

# *Shattered Rails, Ruined Credit: Financial Fragility and Railroad Operations in the Great Depression*

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This article uses a new panel dataset to investigate the relationship between financial fragility and real activity on U.S. railroads during 1929–1940. Leverage had a negative effect on maintenance, within small firms only. Bankruptcy had a positive effect on maintenance and employment, within large firms only. Both leverage and bankruptcy effects were significantly larger during the worst depression years. Had all railroads been bankrupt during 1930–1933, GDP would have increased by 0.2 percent annually, and employment by 0.125 percent annually. Loans by the Reconstruction Finance Corporation had no impact on maintenance or employment.

A growing literature emphasizes the role of financial factors as a central propagating mechanism in the Great Depression. The “new [nonmonetary] view” builds on Irving Fisher’s notion of “debt-deflation” and Hyman Minsky’s related “financial fragility” hypothesis.<sup>1</sup> One of its major propositions is that small shocks to prices and incomes led to large macroeconomic effects, because many economic agents carried a heavy burden of preexisting debts.

What is the link between high levels of debt and the magnification of small shocks? Ben Bernanke and Harold James tell the following story: As the real value of nominal debts increases, borrowers’ net worth decreases; borrowers face greater difficulties in obtaining new credit, because decreased net worth exacerbates the problem of asymmetric information between borrowers and lenders; in order to conserve financial resources, borrowers cut real expenditures.<sup>2</sup> These predictions are essential to the “new

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<sup>1</sup> A seminal paper in this area is Bernanke, “Non-Monetary Effects.” For Fisher and Minsky, see Fisher, “Debt Deflation Theory”; Minsky, “Finance and Stability”; and Fazzari, “Minsky.”

<sup>2</sup> Bernanke and James (“Gold Standard”) address price deflation only. However, their analysis is valid for any decline in asset values or incomes that redistributes net worth from debtors to creditors. As Robert King (“Debt Deflation”) points out, “a falling absolute price level is not a necessary condition for debt deflation.”

view” of the depression, the “credit” view of monetary transmission and the literature on finance constraints and investment.<sup>3</sup>

If Bernanke and James are correct, we can expect actors with heavier debt burdens to make greater reductions in real activity (*ceteris paribus*). The best way to test this prediction is to confront it with individual-level data. But such data are rarely available for historical episodes; therefore, almost all historical studies of financial fragility make use of aggregate data.<sup>4</sup>

Only one known study uses microdata. Charles Calomiris and R. Glenn Hubbard examine fixed investment behavior in 1936, using a panel of U.S. firms.<sup>5</sup> They identify firms that faced a high external finance premium, and find that for these firms, investment was sensitive to the availability of internal funds. Their findings appear to support Bernanke’s view that scarce and expensive credit delayed recovery from the depression.<sup>6</sup>

This article uses a new panel dataset to test the financial fragility hypothesis for U.S. railroads, during the period 1929–1940. A simple accelerator model is used to predict maintenance of way (track) and structures, maintenance of equipment, and employment in a world of perfect capital markets. To capture the effects of finance constraints, I add a measure of firm leverage and a bankruptcy dummy. I find that higher leverage firms had lower growth of maintenance (in both categories, way and equipment), whereas bankruptcy status had a large positive effect on all three variables. Leverage affected the behavior of small firms only; bankruptcy affected the behavior of large firms only. These effects are strongest during years of declining railroad revenues. The bankruptcy effects reported here are not found in the previous literature. However, the direct macroeconomic impact of leverage and bankruptcy appears to be small. Finally, the estimated financial effects are robust to the inclusion of federal loans to distressed railroads.

#### RAILROAD OPERATIONS, FINANCIAL STRUCTURE, AND THE GREAT DEPRESSION

Historically, railroads have been the most failure-prone sector in the U.S. economy.<sup>7</sup> Waves of railroad bankruptcies accompanied the contractions of 1857–1858, 1873–1879, 1882–1885, and 1893–1894. The Great Contraction of 1929–1933, followed by the slow and incomplete recovery of railroad

<sup>3</sup> See Calomiris, “Financial Factors”; Bernanke and Gertler, “Credit Channel”; and Hubbard “Capital Market Imperfections.”

<sup>4</sup> Hubbard, “Capital Market Imperfections,” p. 199. Kimmel (“Bank Credit”) and Hunter (“Business Liquidity”) use categorical data to compare the behavior of small and large firms. However, neither author was able to obtain pre-1933 data.

<sup>5</sup> Calomiris and Hubbard, “Internal Finance.”

<sup>6</sup> Bernanke, “Non-Monetary Effects.”

<sup>7</sup> Over 1,100 railroad bankruptcies occurred from 1876–1970 (including repeated bankruptcy episodes within the same firm). See Altman, “Predicting Railroad Bankruptcies,” p. 184.

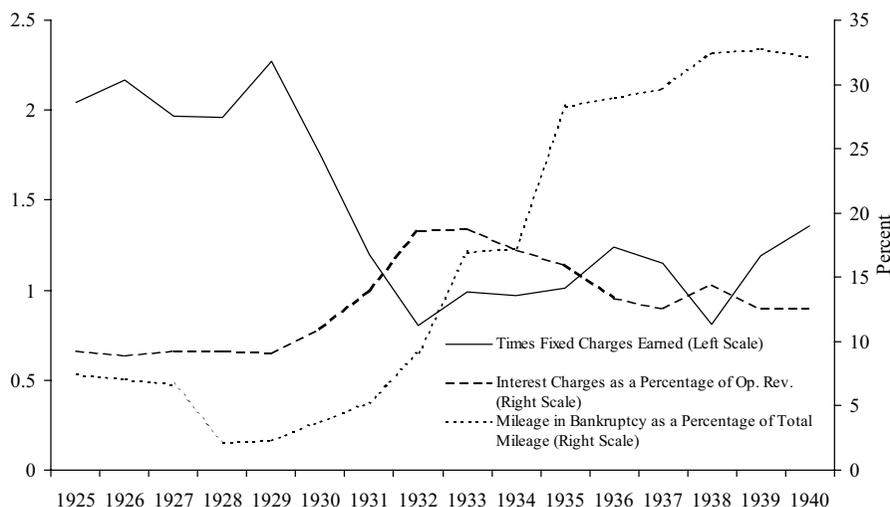


FIGURE 1  
SELECTED MEASURES OF FINANCIAL PERFORMANCE 1925–1940

Notes: “Times Fixed Charges Earned” and “Mileage in Bankruptcy as a Percentage of Total Mileage” are from ICC, *Statistics of Railways*; they cover all U.S. railroads (classes 1, 2, and 3). “Interest Charges as a Percentage of Operating Revenue” is from *Moody’s Steam Railroads*; it covers class 1 railroads.

revenues, drove nearly one-third of U.S. railway mileage into bankruptcy by 1938 (see Figure 1).

