Asset Salability and Debt Maturity: Evidence from Nineteenth-Century American Railroads

Efraim Benmelech
Department of Economics, Harvard University and NBER

I investigate the effect of assets' liquidation values on capital structure by exploiting the diversity of track gauges in nineteenth-century American railroads. The abundance of track gauges limited the redeployability of rolling stock and tracks to potential users with similar track gauge. Moreover, potential demand for both rolling stock and tracks was further diminished when many railroads went under equity receiverships. I find that the potential demand for a railroad's rolling stock and tracks were significant determinants of debt maturity and the amount of debt that was issued by railroads. The results are consistent with liquidation values models of financial contracting and capital structure. (*JEL* G32, G33, L92, N21, N71)

An extensive theoretical literature analyzes financial decisions from an "incomplete contracting" perspective. The driving force in this approach is the right to foreclose on the debtor's assets in the case of default, and the theory predicts that optimal debt structure depends on how costly it is for creditors to liquidate assets. Despite the abundant theory, there is relatively little empirical evidence on the relation between liquidation value and debt structure. Testing the theory requires detailed information about the assets, their liquidation values, and the capital structure of the firm. Unfortunately, liquidation values are typically not observed by the econometrician, and crude accounting proxies such as fixed-asset ratio are far from being accurate. I provide empirical evidence on the link between liquidation values and debt maturity using a unique data set of nineteenth-century American railroads and exploiting variation in track gauges—the width of the tracks—to measure asset salability.

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The railroad industry in the nineteenth century is a natural candidate to evaluate the effect of liquidation values on debt structure. Railroads used to own two main types of assets: (i) tracks; and (ii) rolling stock (e.g., locomotives, freight cars, passenger coaches, etc.) Almost all the debt of railroads in the United States during the nineteenth century was secured by the railroads' property, emphasizing the importance of the liquidation value of tracks and rolling stock for capital structure. Moreover, the nature of railroads' assets is unique. It combines fixed and site-specific tracks with mobile and more flexible equipment. Both tracks and rolling stock are industry-specific, and were put together to their highest use. However, while the iron rails connecting two cities were immobile and specialized to their original location, rolling stock was redeployable elsewhere in the country. Furthermore, for most of the second half of the nineteenth century, lack of standardization in railroad equipment frustrated the interchange of mobile capital. The abundance of track gauges limited the redeployability of the rolling stock and tracks to potential users with exactly the same gauge. Moreover, potential demand for both rolling stock and tracks was further diminished when many railroads went under equity receiverships and were prevented from participating in the market for used capital. I use physical attributes of assets, such as track gauge, the composition of rolling stock, and proxies for industry demand and illiquidity to analyze asset salability of railroads and their corresponding capital structures.

Liquidation value of an asset is determined along two dimensions. Physical attributes of an asset jointly with the number of its potential users, determine its *redeployability*—the alternative uses an asset has. However, as noted by Shleifer and Vishny (1992), the financial strength of its potential users determine its *liquidity*—the ease with which it can be sold in its next-best use value. I use the term *salability*, to describe how the combination of these two effects determine liquidation values.

Using a unique data set of nineteenth-century American railroads, I find a strong link between asset salability and debt maturity. My findings show that firms that owned more redeployable cars and conformed to the "standard gauge" had significantly longer maturities of debt. While the data do not reveal cross-sectional correlation between salability and leverage, I find that during the economic depression of the mid-1870s, railroads with more redeployable assets were able to borrow larger amounts of debt, suggesting that asset salability affects both the amount and the maturity of debt.

This study provides the first evidence of a relation between asset salability and debt maturity. Previous research typically used balance-sheet proxies, such as tangibility (e.g., Rajan and Zingales, 1995), or market-to-book and R&D-to-sales ratios (e.g., Gilson, 1997) as proxies for collateral value and liquidation costs; however, as pointed out by Shleifer and Vishny (1992), oil rigs, satellites, and railways are all very tangible, yet their liquidation values are fairly low. Alderson and Betker (1995) define liquidation costs as the firm's going concern value minus its liquidation proceeds, divided by its going concern value. They obtain liquidation and going concern values from estimates of managers of firms in bankruptcy court. However, as argued by LoPucky and Whitford (1990); and Gilson (1997), managers of bankrupt firms may understate liquidation values of their firms to put pressure on creditors to agree to a reorganization. This paper takes a different approach by using data on the physical attributes of the assets in addition to their book values. Furthermore, the diversity of track gauges provides an environment in which demand for assets can be identified. In a related paper, Benmelech, Garmaise, and Moskowitz (2005) analyze the effect of liquidation values on commercial property nonrecourse loan contracts. By focusing on zoning regulation that determines the potential buyers of real estate properties, Benmelech, Garmaise, and Moskowitz (2005) take a similar approach to this study, in which liquidation values are determined by the number of potential buyers. My paper is also related to MacKay (2003), who finds that investment flexibility increases debt capacity and prolongs debt maturity by making collateral assets more liquid.

This paper is organizedas follows. In the next section, I outline the theoretical predictions on the relation between liquidation values and debt financing. Section 2 overviews the shift to a standard gauge and the characteristics of rolling stock during the period between the end of the civil war and the late 1880s. Data sources and gauge characteristics are described in Section 3. Summary statistics are presented in Section 4. Section 5 introduces the proxies for asset salability. Section 6 discusses the plausibility of reverse causality endogeneity concerns. Section 7 discusses the empirical analysis. Section 8 concludes.

1. Asset Salability and Capital Structure

The salability of an asset affects the willingness of a creditor to provide financing and the terms on which a debt contract may be extended. A vast theoretical literature analyzes the role of collateral and liquidation values in debt financing and capital structure. In general, the "incomplete contracting" approach views salability as being good for the creditor along the supply side of credit, since he gets more if the project is liquidated.

The concept of *liquidation value* used in the incomplete contracts literature is fairly general: an asset's liquidation value is the amount that creditors can expect to receive if they seize the asset. The existing empirical evidence consists mainly of regressions of leverage against the ratio of tangible assets to total assets. However, assets can be very tangible and still have low liquidation values. Williamson (1988); and Shleifer and Vishny (1992) analyze two different aspects of liquidation value. Williamson focuses on an asset's *redeployability* while Shleifer and Vishny use an industry-equilibrium model and show that assets with few potential buyers, or with potential buyers who are likely to be financially constrained, will be poor candidates for debt finance since liquidation is likely to yield a low price.

Following Shleifer and Vishny (1992), I use the notion of salability to describe the extent of the value that an asset retains in liquidation. A salable asset has two characteristics. First, its attributes make the use of the asset less sensitive to its user, and second, its potential buyers have the financial resources to afford paying for its services. The *willingness* of highest valuation potential users to buy is determined by the asset's attributes, while their *ability* to participate in the market depends on the buyer's financial strength. Therefore, both asset redeployability and market liquidity determine asset salability.

In this paper, I focus on the relation between debt maturity, leverage, and asset salability; the following predictions emerge from the incomplete contracting approach to capital structure.

Prediction 1. Debt levels increase in asset salability.

This prediction follows from Harris and Raviv (1990); Shleifer and Vishny (1992); and Williamson (1988). According to Harris and Raviv (1990); and Williamson (1988), the right to foreclose on the debtor's assets in the event of default is more valuable when the asset is more redeployable, and thus redeployability increases the debt capacity of an asset. Shleifer and Vishny (1992) show that liquidation values depend on the financial position of potential buyers of the assets, and thus asset salability increases debt capacity.

Prediction 2. Debt maturity increases in asset salability.

Prediction 2 follows from Benmelech (2005); Berglöf and von Thadden (1994); Hart and Moore (1994); and from Shleifer and Vishny (1992). Hart and Moore (1994) argue that a higher profile of liquidation values over time increases assets' durability and makes longer maturity debt feasible. Berglöf and von Thadden (1994) analyze the optimal structure of debt along the tradeoff between discouraging strategic default and limiting inefficient liquidation. Similar to Hart and Moore (1994), they conclude that firms with fungible assets should be financed with long-term debt. Benmelech (2005) also develops a model that endogenizes debt maturity choice given the liquidation value of the project, and finds that high liquidation values might lead self-interested managers to finance with long-term debt. While Benmelech (2005); Hart and Moore (1994); and Berglöf and von Thadden (1994) all assume that asset redeployability is given exogenously, Shleifer and Vishny (1992) endogenize liquidation values in an industry-equilibrium model. In particular, Shleifer and Vishny (1992) analyze the tradeoff between the benefits of debt overhang in constraining management and liquidation costs. Since higher liquidation values make overhang (long-term) debt more attractive, both leverage and debt maturity increase with asset salability.

Alternative models of contracting and capital structure analyze the "dark side" of high liquidation values (i.e., Myers and Rajan, 1998; Morellec, 2001). Morellec (2001) shows that firms with salable assets may engage in asset stripping that transfers wealth from bondholders to shareholders. Since creditors anticipate the loss from asset stripping, they require higher yield and the optimal leverage decreases, unless the firm is using secured debt that prevents the disposal of pledged assets without creditors' approval.

All the debt of railroads in the United States during the sample period was secured by the railroads' specific property or general lien, emphasizing the importance of the liquidation value of tracks and rolling stock for debt contracts. Since Morellec (2001) shows that secured debt limits a firm's ability to dispose of secured assets, it is unlikely that asset salability would be bad for creditors. Because of its practice of secured debt, the railroad industry in the nineteenth century is a natural candidate to evaluate the effect of liquidation values on financial contracts according to the "incomplete contracting" approach.

2. Track Gauge and Asset Specificity in the American Railroad Industry During the Nineteenth Century

Early American railroads operated lines with a variety of track gauges—the horizontal distance between the two rails.[1] Many of the first roads were built to the English so-called standard gauge of 4′8.5″, since they used English-built engines. Only in the late 1880s was the American rail network really an integrated system. The standard gauge was the most common in New England and in the North, although much variation was to be found in Ohio and Pennsylvania. In most of the southern states, a wider gauge of 5′0″ dominated the lines, while a narrow gauge of 3′0″ was introduced in the western mountain states during the 1870s.

2.1 The origins of gauge diversity

The standard gauge of 4′8.5″ was first adopted by the railroads in the north of England.[2] It was assumed to be wide enough to accommodate the most efficient locomotives, narrow enough to permit train operation around sharp curves, and at the same time able to support substantial freight tonnage. In 1870, the Scottish engineer Robert F. Fairlie argued in favor of a narrow gauge of 3′6″ in his address before the annual meeting of the British Railway Association. Fairlie argued that such a gauge was cheaper to build, equip, and maintain, and that with sharper curves and lighter equipment, the narrow gauge was better suited for mountainous regions. New roads with narrow gauges ranging from 3′0″ to 3′6″ were built in the United States during the 1870s. Much of the narrow-gauge trackage was built in eastern states; however, the standard gauge remained dominant in the east, and narrow gauge was roughly a sixth of the total western mileage in 1880.

Technology and cost reduction were not the only reasons for gauge diversity. In New York, for example, the Erie Railroad deliberately operated a broad

[1] This section draws heavily from M. Klein (1993); Stover (1961); Taylor and Neu (2003); and Wilner (1997).

[2] Wilner (1997) suggests that the term "standard gauge" is related to the width of the ruts made in dirt roads by Roman chariots.

gauge of 6′0″. Not only did the broad gauge enhance the hauling of larger loads for a given freight car, but it also was designed specifically to carve a niche in this market and prevent loss of traffic to other lines. Erie's behavior was no exception. M. Klein (1993), for example, notes that in many cases railroad promoters deliberately chose a different gauge than the one used in neighboring lines. This strategy was assumed to bring trade and commerce to their town, forcing traffic to stop there rather than just pass through.

On the eve of the civil war, American railroads used gauges from as narrow as 2 feet to as wide as 6 feet. The abundance of track gauges was not the only impediment to integration. Strategic behavior, parochial views of cities and towns who owned railroads, and myopic planning were all obstacles to efficient integration of the rail network. Yet different gauges frustrated physical interchange of freight cars and passenger coaches even for those railroads willing to integrate operation. Stover (1961), for example, noted: "Gauge diversity was one of the most serious handicaps to through service. In 1861, because of different gauges, eight changes of cars were necessary for a trip from Charleston to Philadelphia." Further evidence is given by M. Klein (1993): "Differences in gauge forced railroads to 'break bulk' at the terminal town; it encouraged the flow of local traffic and hampered the flow of through traffic."

2.2 Gauge diversity and asset specificity

Gauge diversity made the interchange of equipment between different-gauge tracks almost impossible. Moreover, the flow of through traffic was limited to the length of track mileage with the same gauge. Both rolling stock and railways had lower values in alternative uses outside the railroad industry. Yet, rolling stock was in general more redeployable—had more potential buyers—than railways. The iron (or steel) rails and the wooden ties connecting them are site-specific according to Williamson's (1983) classification; once put in place, they are highly immobile. In contrast, locomotives, freight cars, and passenger coaches are mobile by nature.

