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Indispensable Railroads in a Backward Economy: The Case of Mexico

JOHN H. COATSWORTH

This article assesses the impact of railroads in nineteenth-century Mexico. Social savings estimates are constructed to measure direct benefits: passenger savings were negligible, but freight savings and indirect benefits were large enough to account for more than half of the increase in the productivity of the economy prior to 1910. On the other hand, railroad savings went mainly to stimulate the export sector, backward linkages to Mexican industry failed to develop, foreign exchange costs were high, and the effects on land tenure, social structure, and institutions were negative. Railroads promoted both growth and underdevelopment.

THE contribution of railroads to economic growth in the nineteenth century depended on two critical variables: unit savings in transport costs the railroads made possible and the quantity of passengers and freight the railroads attracted. Unit savings depended mainly on geography; either cheap water transport existed before the railroads or it did not. Unit savings depended secondarily on the value of the time the railroads saved and on the flexibility in selection of routes made possible by the new technology. The quantities of passengers and freight actually transported depended on two interrelated factors: the prior development of the economy and its responsiveness to cheaper transport.

Most of the recent studies of railroad development have found that unit savings were small because waterways made transportation cheap before the railroads were built.¹ Savings due to greater speed and flexibility in

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¹ Robert William Fogel, *Railroads and American Economic Growth: Essays in Econometric History* (Baltimore, 1964); Albert Fishlow, *Railroads and the Transformation of the Antebellum Economy* (Cambridge, Mass., 1965); Gary Hawke, *Railways and Economic Growth in England and Wales, 1840-1870* (London, 1970); Wray Vamplew, "Railways and the Transformation of the Scottish Economy," *Economic History Review*, 2nd ser., 24 (Feb. 1971), 37-54; William Paul McGreevey, *Economic History of Colombia, 1845-1930* (Cambridge, 1971), chap. 10; Jacob Metzger, *Some Economic Aspects of Railroad Development in Tsarist Russia* (Ph.D. diss., Univ. of Chicago, 1972). Somewhat higher savings were reported by John Hurd III, "The Economic Impact of Railways in India, 1853-1947" (paper presented to the Economic History Workshop, Univ. of Chicago, Feb. 1976), p. 4. The existence of cheap water transport prior to railroad construction does not, of course, prevent savings from rising dramatically where railroads are constructed *instead* of canals or where potentially navigable rivers are left undredged. This was the point of the dispute between Fogel and Fishlow in the U.S. case. Jeffrey Williamson has argued recently that both authors have failed to measure fully the railroads' impact on the U.S. economy between 1870 and 1890 by ignoring certain indirect effects (like the im-

routing constituted the railroads' main advantage over rivers and canals in the United States and Britain, the two most studied cases. The quantities of passengers and freight transported were large because these economies possessed highly mobile populations and produced large amounts of transportable goods long before the construction of railroads. Relatively small unit savings flashed signals to a multitude of unhindered individuals and entrepreneurs.

The case of Mexico in the Porfirian era (1877–1910), which may be taken as representative of railroad development in economically backward and geographically fragmented countries, contrasts sharply with the experience of the more developed areas. Unit savings on *passenger* travel were small, despite the railroads' speed and accessibility, because low wages made time less valuable. Mexicans did ride the trains, but not because they were much cheaper than walking. Unit savings on *freight* operations, however, were enormous. The volume of transportables produced was not large at first, but local entrepreneurs and foreign capitalists proved highly responsive. Modern mining and agricultural export industries boomed. The result was economic growth, but growth different from that in the industrializing nations.

In Mexico forward linkages were concentrated in the export sector, backward linkages were few, foreign-exchange costs involved in financing and operation were high, positive institutional consequences were small, and retrograde social forces achieved a new mandate to rule the country. Mexico did not develop; it "underdeveloped."

