*Railroads and American Economic Growth**

In his classic paper[1] on the significance of railroads to American economic development, Leland Jenks distinguished three principal avenues of influence: (1) The railroad was what Jenks called an "innovating idea" with important psychological impact "manifested in a wave-like profusion of new enterprise of many sorts." (2) The railroad and railway construction and maintenance were a stimulus to the industrial and financial sectors of the economy. The railroad not only stimulated the iron and steel, timber, and other industries directly but "encouraged innovations in financial enterprise." (3) Finally, the railroad contributed directly to the generation of national income through the rendering of transportation services. Although on this last point Jenks despaired that, "There appears to be no satisfactory technique for giving a precise measure to the extent of this contribution."

In a new study,[2] however, Robert Fogel rejects as incurably imprecise and romantic the legends that have grown up about the nature and significance of the railroad's contribution to U. S. economic growth in the last half of the nineteenth century. His purpose in the volume here reviewed is to evaluate critically the proposition that railroads were indispensable to American economic growth in the nineteenth century. In addition, his substantive discussion serves as a vehicle for the exposition of certain principles of the "new economic history," a plea for more extensive use of quantitative and theoretical, even "econometric," tools in the study of the economic past. Fogel's work, both substantive and methodological, has its harbingers; but difficult as it may be to believe from the general economist's standpoint, few economic historians have yet made such systematic use of theory and statistics in their attempts to account for past economic growth and change. An econometrician reading this book may be shocked, as I was, at how limited indeed are the uses of econometric technique and how simple minded are those tools actually used. Yet none can deny the fecundity of and advances made possible by even such minimal sophistication. Fogel may have degraded the importance of railroads to American economic growth, but he has surely shown the high productivity at the margin of quantitative and theoretical tools in economic historiography.

Fogel examines the contribution of railroads to U. S. economic growth

* The reviewer is indebted to his colleagues William Parker, Edmund Phelps, and James Tobin for helpful discussion; they are not, however, responsible for the opinions expressed.

[1] L. H. Jenks, "Railroad as an Economic Force in American Development," JOURNAL OF ECONOMIC HISTORY, IV, No. 1 (May 1944), 1-20; reprinted in F. C. Lane and J. C. Riemersma, eds., *Enterprise and Secular Change* (Homewood, Ill.: Richard D. Irwin, 1953), 161-80.

[2] Robert William Fogel, *Railroads and American Economic Growth: Essays in Econometric History* (Baltimore: The Johns Hopkins Press, 1964). Pp. xv, 296. $6.95.

from two main points of view: their direct contribution to income through the provision of transport services, both interregionally and locally; and their indirect contribution to development through stimulation of industries such as iron and steel, coal, and lumber. Fogel's detailed examination of the evidence of direct contribution refers primarily to the transport of agricultural products, but he also makes crude estimates of the overall direct contribution including the transport of manufactured goods and nonagricultural raw materials. His study of the indirect effects of railroad development consists of, first, an examination of the structural change occurring before and during the growth of railroads in major industries having some connection and, second, a detailed investigation of the impact of the railroads on the American iron industry during the period 1840-1860. Fogel does not deal with the railroad as an "innovating idea," with its role in supplying entrepreneurs, or with its impact on financial and other institutions of the American economy in the nineteenth century. Some such influences he would perhaps reject as intrinsically unverifiable, while others he would no doubt agree are worthy subjects for future investigation.

Measurement of the contribution of railroads to national income through the provision of transportation services is divided into three parts. In each case, Fogel asks how much lower GNP would have been without the railroads than it was with them; Fogel calls this the "social saving" attributable to the operation of the railroads. He then computes this social saving in one year, 1890, as follows: in Chapter II, for long-haul traffic (interregional) in a relatively small number of agricultural commodities; in Chapter III, for short-haul shipments (intraregional) of a wider variety of agricultural products; and in Chapter IV, for other types of goods in an admittedly very rough, almost off-the-cuff fashion (pp. 219-24).

It has been recognized for some time that the social saving attributable to the railroads in long-haul traffic was relatively small. Jenks wrote, for example:

> There is no convincing evidence . . . that railroads have ever carried freight at lower costs either to shippers or to society than canals or waterways. The advantages that early railways showed over canals, such as speed, flexibility of service, and special adaptability to short hauls, are analogous to those of modern highway transport over the railroad.[3]

It is Fogel's contribution to measure not only the social cost of doing without railroads in short-haul distribution but also the costs, other than those purely for shipping, associated with canal transportation in interregional traffic and to show that the saving due to railroads was still quite small.