Creative engineers used several expedients to enable the interchange of rolling stock between lines of different gauges. The "compromise car" had wheels with five-inch-wide tread. The compromise cars could be used on either standard-gauge track or track as wide as 4′10″. However, the compromise cars were not considered safe, and their use resulted in several serious accidents. Car hoists with the car lifted to a set of trucks of different gauge, were considered safer and were used more extensively. A second approach was to adjust the rails. In the "double gauge" system, a third rail was added to the line, permitting the use of rolling stock of different gauges. Despite the innovation in multigauge equipment, many railroads adapted the standard gauge: by 1890, roughly 95% of the nation's track mileage conformed to the standard gauge. The railroads incurred substantial expenses to change the track gauge. According to Wilner (1997): "The willingness of railroad owners to pay ... [the expenses] ... often necessitating acquisition of new locomotives, freight cars, and coaches to fit the horizontal distance between rails—was testimony to the strength of market forces demanding greater efficiency." For example, the collapse of the Ohio & Mississippi Railroad, which owned more than 600 miles of road and 2,600 cars, was declared by the receiver to be due to new construction together with the expenses changing the gauge from 6′0″ to 4′9″.[3]

2.3 Gauge diversity and potential users

Rolling stock was mobile despite the diversity in gauge track and breaks in through traffic. Before the linkage between western states to eastern lines was established, rolling stock used to be shipped by lake vessels, or on ocean ships to New Orleans and from there by riverboats. A cheaper and faster solution was to transport cars and locomotives using heavy-duty flatcars. Express shipping firms, such as the Kasson Locomotive Express Company, specialized in handling oversize shipments over roads with different track gauge. As a result, potential buyers of the rolling stock were those railroads that could easily adopt and acquire these assets in the used-capital markets. Their geographic location was less relevant. What really mattered was the fitness of the equipment to their own tracks.

In addition to differences of gauges, other factors determined the redeployability of rolling stock. Locomotives were in general less redeployable than freight cars. While freight cars were usually general-purpose cars that could fit the fleets of different railroads, locomotives were built to meet specific design requirements. Locomotives were specialized to operating conditions, such as speed, hill climbing, short hauls, heavy loads, or specific types of coal for fuel. Hinkley's locomotives, for example, were made of 6,270 parts and pieces (excluding wood work and nails), while less than 60 parts were needed to assemble a general-purpose boxcar. Passenger coaches were based on a similar technology as freight cars, yet interior design, decor, and amenities made them more railroad- or service-specific, and less redeployable compared to general-purpose freight cars. For example, the Pullman "Pioneer" passenger car finished with hand-carved woodwork, plush carpets, and fine mirrors was built for railroads with first-class service. Appendix A describes the role of technology in determining redeployability for the cases of locomotives and freight cars.

Despite their site specificity, tracks had potential buyers as well. Economies of scale made long lines more efficient, and therefore railroads willing to integrate were potential buyers of existing railways. However, given the network nature of a railway system, potential buyers of roads were local railroads. To benefit from unification, potential buyers had to connect to the acquired (or leased) line, which required them to both operate in the same region and have

[3] See Swain (1898, p. 84).

the same gauge. Thus, track gauge was an important determinant of both rolling stock's and track's salability.

3. Data Sources and Gauge Characteristics

To capture both the time-series dynamics of debt maturity and leverage, and the cross-sectional variation across firms, I have collected data at the firm (railroad) level for the years 1868, 1873, 1877, and 1882. To obtain firm-level data, I used the *Poor's Manual of the Railroads*[4] for the relevant years. I included in the sample railroads that had at least 100 miles of operation (owned or leased),[5] and sufficient data to construct the necessary variables. The panel data constructed in this process consist of 390 firm-year observations, representing 221 different railroads.

For each railroad I obtained the total value of its assets, the value of its equipment and constructions, leverage, debt maturity, and profitability from *Poor's Manuals of the Railroads*, as well as data on the firm assets, such as length and location of lines operated, owned, or leased, whether the rails were made of iron or steel, and the numbers of locomotives, passenger coaches, freight cars, and other specialized cars.

3.1 Sample characteristics

Table 1 lists the distribution of the railroads across gauge tracks and over the years 1868, 1873, 1877, and 1882. Panel A of Table 1 reports the gauge distribution of the firms in the pooled data. The most common gauges in the sample are the standard gauge of 4′8.5″ (56.5 inches), and 5′0″ (60 inches), representing 64.6% and 16.4% of the number of firms in the sample, respectively. To capture the evolution of the different gauges over time, Panel B of Table 1 reports the distribution of the railroads across track gauge and time. As can be seen, the proportion of the firms conforming to the standard gauge increased during that period, ranging from 52.2% in 1868 to 76.8% in 1882. Yet the convergence to the standard gauge was not uniform across the country. While new railroads were built to fit the standard gauge in the East and the Midwest, the southern railroads continued to expand their existing wide-gauge lines, frustrating the standardization of rolling stock and tracks.

Table 2 breaks down the data by regions. The table demonstrates that in New England and in the West, between 88.9% and 96.4% of the firms conformed to the standard gauge, while in the East, railroads used different gauges, such as 4′9″ and 4′10″ gauges. The South, on the other hand, was the dominion of

[4] The first volume of the *Poor's Manuals of the Railroads* was published in 1868.

[5] Early American railroads operated short lines. However, standardization accelerated their agglomeration. For example, only one line had more than 1,000 miles in 1867, while there were 28 such railroads in 1887. To make the data collection tractable, I have concentrated on medium and large railroads.

Table 1
The distribution of track gauge, 1868–1882

Panel A: Distribution of gauge across the pooled data

Gauge (inches)	36	56.5	57	57.25	57.5	58	60	65	66	72	Total
Frequency	3	252	32	1	14	14	64	1	3	6	390
Percent (%)	0.8	64.6	8.2	0.3	3.6	3.6	16.4	0.3	0.8	1.5	100.0

Panel B: Distribution of gauge by year

1868											
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	65	66	72	Total
Frequency	0	36	2	0	2	4	17	1	2	5	69
Percent (%)	0.0	52.17	2.9	0.0	2.9	5.8	26.6	1.5	2.9	7.3	100.0
1873											
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	65	66	72	Total
Frequency	2	59	7	1	7	5	19	0	1	1	102
Percent (%)	2.0	57.8	6.9	1.0	6.9	4.9	18.6	0.0	1.0	1.0	100.0
1877											
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	65	66	72	Total
Frequency	0	69	7	0	5	5	18	0	0	0	104
Percent (%)	0.0	66.4	6.7	0.0	4.8	4.8	17.3	0.0	0.0	0.0	100.0
1882											
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	65	66	72	Total
Frequency	1	86	16	0	0	0	9	0	0	0	112
Percent (%)	0.9	76.8	14.3	0.0	0.0	0.0	8.0	0.0	0.0	0.0	100.0

The sample consists of 390 railroad-year observations in the years: 1868, 1872, 1877, and 1882. The track gauge is the horizontal distance separating the two rails in inches. The "standard gauge" was 4′8.5″ (or 56.5 inches).

the wide gauge. More than 64% of the southern railroads used the 5′0″ gauge, representing 81.1% of the total wide-gauge firms in the country.

3.2 Selection biases and representativeness of the sample

Because the sample includes only railroads that operated more than 100 miles, the sample is potentially subject to a selection bias. If larger firms are more likely to operate lines with a specific gauge, then the size threshold could potentially bias the sample and its gauge distribution.

Figure 1 compares my sample with the distribution of the actual population of track mileage in the United States for selected gauges. To obtain the population's distribution, I use the *Poor's Manuals of the Railroads*, which reports the distribution of the nation's track mileage over the different gauges for each of the relevant years. There are no significant differences between my sample and the entire population. The wide gauge of 5′0″ (60 inches), seems to be slightly overweighted in my sample during the years 1873, 1877, and 1882, and the 4′9″ (57 inches) gauge, is slightly overweighted in the sample as well, but as a whole the sample is quite representative. I conclude that the sample seems largely free of a bias in its gauge distribution.

4. Summary Statistics

This section outlines summary statistics of railroad characteristics.

Table 2
The geographical distribution of the track gauge

					New England							
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	62	65	66	72	Total
Frequency	0	53	0	0	0	0	0	0	0	2	0	55
Percent (%)	0.0	96.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	100.0
					East							
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	62	65	66	72	Total
Frequency	0	81	14	0	2	4	3	0	0	0	5	109
Percent (%)	0.0	77.3	12.8	0.0	1.8	3.7	2.8	0.0	0.0	0.0	4.6	100.0
					South							
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	62	65	66	72	Total
Frequency	1	22	9	0	0	0	60	0	0	0	1	93
Percent (%)	1.1	23.7	9.7	0.0	0.0	0.0	64.5	0.0	0.0	0.0	1.1	100.0
					Midwest							
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	62	65	66	72	Total
Frequency	2	112	12	1	13	14	7	0	1	0	2	164
Percent (%)	1.2	68.3	7.3	0.6	7.9	8.5	4.3	0.0	0.6	0.0	1.2	100.0
					West							
Gauge (inches)	36	56.5	57	57.25	57.5	58	60	62	65	66	72	Total
Frequency	0	16	0	0	0	0	1	0	0	1	0	18
Percent (%)	0.0	88.9	0.0	0.0	0.0	0.0	5.6	0.0	0.0	5.6	0.0	100.0

This table reports the distribution of the railroads sample across geographical regions and track gauges in the entire (pooled) sample. The geographical categories are in accordance with the railroads geographical groups, as reported in the *Poor's Manuals of the Railroads*. The frequencies sum up to more than the 390 railroad-year observations, since several railroads operate in more than one region.

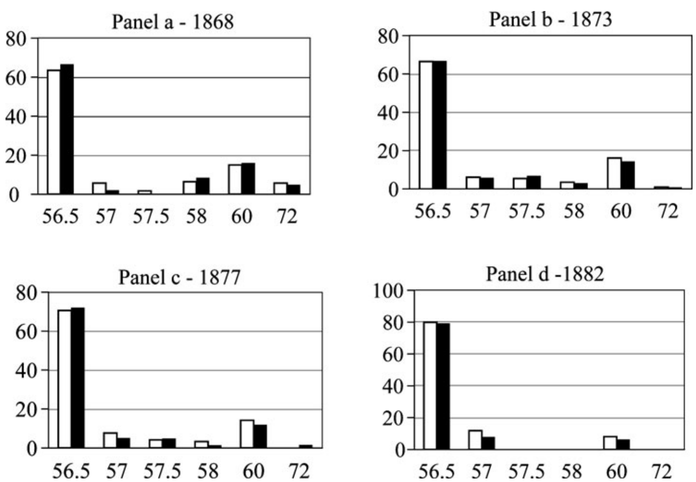

Figure 1
The representativeness of the sample
Comparison of percentage of mileage gauges between my sample and the entire population of the railroads for each of the sample's years: *a*, 1868; *b*, 1873; *c*, 1877; and *d*, 1882, and across selected gauges. All panels compare the percentage of mileage in the most common gauges between my sample (white blocks) and the entire population (black blocks).

Table 3
Railroads' characteristics

	Mean	25th percentile	Median	75th percentile	Standard deviation	Min	Max
Leverage	0.43	0.30	0.43	0.56	0.19	0.0	1.0
Debt maturity	20.1	14.0	20.0	27.0	9.4	0.0	60.0
Profitability	4.85%	2.03%	4.09%	6.53%	4.30%	−2.77%	50.78%
Tangibility	0.84	0.76	0.86	0.95	0.18	0.0	1.0
Road and construction	0.70	0.63	0.76	0.86	0.19	0.01	0.98
Land	0.026	0.002	0.011	0.036	0.037	0.000	0.227
Rolling stock	0.12	0.07	0.10	0.15	0.08	0.02	0.78
Cars	2317.5	427.0	961.0	2150.0	4460.7	0.0	32425.0
Freight	0.87	0.85	0.89	0.93	0.11	0.0	0.99
Passengers	0.043	0.018	0.031	0.051	0.059	0.000	0.873
Locomotives	0.051	0.033	0.046	0.062	0.037	0.005	0.495

This table provides descriptive statistics for the characteristics of the railroads, a sample of 221 American railroads in the years 1868, 1873, 1877, and 1882 (390 firm-year observations). Leverage is measured as the book value of total funded debt divided by the book value of the assets. Debt maturity is the weighted average of the term-to-maturity of all the debt instruments outstanding. Profitability is earnings before interest expenses divided by the book value of total assets. Tangibility is the value of the road and construction, land and rolling stock divided by the book value of assets. Road and construction is the ratio of the book value of road and construction to total assets. Land is defined as the ratio of the book value of land and real estate to total assets. Rolling stock is the ratio of the book value of rolling stock to total assets. Cars is the total number of locomotives, passenger coaches, freight cars, baggage mail, express cars, and service cars. Freight is the number of freight cars divided by the total number of cars. Passengers is the number of passenger coaches divided by the total number of cars. Locomotives is the number of locomotives divided by the total number of cars.