In 1837 the Mexican government issued its first concession for railroad construction to a private contractor who proposed to build a single track from the port city of Veracruz over the mountains to Mexico City. After thirty years of civil and international war, the nation's first major railroad line was finally inaugurated in 1873. Not until 1880, however, did the government succeed in attracting sufficient private capital to launch any major new projects. In that year, new concessions were issued for a number of routes including the two main trunk lines from Mexico City to the northern border. Since diplomatic relations with England, France, and Spain remained suspended until Mexico renegotiated its external debt in the mid-1880s, most of the private capital for the nation's first railroad boom came from the United States. In the 1890s, European companies

pact on regional terms of trade and the spatial distribution of economic activity), and by omitting consideration of possible dynamic linkages between railroads and such variables as the rate of capital formation. See Jeffrey Williamson, *Late Nineteenth-Century American Development: A General Equilibrium History* (Cambridge, 1974), chap. 9. Colin M. White has presented an excellent review of the debate and added to it with references to his own work on nineteenth-century Russian railways in "The Concept of Social Saving in Theory and Practice," *Economic History Review*, 2nd ser., 29 (Feb. 1976), 82–101. See also Patrick O'Brien, *The New Economic History of the Railways* (New York, 1977). The last word to date, and on most issues, is Fogel, "Notes on the Social Saving Controversy," his Presidential Address to The Economic History Association, in this JOURNAL, 39 (March 1979), 1–54.

joined the boom. The Mexican government provided subsidies that covered roughly one third of the construction costs. From 893 kilometers of track at the end of 1879, Mexico's rail system expanded to 19,205 kilometers by 1910.²

Major portions of the country remained outside the rail network in 1910. Baja California and the Southern Pacific Coast region lacked railroads entirely. The railway system on the Yucatan peninsula was not yet linked to the rest of the national system. Only one isolated line across the isthmus of Tehuantepec linked the Atlantic and Pacific coasts directly. On the other hand, railroads covered a far larger area of Mexico than the railroads of most backward regions. They were not confined, as in most of South and Central America, to linking mines and plantations to ports. Mexico's mineral and agricultural resources were so scattered that a physically isolated export enclave never formed.³ (See map, Figure 1.)

The private, usually foreign companies that owned most of Mexico's railways by the turn of the century did not report high profits. The Mexican government refused to guarantee profit margins or contribute to operating costs, unlike a number of other Latin American countries. By 1902, however, the government feared a wave of railroad bankruptcies which would subvert the nation's hard won image as a friend to foreign investors. Finance Minister Jose Yves Limantour cited this danger, and the further prospect that the failing companies might fall into the hands of unscrupulous foreign financiers, in requesting authority from the Congress to purchase controlling shares in a number of the major lines. By 1908, the government controlled or owned outright two thirds of the nation's rail system, and had formed a new corporation, the National Railways of Mexico, to unify management and operations.⁴

Mexico's railroad development reached a peak in 1910. The fall of the Diaz dictatorship in 1911 and the revolutionary turmoil that ensued put an end to railroad construction and caused considerable damage to tracks,

² John Gresham Chapman, *La construcción del Ferrocarril Mexicano (1837-1880)* (Mexico, 1975); Francisco Calderón, *La República restaurada: La vida económica*, in the series edited by Daniel Cosío Villegas, *Historia moderna de México* (Mexico, 1955), Part 3; Francisco Calderón, "Los ferrocarriles," in Daniel Cosío Villegas, ed., *Historia moderna de México: el Porfiriato: la vida económica*, 2 vols. (Mexico, 1965), vol. 1, pp. 483-684; David Pletcher, "The Building of the Mexican Railway," *Hispanic American Historical Review*, 30 (Feb. 1950), 26-62.