In the measurement of direct savings in transport cost, Fogel appears to promise—methodologically speaking—a bit more than he delivers.

[3] Jenks, in Lane and Riemersma, pp. 172-73.

This would be unimportant since the magnitude of the social saving involved is quite small (indeed negative!) were it not for Fogel's methodological emphasis. Given the amounts of four major agricultural commodities to be moved interregionally from primary markets in the Midwest to more numerous secondary markets in the East and South, we are required to compute the cost of transportation for the bundle that did move in 1890 largely by rail assuming that it had moved (optimally) from essentially the same sources to the same destinations by water. It is clear, as Fogel points out, that this difference in costs overstates the social savings in transport costs resulting from the railroads because it does not allow adaptation of the location of primary markets to the absence of railroads; since Fogel's purpose is to show the unimportance of railroads, it is clear that an overstatement is immaterial. Indeed Fogel suggests introducing yet another element of overstatement by supposing that, since actual paths of shipment from primary to secondary markets are unknown, they be supposed optimal as well.

How then to solve the problem of measuring the cost difference between the minimum-cost routing in 1890 with railroads and without them? Fogel ingeniously proposes the use of linear programming techniques and waxes eloquent:

> It is possible to bridge the gap in statistics because of a relatively new mathematical technique—linear programming—which permits one to arrive at the desired solution at a cheaper cost in terms of data requirements. It seems likely, incidentally, that in other cases as well as this one mathematical techniques of analysis can reduce the amount of information required to evaluate a given hypothesis. This characteristic of mathematical technique is, by itself, a forceful argument for increasing efforts to apply mathematical analysis to historical problems.[4]

And later,

> The determination of the saving in cost attributable to railroads involves the use of linear programming and other techniques of even more recent origin. On questions of this nature, a search for the estimates of authorities of the nineteenth century has little more value than a similar search for estimates of the atomic weight of elements in the eighteenth-century literature of chemistry.[5]

The reader may search in vain for this linear programming calculation, the application of which leads Fogel to such flights of methodological generalization; he will not find it. He may notice a small sentence to the effect that Fogel too knows it is not there (p. 26), but he may wonder how, in any event, a *non*application of some technique justifies its advocacy in such emphatic terms.

This is not to say, however, that there is anything wrong with what Fogel actually does, which is to compute the average transit distances by both water and rail then multiply by the appropriate average ton-mile

[4] Fogel, p. 26.
[5] *Ibid.*, pp. 244-45.

rate, and finally, using an estimate of the quantities carried by water despite the availability of rail transport, to compute a cost difference. The difference turns out to be negative, suggesting that on the basis of transport costs alone railroads actually subtracted from the national product. Fogel, however, argues that certain additional costs are neglected: cargo losses in transit, transshipment costs, wagon haulage costs from water points to secondary markets not on waterways, capital costs not reflected in water rates, the cost resulting from time lost when using a slow medium of transportation, and the cost of being unable to use water routes for five months out of the year. His estimates of such additional costs in 1890 are both ingenious and convincing, but, when all is said and done, the social saving due to railroads (now positive) amounts to only six tenths of 1 per cent, thus tending to confirm earlier workers' belief (see the quotation from Jenks above) that the real advantage of railroads lay in short-haul transportation.

The estimation of the social savings due to intraregional transport of commodities by rail is considerably more difficult. Not only did many more commodities enter into intraregional trade, but, due to the high cost of wagon transport, the area of feasible commercial agriculture would have been drastically reduced by the elimination of all railroads. (Fogel shows rather convincingly that in the absence of railroads additional canals would probably have been built, especially in the Midwest, which would have recovered nearly all the land that would have gone out of cultivation on the disappearance of the railroads.) Fogel estimates the loss in national income in two stages: First, he obtains an estimate of the boundary of commercial agriculture in the absence of railroads by using data on land values. He then obtains the social cost by adding the additional cost of shipping agricultural products by wagon rather than rail *within* the new region of feasible commercial agriculture to the loss in national income due to the decrease in agricultural land. This last Fogel measures by multiplying an estimate of the capital value of the land by a mortgage rate of interest. The procedure, as he remarks, contains both upward and downward biases as far as the estimation of social loss is concerned. It is not clear, however, that, "These, of course, tend to cancel."[6] Fogel's initial estimate of the social loss on short-haul account is 2.1 per cent of GNP. However, allowing for roughly 5,000 miles of additional canals, primarily in the Middle West, and some improvement to the roads, all but 7 per cent of the agricultural land in the area lost would be brought to within forty miles of a navigable waterway and hence, according to Fogel's calculation, back within the area of feasible commercial agriculture. Thus, the loss without railroads is reduced to a range of from 1.5 to 1.8 per cent of GNP. Further improvements in the roads could have reduced the loss still further to 1 to 1.2 per cent of GNP.