The railroad sector’s poor performance was a consequence of its structural attributes. Operations were characterized by high fixed costs and economies of scale, highly procyclical revenues and profits, sticky wages that were set by collective bargaining (nearly 60 percent of operating costs went to labor), and regulation by the Interstate Commerce Commission (ICC).<sup>8</sup>

Financial policies had three common characteristics. First, there was an emphasis on debt over equity. Debt was almost exclusively long-term (50-year mortgage bonds were typical). The industry maintained a high debt-to-capital ratio and incurred heavy fixed charges.<sup>9</sup> Second, cash holdings were small and savings were low. Firms had little to cushion them if current earnings fell below fixed charges.<sup>10</sup> Third, most firms failed to plan for the retirement of maturing bond issues, on the assumption that they could simply be refinanced.

<sup>8</sup> Wage stickiness was not unique to railroads. See Hanes, “Nominal Wage Rigidity.” The ICC had extensive power over railway rates. O’Brien (“Freight Rates”) argues that the ICC protected the railroads from the deflationary realities of the depression: “While the Commission approved several general rate increases, it did not allow a single rate reduction during the 1930’s.” He shows that nominal revenue per ton-mile declined slowly throughout the 1930s, but real revenue per ton-mile rose sharply (by over 40 percent) during 1929–1932 (figure 1, p. 75). In his opinion, this harmed industry and made the depression worse.

<sup>9</sup> These consisted primarily of interest on bonds and rent for leased lines. Rent payments were used by the lessor companies to pay interest on their bonds, and were in effect a form of interest.

<sup>10</sup> Cash holdings at the close of 1929 were \$515 million, while the 1929–1933 decline in gross (after tax, before fixed charges) income was \$953.7 million. These figures were compiled by the ICC, based on individual reports of Class 1 railways (railways with annual revenues over \$1 million).

TABLE 1  
SUMMARY STATISTICS FOR MEASURES OF INDEBTEDNESS, 1929 AND 1933

Variable	Mean	Standard Deviation	Median	Interquartile Range	Minimum	Maximum
Long-term debt / miles operated						
1929	42,087	31,029	40,762	46,712	0	136,738
1933	44,522	33,206	40,541	43,451	0	146,880
Fixed charge coverage ratio						
1929	2.493	2.643	1.828	1.087	0.323	22.143
1933	1.817	5.501	0.935	0.763	-1.557	50.626
Fixed charges / operating revenues						
1929	0.160	0.073	0.150	0.085	0.019	0.463
1933	0.291	0.182	0.276	0.159	-0.431	1.064

*Note:* The sample includes all independent firms (as defined in the Data Appendix). There were 92 such firms in 1929 and 87 in 1933.

The degree of indebtedness differed significantly across firms, both prior to and during the depression (Table 1). According to ICC data, long-term debt incurred from 1930–1933 was just 2.6 percent of total long-term debt at the close of 1933. Therefore, almost all of the cross-sectional variation reflects pre-1930 financing decisions, not the impact of the depression.<sup>11</sup>

With fixed charges holding steady, there existed a negative relationship between operating revenues and the ratio of fixed charges to operating revenues. From 1929 to 1933, operating revenues fell by 50.8 percent, while the ratio of interest payments to operating revenues rose from 9.1 percent to 18.8 percent. The fixed-charge coverage ratio (income available for fixed charges divided by fixed charges) fell from 2.27 to less than one (see Figure 1).<sup>12</sup>

Another important financial factor was the “legal list”—a list of permissible investments for banks and trusts, which was binding in several states. Although each state had its own legal list, the concentration of institutional investors in New York made its legal list especially influential. Railroad bonds were legal in New York, as long as they met the following three conditions. First, the issuing firm had covered fixed charges by 1.5 times in the previous year and in five of the previous six years.<sup>13</sup> Second, the firm had paid cash dividends equal to at least one-quarter of fixed charges in five of the previous six years, or alternatively, it had met the coverage ratio condition in nine of the previous ten years. Third, the firm operated at least 500 miles of railroad or generated at least \$10 million in annual

<sup>11</sup> Further details can be found in a supplement to this article, which is available upon request.

<sup>12</sup> Income available for fixed charges is an after-tax measure of profits, equal to the sum of after-tax operating income and nonoperating income.

<sup>13</sup> This requirement was altered twice in response to developments. In 1932 New York “legalized” all nondefaulting railroads. From 1 April 1938, railroads were legal if their coverage ratio was at least one during the previous year, and in five of the last six years (*Moody’s Governments*).

revenues. At the close of 1929, 36 percent of firms in the ICC's Class 1 (firms with annual operating revenues over \$1 million; this group accounted for 98 percent of all railroad operating revenues) failed to meet these criteria.

The early 1930s saw major sell-offs of railroad bonds, a massive collapse in their prices, and a "flight to quality"—only the strongest firms were able to refinance maturing bonds. The legal list probably contributed to this situation.<sup>14</sup> Unable to market new bonds, some troubled railroads resorted to short term bank credit. But bank credit dried up during the early 1930s, as banks scrambled to increase the safety and liquidity of their assets.<sup>15</sup>

Distressed roads were forced to find an internal source of "credit" or go bankrupt. Many borrowed from the future by deferring routine maintenance activities.<sup>16</sup> In the short term, this could be done without impairing safety. But in the long run, the practice of cutting maintenance whenever cash was lacking entailed significant costs. Maintenance workers comprised just over one-half of the predepression railroad workforce; the instability of their employment led to human-capital deterioration and low morale. During slack periods, machines were idle and materials had to be stored at a cost. Railway engineers decried such practices; instead, they advocated steady maintenance programs, based solely on the physical needs of the road.<sup>17</sup> In the 1920s, firms and unions had made a serious cooperative effort to stabilize maintenance, but their mutual understandings gave way in the face of the depression.<sup>18</sup>

As the railroad situation deteriorated, the federal government feared that a wave of railroad defaults would severely damage the financial system. Railroad bonds comprised 20 percent of the corporate bond market, 16 percent of aggregate bank assets, and 24 percent of aggregate insurance company assets.<sup>19</sup> Moreover, the banking and insurance sectors were already in crisis. In January 1932 the government formed the Reconstruction Finance Corporation (RFC) to provide loans to banks and railroads that were unable to obtain private credit. The RFC's railroad program had two major goals: to support railroad bond prices and prevent losses to bondholders; and to stimulate railroad maintenance and employment. The railroad program was highly controversial, and was at best a partial success; 40 Class 1 roads succumbed to bankruptcy after receiving RFC loans.

<sup>14</sup> New York's legal list applied strictly to new investments, but not to existing holdings. If a road lost its legal status, banks could continue to hold its securities, unless the Superintendent of Banks ordered them to sell. In practice, this distinction was unimportant; banks hastened to sell bonds if the issuing railroad fell below the interest-coverage threshold.

<sup>15</sup> Calomiris and Wilson, "Bank Capital."

<sup>16</sup> Baker and Crum, "Railroad Situation"; and Haber et al., "Maintenance of Way Employment."

<sup>17</sup> Haber et al., "Maintenance of Way Employment."

<sup>18</sup> Wood, "Union-Management Cooperation"; and Metropolitan Life, "Personnel Management."

<sup>19</sup> These are 1933 estimates from Horton, "Long Term Debts."