³ Sergio Ortiz Hernán Lozano, *Los ferrocarriles de México: una visión social y económica* (Mexico, 1970), chaps. 2-3; Frederic M. Halsey, *The Railways of Central and South America: A Manual Containing Statistics and Other Information Concerning the Important Railways of South and Central America, Mexico and the West Indies* (New York, 1914). For a sharp contrast, see Rory Miller, "Railways and Economic Development in Central Peru, 1890-1930," in Rory Miller, Clifford T. Smith, and John Fisher, eds., *Social and Economic Change in Modern Peru* (Liverpool: Centre for Latin American Studies, University of Liverpool Monograph Series No. 6, n.d.), pp. 27-52. Only Argentina and Brazil had comparably large railroad networks by 1910, and only the Argentine system extended over as large a portion of the national territory as that of Mexico.

⁴ Secretaría de Hacienda, *Informe presentado al Presidente de la República por el Secretario de Hacienda y Crédito Público sobre los estudios y gestiones de la Secretaría de su cargo en asuntos de ferrocarriles* (Mexico, 1903); John H. McNeely, *The Railways of Mexico: A Study in Nationalization* (El Paso, Texas, 1964).

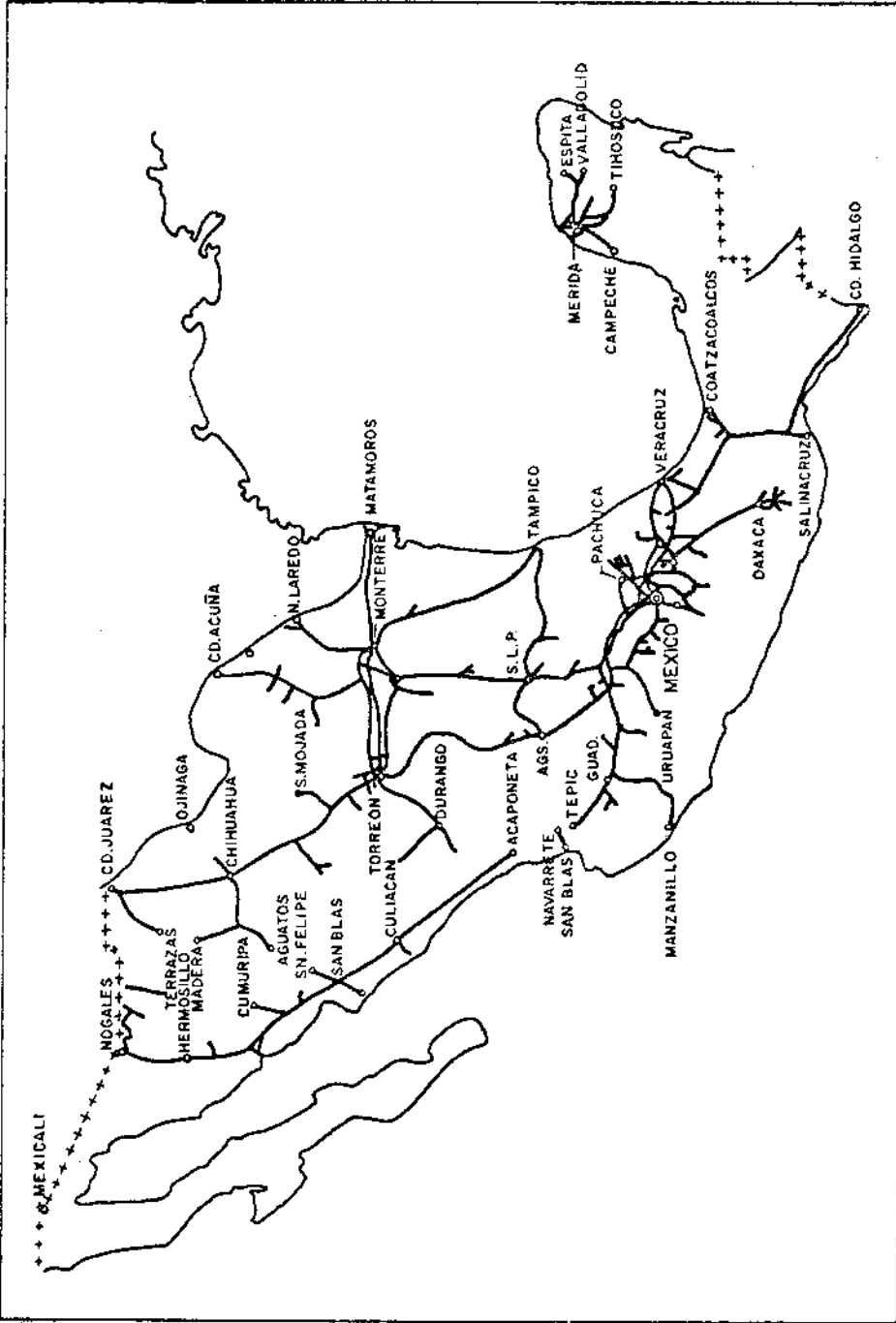


FIGURE 1
MEXICAN RAILROAD SYSTEM, 1910

Source: Sergio Ortíz Hernán Lozano, *Los ferrocarriles de México: una visión social y económica* (Mexico: Sria. de Comunicaciones y Transportes, 1970).

bridges, and rolling stock. By the time the economy began to recover in the 1920s, the railroad system had fallen into disrepair and faced competition from trucks and buses.

To measure the impact of railroads on Mexico's economy, this essay begins with the social savings approach. An upper bound estimate of social savings from passenger transport and a lower bound estimate of freight social savings for 1910 are presented in the next two sections. The third and fourth sections consider a range of economic effects not captured in the social savings estimates. The fifth section considers some institutional consequences. Finally, a concluding discussion raises some problems in assessing the net aggregate impact of the railroads.

PASSENGER SOCIAL SAVINGS