The aggregate social saving attributable to railroad transportation of agricultural commodities is thus estimated by Fogel to be in the neighborhood of 2 per cent of GNP, perhaps 3 per cent if no additional canal

[6] *Ibid.*, p. 55.

construction were permitted. Of course, not all the contribution of railroads to national income was made in the form of transportation of agricultural commodities, and before definitive conclusions can be reached on the primary contribution of railroads some computation of the social saving on nonagricultural items must be made. Fogel does not make detailed estimates, but he argues that the additional saving cannot have amounted to more than 1 or 2 per cent of GNP. In total, then, Fogel estimates the social saving due directly to the transportation services supplied by railroads cannot have amounted to more than 4 to 5 per cent of GNP. Below, I shall examine the question as to whether this is a small or a large number.

In chapters IV and V, Fogel studies the indirect effects of railroads and railroad construction and maintenance on the structure of the economy and on the iron industry in particular. Through their demand for coal, iron, machinery, and other manufactured goods railroads are supposed to have induced a radical change in the structure of the American economy in the years 1843-1860, according to Rostow, and thus to have ushered in "the take-off into self-sustained growth." Fogel attempts to explode this thesis, first, by showing that the radical changes supposedly induced by railway development were well under way prior to 1843, and, second, that a detailed examination of the U. S. iron industry suggests: "The strongest statement that can be made . . . is that the demand for railroad iron played an increasingly important role during the fifties in maintaining the previous *level* of production when the demand for other items sagged."[7] Fogel's support of this last proposition involves estimation of rail consumption by means of a model explaining rail replacement, demand for new rails, and the contribution of scrappage to the total supply of crude iron. Although it is rough by strict econometric standards (involving as it does only a small number of identities, a simple trend relationship, and a couple of autoregressions) the model is apparently highly effective in combining a number of otherwise isolated data fragments.

Fogel does not discuss the role which railroads may have played in the development of financial institutions in the U. S. or in the attraction of foreign capital which might otherwise have been unavailable, and in general his discussion of the indirect effects is less satisfying than his chapters on the direct effects. Perhaps the nature of the problem is more subtle and difficult.

The direct effects due to railroads are estimated at not more than 4 to 5 per cent of GNP in 1890, a year of peak railroad efficiency. Fogel seems to take it for granted that this is quite a small number. Yet, in 1890, GNP was roughly 12.7 billion in current dollars (1890). Four to five per cent amounts to some 500 to 600 million.[8] Considering the change in price

[7] *Ibid.*, p. 233.

[8] Average of Kuznets' figures for 1887-91 and 1889-93, U. S. Bureau of the Census, *Historical Statistics of the United States* (Washington. GPO, 1960), p. 139. The figure would be somewhat higher if the Department of Commerce concept were used.

level this hardly seems a trivial amount; indeed, 4 to 5 per cent to today's GNP would be over 30 billion. Fogel's tacit acceptance of the triviality of the saving due to railroads is just the sort of half-conscious quantification of which he accuses the traditional economic historians. To decide whether the social saving due to railroads is small or large it seems necessary to compare this saving with some other magnitude; size is after all a relative thing—as is triviality. Yet choice of an appropriate yardstick is no simple matter; compared with, say, sewing machines, railroads were surely highly significant. To obtain an assessment of the relative contribution of railroads to economic growth free of the effects of arbitrary industrial classifications and the like, it seems to me necessary to rephrase the question. Instead of asking whether the contribution of railroads to American economic growth was great or small *in toto* and absolutely, we should ask whether it was great or small at the margin and relatively. That is to say, we should ask whether the marginal social return (gross or net) to capital invested in the railroads was greater, equal, or less as compared to the marginal social return on other forms of investment. If it were greater we could conclude that growth would have been greater had more capital been invested in railroads and less in other types of enterprise; if less, the converse. One might argue, I suppose, that the reformulation of the question in this way takes us away from the "importance" of the railroads. If "importance" is measured only in absolute terms, however, I would suggest the question is meaningless. Can one assess the absolute "importance" of water? Perhaps one of the greatest contributions of economic thought has been to show that the "importance" or the "value" of something is best and most meaningfully measured at the margin. In some sense, then, one can only measure the functioning of the capital market in the allocation of resources and the potential effects on growth of overinvestment in the most romantic of enterprises.