When a firm entered bankruptcy, its operations were placed in the hands of court-appointed receivers (firms were rarely liquidated). The court authorized them to issue “receivers’ certificates,” which were senior to all preexisting debts. The proceeds were used to pay off immediate obligations, and to rehabilitate the road physically, in preparation for its (eventual) emergence from bankruptcy.<sup>20</sup> Meanwhile, the firm’s stakeholders worked out a reorganization plan; this was a lengthy, costly, and complex process. In 1933 Congress passed a bankruptcy law; its railroad provisions became known as “Section 77.” The new “trusteeship” procedure was designed to expedite the reorganization process, but in practice, this goal was not realized.<sup>21</sup>

#### MAIN HYPOTHESES

Armed with this historical background, we can now state our main hypotheses (with a *ceteris-paribus* qualification). Roads with low leverage should exhibit stronger growth in maintenance and employment than roads with high leverage. For large roads, the influence of leverage should be weaker, as large firms are expected to have easier and cheaper access to credit than small roads.<sup>22</sup> Bankrupt roads should exhibit higher maintenance and employment growth than nonbankrupt roads, because bankrupt roads were free from making interest payments and were able to tap a new source of credit. The bankruptcy effect may differ by firm size, as large firms generally face greater difficulties and incur higher costs in renegotiating their debts.<sup>23</sup> Also, leverage and bankruptcy may have asymmetric effects, exerting a stronger influence during downturns, because declines in revenue make credit constraints tighter.<sup>24</sup>

Over the 1929–1936 period, (real) maintenance of way was more cyclical than (real) maintenance of equipment and employment (Figure 2). Financial factors may have played a role in generating these differences. However, other factors, such as changes in technology and productivity, may have been more important; this question is left for further research.

<sup>20</sup> Dewing, “Theory,” pp. 777–78.

<sup>21</sup> Trusteeship took 7.5 years on average, compared to 3–4 years for the pre-1933 receivership (Altman, “Predicting Railroad Bankruptcies,” pp. 188–89).

<sup>22</sup> Gilchrist and Himmelberg (“Investment”) give three theoretical reasons: If there are fixed costs in obtaining external finance, large firms benefit from economies of scale; size proxies for age and other unobservable firm characteristics; and large firms are better known and more established as borrowers, so problems of asymmetric information are less severe. Does the empirical evidence confirm that small firms face greater finance constraints? Fazzari, Hubbard, and Petersen (“Financing Constraints” and “Investment–Cash Flow Sensitivities”) say yes, but Kaplan and Zingales (“Useful Measures?” and “Not Valid Measures”) strongly disagree.

<sup>23</sup> Gilson, John and Lang, “Troubled Debt Restructurings.”

<sup>24</sup> This hypothesis of asymmetric leverage effects is consistent with the findings of Calomiris, Orphanides, and Sharpe, “Leverage.”

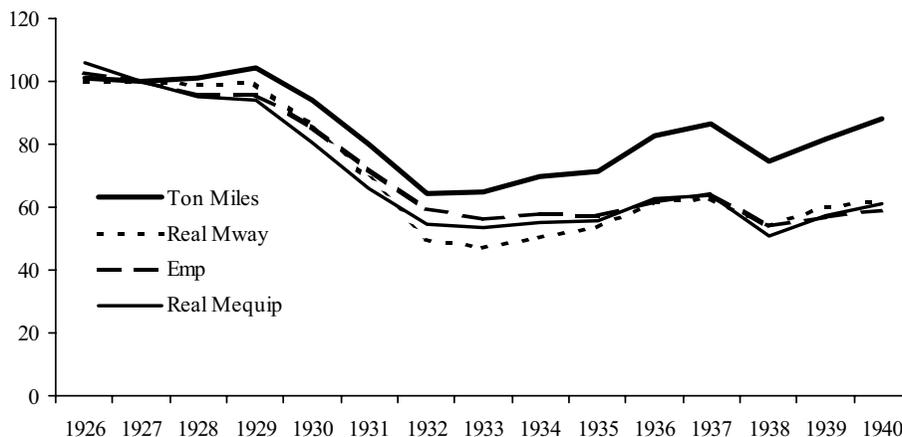


FIGURE 2  
INDICES OF REAL ACTIVITY, CLASS 1 RAILROADS (1927 = 100)

Sources: Ton Miles = Gross Ton Miles from Association of American Railroads, "Railroad Transportation." Employment and (nominal) maintenance series are taken from ICC, "Statistics of Railways." The following deflators are used to compute real maintenance: for way, the ICC's Railroad Construction Index (published in ICC, "ICC Activities"); for equipment,  $0.75 * \text{Wages of Shop Craft Group} + 0.25 * \text{Index of Metals Prices}$ . (Maintenance of equipment expenses were approximately 75 percent labor, 25 percent materials.) Wages of Shop Crafts Group was compiled by the ICC, and is reproduced in Bureau of Information of the Eastern Railways, "Railroad Wages." Index of Metals Prices was compiled by the Bureau of Labor Statistics, and is reproduced in the NBER Macro History Database.

#### A FLEXIBLE ACCELERATOR MODEL

To test for financial effects, we formulate a "benchmark" model of maintenance in an environment free of finance constraints, and compare actual maintenance decisions with those predicted by the benchmark. I choose the flexible accelerator model as the finance constraint-free benchmark.<sup>25</sup> In this model, the firm chooses its long run optimal capital stock ( $K^*$ ) by equating the user cost of capital ( $UC$ ) with the marginal product of capital ( $MPK$ ). Due to adjustment costs, actual capital stock ( $K$ ) may deviate from  $K^*$ . In each period, the firm adjusts  $K$  to make up a fraction ( $\lambda$ ) of the difference between  $K^*$  and (one-period-lagged)  $K$ :

$$\Delta \ln K_t = \lambda (\ln K_t^* - \ln K_{t-1}) \quad 0 < \lambda < 1 \quad (1)$$

To find  $K^*$ , we must know  $UC$  and  $MPK$ . The standard formula for user cost is  $UC_t = p_t^k (r_t + \delta_t)$ , where  $p^k$  is the price of capital,  $r$  is the expected real interest rate and  $\delta$  is the rate of capital depreciation. If  $p^k$  is chosen as the numeraire,  $UC_t = r_t + \delta_t$ . To derive an expression for  $MPK$ , suppose that

<sup>25</sup> Models based on Tobin's  $q$  are not well-suited for identifying finance constraints (Gilchrist and Himmelberg, "Investment").