Consider, first, the savings on passenger traffic. In the cases where estimates for passengers have been constructed (the United States and England and Wales), they were found to be relatively large, amounting to between 31.1 and 65.7 percent of savings on freight.⁵ Railroads saved time, and, among *los anglo-sajones*, time was money. In low-wage regions, however, time was less valuable; hence, passenger savings in nineteenth-century Mexico were low relative to both freight benefits and national income.

Before the railroad travelers in Mexico could choose from an array of different conveyances. A few traveled by stagecoach (*diligencia*), but this service was available only on highways maintained by federal authorities. In 1877 one stretch of federal "highway" was reported too dangerous even for mules.⁶ A few went by litter (*litera*), carried between mules or by human porters, mainly in the tropics or down the highway from Mexico City to the port of Veracruz. Litters were slower and more expensive than the stagecoach, but they could bypass washouts and obstructions more easily and were widely believed less subject to holdups. Between luxury and poverty there was mounted travel on donkeys, mules, and horses. Most people, of course, walked.⁷

Reports of highway directors to the Ministry of Development (*Fomento*) between 1877 and 1882 show that, out of a total of more than 6

⁵ Fishlow, *Railroads*, pp. 90-93; J. Hayden Boyd and Gary M. Walton, "The Social Savings from Nineteenth-Century Rail Passenger Services," *Explorations in Economic History*, 2nd ser., 9 (Spring 1972), 237-40; Hawke, *Railways*, p. 188. Fishlow's estimate places passenger savings at 31.1 percent of freight benefits; Hawke's passenger estimates run between 38.4 and 65.7 percent of freight savings; while Boyd and Walton's passenger benefits amount to 38.1 percent of Fogel's freight savings for the same year.

⁶ Secretaría de Fomento, *Memoria presentada al Congreso de la Unión por el Secretario de Estado y del Despacho de Fomento, Colonización, Industria y Comercio de la República Mexicana, General Carlos Pacheco, corresponde a los años transcurridos de diciembre de 1877 a diciembre de 1882*, 4 vols. (Mexico, 1885), vol. 2, p. 605.