4.1 Railroad characteristics

Table 3 displays descriptive statistics for a selected set of variables. I examine the following variables: leverage (defined as the ratio of funded debt to total assets), debt maturity (defined as the weighted average maturity of the firm's debt structure), profitability (defined as earnings before interest expenses scaled by total assets), tangibility (defined as the ratio of the book value of road and construction, land, and rolling stock to total assets), road and construction (defined as the ratio of the book value of road and construction to total assets), land (the ratio of the book value of land and real estate to total assets), and rolling stock (the ratio of the book value of rolling stock to total assets). In order to describe the nature of the railroads' rolling stock, I report descriptive statistics for the size of the cars fleet (defined as the total number of locomotives, passenger coaches, freight cars, baggage mail and express cars, and service cars), the ratio of freight cars to total cars, and the ratios of passenger coaches and locomotives to the total number of cars.

Railroads' assets were almost entirely constituted of fixed assets during the period being examined. Across the 390 firm-year observations, the median tangibility value is 0.86, representing a high level of fixed assets. Road and construction and rolling stock accounted on average for 70% and 12%, respectively. While the federal government gave 131 million acres of public lands to the railroads between 1850 and 1871, Table 3 suggests that the book value of land represented only 2.6% of total assets. According to Attack and Passell (1994): "With some notable exceptions, the land grants were not a major source of capital for the railroads. Between 1850 and 1880 gross investment in track and equipment was about \$8 billion (in 1909 dollars). The value of the land grants was much smaller." Similar to the results in Table 3, Attack and Passell (1994) also suggest that estimates of the land subsidy are around \$400 million, representing about 5% of the amount invested in railroads between 1850 and 1880. Furthermore, most of the land grants were granted after the civil war for the purpose of constructing transcontinental railroads, while the vast majority of railroads did not own substantial amounts of land.

Most of the railroads in the sample appear to be profitable: only nine firms, representing 2.3% of the sample, experienced losses. Yet, while positive, the modest profitability rate seems low relative to the required initial investment and sunk costs. The average (median) return on assets, defined as net earning divided by the book value of construction, was 6.6% (5.2%) and is similar in magnitude to the profitability rate. This evidence confirms Baird and Ramussen's (2002) observation that "many railroads turned an operating profit, but could not hope to recoup their construction costs." Finally, freight cars dominated the railroads rolling stock, accounting for 87% on average of the total cars' fleet, with a median of 805 freight cars.

4.2 A measure of debt maturity

Following Stohs and Mauer (1996), I construct a measure of the weighted average maturity of the firm's debt structure. I calculate the weighted average maturity of a firm's debt as

$$Maturity = \sum_{j}^{J} D_j M_j \Big/ \sum_{j}^{J} D_j, \tag{1}$$

where J is the number of debt instruments outstanding, D_j is the dollar book value of debt instrument j, and M_j is the term to maturity of debt instrument j.

There are alternative measures of debt maturity. For example, Titman and Wessels (1988) used the proportion of short-term debt as a measure of debt maturity. Most notably, Barclay and Smith (1995) used the information provided in Compustat files to construct a measure of debt maturity using the proportion of short-term debt with maturities exceeding three years. In addition, Guedes and Opler (1996) study the determinants of individual public bond issues using individual bond issue data.

Given the availability of the data, I follow Stohs and Mauer (1996). The weighted average maturity method captures the entire maturity structure of the firm's liabilities and takes into account the role of debt buybacks and exchange offers. Firms often decide to amortize their debt service by buying back debt, swapping short- for long-term debt, or by exchanging debt for equity—these "negative issuance activities" are captured by the weighted average measure.

According to Table 3, the average and median debt maturity in the sample are 20.1 and 20.0 years, respectively. Only 25% of the railroads in the sample had a weighted maturity shorter than 14.0 years, and 25% of the railroads in the sample had weighted maturity longer than 27 years. This seems to be consistent with the conventional wisdom, as well as the predictions by Myers (1977); and Hart and Moore (1994), that assets should be matched with liabilities and that long-lived assets support long-term debt.

5. Measures of Asset Salability

5.1 Methodology

Economies of scale and the network nature of railroads, both suggest that an existing road or line and a potential buyer had to *connect* in order to take advantage of cost reduction and scale economies. I assume that potential buyers of lines and roads were railroads that were located in the same area of the road and operated the same gauge. In order to test this hypothesis, I have collected data on mergers, consolidations, and lease contracts between 1866 and 1872. In a sample of 60 such cases, I find that in *all* the cases the buyer (or lessee) and seller (or lessor) operated in a common state—confirming that location was crucial for the salability of roads. Furthermore, in 53 cases representing 88.3% of the sample, both the buyer (or lessee) and seller (or lessor) had exactly the same gauge, in four leases (6.7%) the lessee operated two types of gauge (56.5 and 72 inches) where one was also the gauge of the lessor, and only in three cases (5.0%) did the buyer have a different gauge from the seller—suggesting that common gauge was an important determinant of salability. I conclude that matching potential buyers along gauge and operation in a common state is a reasonable proxy for the actual set of potential buyers.

Given its mobility, I assume that potential buyers of rolling stock were railroads with same gauges regardless of their location. As discussed earlier, rolling stock used to be shipped by lake vessels and riverboats, or by transporting it using heavy-duty flatcars over roads with different track gauge. Unfortunately, rolling stock sales transactions are not reported in the *Poor's Manuals of the Railroads*, but anecdotal evidence confirms that common gauge was crucial for rolling stock salability while proximity was not. For example, according to the Colorado Railroad Museum (1980), following the conversion of the Denver & Rio Grande from narrow to standard gauge, it sold narrow-gauge rolling stock to neighboring lines as well as to roads through Texas and the south, "with some going to such faraway places as Pennsylvania, Florida and Mexico."

The idea that liquidation values are lower when there are fewer potential buyers was noted by researchers of the railroad industry. According to Hilton (1990): "Conversion of most of the large narrow gauges [railroads] outside of Colorado in the late 1880s and early 1890s released a large amount of relatively new narrow gauge equipment at bargain prices." He provides additional evidence that the conversion of narrow-gauge railroads to the standard gauge dampened prices of narrow-gauge rolling stock by 30 to 40%.

5.1.1 Proxies for road salability. To construct the salability proxies, I need to identify potential buyers. I start by calculating (i) total track mileage for each gauge in every state,[6] and (ii) the number of railroads operating in every state for each of the different gauges. Thus, in every state I have calculated the number of railroads and their mileage for each of the gauge categories.

The next step is to identify the potential buyers that are financially constrained, and thus are less likely to be buyers of used capital. I use railroads in receiverships as a proxy for potential buyers that could not participate in the market for used capital, since they had low cash flow, and their access to external finance was limited. Equity receivership was a legal device designed originally to oversee property of a firm during the pendency of a suit or upon order of court. Lawyers and investment bankers extended the equity receivership to a procedure similar in its principal features (automatic stay, infusion of operating funds, and negotiations among creditors) to the current chapter 11 of the Bankruptcy Code. I address Shleifer and Vishny's notion of liquidity by assuming that more equity receiverships imply a less liquid market. I obtain the equity receiverships data from Swain (1898), and from the *Poor's Manuals of the Railroads*.[7]

I use the total mileage in addition to the number of railroads in equity receiverships, as proxies for the market share and number of railroads in financial distress in each of the state-gauge cohorts. To obtain the adjusted demand of potential buyers that are not financially constrained, I subtract the mileage and number of railroads from their corresponding mileage and railroads number in each of the state-gauge cohorts.[8] This process yields two sets of numbers for each of the sample years: (i) statewide track mileage for each gauge; and (ii) statewide number of railroads for each gauge. For example, in 1882 there were 156 standard-gauge railroads that were not in equity receivership in New York. The aggregate mileage of these 156 railroads was 6,694. In contrast, in 1868 there were only six standard-gauge railroads that were not in the hands of receivers in Rhode Island that operated a total of 150 miles. Equations (2)

[6] I use a broad definition of state that includes territories, such as the, Washington Territory that was formed from part of Oregon and joined the United States as a separate state in 1889, and the Wyoming Territory that was established in 1868, and joined the United States in 1890. In addition, Arizona, Idaho, and Montana enter the sample in 1882, although they were not members of the Union at that time. I include a "state" in the sample whenever it is classified as such by the *Poor's Manuals of the Railroads*.

[7] While railroads in equity receivership are clearly constrained, it is not clear that firms that are not in receiverships are unconstrained, and thus my redeployability measures may underestimate asset salability. However, alternative accounting-based measures (such as liquidity, profitability, or leverage) cannot be constructed for the entire population of potential buyers, since not all the railroads disclose their financials every year, while the receiverships data are available for all the railroads in the United States.

[8] For each railroad I check whether this particular railroad was in equity receivership to avoid double counting.

and (3) summarize the calculations of tracks mileage and number of railroads, respectively.

$$mileage^{road}_{s,g,t} = \sum_{b \in B^{s,g,t}} length_b \tag{2}$$

$$number^{road}_{s,g,t} = \sum_{b \in B^{s,g,t}} I_b, \tag{3}$$

where B is the set of all railroads that are not in receiverships and operate *length* miles in state s and sample year t for a given gauge g, and I is an indicator variable that equals 1 for railroads that belong to the set B, and 0 otherwise.

To construct the proxies at the railroad level, I define the salability of the road to be the mileage-weighted average of the state salability index corresponding to the states of the railroad's line. I calculate two measures of road salability using (i) tracks mileage and (ii) number of railroads. Equations (4) and (5) present the two proxies for the salability of the railroad's road.

$$mileage^{road}_{i,t} = \sum_{s}^{S} \sum_{g}^{G} \omega_{i,s,g,t} \left(mileage^{road}_{s,g,t} - length_{i,s,g,t} \right) \tag{4}$$

$$number^{road}_{i,t} = \sum_{s}^{S} \sum_{g}^{G} \omega_{i,s,g,t} \left(number^{road}_{s,g,t} - 1 \right), \tag{5}$$

where t represents sample year, s a state, g denotes the gauge, $length_{i,t,s,g}$ is railroad's i own mileage in state s gauge g and sample year t, and $\omega_{i,t,s,g}$ is defined as

$$\omega_{i,s,g,t} = length_{i,s,g,t} \Bigg/ \sum_{s}^{S} \sum_{g}^{G} length_{i,s,g,t}. \tag{6}$$

I subtract the railroad's own mileage in each of the operation states in order to account for the *residual demand* for its road.

5.1.2 Proxies for rolling stock salability. I follow the same algorithm as in the previous proxies. Given that rolling stock was salable across the country as long as the potential buyer had the same gauge, the proxies are calculated at the country level.

$$mileage^{rolling}_{g,t} = \sum_{c \in C^{g,t}} length_c \tag{7}$$

$$number^{rolling}_{g,t} = \sum_{c \in C^{g,t}} I_c, \tag{8}$$

where C is the set of all railroads that are not in receiverships and operate *length* miles in sample year t for a given gauge g, and I is an indicator variable that equals 1 for railroads that belong to the set C, and 0 otherwise. To construct the proxies at the railroad level, I define the salability of the rolling stock to be the mileage-weighted average of the gauge salability index corresponding to the railroad's gauge.

$$mileage_{i,t}^{rolling} = \sum_{g}^{G} \pi_{i,g,t}\left(mileage_{g,t}^{rolling} - length_{i,g,t}\right) \tag{9}$$

$$number_{i,t}^{rolling} = \sum_{g}^{G} \pi_{i,g,t}\left(number_{g,t}^{rolling} - 1\right), \tag{10}$$

where t represents sample year, g denotes the gauge, $length_{i,g,t}$ is railroad's i own mileage in gauge g, and $\pi_{i,g,t}$ is defined as

$$\pi_{i,g,t} = length_{i,g,t} \Big/ \sum_{g}^{G} length_{i,g,t}\,. \tag{11}$$

5.1.3 Receiverships share. Finally, I construct a proxy for market illiquidity by calculating the percentage of tracks mileage in equity receiverships. This measure corresponds to road salability proxies as it captures the fraction of financially constrained potential buyers of roads that are located in the same state and operate the same gauge. Equations (12)–(14) summarize the calculations of the receiverships share proxy.

$$mileage_{s,g,t,U}^{road} = \sum_{U \in U^{s,g,t}} length_{U} \tag{12}$$

$$mileage_{s,g,t,R}^{road} = \sum_{R \in R^{s,g,t}} length_{R}, \tag{13}$$

where U is the universe of all railroads that operate *length* miles in state s and year t for a given gauge g, and R is the set of all railroads that are in receiverships and operate *length* miles in state s and sample year t for a given gauge g.

To construct receiverships share at the railroad level, I define the measure to be the mileage-weighted average of the state receiverships share index corresponding to the states of the railroad's line.

$$Receivership\ share_{i,t} = \sum_{s}^{S} \sum_{g}^{G} \left(\omega_{i,s,g,t} mileage_{s,g,t,R}^{road} \Big/ mileage_{s,g,t,U}^{road}\right) \tag{14}$$

where t represents sample year, s a state, g denotes the gauge, and $\omega_{i,s,g,t}$ is defined as in Equation (6). High values of the receiverships share measure indicate illiquidity, since more railroads are in financial distress, and hence the fraction of solvent potential buyers is lower.