$Y_t = K_t^\theta L_t^{1-\theta}$ , where  $Y$  is output and  $L$  is labor; the firm faces the inverse demand curve  $P_t = \epsilon_t Y_t^{-\eta}$ , where  $P$  is the real price of output,  $\epsilon$  is an iid stochastic shock, and  $\eta$  is the inverse elasticity of demand. Denoting total sales revenue as  $S$ , we have  $S_t = P_t Y_t = \epsilon_t Y_t^{1-\eta} = \epsilon_t (K_t^\theta L_t^{1-\theta})^{1-\eta}$ . Differentiating partially with respect to  $K_t$  yields  $MPK_t = \theta(1 - \eta)(S_t / K_t)$ . Setting  $UC_t = MPK_t$  and solving for  $K^*$  yields

$$K_t^* = \frac{\theta(1 - \eta)}{r_t + \delta_t} S_t \tag{2}$$

Substituting equation 2 into equation 1 and rearranging, we have

$$\Delta \ln K_t = \lambda \ln \theta(1 - \eta) + \lambda \Delta \ln S_t - \lambda (\ln K_{t-1} - \ln S_{t-1}) - \lambda \ln(r_t + \delta_t) \tag{3}$$

Because railroads measured  $K$  poorly, it is best to substitute for  $K$  in terms of maintenance expenditures, which were measured more accurately.<sup>26</sup> Suppose that in the short run, the firm cannot invest in new capital, but it can expend resources to maintain existing capital ( $M$ ). This activity adds to the effective capital stock. At the same time, capital depreciates geometrically at a constant rate of  $\delta$ . In symbols, the accumulation equation is

$$K_t = (1 - \delta)K_{t-1} + M_t \tag{4}$$

This equation has a steady state, which is defined by  $\bar{M} = \delta \bar{K}$ ,  $K_t = K_{t-1} = \bar{K}$ . To substitute out  $K$ , I take the following steps: loglinearize equation 4 around its steady state; use the resulting expression to substitute for  $\ln \Delta K_t$  in equation 3, in terms of  $\ln \Delta M_t$ ; solve recursively for  $K_{t-1}$  as a function of (infinite lags of) maintenance; and solve for  $\ln \Delta M_t$  and write the resulting equation in “error-correction” form.<sup>27</sup> The resulting expression is

$$\begin{aligned} \Delta \ln M_t \approx & (\lambda / \delta) \ln \delta + ((1 - \delta)(\lambda - \delta) / \delta^2) \ln \bar{K} + (\lambda / \delta) \ln \theta(1 - \eta) \\ & - (\lambda / \delta) \ln(r_t + \delta) + (\lambda / \delta) \Delta \ln S_t - (\ln M_{t-1} - \ln S_{t-1}) \\ & - ((\delta - \lambda) / \delta) \ln S_{t-1} + (\delta - \lambda) \sum_{i=1}^{\infty} (1 - \delta)^{i-1} \ln M_{t-i} \end{aligned} \tag{5}$$

EMPIRICAL SPECIFICATION

It is essential to specify an empirical counterpart to equation 5, which can be estimated using panel data. For this purpose, I make a number of small modifications: Although equation 5 places explicit restrictions on the coefficients to be estimated, I do not impose them in practice. In order to better capture the time-series dynamics, I replace  $\ln S_{t-1}$  with  $\Delta \ln S_{t-1}$ . I include two

<sup>26</sup> This point is explained in the data appendix.

<sup>27</sup> Details are available upon request.

lags of maintenance, in place of the infinite distributed lag in equation 5. Firm fixed effects are included to pick up differences in the elasticity of demand across firms.<sup>28</sup> Time dummies are included to capture (as well as possible) the effects of productivity improvements in maintenance activities.<sup>29</sup> The time dummies also serve to absorb the effect of changes in the expected real interest rate.<sup>30</sup>

After making these modifications, I add two terms that capture the influence of finance constraints: the lagged ratio of fixed charges to operating revenues and a bankruptcy dummy.<sup>31</sup>

The equations to be estimated take the form

$$\begin{aligned} \Delta \ln M_{it} = & \alpha_i + \gamma_t + \beta_1 \Delta \ln S_{it} + \beta_2 \ln \Delta S_{i,t-1} + \beta_3 (\ln M_{i,t-1} - \ln S_{i,t-1}) \\ & + \beta_4 \ln M_{i,t-1} + \beta_5 \ln M_{i,t-2} + \beta_6 (FC / OR)_{i,t-1} \\ & + \beta_7 BANKRUPT_{it} + \epsilon_{it} \end{aligned} \quad (6)$$

where  $M$  represents maintenance of way or maintenance of equipment,  $\alpha$  is a firm fixed effect,  $\gamma$  is a year dummy,  $S$  is operating revenue,  $(FC / OR)$  is the ratio of fixed charges to operating revenue, and  $BANKRUPT$  is a bankruptcy dummy.

I allow for variants of equation 6, in which the finance-related terms have an asymmetric impact, depending on the state of the economy. I also allow separate equations for small and large firms.

Maintenance workers accounted for about one-half of total railroad employment. Therefore, it is sensible to assume that employment followed the same dynamics as maintenance, and was driven by the same variables (both fundamental and financial). On the basis of this assumption, equation 6 is estimated for three dependent variables: maintenance of way, maintenance of equipment, and employment.

#### NEW DATA ON U.S. RAILROADS, 1929–1940

My panel dataset is collected from the *Statistics of Railways in the United States* (SOR), an annual publication of the Interstate Commerce Commission. Summary statistics are shown in Table 2. The sample spans the years

<sup>28</sup> Firms differed in the mix of commodities that they transported, their ratio of passenger revenues to total revenues, and their exposure to competition from other modes of transportation.

<sup>29</sup> During our sample period, maintenance of way became increasingly mechanized, and better materials were introduced (Haber et al., “Maintenance of Way Employment”).

<sup>30</sup> There is no firm-level measure of expected real interest rates. An economywide rate of interest cannot be used because it varies only with time and would be collinear with the time dummy.

<sup>31</sup> Moody’s and Poor’s emphasized the (lagged) fixed charge coverage ratio as a measure of financial strength. However, due to a skewed, non-normal distribution, it performs poorly in regressions and is not used here. I do not distinguish receivership from trusteeship; only a few bankruptcies preceded 1933.

TABLE 2  
SUMMARY STATISTICS

Variable	<i>N</i>	Mean	Standard Deviation	Minimum	Maximum
Maintenance of way	1,044	4,901,799	8,106,245	12,979	87,847,376
Maintenance of equipment	1,044	8,030,747	14,200,907	10,392	131,642,784
Employment	1,043	11,426	19,411	115	171,589
Bankruptcy dummy	1,044	0.166	0.372	0	1
Fixed charges	1,044	7,617,545	13,615,759	-4,179,505	102,090,286
Operating revenues	1,044	41,247,690	70,188,008	46,340	682,702,931
RFC loan	1,044	770,118	5,160,466	0	99,422,400
Log difference of maintenance of way	1,044	-0.038	0.241	-2.648	1.022
Log difference of maintenance of equipment	1,044	-0.031	0.250	-2.619	2.245
Log difference of employment	1,042	-0.034	0.127	-0.818	0.959
Log difference of operating revenues	1,044	-0.026	0.221	-2.963	1.437
Log (maintenance of way / operating revenues)	1,044	-2.04	0.302	-2.891	-0.634
Log (maintenance of equipment / operating revenues)	1,044	-1.734	0.317	-3.854	-0.320
Log (employment / operating revenues)	1,043	-8.195	0.330	-9.379	-4.836
Fixed charges / operating revenues	1,044	0.204	0.142	-0.431	1.257
Deductions from gross income / operating revenues, 1929–1934	530	0.244	0.151	-0.431	1.257
Fixed charges / operating revenues, 1935–1940	514	0.163	0.118	9.77×10 <sup>-6</sup>	0.868
Fixed charges / operating revenues, demeaned and adjusted for break in 1935	1,044	-0.019	0.135	-0.687	1.001
RFC loan ( <i>t</i> ) / fixed charges ( <i>t</i> -1)	1,044	0.102	0.714	0.000	16.570

Note: The sample includes all independent firms (as defined in the Data Appendix), 1929–1940, unless otherwise noted.