⁷ Fomento, *Memoria*, vol. 2, contains reports from all federal highway directors on road conditions, traffic, transport costs, etc.

million travelers counted at 37 checkpoints along 14 federal highways, 6.5 percent rode in coaches, 25.1 percent were mounted, and 68.4 percent were walking.⁸ Thirty years later, in 1910, the percentage of first-class passengers on Mexican railroads (29.0) approximated that of stagecoach and mounted travelers in the earlier period (31.6), while second-class passengers approximated the percentage of foot travelers.⁹ The data reveal a strong inverse correlation between the number of mounted and foot travelers, but no significant relation between coach passengers and either of the other groups. The significant trade-off, therefore, was between riding on the ubiquitous *burro* and walking. Donkeys moved no faster, and sometimes slower, than pedestrians. They required some upkeep but also carried freight. Travelers gained in comfort by using donkeys at little or no additional cost over walking. To estimate direct savings on passenger services, then, it is assumed that in the absence of railroads all first-class passengers would have switched to stagecoach and all second-class passengers would have walked.¹⁰

For first-class passengers, two cost differentials are estimated: the difference in fares and the difference in time costs. Stagecoach fares prior to the railroad averaged approximately 0.05 pesos per passenger kilometer, in current pesos of 1876.¹¹ The time cost of travel is more difficult to estimate. At the risk of anachronism, one can use recent studies on the value of time spent in air travel, which find that modern businessmen value their time at roughly twice the average hourly wage in industry.¹² Since

⁸ Calculated from *ibid.*, in John H. Coatsworth, "The Impact of Railroads on the Economic Development of Mexico, 1877-1910" (Ph.D. diss., Univ. of Wisconsin, 1972), pp. 75-78.

⁹ Calculated from annual reports of all Mexican railroad companies on file in the Archivo Histórico de la Secretaría de Comunicaciones y Transportes, Mexico City (hereafter cited as *AHSCT*, followed by file number).

¹⁰ Rail passenger fares, even for second-class travel, were quite high in relation to wages in Mexico (see below). Long-distance travel by commercial carrier probably increased more rapidly among upper-income earners than among the poor. It seems likely that some second-class passengers would have switched to stage travel as well as to riding if railroads had not existed. Since both mounted and stage travel were more costly than walking, the second-class savings estimate is exaggerated, because it assumes the least costly (and least comfortable) alternative for all second-class rail passengers. The first-class estimate is exaggerated because it assumes that stagecoach travel faced constant marginal costs over an enormous range of output.

¹¹ Stagecoach fares for fourteen major routes in 1876 are reported by Calderón, *La República restaurada*, pp. 604-06. The charge per passenger kilometer for each route was calculated on distances reported in Fomento, *Memoria*, vol. 2, *passim*. This charge varied between P\$ 0.033 and P\$ 0.083. The average for all routes was P\$ 0.061. Boyd and Walton cite stagecoach rates varying from U.S. \$0.05 to U.S. \$0.135 per passenger mile for various dates in the nineteenth century. They employ a rate of U.S. \$0.06 per mile for their 1890 estimate. At the 1890 exchange rate, this amounts to just over P\$ 0.07 and about the same in pesos of 1877. This is about P\$ 0.04 per passenger kilometer, or about 20 percent below Mexican stagecoach fares in the 1870s. Boyd and Walton, "The Social Savings," pp. 243-44.

¹² Contemporary air passengers on business trips valued their time at approximately twice the U.S. hourly wage in manufacturing, according to Reuben Gronau, *The Value of Time in Passenger Transportation: The Demand for Air Travel* (New York: National Bureau of Economic Research, Occasional Paper no. 109, 1970). See also Arthur De Vany, "The Revealed Value of Time in Air Travel," *Review of Economics and Statistics*, 56 (Feb. 1974), 77-82; and Boyd and Walton, "The Social Savings," p. 245. Most studies of passengers using other modes of transport place the value of time much

TABLE I
DIRECT SOCIAL SAVINGS ON
FIRST-CLASS PASSENGER SERVICES, 1910
(in millions)

