national bank failures (including those eventually restored to solvency) were compiled from the list of receiverships reported in the Comptroller of the Currency's Annual Report. Assets of banks placed in receivership and subsequently restored to solvency were frequently not reported in the list of receiverships; assets of these institutions were taken from previous Annual Report statements of the condition of banks. The money supply is M2, taken from Friedman and Schwartz (1963).

Our interwar data set, following Bernanke and James, was compiled mainly from publications of the League of Nations and the International Labour Organisation. We use the log difference of industrial production and of the wholesale price index, as in Bernanke and James, Tables 2.2 and 2.4. The log difference of money wages was measured using nominal hourly wages, from the ILO, wherever possible. The central bank discount rate, the commercial paper rate, and the log difference of notes and currency in

circulation are from the League of Nations' Statistical Yearbook (various issues).

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