1929–1940 (after lags and differencing). It includes all Class 1 firms, except those that were dependent subsidiaries of other firms (operationally or financially). In 1929 there were 92 independent firms (this fell to 85 by 1940).<sup>32</sup> Revenues of independent firms accounted for 82.7 percent of all railroad revenues and 5.1 percent of GDP. Their maintenance expenditures totaled 1.7 percent of GDP, and they employed 2.9 percent of the U.S. labor force.

#### ECONOMETRIC ISSUES

It can be argued that using  $(FC / OR)_{t-1}$  creates a simultaneity problem—perhaps firms borrowed in the previous year to pay for current maintenance.<sup>33</sup> This is unlikely, because maintenance budgets were prepared monthly, five to ten days before the first of the month.<sup>34</sup> Nevertheless, I consider  $(FC/OR)$  in 1929 as an alternative. This variable is predetermined with respect to the dependent variable, and its correlation with  $(FC / OR)_{t-1}$  is 0.55. But because it does not vary over time, it cannot be included in a fixed-effects regression.

In order to compare the effects of the two leverage measures, I estimate equation 6 for each of the three dependent variables, using  $(FC / OR)_{t-1}$  or  $(FC / OR)_{1929}$ . Pooled OLS is used (no fixed effects), and the sample period is 1930–1940. If simultaneity bias is present, there should be substantial differences in coefficient estimates, depending on which leverage measure is used. I find no evidence of simultaneity; coefficient estimates are nearly identical, regardless of leverage measure.<sup>35</sup>

As  $(FC / OR)_{t-1}$  does not cause simultaneity bias, we may use it in a fixed effects model. This specification is best, for two reasons: the theory calls for fixed effects, in the absence of actual firm-level data on demand elasticity; and, if the correct model includes fixed effects, and the fixed effects are correlated with any of the other regressors, pooled OLS yields biased and inconsistent estimates.

Another important issue is heteroskedasticity. The Breusch-Pagan test rejects the null hypothesis of homoskedasticity ( $p$ -value = 0.0000) for all three dependent variables. Therefore, heteroskedasticity-consistent  $t$ -statistics are reported with all regressions.

#### EMPIRICAL RESULTS

I estimate four specifications of equation 6, which share the same set of “fundamental” variables, but differ with respect to the financial variables

<sup>32</sup> The construction of the dataset is described in the data appendix.

<sup>33</sup> I thank one of the referees for bringing this issue to my attention.

<sup>34</sup> Bunnell, “Railroad Accounting,” p. 238.

<sup>35</sup> These results are available upon request.

included. Specification A adds  $(FC / OR)_{t-1}$  to the set of fundamentals, whereas B adds both  $(FC / OR)_{t-1}$  and  $BANKRUPT_t$ . Specification C is identical to B, except that  $(FC / OR)_{t-1}$  enters asymmetrically. In asymmetric specifications, 1930–1933 and 1938 (during which aggregate operating revenues fell) are treated as “depression” years, whereas all other years are treated as “nondepression” years. In specification D, both  $(FC / OR)_{t-1}$  and  $BANKRUPT_t$  enter asymmetrically. I also split the sample and estimate specification D for large and small firms. A firm is considered large if it met the size criteria of New York’s legal list. Over the 1929–1940 period, revenues of large firms accounted for 97.7 percent of independent firm revenues and 4.29 percent of GDP.

The “fundamental” variables capture the dynamics of maintenance and employment reasonably well (Tables 3–5). The error correction term is negative and statistically significant for all three dependent variables; this confirms the importance of intertemporal shifts in maintenance and employment. We now turn to the financial effects (Table 6), beginning with maintenance of way. A firm whose  $(FC / OR)_{t-1}$  was one standard deviation above average reduced maintenance of way by three percentage points per year, relative to an average firm (specification B). A bankrupt firm increased maintenance of way by over eight percentage points per year, relative to a nonbankrupt firm. Allowing for asymmetric effects (specification D), we see that financial distress had a significantly larger effect in depression years (–5.57 percentage points and significant) than in nondepression years (–1.81, not significant). Bankruptcy effects were large and positive, and their magnitude doubled during depression years. Splitting the sample by firm size reveals that small firms were most affected by financial distress (–7.45 percentage points in depression years; for large firms, the corresponding effect was –3.12, and not statistically significant). Bankruptcy effects were very large (and asymmetric) for large firms, reaching 16.46 percentage points in depression years, but for small firms, we cannot reject the hypothesis that they were zero.

For maintenance of equipment, leverage had no significant impact during nondepression years, but did have a significant impact (near –3) in depression years. Bankruptcy effects were large and symmetric (near 10) for the entire sample (specifications C and D). Splitting the sample by firm size reveals that only small firms were (significantly) affected by leverage (–4.30, during depression years only). Only large firms were (significantly) affected by bankruptcy; this effect was asymmetric, and reached 15.1 percentage points in depression years.

For employment, leverage had no significant effect. However, in specification D (all firms or large firms) the estimated leverage effect is near –2, and there is evidence of asymmetry (at a 10-percent significance level).

TABLE 3  
MAINTENANCE OF WAY REGRESSIONS

Dependent Variable: Log Difference of Maintenance of Way	A All Independent Firms	B All Independent Firms	C All Independent Firms	D All Independent Firms	D Large Independent Firms	D Small Independent Firms
Log difference of operating revenues ( $t$ )	0.624*** (8.03)	0.637*** (8.04)	0.645*** (8.29)	0.642*** (8.04)	0.632*** (5.70)	0.644*** (6.04)
Log difference of operating revenues ( $t-1$ )	0.067 (1.25)	0.052 (0.95)	0.063 (1.15)	0.069 (1.27)	-0.061 (1.20)	0.155** (2.00)
Log maintenance of way ( $t-1$ ) – log operating revenues ( $t-1$ )	-0.409*** (6.72)	-0.444*** (7.01)	-0.444*** (7.13)	-0.434*** (6.83)	-0.543*** (6.96)	-0.436*** (4.35)
Log maintenance of way ( $t-1$ )	-0.090 (1.35)	-0.074 (1.09)	-0.080 (1.19)	-0.089 (1.30)	0.093 (1.52)	-0.165 (1.36)
Log maintenance of way ( $t-2$ )	0.034 (0.74)	0.032 (0.69)	0.045 (0.94)	0.053 (1.11)	-0.038 (0.85)	0.109 (1.42)
(Fixed charges / operating revenues) ( $t-1$ )	-0.178* (1.86)	-0.222** (2.30)	-0.155 (1.45)	-0.134 (1.22)	-0.167 (1.24)	-0.144 (0.95)
Depression ( $t$ ) dummy × (fixed charges / operating revenues) ( $t-1$ )			-0.238** (2.52)	-0.278*** (2.82)	-0.064 (0.46)	-0.408*** (3.20)
Bankruptcy ( $t$ ) dummy		0.083*** (4.56)	0.082*** (4.50)	0.061*** (2.98)	0.081*** (3.52)	0.006 (0.13)
Depression ( $t$ ) dummy × Bankruptcy ( $t$ ) dummy				0.062** (2.46)	0.083*** (2.91)	0.005 (0.11)
Observations	1,044	1,043	1,043	1,043	665	378
R-squared	0.710	0.715	0.719	0.720	0.768	0.700

\*\*\* = Significant at the 1-percent level

\*\* = Significant at the 5 percent level

\* = Significant at the 10 percent level

Note: All specifications include fixed firm effects as well as year dummies (whose coefficients are not reported). The sample consists of all independent firms, 1929–1940, unless otherwise noted. A large firm is a firm that meets the size requirements for the “legal lists” of New York and New Jersey—operation of at least 500 miles of railway or operating revenues of at least \$10 million, as of the previous year. The depression dummy equals one in the years 1930–1933 and 1938, zero in all other years. Numbers in parentheses are heteroskedasticity-consistent  $t$ -statistics, expressed as absolute values.