A. Time Cost	
1. Railroad first-class passenger kilometers.....	229.9
2. Daylight passenger kilometers (80% of 1.).....	183.9
3. Daylight passenger kilometers of income earners (50% of 2.).....	92.0
4. Daylight hours required by stagecoach (at 15 kph).....	6.1
5. Daylight hours required by railroad (at 40 kph).....	2.2
6. Additional hours required by stagecoach (4. -5.).....	3.8
7. Value of additional time (in 10-hour days) required by stagecoach (estimated at twice the 1910 average railroad workers' daily wage of P\$ 1.08).....	P\$ 0.8
B. Price Differential	
1. Cost of traveling 229,906,677 kilometers by stagecoach (1876 rate of P\$ 0.05 per km., or P\$ 0.0738 in pesos of 1900).....	P\$ 16.7
2. Actual first-class passenger revenues, Mexican railroads, in pesos of 1900.....	P\$ 5.1
3. Additional cost of stagecoach travel (1. -2.).....	P\$ 11.6
C. Direct Savings (A.7 + B.3).....	P\$ 12.4

Mexico was a largely agrarian country in 1910, using this proportion to value the time cost of travel should bias the savings estimate upward.¹³

Three more assumptions are necessary: (1) stagecoach speed is set at 15 kilometers per hour, trains at 40;¹⁴ (2) half of all passengers are assumed to be unproductive (children, unemployed, old people) and are not included in the estimate;¹⁵ and (3) stagecoaches are assumed capable of equaling the nighttime passenger output of trains (roughly 20 percent), and nighttime travel is excluded from the estimate of time costs. Assumptions (2) and (3) mean that the savings estimate is based on 40 percent of the passenger kilometers actually produced by railroads in 1910.

The results of the first-class, direct-social-savings calculation are reported in Table I. Total savings amount to a maximum of 12.5 million pesos, or 1.05 percent of Mexico's gross domestic product in 1910.¹⁶ Of

lower, at less than half the wage of the traveling population and well below the average wage in industry. See David A. Hensher and Williard E. Hotchkiss, "Choice of Mode and the Value of Travel Time Savings for the Journey to Work," *Economic Record*, 50 (March 1974), 94-112; John Kraft and Arthur Kraft, "Empirical Estimation of the Value of Travel Time Using Multi-mode Choice Models," *Journal of Econometrics*, 2 (Dec. 1974), 317-26.

¹³ Existing historical data collections report only "average minimum daily wages," unsuitable for our purposes. The estimates here employ the average wage paid to railway workers, based on data for the National Railways of Mexico, the government-controlled firm that employed more than half of all railway workers in 1910. According to its annual report for 1910 (Manuscript Version, AHSCT, 10/2329-1), the average wage (excluding top-management personnel) amounted to P\$ 1.78 per day. This wage, adjusted by the Mexico City Wholesale Price Index (reproduced in Table 3), amounted to P\$ 1.08, in pesos of 1900.

¹⁴ Calderón, *La República restaurada*, p. 603.

¹⁵ Boyd and Walton, "The Social Savings," pp. 248-51.

¹⁶ GDP estimates in current pesos are taken from Leopoldo Solís, "La evolución económica de México a partir de la Revolución de 1910," *Demografía y Economía*, 3 (1969), 12. The Solís estimates are deflated using the Mexico City Wholesale Price Index.

TABLE 2
DIRECT SOCIAL SAVINGS ON
SECOND-CLASS PASSENGER SERVICES, 1910
(in millions)

1. Railroad second-class passenger kilometers.....	830.5
2. Daylight passenger kilometers (80% of 1.).....	664.4
3. Daylight passenger kilometers of income earners (50% of 2.).....	332.2
4. Daylight hours required by railroad (at 40 kph).....	8.3
5. Ten-hour working days required by rail.....	0.8
6. Days required to walk 332,215,126 kilometers (at 30 km. per day).....	11.1
7. Working days saved by rail (6. -5.).....	10.2
8. Value of additional time required for walking (at 1910 average railroad workers' daily wage of P\$ 1.08).....	P\$ 11.1
9. Railroad second-class passenger revenues (in pesos of 1900).....	P\$ 7.2
10. <i>Direct Savings</i> (8. -9.).....	P\$ 3.9

this total, only 6.6 percent, or 0.8 million pesos, is the value of the time saved by railroad travel. The remainder, 11.6 million pesos, or 93.4 percent of the estimate, represents the difference between stagecoach and first-class rail fares.