Panel A of Table 4 presents descriptive statistics for the salability proxies. Panel B of Table 4 stratifies the salability proxies, by the 10th, 25th, 50th, 75th, and 90th percentiles of debt maturity, and reports the relevant means and medians for each of the subsamples. The last column reports p-values from a Kruskal-Wallis test of the hypothesis that the characteristic's median is distributed uniformly over the six debt maturity ranges. Panel B reveals a positive correlation between asset salability and debt maturity. While the pattern is not monotone in some ranges, it is increasing over most of the distribution of debt maturity in all the measures of salability. I have also partitioned the salability proxies into six subsamples based on the same percentiles of leverage. As Panel C of Table 4 demonstrates, leverage is not correlated with any of the measures of asset salability and receiverships share.

6. Reverse Causality and Endogeneity

One concern about using gauge-based proxies in the analysis is the direction of causality. A reverse causality argument suggests that instead of track gauge explaining capital structure, it was finance that drove the gauge choice. According to this explanation, railroads with better access to finance would choose commonly used gauges and more redeployable cars. If better access to finance also facilitated longer maturities, then the direction of causality might be reversed. However, other factors—not related to finance—determined the initial distribution of gauge tracks. According to Puffert (2001), railroads in the United States were initially viewed as inferior substitutes for waterways, were used for routes where canal construction was impractical, and served strictly local purposes. As a result, local considerations determined the gauge choice. For example, some gauge choices were designed to divert traffic from competing lines (e.g., the wide gauges of 5′6″ in Maine), and others were based on local topography (e.g., the narrow gauges of 3′0″ and 3′6″). Few states regulated the choice of the gauge; the Ohio legislature passed a law in 1848 requiring that all roads built within the state should have a 4′10″ gauge, and North Carolina prohibited by law the use of 5′0″ gauge. The 5′0″ gauge in the south resulted from the desire of the Charleston and Hamburg, the earliest important railroad in the south, to divert trade from Savannah to Charleston. According to Taylor and Neu (2003),

> Although a width of 4 feet 6 inches had been originally advised for the Charleston and Hamburg railroad, Horatio Allen, who became chief engineer of the road in September 1829, recommended a 5-foot gauge on

Table 4
Characteristics of the salability proxies

Panel A: Summary statistics of the salability measures

	Mean	25th percentile	Median	75th percentile	Standard deviation	Min	Max
Road (mileage)	1859.8	440.2	1162.3	3257.0	1857.7	0.0	7649.8
Road (number of buyers)	28.4	5.7	17.7	35.7	34.4	0.0	162
Rolling stock (mileage)	35605.8	6254.0	37262.9	48483	30137.1	0.0	83603.7
Rolling stock (number of buyers)	460.3	63	456	649	407.6	0	1100
Receiverships share (mileage)	5.12%	0.00%	0.0%	8.9%	14.20%	0.00%	100.00%

Panel B: Salability proxies stratified by debt maturity

Maturity ranges	1–8	9–14	15–20	21–27	28–30	31+	Kruskal-Wallis
Road	1265.0	1472.1	1596.3	1781.2	2479.0	3170.6	0.0001
(mileage)	(991.4)	(1026.8)	(1002.2)	(1181.1)	(2359.5)	(3680.8)	
Road	23.93	23.46	27.4	22.7	33.5	50.2	0.0034
(number of buyers)	(12.1)	(15.83)	(17.0)	(15.3)	(31.8)	(30.6)	
Rolling stock	20171.6	29723.5	34323.1	33593.8	48117.8	55142.4	0.0001
(mileage)	(7226)	(19535)	(37334.9)	(37218.9)	(48289.1)	65310.9	
Rolling stock	265.4	366.0	452.0	437.0	622.4	710.8	0.0001
(number of buyers)	(105)	(217)	(456)	(456)	(649)	(874.5)	
Receiverships share	5.23%	4.26%	3.56%	3.58%	2.03%	1.77%	N/A[a]
(mileage)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	

Panel C: Salability proxies stratified by leverage

Leverage ranges	0–0.18	0.19–0.29	0.30–0.43	0.438–0.55	0.56–0.66	0.67+	Kruskal-Wallis
Road	1797.8	1805.0	1661.0	2203.2	2039.7	1541.9	0.46
(mileage)	(1236.6)	(1104.7)	(999.3)	(1389.4)	(1181.1)	(1069.7)	
Road	32.6	30.1	26.2	28.9	34.7	20.7	0.34
(number of buyers)	(22.0)	(19.6)	(13.2)	(21.0)	(18.0)	(14.0)	
Rolling stock	31376.9	37618.3	34802.3	37760.4	39173.4	33390.1	0.75
(mileage)	(19658.5)	(37352.4)	(36692.9)	(37405.9)	(37376.9)	(37171.9	
Rolling stock	395.2	474.0	453.5	499.5	514.5	417.0	0.84
(number of buyers)	(217)	(456)	(456)	(649)	(456)	(456)	
Receiverships share	4.90%	2.19%	3.62%	3.47%	3.50%	3.19%	0.32
(mileage)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.001%)	(0.00%)	

This table provides descriptive statistics for the characteristics of the salability proxies. Panel A reports summary statistics for the proxies of road salability, rolling stock salability, and receiverships share. I use both total mileage and number of railroads to calculate the proxies of road and rolling stock salability. Panel B reports means (medians) of the proxies of road salability, rolling stock salability, and receiverships share stratified by debt maturity. Panel C reports means (medians) of the proxies of road salability, rolling stock salability, and receiverships share stratified by leverage. The Kruskal-Wallis *p*-value gives the significance of a test of whether a variable is not distributed identically across debt maturity (leverage) ranges. Low *p*-values indicate that the null hypothesis of random sampling is rejected.
[a] The Kruskal-Wallis cannot be used for the receiverships share variable in Panel B, since all the medians equal 0.

> the basis of engineering consideration . . . . The decision to adopt this gauge greatly influenced railroad construction throughout most of the South. Georgia, South Carolina, and Tennessee railroads adopted it exclusively, and it was the predominant gauge in Kentucky, Mississippi, and Alabama.

Furthermore, engineering mistakes also played a role in determining gauge choices. Some gauge choices are attributed to engineering mistakes (for example, the 4′10″ inches), as the following quote from an article in *The American Railway Times* illustrates:[9]

> In the early history of railways in America they were laid with timbers running lengthwise with strips of iron, 3.5 inches wide, nailed or spiked on the top, for the wheels to run upon; they were of 5 feet gauge, measuring from centre to centre of the iron or strap rail, as it was called; hence the origin of the 4 feet 8.5 inch gauge. At a later date, when the solid iron rail was introduced, it was with a two inch face also, the five foot gauge measuring from centre to centre of rails; hence the origin of the 4 feet 10 inch gauge; hence the conclusion that if our system of measuring from inside to inside of the rails had been adopted at first, the uniform gauge of this country would have been five feet.

Moreover, the evolution of gauge tracks in the *postbellum* years was determined by network coordination considerations. Puffert (2001) uses a path-dependent process to explain the evolution of gauge tracks, while it is also possible that as the demand for interregional transport grew, standardization became more important.

The benefits from a connection to a unified network were the key determinants of the conversion to the standard gauge. Railroads that deliberately chose different gauges in later years seem to have done so because of local network externalities (in the south), and topographical conditions (narrow gauge in the 1870s). The initial distribution of gauges, which is plausibly exogenous to finance, had a major impact on the evolution of the railroad network in the second half of the nineteenth century. Since the origins of gauge choice were not determined by finance, a reverse-causality explanation is not consistent with the historical evolution of the American railroad network.

Another concern about using gauge-related proxies is endogeneity. Is it possible that an omitted variable explains both capital structure and track gauge? Given the nature of railroads, if any omitted variable drives both debt maturity and the choice of the gauge, it should be regional, correlated with local network effects, and correlated with regional financial development. To control for such omitted variables, I use state-fixed effects in the analysis.[10] State-fixed effects

[9] *The American Railway Times*, 11 May 1861.

[10] I also use regional (instead of state) fixed effects (not reported) that do not affect any of the results. I have also used state-fixed effects and a dummy variable for the south (the largest nonstandard gauge region) and obtained similar results.

should absorb any regional heterogeneity. It is unlikely that an omitted variable that correlates with track gauge but is uncorrelated with regional heterogeneity drives the empirical results.

7. Empirical Analysis

7.1 Determinants of leverage

The six OLS regressionsreported in Table 5 use different specifications to predict leverage. Among the various variables used in the analysis, only profitability proves to be a significant determinant of leverage for nineteenth-century American railroads. These results are in contrast with the common wisdom (e.g., Harris and Raviv, 1991; Rajan and Zingales, 1995), which suggests that both size and tangibility are positively and strongly correlated with leverage. Moreover, the proxies for the salability of both the tracks and the rolling stock, and the receiverships share do not prove to be determinants of leverage.[11] Of all the liquidation values proxies, only receiverships share has the right sign, yet it is not statistically significant (t-statistic $= -1.46$).

Myers (1977) suggests that firms that expect high future growth should use less debt to avoid underinvestment. Thus, he predicts a negative correlation between growth opportunities and leverage. Traditionally, researchers have confirmed Myer's hypothesis by using a Tobin's Q proxy (typically the ratio between market value of assets to their book value) to control for growth opportunities. Stock prices and the number of shares, however, are seldom reported by *Poor's Manuals of the Railroads* and many of the railroads were privately held, so a market-to-book proxy cannot be used.

It is possible that profitability is a noisy proxy for growth opportunities as well. Poterba (1988) argues that current cash flow (which drives profitability in my calculation) is correlated with the "true" marginal Q, and that market-to-book is not a sufficient statistic for future cash flows. If current cash flow and growth opportunities are positively correlated, then the negative relation between profitability and leverage is consistent with Myers's (1977) prediction.

Since technology was quite similar across railroads, it is plausible that expected growth opportunities *within* the industry were determined mainly by the geographical location of the railroad. For example, the shift from waterway traffic to railroads enhanced the expected earnings and investment of railroads located along rivers and canals. Another example for the connection between geography and growth is the shift of crop production centers westward between 1860 and 1900. This shift was partly caused by the use of railroads, but it had a feedback effect as well, amplifying investment and expected growth of these lines. I use state-fixed effects as proxies for growth opportunities (and as argued

11 I include each of the salability measures in a separate regression, since they are highly correlated and to avoid a multicollinearity problem.

Table 5
Asset salability and leverage

	Dependent variable = leverage					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Size	−0.002	0.001	0.001	−0.003	0.001	−0.022*
	(−0.12)	(0.01)	(0.01)	(−0.02)	(0.06)	(−1.72)
Tangibility	0.113	0.110	0.113	0.115	0.127	0.010
	(1.36)	(1.31)	(1.42)	(1.44)	(1.64)	(1.03)
Profitability	−0.783**	−0.769**	−0.759**	−0.768**	−0.833**	−0.743*
	(−2.54)	(−2.44)	(−2.35)	(−2.38)	(−2.54)	(−1.82)
Freight	0.101	0.107	0.103	0.104	0.114	0.080
	(0.94)	(0.94)	(1.11)	(1.13)	(1.29)	(0.69)
Road salability (mileage)	−0.005					−0.001
	(−1.25)					(−0.30)
Road salability (number of buyers)		−0.004				
		(−0.94)				
Rolling stock salability (mileage)			−0.007			
			(−1.08)			
Rolling stock salability (number of buyers)				−0.000		
				(−0.41)		
Receiverships share (mileage)					−0.105	
					(−1.46)	
1873 dummy	0.052	0.056*	0.058	0.056	0.048	0.054
	(1.63)	(1.76)	(1.42)	(1.38)	(1.20)	(1.23)
1877 dummy	0.077**	0.083**	0.081**	0.080*	0.075*	0.072
	(2.45)	(2.53)	(2.00)	(1.93)	(1.70)	(1.68)
1882 dummy	0.061*	0.072**	0.070*	0.068	0.054	0.063
	(1.89)	(2.04)	(1.86)	(1.57)	(1.55)	(1.60)
State-fixed effects	No	No	No	No	No	Yes
Adjusted R^2	0.06	0.06	0.06	0.06	0.08	0.13
Observations	382	382	382	382	382	382

The dependent variable in the regressions is the book value of total funded debt divided by the book value of the assets. Size is the log of the book value of assets. Tangibility is the value of the road and construction, land, and rolling stock divided by the book value of assets. Profitability is earnings before interest expenses divided by the book value of total assets. Freight is the number of freight cars divided by the total number of cars. Road salability is defined as the mileage-weighted average of the state salability index corresponding to the states of the railroad's line, where the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. Rolling stock salability is defined as the mileage-weighted average of the gauge salability index corresponding to the railroad's gauge, where as before the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. The salability proxies that are calculated using mileage are in logarithm terms. Receiverships share is the tracks mileage share of potential buyers of roads that are in receiverships. All regressions include an intercept (not reported) and years dummies (year 1868 omitted). t-statistics are calculated using robust standard errors that are clustered by state and reported in parentheses.
* and ** denote significance at the 10%, and 5% levels, respectively.

earlier to absorb any regional heterogeneity), and report the results in the last column of Table 5.[12]

Finally, it is important to note that according to Shleifer and Vishny (1992), even when asset salability is low, some firms may strategically adopt high leverage while others may maintain spare debt capacity to facilitate opportunistic

[12] I also use alternative proxies for growth opportunities, such as measures of competition and efficiency and find similar results. Also, in unreported results, I have included state-fixed effects for each of the salability and equity receiverships specifications and found no correlation between theses measures and leverage.

acquisitions.[13] Thus, the simple linear specification in Table 5 may not reveal this relationship.[14]

7.2 Asset salability and debt maturity

Table 6 displays the results from estimating the effect of asset salability on debt maturity.[15] In models 1–5, I use the four different proxies for asset salability, and the receiverships share proxy in addition to: size, tangibility, profitability, the proportion of freight cars, and year-fixed effects. To control for potential heterogeneity at the state level and in an attempt to address the omission of a proxy for growth opportunities, models 6–10 include state-fixed effects as well. As in Table 5, I include each of the measures in a separate regression to avoid a multicollinearity problem. Among the control variables, size is significant at the 5% level in all the regressions and profitability is significant at the 5% level in 8 regressions out of 10. Larger firms have longer average maturities, while more profitable firms have shorter maturities. The size result is consistent with the empirical findings of Barclay and Smith (1995). If current profitability is correlated with growth opportunities, then the negative relation between profitability and maturity is consistent with Myers's (1977) prediction that firms with higher growth opportunities should shorten their debt maturity.