TABLE 4  
MAINTENANCE OF EQUIPMENT REGRESSIONS

Dependent Variable: Log Difference of Maintenance of Equipment	A All Independent Firms	B All Independent Firms	C All Independent Firms	D All Independent Firms	D Large Independent Firms	D Small Independent Firms
Log difference of operating revenues ( $t$ )	0.559*** (6.42)	0.575*** (6.46)	0.579*** (6.51)	0.578*** (6.41)	0.526*** (4.46)	0.601*** (5.24)
Log difference of operating revenues ( $t-1$ )	-0.004 (0.09)	-0.021 (0.45)	-0.016 (0.35)	-0.016 (0.33)	-0.073 (1.45)	0.037 (0.56)
Log maintenance of equip. ( $t-1$ ) - log operating revenues ( $t-1$ )	-0.514*** (6.74)	-0.549*** (7.17)	-0.547*** (7.12)	-0.545*** (7.10)	-0.577*** (5.63)	-0.575*** (5.11)
Log maintenance of equipment ( $t-1$ )	-0.281*** (3.83)	-0.262*** (3.81)	-0.262*** (3.81)	-0.263*** (3.80)	-0.225** (2.51)	-0.246** (2.36)
Log maintenance of equipment ( $t-2$ )	0.042 (0.98)	0.038 (0.97)	0.041 (1.06)	0.042 (1.07)	0.047 (0.89)	0.007 (0.12)
(Fixed charges / operating revenues) ( $t-1$ )	-0.086 (0.98)	-0.135 (1.50)	-0.099 (1.00)	-0.092 (0.91)	-0.157 (1.17)	-0.083 (0.59)
Depression ( $t$ ) dummy $\times$ (fixed charges / operating revenues) ( $t-1$ )			-0.126 (1.31)	-0.141 (1.40)	0.007 (0.07)	-0.235* (1.74)
Bankruptcy ( $t$ ) dummy		0.101*** (3.06)	0.100*** (3.03)	0.092*** (2.67)	0.085** (2.15)	0.075 (1.34)
Depression ( $t$ ) dummy $\times$ bankruptcy ( $t$ ) dummy				0.025 (0.87)	0.066** (2.33)	-0.046 (0.83)
Observations	1,044	1,043	1,043	1,043	665	378
R-Squared	0.649	0.656	0.657	0.658	0.651	0.692

\*\*\* = Significant at the 1-percent level

\*\* = Significant at the 5-percent level

\* = Significant at the 10-percent level

Note: See Table 3.

TABLE 5  
EMPLOYMENT REGRESSIONS

Dependent Variable: Log Difference of Employment	A All Independent Firms	B All Independent Firms	C All Independent Firms	D All Independent Firms	D Large Independent Firms	D Small Independent Firms
Log difference of operating revenues ( $t$ )	0.242*** (3.79)	0.246*** (3.86)	0.249*** (3.88)	0.248*** (3.92)	0.335*** (2.95)	0.162*** (2.63)
Log difference of operating revenues ( $t-1$ )	0.049 (1.62)	0.046 (1.51)	0.051* (1.68)	0.054* (1.78)	0.047 (0.98)	0.031 (0.98)
Log employment ( $t-1$ ) – log operating revenues ( $t-1$ )	-0.122*** (2.82)	-0.131*** (3.02)	-0.131*** (3.06)	-0.128*** (2.99)	-0.177*** (2.77)	-0.115** (2.42)
Log employment ( $t-1$ )	-0.143** (2.53)	-0.141** (2.50)	-0.147*** (2.64)	-0.154*** (2.75)	-0.040 (0.90)	-0.232** (2.53)
Log employment ( $t-2$ )	-0.048 (1.08)	-0.047 (1.04)	-0.037 (0.86)	-0.030 (0.70)	-0.021 (0.45)	-0.090 (1.30)
(Fixed charges / operating revenues) ( $t-1$ )	-0.030 (0.43)	-0.042 (0.59)	-0.013 (0.18)	-0.001 (0.02)	-0.004 (0.04)	-0.032 (0.34)
Depression ( $t$ ) dummy $\times$ (fixed charges / operating revenues) ( $t-1$ )			-0.101 (1.45)	-0.126* (1.69)	-0.152* (1.76)	-0.073 (0.80)
Bankruptcy ( $t$ ) dummy		0.025** (2.18)	0.024** (2.17)	0.011 (0.93)	0.012 (0.90)	0.002 (0.04)
Depression ( $t$ ) dummy $\times$ bankruptcy ( $t$ ) dummy				0.040** (2.50)	0.042*** (2.61)	0.031 (1.09)
Observations	1,041	1,040	1,040	1,040	662	378
R-Squared	0.670	0.672	0.675	0.677	0.739	0.700

\*\*\* = Significant at the 1-percent level

\*\* = Significant at the 5-percent level

\* = Significant at the 10-percent level

Note: See Table 3.

TABLE 6  
EFFECTS OF FINANCIAL FACTORS ON REAL ACTIVITY  
(percentage points)

	A All Indep. Firms	B All Indep. Firms	C All Indep. Firms	D All Indep. Firms	D Large Indep. Firms	D Small Indep. Firms
Dependent Variable: Log Difference of Maintenance of Way						
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, all years	-2.41* (1.86)	-3.00** (2.30)				
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, nondepression years			-2.09 (1.45)	-1.81 (1.22)	-2.26 (1.24)	-1.95 (0.95)
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, depression years			-5.31*** (3.89)	-5.57*** (4.13)	-3.12 (1.49)	-7.45*** (3.71)
Is the (fixed charges / operating revenues) ( $t-1$ ) effect asymmetric?			Yes** (2.52)	Yes*** (2.82)	No (0.46)	Yes*** (3.20)
In bankruptcy ( $t$ ), all years		8.29*** (4.56)	8.17*** (4.50)			
In bankruptcy ( $t$ ), nondepression years				6.08*** (2.98)	8.14*** (3.52)	0.64 (0.13)
In bankruptcy ( $t$ ), depression years				12.26*** (5.18)	16.46*** (6.06)	1.11 (0.24)
Is the bankruptcy ( $t$ ) effect asymmetric?				Yes** (2.46)	Yes*** (2.91)	No (0.11)
Dependent Variable: Log Difference of Maintenance of Equipment						
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, all years	-1.16 (0.98)	-1.82 (1.50)				
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, nondepression years			-1.34 (1.00)	-1.24 (0.91)	-2.12 (1.17)	-1.13 (0.59)
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, depression years			-3.04** (2.17)	-3.15** (2.24)	-2.02 (0.93)	-4.30** (2.21)