Unfortunately, the marginal social rate of return on capital, either in the economy as a whole or in a particular industry, is not so easy to measure despite Solow's pathbreaking work.[9] In a model in which there is embodied technological change, Solow argues that the social rate of return on investment is equal to the marginal product of effective capital minus an allowance for depreciation and obsolescence.[10] Thus, to assess the contribution of railroads at the margin to American economic growth in the nineteenth century would require measurements of the marginal products of capital in the economy as a whole and in railway transportation, and estimates of depreciation and technical change for both as well. To do so in any but the crudest fashion would require explorations in "econometric history" far beyond even Fogel's extensive investigations. Nonetheless it may be possible to get a very rough idea of the magnitudes involved on the basis of available evidence.

[9] R. M. Solow, *Capital Theory and the Rate of Return* (Amsterdam: North-Holland Publishing Co., 1964).

[10] *Ibid.*, pp. 56-65.

To begin, assume that a Cobb-Douglas production function is an appropriate approximation for both the economy as a whole and for railroads. The gross marginal productivity of capital is obtained for this function by multiplying the elasticity of output with respect to capital by the ratio of output to capital input. If there is embodied technological change occurring, measured capital stock will not be the appropriate magnitude but will require some adjustment for age. Without knowledge of the rate of technological advance, however, it is not possible to make the appropriate adjustment; this aspect must, perforce, be neglected. A higher rate of technological advance in railroad transportation than in the rest of the economy would, assuming a roughly similar age distribution of capital, reduce the effective stock of capital invested in railroads relative to the measured stock in 1890 by a greater amount than for invested capital in the rest of the economy and, hence, would tend to increase the output-to-effective-capital ratio and raise the implied rate of return. However, the correct elasticity of output with respect to capital input would also be reduced, so that the net effect on the measured marginal gross productivity of capital could be slight—and would be, if recent experience is any guide. Furthermore, taking rates of return net of obsolescence would reduce the rate of return in railroads relative to the rest of the economy. If depreciation were greater for railroads than for other capital, an overstatement of the relative rate of return in railroading would result from a comparison of gross marginal rates of return. Both more rapid technological change and higher depreciation rates may be plausible for capital invested in railroads, but it should be recognized that with a reversal the estimates presented below will no longer represent an overstatement of the relative rate in railroads as compared with the rest of the economy.

Ulmer gives a considerable variety of figures on capital stock.[11] To use any such stock figures in the estimation of rates of return we should be able to assume comparable rates of capital utilization in railroads and in the rest of the economy. By most accounts 1890 was a relatively prosperous year despite the brief contraction from July, 1890, through May, 1891.[12] If anything, we might expect such underutilization as may have occurred to be greater in the rest of the economy than in railroads, so that use of stock figures would tend to result in an understatement of the overall rate of return relative to the rate of return on capital in railroads. According to Ulmer's calculations, the value of road and equipment, including structures but not land, in current (1890) dollars was some 5.83 billion dollars.[13] Book values were considerably in excess of

[11] M. J. Ulmer, *Capital Formation in Transportation, Communications, and Public Utilities: Its Formation and Financing* (Princeton, N. J.: Princeton University Press, 1960).

[12] G. H. Moore, "Statistical Indicators of Cyclical Revivals and Recessions," in G. H. Moore, ed., *Business Cycle Indicators*, I (Princeton, N. J.: Princeton University Press, 1961), 198; M. Friedman and A. Schwartz, *A Monetary History of the United States* (Princeton, N. J.: Princeton University Press, 1963), pp. 104-5.

[13] Ulmer, p. 256.

this figure; and estimated reproduction cost excluding land and land rights, which might be thought would give a fair indication of service flows, was in the order of 7.5 billion in current dollars.[14] We use both figures in the calculation below. Using Fogel's estimate that the direct contribution of railroads to national income through the provision of transportation services was not over 600 million in 1890, we find that the average social rate of return to capital gross of depreciation and obsolescence was in the neighborhood of 8.0 to 10.3 per cent. To arrive at a gross marginal rate, assuming a Cobb-Douglas production function, we must multiply the gross average rate by the elasticity of the amount of railway transportation services with respect to capital input in 1890.