Fixed assets (proxied by tangibility) have a positive impact on debt maturity, and the composition of the assets is important as well; the proportion of freight cars in the railroad's rolling stock fleet and debt maturity are positively correlated. It is reasonable that specificity and redeployability of rolling stock varied a lot with the rolling stock's type. As I discuss in Appendix A, freight cars were less specific than locomotives and passenger coaches. Moreover, Klein, Crawford, and Alchian (1978) use the American steam locomotives as an example for a specialized (hence less redeployable) asset. If freight cars were more redeployable, then redeployability and debt maturity are positively correlated. I do not include leverage as an explanatory variable in the debt maturity regressions, since it is likely that leverage and debt maturity are jointly determined.[16]

Models 1, 2, 6, and 7 investigate how road salability affects debt maturity. The models control for railroad-specific variables using size, tangibility,

[13] Railroads were not using debt for tax shield reasons, since corporate taxation was not introduced in the United States until 1909. However, profitable firms will demand more debt according to Jensen (1986), if the market for corporate control is effective. Although there is no direct empirical evidence on the effectiveness of the market for corporate control in the nineteenth century, there are many anecdotes that describe an aggressive takeover activity by figures like Jay Gould, Thomas A. Scott, and especially Cornelius Vanderbilt.

[14] I thank an anonymous referee for suggesting this explanation.

[15] I have used an ordered logit model as well, to address a possible nonlinear ranking of debt maturity. The marginal effects and their statistical significance are quite similar to those found by the linear model and are not reported.

[16] There is no theoretical model that allows for a reduced-form estimation. To potentially address this issue, I try different specifications of 2SLS estimation procedures, using tangibility or profitability as instruments for leverage, and salability proxies as instruments for debt maturity. In these regressions (not reported), leverage is found to have a positive and statistically significant coefficient. The magnitudes and the significance of the other explanatory variables of debt maturity remain intact.

Table 6
Asset salability and debt maturity

	Dependent variable = Debt maturity									
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Size	2.37***	2.28***	2.24***	2.22***	2.25***	1.31***	1.19**	1.17**	1.22**	1.20**
	(5.35)	(5.00)	(4.80)	(4.75)	(4.98)	(2.75)	(2.54)	(2.30)	(2.42)	(2.28)
Tangibility	7.75***	8.00***	7.87***	8.15***	7.97***	4.07*	4.43*	4.04*	4.12*	3.91
	(2.61)	(2.73)	(2.61)	(2.65)	(2.69)	(1.72)	(1.91)	(1.72)	(1.82)	(1.54)
Profitability	−26.86**	−27.60**	−29.04**	−28.82***	−29.00**	−28.87*	−26.36*	−29.46**	−28.49**	−29.57**
	(−1.97)	(−2.13)	(−2.20)	(−2.23)	(−2.15)	(−1.95)	(−1.89)	(−2.16)	(−2.10)	(−2.02)
Freight	13.25***	13.31***	13.70***	13.61***	13.45***	6.96*	6.67*	7.24**	7.42**	7.66**
	(4.17)	(4.25)	(4.02)	(4.17)	(3.98)	(1.91)	(1.87)	(2.06)	(2.12)	(2.17)
Road salability	0.262**					0.380**				
(mileage)	(2.20)					(2.37)				
Road salability		0.023***					0.049***			
(number of buyers)		(2.66)					(3.20)			
Rolling stock salability			0.633***					0.749***		
(mileage)			(2.61)					(2.62)		
Rolling stock salability				0.004***					0.003*	
(number of buyers)				(2.62)					(1.92)	
Receiverships share					−11.14**					−4.83
(mileage)					(−4.73)					(−1.51)
1873 dummy	3.56***	3.37***	3.19***	3.09**	3.59***	3.84***	3.40***	3.33***	3.33***	3.71***
	(3.26)	(2.94)	(2.78)	(2.67)	(3.09)	(3.88)	(3.19)	(3.14)	(3.05)	(3.42)
1877 dummy	2.14	1.76	1.74	1.12	2.70*	2.26*	1.24	1.91	1.43	2.58*
	(1.67)	(1.33)	(1.32)	(0.84)	(1.93)	(1.78)	(1.02)	(1.48)	(1.10)	(1.89)
1882 dummy	6.04***	5.29***	5.05***	3.69**	6.36***	6.32***	4.51**	5.31***	4.34***	6.54***
	(3.68)	(3.00)	(3.01)	(2.02)	(3.70)	(3.96)	(2.72)	(3.09)	(2.11)	(3.81)
State-fixed effects	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.20	0.20	0.20	0.21	0.22	0.29	0.29	0.28	0.28	0.27
Observations	379	379	379	379	379	379	379	379	379	379

The dependent variable in the regressions is the weighted average of the term-to-maturity of all the debt instruments outstanding. Size is the log of the book value of assets. Tangibility is the value of the road and construction, land and rolling stock divided by the book value of assets. Profitability is earnings before interest expenses divided by the book value of total assets. Freight is the number of freight cars divided by the total number of cars. Road salability is defined as the mileage-weighted average of the state salability index corresponding to the states of the railroad's line, where the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. Rolling stock salability is defined as the mileage-weighted average of the gauge salability index corresponding to the railroad's gauge, where as before the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. The salability proxies that are calculated using mileage are in logarithm terms. Receiverships share is the tracks mileage share of potential buyers of roads that are in receiverships. All regressions include an intercept (not reported) and years dummies (year 1868 omitted). t-statistics are calculated using robust standard errors that are clustered by state and reported in parentheses.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

profitability, and the proportion of freight cars as explanatory variables. The results indicate that larger railroads with more tangible assets had debt of longer maturity, and that profitability is negatively correlated with debt maturity. Interestingly, debt gets longer when the railroad's rolling stock consists of more freight cars. Moreover, consistent with the univariate analysis in Panel B of Table 4, I find that the salability of the road (measured by mileage or number of potential buyers) is positively correlated with debt maturity. Similarly, models 3, 4, 8, and 9 use the same specification and controls as models 1, 2, 6, and 7, but the salability proxies are constructed at the country level to estimate the effect of the rolling stock salability (measured by mileage or number of potential buyers).

After controlling for railroads characteristics, year dummies, and state-fixed effects, the salability of road and rolling stock has a positive and statistically significant impact on debt maturity. The effect is also economically sizable. Moving from the 25th percentile of road salability measure (using mileage) to the 75th percentile increases the average maturity by almost three years, while moving from the 10th percentile of road salability measure (using mileage) to the 90th percentile increases the average maturity by almost four years. Moving from the 25th percentile of rolling stock salability measure (using number of buyers) to the 75th percentile prolongs the average maturity by 2.3 years, while moving from the 10th percentile of rolling stock salability measure (using number of buyers) to the 90th percentile increases the average maturity by 4.4 years. Moreover, when I include state-fixed effects in the regressions, the economic effect of the salability measure increases significantly in three out of the four regressions suggesting that these estimates are biased downward. This bias is in particular notable in the road salability coefficients that increase in magnitudes of between 45% to more than two-fold. The state-fixed effects also dramatically cut the economic significance of size, tangibility, and freight by about a half and decrease their statistical power. The changes in the coefficients and statistical significance result from the nature of the within estimator of a fixed-effects regression. Since the within-state estimator uses only time-series variation within a state, estimates of railroads characteristics that are similar across railroads within a state (e.g., size) and do not vary much over time are expected to be lower economically and statistically.

Interestingly, the coefficient of profitability is unaffected by the state-fixed effects and its statistical significance hardly changes, which indicates that profitability was hardly determined at the state level. If future investment opportunities and current profitability are correlated, then an inclusion of state-fixed effects would control for state-level unobservables that are different from investment opportunities. However, if investment opportunities are determined by location—which is more likely in a network economy—then the negative relation between profitability and debt maturity is not driven by Myers's (1977) prediction. The within-state estimates of asset salability become stronger statistically and economically in three out of four regressions.

Table 7
Economic significance of the determinants of debt maturity

	Long-term debt		
	Standard deviation	25th–75th percentile	10th–90th percentile
Size	6.39%	9.08%	16.35%
Tangibility	3.65%	3.85%	8.26%
Profitability	−6.17%	−6.45%	12.07%
Freight	3.80%	2.78%	6.37%
Road salability (mileage)	6.28%	14.86%	16.09%
Road salability (number of buyers)	8.19%	7.78%	15.6%
Rolling stock salability (mileage)	6.15%	10.17%	13.69%
Rolling stock salability (number of buyers)	3.30%	6.61%	16.30%
Receiverships share (mileage)	−7.87%	−4.93%	−9.87%

Predicted changes in the dependent variables as each explanatory variable varies (i) by one standard deviation, (ii) from the 25th percentile to the 75th percentile, (iii) from the 10th percentile to the 90th percentile. The results are computed using the specifications in Table 6.

Finally, to provide more evidence on link between market illiquidity and debt maturity, models 5 and 10 investigate the relation between debt maturity and market illiquidity proxied by the percentage of tracks mileage in receiverships; the fraction of financially constrained potential buyers of roads that are located in the same state and operate the same gauge. Similar to the rest of the analysis, I control for size, tangibility, profitability, the proportion of freight cars, and year-fixed effects. As model 5 demonstrates and consistent with the univariate analysis in Table 4, the fraction of potential buyers in receiverships is an important determinant of debt maturity. A large fraction of insolvent potential buyers of the railroad assets (higher receivership share) is associated with lower debt maturity. The coefficient of −11.14 (t-statistic = −4.73) in model 5 suggests that solvent railroads issued shorter term debt when potential buyers were in receiverships. The effect is economically sizeable; moving from the 10th percentile of the receiverships share to the 90th percentile decreases the average maturity by 6.5 years. The within-state estimate of receiverships share (model 10) has the right sign, but is smaller and not statistically significant (t-statistic = −1.51). Taken together, the results in Table 6 are consistent with prediction 2 that salable assets support long-term debt.

Table 7 reports the economic significance of all the explanatory variables that are used in Table 6. The table presents percentage changes in debt maturity for a one-standard-deviation shift in each of the explanatory variables, as well as a move from the 25th percentile to the 75th percentile, and from the 10th percentile to the 90th percentile. I report the percentage change in debt maturity relative to the mean. As the table indicates, after the salability measures, size and profitability are the most important determinants of debt maturity. The effect of the receivership share is negative, since a higher share of insolvent railroads imply a less liquid market. As Table 7 shows, receiverships share has the largest impact per one standard deviation.

7.3 The size distribution of firms and debt maturity

While economies of scale in issuing public debt and reducing flotation costs induce larger firms to issue longer maturities on the demand side, large firms are also less salable in periods of market illiquidity. As such, creditors would prefer shorter maturities on the supply side, if larger firms retain lower values from selling assets in illiquid markets. The idea is that larger firms are more likely to suffer from fire sales if the market capacity to absorb their assets is limited. Shleifer and Vishny (1992) predict that smaller firms are *ceteris paribus* better candidates for debt finance. However, smaller firms might be too specialized and have a thin market because of asset specificity. According to Shleifer and Vishny (1992), "The way to test this prediction is to look at an industry where firms of different sizes operate together, and to see if smaller ones have more debt." It is important to note that it is not the absolute size that affects the salability of the assets but rather the firm size relative to the size of its potential buyers. To test this prediction, I construct three different measures of relative size.

The first measure is defined as the ratio between the railroad mileage and the mileage of the potential buyers of its road,

$$State\ share_{i,t} = length_{i,s,g,t} \Big/ \sum_{s}^{S} \sum_{g}^{G} \omega_{i,s,g,t}(mileage_{s,g,t}), \tag{15}$$

where t represents sample year, s is a state, g denotes the gauge, $length_{i,s,g,t}$ is railroad's i own mileage in state s gauge g and sample year t, and $\omega_{i,s,g,t}$ is defined as in Equation (6).