TABLE 6 — continued

	A	B	C	D	D	D
Is the (fixed charges / operating revenues) ( $t-1$ ) effect asymmetric?			No (1.31)	No (1.40)	No (0.08)	Yes* (1.74)
In bankruptcy ( $t$ ), all years		10.09*** (3.07)	10.03*** (3.03)			
In bankruptcy ( $t$ ), nondepression years				9.19*** (2.67)	8.45** (2.15)	7.53 (1.34)
In bankruptcy ( $t$ ), depression years				11.70*** (3.06)	15.10*** (3.27)	2.95 (0.56)
Is the bankruptcy ( $t$ ) effect asymmetric?				No (0.87)	Yes** (2.33)	No (0.83)
Dependent Variable: Log Difference of Employment						
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, all years	-0.41 (0.43)	-0.57 (0.59)				
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, nondepression years			-0.18 (0.18)	-0.02 (0.02)	-0.05 (0.04)	-0.43 (0.34)
(Fixed charges / operating revenues) ( $t-1$ ) one standard deviation above average, depression years			-1.55 (1.30)	-1.72 (1.42)	-2.10 (1.28)	-1.42 (1.01)
Is the (fixed charges / operating revenues) ( $t-1$ ) effect asymmetric?			No (1.45)	Yes* (1.69)	Yes* (1.76)	No (0.80)
In bankruptcy ( $t$ ), all years		2.45** (2.18)	2.43** (2.17)			
In bankruptcy ( $t$ ), nondepression years				1.12 (0.93)	1.19 (0.90)	0.15 (0.04)
In bankruptcy ( $t$ ), depression years				5.10*** (3.15)	5.34*** (3.41)	3.25 (0.88)
Is the bankruptcy ( $t$ ) effect asymmetric?				Yes** (2.50)	Yes*** (2.61)	No (1.09)

Note: Financial effects are computed from the regression coefficients reported in Tables 3–5. The standard deviation of (Fixed charges / operating revenues) ( $t-1$ ) is 0.135. Numbers in parentheses are heteroskedasticity-consistent  $t$ -statistics, expressed as absolute values.

Bankruptcy had a significant effect in depression years only (over 5), and in large firms only.

In summary, leverage affected both types of maintenance, in small firms only. It had no significant effect on employment, regardless of firm size. Bankruptcy affected all three dependent variables, in large firms only.

#### DISCUSSION

For both maintenance categories, leverage had a significant effect on small firms only, and during the worst years of the depression only. This is broadly consistent with previous work on finance constraints and investment.

Leverage affected maintenance of way more than maintenance of equipment. According to George Baker and William Crum, managers gave first priority to the latter.<sup>36</sup> I suggest that this behavior was driven by several factors: First, equipment purchases were financed by means of the “equipment trust.” The trustee (typically a bank) owned the equipment and leased it to the railroad. The railroad promised (in writing) to keep the equipment in good shape. If it failed to do so, the trustee could repossess. Second, cars were regularly hired from one railroad to another. Third, undermaintenance of equipment was obvious to customers, and would cause them to defect to competitors. Undermaintenance of track was easier to hide, especially in freight service (which accounted for almost 80 percent of revenues).

Why did leverage have no effect on the employment decisions of small firms, even in 1930–1933 and 1938? Perhaps firms minimized layoffs by reducing the hours of existing employees. To measure the importance of this factor, it would be useful to estimate the model with payroll expenditure (instead of employment) as the dependent variable. (This is left for future work.)

Why did the effects of bankruptcy depend so critically on size? Perhaps large firms wielded greater influence over judges and legislators, and used that influence to tilt the bankruptcy process in their favor. There is no explicit support for this proposition, however.<sup>37</sup> A more plausible explanation is that large roads suffered from diseconomies of scale while in distress, but enjoyed significant economies of scale once they entered bankruptcy.

Large roads tended to have complex capital structures, with multiple classes of bonds.<sup>38</sup> Firms with many creditors are less likely to successfully renegotiate their debts (without resorting to bankruptcy).<sup>39</sup> Indeed, large

<sup>36</sup> Baker and Crum, “Railroad Situation,” p. 84. No attempt is made to explain why.

<sup>37</sup> If the proposition were true, one would expect small firms to complain of unfair treatment by the courts. I have found no mention of such complaints in any source.

<sup>38</sup> This can be seen easily by leafing through a railroad manual (Moody’s or Poor’s).

<sup>39</sup> Gilson, John, and Lang, “Troubled Debt Restructurings.”

railways rarely succeeded in renegotiating, even after the passage of Section 77, which allowed for judicial readjustment outside of bankruptcy.<sup>40</sup>

Jerrold Warner finds significant economies of scale in bankruptcy.<sup>41</sup> Using a sample of 11 railroad bankruptcy episodes (with beginning dates from 1933 to 1955), he measures “direct” bankruptcy costs, which can be attributed to the court proceedings themselves.<sup>42</sup> He finds that the ratio of bankruptcy costs to prebankruptcy market value was (significantly) negatively correlated with the prebankruptcy market value. He attributes this to fixed costs and economies of scale. Warner’s results explain why small firms failed to boost maintenance while in bankruptcy. Because they incurred heavy bankruptcy costs, they had fewer resources to spend on maintenance.

What is the macroeconomic significance of these findings? Because leverage effects are confined to small firms (whose revenues equaled 0.1 percent of GDP over 1929–1940), the macroeconomic effect of leverage is minuscule. Bankruptcy effects, however, are associated with large firms, whose revenues were 4.29 percent of GDP. Suppose that all large (independent) firms were in bankruptcy. What would have been the effect on GDP and total U.S. employment?

The following example demonstrates the relevant calculations: In 1929 maintenance of way on large, independent, nonbankrupt railroads was 0.66 percent of GDP. The bankruptcy effect for large firms (from specification D, with split sample) in nondepression years was 6.08 percent. Had all nonbankrupt firms been bankrupt instead, the impact on 1929 maintenance of way would have been 0.66 percent \* 6.08 percent = 0.04 percent of GDP. Making a calculation of this type for every year (1929–1940) and dependent variable, while assigning statistically insignificant effects a value of zero, yields the entries in Table 7. The impact of bankruptcy was strongest over 1930–1933; had all large firms been bankrupt over that period, the additional maintenance spending would have boosted GDP by an average of 0.199 percent per year, and employment would have increased by an average of 0.125 percent per year. These estimates are rather conservative, because they assume that dependent firms are unaffected by bankruptcy, and ignore potential multiplier effects. Of course, this counterfactual is subject to the Lucas Critique. A policy decision to place all firms in bankruptcy probably would have altered the behavior of firms, and (consequently) the values of the relevant parameters.