While no estimate of the elasticity exists for 1890, Klein has estimated a comparable parameter for a cross section of railroads in 1936.[15] He uses train-hours as a measure of the flow of capital services and relates this to a composite index of passenger and freight transportation with weights determined by the statistical analysis. The elasticity Klein obtains is 0.28. Combining this figure with those presented above, we find the gross marginal social rate of return on capital invested in railroads implied by Fogel's calculation to be only on the order of 2 to 3 per cent. This is lower than the then-current yield of 4.5 per cent on long-term railroad bonds,[16] and it seems even more out of line with other rates, even considering the possible extra risk involved; for example, prime commercial paper in New York and Boston, about 5 per cent, or mortgage rates in 1889 ranging from nearly 6 per cent in the North Atlantic region to over 9 per cent in the western region.[17] Of course, the calculation above is very rough, but even a doubling of the assumed elasticity of output with respect to capital input in the railroad industry of 1890 would still not lead to an implied gross marginal rate of return much in excess of 6 per cent.

The question of what the gross marginal social rate of return was in 1890 on capital invested in other sectors is more difficult to answer. Even less confidence should be placed in the figure obtained below than in the rate for railroads (if that is possible). As indicated earlier, GNP ran roughly 12.7 billion in current (1890) prices. Reproducible tangible assets (excluding land) amounted to some 46.1 billion in 1890 current prices.[18] However, given the size of the agricultural sector in 1890, it cannot be supposed that land did not play an important role in production; furthermore, we shall find it difficult to get an idea of the elasticity of output with respect to inputs of tangible capital alone; hence, some adjustment ought to be made for the value of the land. Since land represented some 35 per cent of national wealth in 1900, a rough estimate of the total national wealth in 1890, including land, would be some 70 billion in

[14] *Ibid.*, p. 288.

[15] L. R. Klein, *A Textbook of Econometrics* (Evanston, Ill.: Row, Peterson, 1953), p. 234.

[16] *Historical Statistics*, p. 656. No doubt some allowance must be made for default.

[17] Fogel, p. 82.

[18] *Historical Statistics*, p. 151.

current prices.[19] This yields an estimate of 18 per cent for the gross average rate of return on capital, including investment in land, in 1890—that is, about double the gross average rate on investments in railroads implied by Fogel's calculation. To obtain the marginal gross social rate of return on capital, assuming a Cobb-Douglas function, the average rate must be multiplied by the elasticity of output with respect to capital input. Valavanis-Vail, using overlapping decade averages on gross real output, employment, and capital stock, has estimated a value of 0.70 for this elasticity which would imply a marginal rate of 12.7 per cent.[20] However, an elasticity of 0.35 is more in line with current estimates for much more recent periods. An acceptable compromise might be to use capital's share in 1890 as an estimate of the elasticity since, with a Cobb-Douglas function and approximately competitive conditions, the share does tend to be the elasticity. According to Budd, labor's share was 48.4 per cent in 1889-1890, leaving 51.6 per cent for capital and land.[21] Using this figure we obtain a marginal social rate of return to capital of 9.3 per cent, or *three times* our estimate of the gross marginal social returns to capital investment in railroads.[22]

Thus Fogel's calculation of the difference between GNP in 1890 with the railroads and what it probably would have been without them suggests a gross marginal social rate of return to investment so low as to imply that the nation would have literally grown faster and been better off had it relied on wagons and canals and invested the billions it did invest in railroads in other forms of enterprise. While the thread of evidence is certainly too slender to support a *reductio ad absurdum*, it does make one wonder whether the capital markets of that era were so imperfect as to permit such serious misallocation to develop or whether, in fact, Fogel's calculations, convincing as they are, may understate the contribution of the railroads to American economic growth. Alternatively, shaky as they undoubtedly are, one might argue that the calculations presented here dramatically confirm Fogel's conclusion.

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[19] *Ibid.*

[20] S. Valavanis-Vail, "An Econometric Model of Growth: U. S. A. 1869-1953," *American Economic Review*, XLV (May 1955), 208-21.

[21] E. C. Budd, "Factor Shares, 1850-1910," in *Trends in the American Economy in the Nineteenth Century* (Princeton, N. J.: Princeton University Press for the NBER, 1960), p. 382.

[22] Solow, p. 92, obtains a *net* rate of 18 per cent in the United States in 1954. I do not at this time see any explanation of why the rate of return should be so much lower in 1890. However, use of a higher rate would, of course, only widen the distance between the overall rate of return on capital and the specific rate of return to capital invested in railroads.