The second measure is defined as the ratio between the railroad mileage and the mileage of the potential buyers of its rolling stock,

$$Country\ share_{i,t} = length_{i,s,g,t} \Big/ \sum_{g}^{G} \pi_{i,g,t}(mileage_{g,t}), \tag{16}$$

where t represents sample year, g denotes the gauge, $length_{i,g,t}$ is railroad's i own mileage in gauge g, and $\pi_{i,g,t}$ is defined in Equation (11).

In the third measure, I calculate the number of potential buyers for the road in two categories: (i) railroads with similar gauge that operate in the same states and are not in receiverships with road length smaller than or equal to 300 miles, and (ii) the number of railroads with similar gauge that operate in the same states and are not in receiverships with road length larger than 300 miles. While the first two proxies measure the railroad size relative to the *aggregate* size of its potential buyers, the third measure is designed to capture the influence of a relatively large *individual* buyer.

The negative coefficients on the share variables in models 1–4 reported in Table 8 are consistent with the prediction, since a larger fraction of the industry assets owned by the firm implies lower market liquidity for its own assets.

Table 8
The size distribution of railroads and debt maturity

	Dependent variable = Debt maturity					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Mileage	3.08***	2.88***	1.92**	1.68**	1.40***	1.34**
	(4.22)	(4.05)	(2.50)	(2.26)	(2.76)	(2.53)
Tangibility	6.15**	6.20**	3.53	3.25	4.18*	3.40
	(2.01)	(1.97)	(1.47)	(1.30)	(1.81)	(1.32)
Profitability	−28.58*	−29.26**	−32.44**	−32.29**	−30.72**	−43.78**
	(−1.93)	(−2.03)	(−2.14)	(−2.22)	(−2.32)	(−2.46)
Freight	14.13***	14.54***	7.11*	7.36**	10.84***	11.37***
	(3.89)	(3.82)	(1.95)	(2.07)	(3.56)	(3.67)
State-gauge share	−1.92		−3.19**			
	(−1.63)		(−2.31)			
Country-gauge share		−5.06***		−7.20***		
		(−3.39)		(−2.90)		
No. of railroads $\leq$ 300					0.245***	
					(3.52)	
No. of railroads > 300						1.49**
						(2.16)
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
State-fixed effects	No	No	Yes	Yes	Yes	Yes
Adjusted R^2	0.19	0.18	0.29	0.28	0.26	0.25
Observations	379	379	379	379	379	379

The dependent variable in the regressions is the weighted average of the term-to-maturity of all the debt instruments outstanding. Mileage is the log of the total mileage owned by the railroad. Tangibility is the value of road and equipment divided by the book value of assets. Profitability is earnings before interest expenses by the book value of total assets. Freight is the number of freight cars divided by the total number of cars. State-gauge share is the ratio between the railroad's mileage and the corresponding mileage of railroads with similar gauge that operate in the same states and are not in receiverships. Country-gauge share is the ratio between the railroad's mileage and the corresponding mileage of railroads with similar gauge in the country that are not in receiverships. Number of railroads $\leq$300 is the number of railroads with similar gauge that operate in the same states and are not in receiverships with total length smaller than or equal to 300 miles. Number of railroads >300 is the number of railroads with similar gauge that operate in the same states and are not in receiverships, with total length larger than 300 miles. All regressions include an intercept (not reported). t-statistics are calculated using robust standard errors that are clustered by state and reported in parentheses.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

After controlling for size (defined here as the logarithm of the road's length in miles), tangibility, profitability, and the proportion of freight cars, I find that being too large relative to the aggregate size of potential buyers decreases debt maturity.[17] Similar to the results in Table 6, the within-states estimator dampens the estimates of size, tangibility, and freight. As before, the within-states estimator increases the economic significance of the salability estimates. It is also interesting to note that while firm size has a positive effect on debt maturity (significant at 5% level in all the regressions), being too large relative to the aggregate size of potential buyers decreases debt maturity.

Models 5 and 6 estimate the effect of the number of buyers with (i) road length smaller than 300 miles (model 5) and (ii) road length larger than 300 miles (model 6). Consistent with Table 6, the number of buyers is correlated with debt maturity. Furthermore, having one large firm as a potential buyer prolongs debt maturity by almost 1.5 years. A one-standard-deviation shift in the number

[17] I estimated the effects of these measures on leverage and did not find statistically significant results.

of smaller potential buyers increases debt maturity by 2.1 years, and moving from the 25th percentile to the 75th percentile increases debt maturity by almost three years. Hence, the relative size of the market for railroads' assets is found to be important for debt structure. Holding a smaller fraction of the industry assets, and having large buyers who are not credit constrained affect the maturity structure of debt.

7.4 Asset salability and debt refinancing

The analysis so far suggests that asset salability is correlated with the cross-section of debt maturity structure. In this section, I analyze how predetermined levels of redeployability affect the size and the maturity of new debt issues. In particular, I analyze how the financial crisis of September 1873 that eventually led to a severe economic depression between 1873 and 1879, and to many defaults by railroads, affected debt financing. The railroad sector was hit the hardest by the financial crisis of 1873. During the first month of the crisis, 88 railroads defaulted on debt payments with an aggregate value of $370,182,668. According to Swain (1898), during the years that followed the crisis of 1873, about 18.0% of total US railroad mileage (between 75 and 85 railroads) were in equity receiverships. The 1873 crisis was also followed by a meltdown of debt and credit markets. For example, after learning about the difficulties of the banking firm of Cooke & Co., John Pierpont Morgan called in all of the loans of Drexel, Morgan, and Co. (Carosso, 1987). Furthermore, according to Friedman and Schwartz (1963),

> Capital inflows declined drastically after 1873 and were soon replaced by net outflows . . . . The decline in capital inflows reflected also the widening financial difficulties of railroads and the default of some roads on their obligations. These contributed importantly to banking failures that set off the financial panic of 1873. In its turn, one consequence of the panic was to intensify the difficulties of the railroads.[18]

Thus, the crisis of 1873 is a natural experiment to test Shleifer and Vishny's notion of market liquidity.

I study how the number of potential buyers (and their mileage) for both tracks and rolling stock—that substantially declined during the years after 1873, as many railroads were in equity receiverships—and the fraction of railroads in receiverships, affected both the maturity and the amount of debt issues. To analyze the effect of asset salability on debt, I have collected data on debt issues by 102 railroads during the year 1875, when 45 railroads (8.8% of the total mileage of railroads) were in equity receiverships and many others were struggling financially.

Panel A of Table 9 displays the results from estimating a probit model (marginal effects reported) of the probability of long-term bond financing

[18] Friedman and Schwartz (1963, pp. 77–78).

Table 9
Asset salability and debt refinancing: Evidence from 1875

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Panel A: Asset salability and the probability of long-term/short-term financing										
	Probability of long-term bond financing					Probability of credit line financing				
Road salability (mileage)	0.044** (2.26)					−0.058*** (−3.07)				
Road salability (number of buyers)		0.008* (1.81)					−0.001 (−0.53)			
Rolling stock salability (mileage)			0.102*** (3.38)					−0.101*** (−4.70)		
Rolling stock salability (number of buyers)				0.001*** (3.44)					−0.001*** (−4.90)	
Receiverships share (mileage)					−0.607** (−2.27)					0.426*** (4.88)
Pseudo R^2	0.16	0.16	0.18	0.17	0.13	0.44	0.28	0.26	0.27	0.20
Observations	102	102	102	102	102	102	102	102	102	102
Panel B: Asset salability and the amount and maturity of debt financing										
Dependent Variable	Amount	Amount	Amount	Amount	Amount	Maturity	Maturity	Maturity	Maturity	Maturity
Road salability (mileage)	0.055*** (2.70)					2.362*** (2.84)				
Road salability (number of buyers)		0.010* (1.76)					0.503** (2.25)			
Rolling stock salability (mileage)			0.208*** (3.02)					3.505 (1.47)		
Rolling stock salability (number of buyers)				0.001*** (3.41)					0.039** (2.15)	
Receiverships share (mileage)					0.670 (0.99)					−17.39*** (−3.40)
Adjusted R^2	0.40	0.40	0.39	0.42	0.40	0.62	0.60	0.44	0.53	0.37
Observations	53	53	53	53	53	53	53	53	53	53

The dependent variable in Panel A is the probability of long-term bond financing (Models 1–5), or credit line financing (Models 6–10). The dependent variable in Panel B is either the natural logarithm of the amount of debt raised or the maturity of the debt. All regressions control for size, tangibility, profitability, and the number of freight cars divided by the total number of cars. Road salability is defined as the mileage-weighted average of the state salability index corresponding to the states of the railroad's line, where the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. Rolling stock salability is defined as the mileage-weighted average of the gauge salability index corresponding to the railroad's gauge, where as before the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. The salability proxies that are calculated using mileage are in logarithm terms. Receiverships share is the tracks mileage share of potential buyers of roads that are in receiverships. All regressions include an intercept (not reported). Regressions in Panel A are estimated using a probit model, and regressions in Panel B are estimated using OLS. t-statistics are calculated using robust standard errors that are clustered by state and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

(models 1–5) and the probability of short-term (credit line) financing (models 6–10). In addition to the five different proxies for asset salability, all the regressions include as control variables: size, tangibility, profitability, and the proportion of freight cars (not reported for brevity). As in Tables 5 and 6, I include each of the salability measures in a separate regression to avoid a multicollinearity problem. The results in Panel A demonstrate that predetermined asset salability affects debt maturity. The effect of asset salability on debt maturity is significant both economically and statistically. Four out of the five salability measures are statistically significant at the 1% level in explaining the probability of long-term debt financing. The effect is also economically sizeable. For example, a one-standard-deviation increase in each of the five salability measures increases the probability of long-term bond financing by between 12.2 and 42.6 percentage points. Likewise, a one-standard-deviation increase in each of the four salability measures decreases the probability of short-term debt financing by between 15.7 and 60.7 percentage points.

Panel B of Table 9 present the results from regressing the amount and maturity of incremental debt issues for the railroads that issue debt during the period, on the five different proxies for asset salability. All regressions include size, tangibility, profitability, and the proportion of freight cars as control variables (not reported for brevity). As Panel B demonstrates, both the quantity and the maturity of the debt are positively related to asset salability. In the first five columns of Panel B, I use the natural log of the amount of the debt issue as a dependent variable, while in the last five columns, I use the term to maturity of the bond or the short-term debt as a dependent variable.[19] Out of the five salability measures, three are statistically significant at least at the 1% level. A one-standard-deviation increase in the first four salability measures increases the amount of debt by between $620,919 and $1,420,994, representing an increase of between 24.0% and 54.9% relative to the mean, while the receiverships share proxy is not statistically significant. Furthermore, a one-standard-deviation increase in the first four salability measures increases the maturity of debt by between 6.1 and 8.5 years, representing an increase of between 30.2% and 42.2% relative to the mean. Moreover, a large fraction of insolvent potential buyers of the railroad assets is associated with shorter debt maturity. Taken together, the results in Panels A and B of Table 9 are consistent with both predictions 1 and 2.

7.5 The railroad's age and asset durability

In this section, I analyze a life-cycle explanation for the relation between gauge and debt maturity. If railroads were more likely to issue long-term debt when young (e.g., to finance the construction of the road), then young railroads should have longer term debt. Moreover, if new railroads were built after the Civil War to the standard gauge, then the relation between maturity and gauge

[19] I set the maturity of a credit line to be one year, which is an upper bound on short-term financing.

may be challenged, as the results might capture a life-cycle pattern of external finance.[20] Using data on the age of the railroad, I reject this hypothesis.

To rule out the life-cycle effect, I have collected data on the railroads' age. The manuals report (when applicable) the year in which: (i) the railroad was chartered, (ii) the road was completed, and (iii) the railroad was reorganized. Whenever the firm was not reorganized or consolidated, I chose the date of charter for the railroads' age, and not the completion date, since it reflects the period in which the railroad was in need of external finance. If the firm was reorganized, I checked whether the existing debt was negotiated, and used the reorganization year to calculate the railroad's age. I obtained data for 326 firm-year observations, which represent about 86% of the entire sample, and I define a railroad's age as the number of years since its establishment (reorganization). Models 1–5 in Table 10 display the results from estimating the impact of railroads' age on their debt maturity. Since the age of the firm is the focus of my interest and given that age is a time-dependent variable, I estimate its effect without year-fixed effects.[21] As the table illustrates, railroad age does not have a statistically significant impact on the term of the debt. Furthermore, four out of the five salability proxies are still statistically significant and their marginal effects are even stronger. For example, moving from the 25th percentile of rolling stock salability measure (using number of buyers) to the 75th percentile prolongs the average maturity by 5.5 years. I thus conclude that the life-cycle hypothesis is not supported by the empirical results in Table 10.