<sup>40</sup> Regarding out-of-court renegotiations, see Dewing, “Procedure,” p. 8. Over 1933–1940, only one large road avoided bankruptcy through judicial readjustment—the Baltimore and Ohio in 1938.

<sup>41</sup> Warner, “Bankruptcy Costs.”

<sup>42</sup> The following are examples of indirect costs: customers avoid doing business with a bankrupt firm, because they fear imminent default; managers fulfill their operating functions poorly because they are preoccupied by court proceedings; and lenders restrict credit.

TABLE 7  
 HYPOTHETICAL IMPACT OF PLACING ALL LARGE RAILROADS IN BANKRUPTCY

Year	(1) Maintenance of Way (percentage of GDP)	(2) Maintenance of Equipment (percentage of GDP)	(3) Employment (percentage of Total U.S. Employment)	(4) Maintenance of Way + Maintenance of Equipment (percentage of GDP)
1929	0.040	0.081	0.000	0.121
1930	0.079	0.145	0.147	0.224
1931	0.070	0.137	0.133	0.208
1932	0.059	0.130	0.118	0.188
1933	0.051	0.123	0.102	0.174
1934	0.025	0.063	0.000	0.088
1935	0.022	0.057	0.000	0.079
1936	0.021	0.056	0.000	0.078
1937	0.022	0.054	0.000	0.076
1938	0.037	0.080	0.077	0.118
1939	0.020	0.049	0.000	0.068
1940	0.019	0.048	0.000	0.068

Notes: See the text for an explanation of the calculations. Column 4 is the sum of columns 1 and 2.

At this point, it is important to discuss the possible influence of RFC assistance on our results. Over 1932–1940, 96.7 percent of RFC credit went to large firms (98.1 percent if dependent firms are excluded). Therefore, observed differences in behavior by firm size may actually be attributable to effects of RFC activity, not to differences in credit availability.

To check whether the omission of RFC loans biases the results, I add the ratio (Total RFC Loans ( $t$ ) / Fixed Charges ( $t-1$ )) to specification D (with the sample split by firm size), and allow it to enter asymmetrically. Six regressions are run (small and large firms, for each of the three dependent variables). The RFC loan ratio is either negative and significant (employment on small firms) or insignificant (all other regressions). The estimates of other financial effects are virtually unchanged. Similar results are obtained if the RFC loan ratio is replaced with a dummy (one if the RFC loan is positive, zero otherwise).<sup>43</sup>

It is clear that RFC loans had no positive impact on maintenance or employment.<sup>44</sup> By delaying the entry of firms into bankruptcy, they perpetuated the state of financial distress, and most likely prevented increases in maintenance and employment. Furthermore, they did not cause the observed relationship between financial effects and firm size.

<sup>43</sup> These results are available upon request.

<sup>44</sup> This confirms the view of Spero (*Reconstruction Finance Corporation Loans*), who sees the RFC loans as counterproductive.

## CONCLUSION

During the Great Depression, U.S. railroads behaved according to the predictions of financial fragility theory. Leverage had a significant negative effect on the real activity of small firms (except employment), whereas bankruptcy had a significant positive effect on the real activity of large firms. These effects were significantly larger during 1930–1933 and 1938. The results concerning bankruptcy are not found in previous literature, and can be explained by economies of scale in bankruptcy, combined with diseconomies of scale in (nonbankrupt) states of financial distress.

Various categories of maintenance expenditure were not equally sensitive to leverage; in highly indebted small firms, reductions in track maintenance were the leading mechanism for absorbing revenue shocks while avoiding default on interest payments. This behavior was driven by railroad-specific institutional factors.

Although bankruptcy boosted maintenance and employment, RFC loans did not. The U.S. experience with railroads demonstrates that governments should allow distressed firms to go bankrupt, instead of providing bailouts that merely postpone the inevitable. This general insight seems particularly relevant for Japan, whose economy is depressed by an enormous overhang of bad debts.

Despite the importance of leverage and bankruptcy within the railroad sector, their direct macroeconomic significance appears to be small. However, further research may identify other real-financial links, both within the railroads and within other sectors of the economy.

*Appendix 1: Data**Coverage*

For each Class 1 railway, the ICC published a complete income account, balance sheet, operating averages, and equipment in service. Annual employment figures are an average of 12 mid-month counts, and were first published in 1927. There were 174 active firms in 1927; this fell gradually to 133 in 1940. Firms exited through merger, through being reclassified as Class 2, or because their parent corporations began to report on a consolidated system basis. Entry occurred through reclassification of firms formerly in Class 2. After lags and differencing, I have up to 12 years of data for each firm (1929–1940).

*Quality of Capital Stock Data*

Capital stock figures are available, but they are not used in practice, due to the following problems: First, for some firm-years, there is no distinction between way and structures capital and equipment capital; second, the ICC did not require depreciation accounting on way and structures until 1943. Equipment was depreciated by the straight-line method, but depreciation rates varied arbitrarily, and were sometimes reduced by managers in response

to financial pressures. Third, book values of capital were not adjusted in response to changes in maintenance expenditure, which had a major impact on physical condition. See Schultz, "Depreciation" for more details.

#### *Removal of Dependent Subsidiaries*

Some railroads had one or more subsidiaries. Subsidiaries made their own reports to the ICC until the mid-1930s, when consolidated system reports were phased in. Financial data of a subsidiary may be completely irrelevant for our purposes. In some cases, the parent railroad made intercorporate transfers each year to ensure that its subsidiary covered fixed charges exactly. Some subsidiaries carried heavy debt burdens each year, which would have been unsustainable without assistance from the parent road (for example, fixed charges at 45 percent of operating revenues in a good year and 90 percent in a bad year). Subsidiaries were usually managed by executives of the parent road. Their operating decisions were, most probably, independent of the subsidiary's financial position.

It is necessary to identify and eliminate dependent subsidiaries from the sample, as their presence would bias the empirical results. I follow the 1927 volume of SOR and classify as dependent any road which was part of a system headed by another road. I allow two exceptions to this rule—the Louisville & Nashville and the Texas & New Orleans. These roads were so large that their financial status was bound to influence operating decisions, even if the interests of their parent roads came first. After eliminating dependent subsidiaries, I am left with 92 independent roads in 1927. These roads comprised 82 percent of employment and operating revenues of all U.S. railroads (Classes 1, 2, and 3). (The number of independent firms reached a maximum of 93 during 1928, then declined gradually to 85 in 1940.)

#### *Adjusting for Changes in Accounting Procedures*

Prior to 1935 the ICC reported the statistics "gross income" and "deductions from gross income." Beginning in 1935 the ICC reported the statistics "available for fixed charges" and "fixed charges." The newer (1935–1940) measures represent somewhat narrower categories than the older (pre-1935) measures. This creates the illusion of a drop in fixed obligations from 1934 to 1935. (The problem affects firm-level data, but not industry-level data). To adjust for the change in measurement, I demean the ratio of fixed charges to operating revenues, using different means for 1927–1934 and 1935–1940.

#### *Employment on the Western Maryland, 1933*

The Western Maryland experienced a strike in 1933, and chose to subcontract out many of its operations; therefore, its 1933 employment observation is coded as missing.

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