Another potential explanatory variable of debt maturity is the age of the assets. Myers (1977); and Hart and Moore (1994) predict that firms should match assets with liabilities, and that durable assets should be financed with long-term debt. Furthermore, Guedes and Opler (1996) have found that an accounting-based proxy for asset maturity is an important determinant of debt maturity. Estimating the age of the assets is tricky, since fixed assets accounting rules and depreciation reporting were promulgated by the Interstate Commerce Commission (ICC) only in 1907. I use the fraction of the tracks mileage that were made of steel as a proxy for the assets age. This proxy plays two roles. First, steel rails came into use during the 1870s and as such steel is a proxy for the timing of the investment in addition to the railroad's age. Second, steel rails were also considered more durable than iron rails or iron-capped wooden rails.[22]

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[20] There is not much empirical work on the life-cycle pattern of external finance over the long-run economic life of firms. Rajan and Zingales (1998), for example, find support for the common wisdom that firms rely more on external finance in their early years. It is not clear, however, if they begin with short-term or long-term debt. If young firms are subject to more asymmetric information, then according to Myers and Majluf (1984), they will issue short-term debt assuming that it is less sensitive to information asymmetries than long-term debt. In addition, Fluck (1999) develops a model in which firms issue short-term debt first.

[21] In this table, I include state-fixed effects in all the regressions except the receiverships share specifications, given the results in Table 6.

[22] According to a road engineer quoted in *The Railroad Gazette* from 21 September 1872: "A steel rail will carry one-fifth more dead load than the iron rail before taking permanent set. Therefore in using steel and iron rails on

Table 10
Railroad's age, asset durability, and debt maturity

	Dependent variable = Debt maturity							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Freight	11.73***	9.76**	11.23***	9.42**	17.08***	6.47*	6.12*	13.62***
	(2.66)	(2.19)	(2.61)	(2.09)	(5.31)	(1.80)	(1.73)	(3.41)
Road salability	0.266					0.393**		
(mileage)	(1.12)					(2.41)		
Road salability		0.058***					0.050***	
(number of buyers)		(4.34)					(4.93)	
Rolling stock salability			1.17**					
(mileage)			(2.16)					
Rolling stock salability				0.005***				
(number of buyers)				(3.82)				
Receiverships share					−7.81**			−9.98***
(mileage)					(−2.18)		(−3.70)	
Age	−0.057	−0.064	−0.067	−0.072	−10.108			
	(−0.73)	(−0.87)	(−0.89)	(−0.97)	(−1.67)			
Steel						5.25**	5.25**	5.37**
						(2.42)	(2.36)	(2.78)
State-fixed effects	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Year-fixed effects	No	No	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.21	0.23	0.22	0.24	0.17	0.27	0.28	0.21
Observations	326	326	326	326	326	379	379	379

The dependent variable in the regressions is the weighted average of the term-to-maturity of all the debt instruments outstanding. Road salability is defined as the mileage-weighted average of the state salability index corresponding to the states of the railroad's line, in which the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. Rolling stock salability is defined as the mileage-weighted average of the gauge salability index corresponding to the railroad's gauge, where as before the state salability index is calculated using (i) statewide track mileage for each gauge, and (ii) the number of railroads in the state for each gauge. The salability proxies that are calculated using mileage are in logarithm terms. Receiverships share is the tracks mileage share of potential buyers of roads that are in receiverships. Age is the difference between the actual year and the railroad's charter year. Steel is the ratio of the length of steel tracks to the total mileage of the railroad. Regressions include intercepts, and controls for the proportion of freight cars, size, tangibility, and profitability. For brevity, only the coefficient on the freight salability proxies, age, and steel are reported. t-statistics are calculated using robust standard errors that are clustered by state and reported in parentheses.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Models 6, 7, and 8 in Table 10 report the results from estimating the impact of the fraction of steel tracks on debt maturity. Having tracks made of steel has a positive effect on debt maturity, after controlling for the regular variables. It is difficult, however, to separate the two explanations of durability and investment timing. Finally, after controlling for size, tangibility, profitability, proxies for growth opportunities, age, durability, or investment timing, higher salability is positively correlated with debt maturity.

7.6 Robustness

My results demonstrate that proxies for salability are positively correlated with debt maturity. In this section, I analyze the robustness of the results to alternative explanations. I start by testing whether my salability measures are correlated with competition and profitability. I find that gauge-based salability measures

the same road, a reduction of the weight of steel rails should not exceed 20 per cent. I estimate the life of steel rails on equal conditions to be six times as great as iron."

and profitability are not correlated. Furthermore, I employ different measures of growth opportunities in addition to the state-fixed effects used in the previous analysis. I also discuss the possibility that the salability measures are correlated with growth opportunities, and argue that this interpretation contradicts both the theory and the empirical evidence.

7.6.1 Asset salability or profitability? The analysis so far suggests that the mileage, number, and share of solvent potential buyers are correlated with debt maturity. The interpretation suggested in the paper is that a larger number of potential buyers leads to higher liquidation values. However, the number of railroads with similar gauge is possibly correlated with competition and profitability. Is it the case that the results are driven by profitability rather than salability? The regressions in Table 6 show that the salability proxies are correlated with debt maturity controlling for profitability,[23] yet they don't test the direct relation between profitability and the number, mileage, or share of railroads with similar gauge that are not in equity receiverships. To address this concern, I regress profitability on the salability measures controlling for size, the proportion of freight cars, the railroad's age, Herfindahl-Hirschman index (HHI) of railroads concentration for every state in each of the years as a proxy for competition, and year-and firm-fixed effects. For brevity, I report only the coefficients of the salability proxies in Panel A of Table 11. As Panel A of Table 11 shows, salability is not a significant determinant of profitability in *any* of the five salability proxies, with t-statistics on these variables ranging from -1.58 to 0.46. Moreover, Panel B of Table 11 presents means and medians of profitability stratified by salability. I stratify profitability by the 20th, 40th, 60th, 80th, and 100th percentiles of each of the salability measures, and report the means and medians of profitability for the first four salability measures. I cannot stratify profitability by the receiverships share variable, since its 20th, 40th, and 50th percentiles all equal zero (see Table 4). As Panel B of Table 11 demonstrates, profitability levels seem to be similar across different levels of salability. The salability proxies thus do not capture a profitability effect.

Another concern is that the salability proxies are correlated with the volatility of earnings. The volatility hypothesis suggests that a larger number of potential buyers leads to more stable cash flows that support long-term debt. To address this concern, I stratify profitability by the 20th, 40th, 60th, 80th, and 100th percentiles of each of the salability measures, and report the standard deviations of profitability across the stratified salability measures in Panel C of Table 11. As in Panel B, I cannot stratify profitability by the receiverships share variable. According to Panel C, there is almost no difference between earnings' volatility across the stratified salability measures. Finally, a Bartlett's χ^2 test cannot reject

[23] I also control later (in Table 12) for competition using the Herfindahl-Hirschman index (HHI) of railroads concentration for every state in each of the years.

Table 11
Asset salability and profitability

Panel A: Profitability and asset salability Dependent variable = Profitability					
	Model 1	Model 2	Model 3	Model 4	Model 5
Road (mileage)	0.001 (0.06)				
Road (number of buyers)		−3.0e−04 (−0.26)			
Rolling stock (mileage)			0.010 (0.46)		
Rolling stock (number of buyers)				3.28e−06 (0.37)	
Receiverships share (mileage)					−0.016 (−1.58)
Adjusted R^2	0.18	0.18	0.18	0.18	0.18

Panel B: Mean and median profitability stratified by salability					
	Low salability 1	2	3	4	High salability 5
Road (mileage)	4.20% (3.60%)	4.09% (4.05%)	4.42% (4.44%)	5.01% (4.51)%	4.36% (4.02%)
Road (number of buyers)	4.09% (3.48%)	4.34% (4.44%)	3.89% (3.42%)	4.93% (4.70)%	4.76% (4.49%)
Rolling stock (mileage)	4.27% (3.70%)	4.18% (3.55%)	4.34% (4.02%)	5.24% (5.13%)	4.12% (4.20%)
Rolling stock (number of buyers)	4.32% (3.75%)	4.47% (4.14%)	4.62% (4.40%)	4.21% (4.25%)	4.41% (4.31%)

Panel C: Profitability volatility stratified by salability					
	Low salability 1	2	3	4	High salability 5
Road (mileage)	2.77%	2.36%	2.31%	2.79%	2.70%
	Bartlett's test for equal variances: $\chi^2(4) = 4.47$ (p-value = 0.346)				
Road (number of buyers)	2.76%	2.38%	2.33%	2.87%	2.50%
	Bartlett's test for equal variances: $\chi^2(4) = 4.57$ (p-value = 0.334)				
Rolling stock (mileage)	2.74%	2.56%	2.54%	2.69%	2.35%
	Bartlett's test for equal variances: $\chi^2(4) = 1.91$ (p-value = 0.753)				
Rolling stock (number of buyers)	2.57%	2.77%	2.61%	2.44%	2.37%
	Bartlett's test for equal variances: $\chi^2(4) = 1.30$ (p-value = 0.728)				

This table examines the relation between profitability and salability. Panel A reports the results from regressing profitability on the salability measures. All regressions include an intercept, year- and state-fixed effects, and a vector of control variables (size, freight, the railroad's age and Herfindahl-Hirschman concentration index of railroads at the state-year level), which are not reported for brevity. t-statistics are calculated using robust standard errors that are clustered by state and reported in parentheses. Panel B reports means (medians) of profitability stratified by different salability measures. I use both total mileage and number of railroads to calculate the proxies. Panel C reports the cross-sectional standard deviation of profitability stratified by proxies of road salability and rolling stock salability. Profitability is earnings before interest expenses divided by the book value of total assets. The Bartlett's p-value gives the significance of a test whether the subsamples have equal variances. Low p-values indicate that the null hypothesis of equal variances is rejected.

the hypothesis that the stratified subsamples have equal variances. I conclude that the salability proxies do not capture a volatility effect.[24]

[24] For robustness, I have regressed profitability on size, the proportion of freight cars, the railroad's age, Herfindahl-Hirschman index (HHI), and year-and state-fixed effects. I then regressed the squared residual from this regression on each of the salability measures. This procedure tests whether volatility of the earnings' part that is not explained by a set of firm's level controls and year-and state-fixed effects is correlated with asset salability. The regressions

Table 12
Debt maturity and alternative measures of growth opportunities

	Dependent variable = Debt maturity				
	Model 1	Model 2	Model 3	Model 4	Model 5
Freight	5.70*	9.64**	11.28	10.37***	17.45***
	(1.78)	(2.57)	(3.42)	(3.26)	(5.48)
Rolling stock salability	0.756***	0.409*	1.29***	1.20***	1.05***
(mileage)	(2.70)	(1.72)	(3.15)	(3.24)	(3.56)
Efficiency	−10.34***				
	(−2.58)				
Freight earnings		−12.26**			
		(−2.10)			
Area-to-population			−44.55		
			(−1.42)		
HHI				−7.99	
				(−0.65)	
Waterways					0.097
					(0.88)
State-fixed effects	Yes	Yes	Yes	Yes	No
Year-fixed effects	Yes	Yes	No	No	No
Adjusted R^2	0.31	0.28	0.26	0.26	0.20
Observations	371	318	376	376	376

The dependent variable in the regressions is the weighted average of the term-to-maturity of all the debt instruments outstanding. Size is the log of the book value of assets. Tangibility is the value of the road and construction, land, and rolling stock divided by the book value of assets. Profitability is earnings before interest expenses divided by the book value of total assets. Freight is the number of freight cars divided by the total number of cars. Rolling stock salability is defined as the mileage-weighted average of the gauge salability index corresponding to the railroad's gauge, where the state salability index is calculated using statewide track mileage for each gauge. The salability proxy is in logarithm terms. Efficiency is the ratio of operating expenses to revenue. Freight earning is defined as earnings from freight divided by total earnings. Area-to-population is the ratio of the state's area in squared miles to the population size. HHI is the Herfindahl-Hirschman concentration index of railroads at the state-year level. Waterways is defined as the number of navigable streams and rivers, and canals within a state. Regressions include intercepts and controls for size tangibility and profitability that are not reported for brevity. All regressions include an intercept (not reported). t-statistics are calculated using robust standard errors that are clustered by state and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

7.6.2 Gauge and growth opportunities. In Table 12, I use alternative proxies for growth opportunities, and all the regressions control for size, tangibility, and profitability, which are not reported for brevity. The proxies that I examine are; efficiency (the ratio of operating profit to expenses), freight earning (the ratio of earning from freight to total earning), area-to-population (the ratio of the state's area in squared miles to the population size), Herfindahl-Hirschman index (HHI) of railroads concentration for every state in each of the years, and state-level competition with waterways (defined as the number of navigable streams and rivers, and canals).[25]

According to Myers (1977), short-term debt reduces the potential for underinvestment caused by debt overhang, and firms with more growth opportunities should have shorter term debt. This prediction is also supported by the general

(not reported) show that this is not the case. None of the salability measures (including receiverships share) is statistically significant in explaining earnings' volatility.

[25] I use the list of navigable waterways compiled by Fogel (1964).

evidence that value firms issue longer term debt than growth firms. In model 1, growth opportunities are assumed to be determined by the railroad's efficiency. If more efficient railroads have more growth opportunities, then Myers's (1977) prediction is supported by the data. Moving from the 25th percentile to the 75th percentile of the efficiency measure reduces debt maturity by almost two years. Furthermore, it is possible that the number of freight cars is correlated with earning from freight and not with the redeployability of the freight cars. However, including earnings from freight in the regression in addition to the proportion of freight cars should separate salability from profitability. According to model 2 of Table 12, earnings from freight have a negative impact on debt maturity, which is consistent with a growth opportunities explanation. This result suggests that current cash flows from operating the cars cannot explain the relation between freight cars and debt maturity.

Out of the three state-level competition proxies used in models 3, 4, and 5, none are found to be statistically significant. If area-to-population is positively correlated with growth opportunities, then its negative coefficient (though not statistically significant) may indicate that higher growth opportunities implies shorter term debt. Moreover, concentration within the railroad industry (proxied by HHI at the state level), and competition with the waterways are not found to be statistically significant. The HHI measure, is different from the salability measures since it takes into account competition from all railroads regardless of their gauge, while the salability measures are calculated based on both location and gauge. Furthermore, the rolling stock salability is constructed using all railroads with a similar gauge regardless of their location, while the HHI is based only on local competitors. Thus, the measure of the salability of the rolling stock (that is being used in Table 12) is much less correlated with local competition, and thus is not likely to be driven by local market competitiveness. Finally, after controlling for size, tangibility, profitability, proxies for growth opportunities, and state-fixed effects, higher salability is positively correlated with debt maturity in all the regressions.

8. Conclusion

In this study, I present empirical evidence on the link between asset salability and debt maturity. The nineteenth-century American railroad industry is an excellent candidate for this task given the unique structure of their assets that enables the construction of proxies for liquidation values based on the potential demand for railroads' assets.

Is the liquidation value of the assets an important determinant of capital structure? This question is of major importance to theories of contracting and capital structure, yet little direct empirical evidence has been established. Theoretical predictions have focused on the relation between liquidation values and different facets of debt financing (see Benmelech, Garmaise, and Moskowitz (2005) for a summary of the theoretical predictions and empirical evidence).

Benmelech, Garmaise, and Moskowitz (2005) use commercial property zoning laws as a proxy for liquidation values. They find that higher liquidation values are associated with longer term loans, smaller number of creditors, higher loan-to-value ratios, and lower interest rates. However, they study project-specific financing and not capital structure choices of firms. The evidence in this paper suggests that more salable assets are in particular important for longer debt maturities.

Appendix A: The Redeployability of Rolling Stock

Locomotives

According to Klein, Crawford, and Alchian (1978), steam locomotives were specialized to operating conditions, such as "high speed, hill climbing, short hauls, heavy loads, sharp corners, as well as types of coal for fuel." Locomotives were built to meet the design requirements of the railroads. According to Brown (2001), "Railroads increasingly sought locomotives with particular characteristics to suit the *terrain* of their routes and the types of service they ran, such as heavy freights or fast passenger trains." For example, in 1886, Baldwin Locomotives Works built the 2-10-0 locomotive, which was designed for the Northern Pacific Railroad's heavy freight service lines in mountainous territories. The potential buyers of this $13,225-value locomotive were railroads that operated similar lines. Yet less than a handful of railroads managed this kind of services in 1886. Some locomotives were designed for special tasks and used distinctive types of coal. For example, the St. Louis Bridge Company hauled trains across the Eads Bridge over the Mississippi at St. Louis, then through a downtown tunnel into St. Louis Union Station. For this task it used special locomotives with slant-back tender to improve backward visibility in frequent switching moves. Moreover, according to Brown (2001), the special nature of tunnel operation "required that it burn smokeless coke fuel."

Locomotives were often not redeployable even within different segments of their own railroad. Unlike freight cars, they seldom traveled beyond the tracks of their own roads. According to Brown (2001), "Locomotives were generally assigned to separate operating divisions - sections of the line ranging from 75 to 100 miles in length. Conditions varied greatly between divisions in such matters as balance and intensity of freight versus passenger traffic, hilly or level terrain, curved versus straight track, right-of-way clearance, and weight of tracks."

Gauge differences further frustrated locomotives' redeployability. The narrow-gauge Ptarmigan looked like a standard locomotive, but the engine ran on a 3-foot gauge track rather than the standard gauge, "consequently the entire design was scaled down from normal mainline practice." While the standard-gauge American locomotive in 1880 had 18- by 24-inch cylinders, weighed 74,000 pounds with hauling capacity up to 1,400 long tons, "[The Ptarmigan] had 12- by 18-inch cylinders, weighed 42,000 pounds, and could haul 750 long tons on level track."[26] Changing the gauge of locomotives was often impossible or very expensive, as exemplified by the case of the Chicago, St. Louis, and New Orleans Railroad, which was part of the Illinois Central system. On 29 November 1880, W. H. Pundy, who worked for the department of machinery of the Illinois Central, sent a memo to J. C. Clarke, the Vice President and General Manager of the Illinois Central, regarding the expenses associated with changing the gauge of the Chicago, St. Louis, and New Orleans Railroad from 5′0″ to 4′8.5″. He wrote:

> I would gratefully [suggest] the following: Engines 1,2,3,4,5,6 & 7 are all very light, none of their cylinders being over 13 inches diameter and none of them can be narrowed up without bringing the frame closer together and in some cases narrowing the fire box. The changing of

[26] See Brown (2001, p. 42).

these engines will be expensive and will take considerable time. If the change of the gauge is not made until the summer of 1882 I would recommend that during the coming years we build new engines to take the place of these, and that the old engines be taken to pieces, or sold as may be deemed the best.[27]

Freight cars

There were different types of freight cars. Boxcars, flatcars, cabooses, and gondola cars were all designed for general-purpose freight. More specialized cars included grain hoppers, coal cars, refrigerator, milk, heated, and ventilated cars. However, the abundance of freight car models did not impede standardization. The increase in traffic volume after 1870 and larger car fleets led to the adoption of relatively standardized cars. Freight cars were, according to Klein, Crawford, and Alchian (1978), "generally easily movable and not very specific. Mass production of freight cars boosted standardization; "Cars were being purchased in groups of hundreds and occasionally thousands, and each lot normally followed a single design."[28]

The interchange of freight cars became more popular after the Civil War, but gauge differentials hampered its efficiency. According to White (1993): "Even when railroads were ready to exchange cars and local governments did not block the way, the American railroad industry was crippled by the self-inflicted obstacle of gauge differences." Getting around gauge differentials with engineering expedients was either hazardous or expensive. Laying a third rail to permit dual-gauge operations was costly—the additional rail, extra-long ties and special switches were all expensive items. Operation of mixed-gauge freight cars was "surely awkward since nothing really matched or coupled easily."[29] Exchanging the trucks of different gauge cars using car hoists, commonly used in the South, was an expensive remedy for gauge differentials. The hoists cost $3,000 in 1870 while a flatcar cost only $500. Switching cars from one set of trucks to another was a lengthy process and the orphan trucks had to be stored for weeks awaiting the return of the loaner body. There was no alternative to using cars with the correct gauge. While individual freight cars were cheap, ranging from $500 for wood-frame flatcar up to $1,000 for a steel-frame hopper, assembling an average fleet of more than 2,200 freight cars was a major investment. Even if the cost of changing the gauge of a single freight car was relatively low, the fleet scale made this process expensive and long.

References

Alderson, M., and B. Betker. 1995. Liquidation Costs and Capital Structure. *Journal of Financial Economics* 39:45–69.

Attack, J., and P. Passell. 1994. *A New Economic View of American History*, 2nd ed. New York: W. W. Norton & Company.

Baird, D. G., and R. K. Rasmussen. 2002. The End of Bankruptcy. *Stanford Law Review* 55:751–89.

Barclay, M. J. and C. W. Smith Jr. 1995. The Maturity Structure of Corporate Debt. *Journal of Finance* 50:609–31.

Benmelech, E. 2005. Essays on Debt Maturity. Ph.D. thesis, University of Chicago.

Benmelech, E., M. J. Garmaise, and T. J. Moskowitz. 2005. Do Liquidation Values Affect Financial Contracts? Evidence from Commercial Loan Contracts and Zoning Regulation. *Quarterly Journal of Economics* 120:1121–54.

Berglöf, E. and E. Von Thadden. 1994. Short-Term Versus Long-Term Interests: Capital Structure with Multiple Investors. *Quarterly Journal of Economics* 109:1055–84.

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[27] Chicago St. Louis and New Orleans RR Co. (Papers accompanying Board meetings 1877–1950), The Illinois Central Archive, Newberry Library Chicago.

[28] White (1993).

[29] White (1993).

Brown, J. K. 2001. *The Baldwin Locomotive Works, 1831–1915*. Baltimore, MD: Johns Hopkins University Press.

Carosso, V. P. 1987. *The Morgans: Private International Bankers, 1854–1913*. Cambridge, MA: Harvard University Press.

Colorado Railroad Museum. 1980. *Locomotives of the Rio Grande*. Boulder, CO: Johnson Publishing Company.

Fluck, Z. 1999. Capital Structure Decisions in Small and Large Firms: A Life-cycle Theory of Financing. Working Paper, Stern School of Business, New York University.

Fogel, R. W. 1964. *Railroads and American Economic Growth: Essays in Econometric History.* Baltimore, MD: Johns Hopkins University Press.

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

Gilson, S. C. 1997. Transactions Costs and Capital Structure Choice: Evidence from Financially Distressed Firms. *Journal of Finance* 52:161–96.

Guedes, J., and T. Opler. 1996. The Determinants of the Maturity of Corporate Debt Issues. *Journal of Finance* 51:1809–33.

Harris, M., and A. Raviv. 1990. Capital Structure and the Informational Role of Debt. *Journal of Finance* 45:321–49.

Harris, M., and A. Raviv. 1991. The Theory of Capital Structure. *Journal of Finance* 46:297–355.

Hart, O., and J. Moore. 1994. A Theory of Debt Based on the Inalienability of Human Capital. *Quarterly Journal of Economics* 109:841–79.

Hilton, W. G. 1990. *American Narrow Gauge Railroads*. Stanford, CA: Stanford University Press.

Jensen, M. C. 1986. Agency Costs of Free Cash Flow, Corporate Finance and Takeovers. *American Economic Review* 76:323–39.

Klein, M. 1993. *Unfinished Business: The Railroad in American Life*. Hanover, NH: University Press of New England.

Klein, B., R. A. Crawford, and A. A. Alchian. 1978. Vertical Integration, Appropriable Rents, and the Competitive Contracting Process. *Journal of Law and Economics* 21:297–326.

LoPucky, L. M., and W. C. Whitford. 1990. Bargaining over Equity's Share in the Bankruptcy Reorganization of Large, Publicly Held Companies. *University of Pennsylvania Law Review* 139:125–96.

MacKay, P. 2003. Real Flexibility and Financial Structure: An Empirical Analysis. *Review of Financial Studies* 16:1131–65.

Morellec, E. 2001. Asset Liquidity, Capital Structure, and Secured Debt. *Journal of Financial Economics* 61:173–206.

Myers, S. C. 1977. Determinants of Corporate Borrowing. *Journal of Financial Economics* 5:147–75.

Myers, S. C., and N. S. Majluf, 1984. Corporate Financing and Investment Decisions When Firms Have Information the Investors Do Not Have. *Journal of Financial Economics* 13:187–221.

Myers, S. C., and R. G. Rajan. 1998. The Paradox of Liquidity. *Quarterly Journal of Economics* 113:733–71.

Poor's Railroad Manual Company. 1868, 1869, 1873, 1874, 1877, 1878, 1882, 1883. *Poor's Manual of the Railroads*. New York: Poor's Railroad Manual Co.

Poterba, J. M. 1988. Comment: Financing Constraints and Corporate Investment. *Brookings Papers on Economic Activity* 1:200–06.

Puffert, D. J. 2001. Path Dependence in Spatial Networks: The Standardization of Railway Track Gauge. Working Paper, University of Munich.

Rajan, R. G., and L. Zingales. 1995. What Do We Know About Capital Structure? Some Evidence from International Data. *Journal of Finance* 50:1421–60.

Rajan, R. G., and L. Zingales. 1998. Financial Dependence and Growth. *American Economic Review* 88:559–86.

Shleifer, A., and R. W. Vishny. 1992. Liquidation Values and Debt Capacity: A Market Equilibrium Approach. *Journal of Finance* 47:143–66.

Stohs, M. H., and D. C. Mauer. 1996. The Determinants of Corporate Debt Maturity Structure. *Journal of Business* 69:279–312.

Stover, J. F. 1961. *American Railroads.* Chicago, IL: The University of Chicago Press.

Swain, H. H. 1898. Economic Aspects of Railroads Receiverships. *Proceedings of the American Economic Association* 3:53–161.

Taylor, G. R., and I. D. Neu. 2003. *The American Railroad Network, 1861–1890*. Chicago, IL.: University of Illinois Press.

Titman, S., and R. Wessels. 1988. The Determinants of Capital Structure Choice. *Journal of Finance* 43:1–19.

White, J. H., Jr. 1993. *The American Railroad Freight Car*. Baltimore, MD: Johns Hopkins University Press.

Williamson, O. E. 1983. Credible Commitment: Using Hostages to Support Exchange. *American Economic Review* 73:519–40.

Williamson, O. E. 1988. Corporate Finance and Corporate Governance. *Journal of Finance* 43:567–91.

Wilner, F. N. 1997. *Railroad Mergers: History, Analysis, Insight*. Omaha, NE: Simmons-Boardman Books.