The second-class savings estimate involves no fare differential. The only relevant cost of walking is the value of the time it takes. Here it is assumed that the opportunity cost of time spent traveling was equal to the average hourly wage in industry. And it is assumed that people with a positive opportunity cost in mind would have loped along at 30 kilometers per day if forced to walk. As before, trains move people at 40 kilometers per hour and half the passengers are unproductive. The results are presented in Table 2. Total direct savings on second-class passenger services amount to a negligible 3.9 million pesos, or 0.33 percent of the 1910 GDP.

Exaggerate as we may, it is difficult to avoid the conclusion that the Mexican economy would not have been much affected, *directly*, if the rich had switched back to stagecoaches and the poor continued to walk. This conclusion is strengthened by reflection on the elasticities. The demand for passenger travel, especially when there is any substantial "luxury" component, is notoriously elastic. "Real" social savings were no doubt much smaller than these estimates, not only because some of the variables were deliberately biased to produce a maximum figure but also because, at a higher cost, many fewer people would have traveled.

Mexicans traveled less than people in the United States or Great Britain in the late nineteenth century, but they traveled nearly twice as far as their U.S. counterparts and more than four times the average distance of British passengers.¹⁷ Including time cost and second-class fares, the aver-

¹⁷ While the average journey of Mexican rail passengers in 1910 was 67 kilometers, that of U.S. passengers at a comparable stage of railroad development (the 1880s and 1890s) was approximately 25 miles, or less than 40 kilometers. In 1910 the average U.S. rail journey was 33.5 miles (56 kilometers); Thor Hultgren, *American Transportation in Prosperity and Depression* (New York, 1948), p. 61. In Britain, the average journey covered 9 miles (14 kilometers); Hawke, *Railways and Economic Growth*, p. 51.

age journey (67 kilometers) cost the equivalent of 6.3 days' wages at the minimum daily agricultural wage of 0.26 pesos in 1910. Even for relatively well-paid groups, like miners and bureaucrats, the average rail journey cost more than two days' wages.¹⁸ For most Mexicans, maximizing only their money incomes, it would have been cheaper to walk.

FREIGHT SOCIAL SAVINGS

Before the railroad Mexico depended almost exclusively on overland transportation. Unlike the United States and Britain, or even Tsarist Russia and Colombia, Mexico had no river system suitable for use in transportation. Except for local freight across three large lakes near highland population centers and short hauls up several rivers from the Gulf to the base of the mountains, internal water transport was unknown. Since most of the population and economic activity has always been located far from the two coasts, in plateaus and mountain valleys, coastal shipping never played the role in Mexico that it did in Europe and the United States. Unit savings from railroad freight transport, therefore, were high.

In the prerail era freight went by wagon or on the backs of animals or men. Some loads once carried by men shifted to passenger cars; second-class baggage allowances were usually fixed at 25 kilos, and small animals were permitted to travel free. The railroads, however, did not replace non-commercial carriers; hence, the savings estimate is based on freight that could only have shifted back to commercial wagons and mule trains for transport over long distances. Wagons were less costly and faster than mules but available only on improved roads.¹⁹

In contrast to the passenger estimates, the estimates of direct savings on freight services have been biased downward, for the hypothesis is that they were large. The first step is to exclude from the savings calculation all the hidden costs of prerail shipping (higher insurance rates, handling charges, seasonal inventory costs). In the case of Fogel's estimates for the United States, these hidden costs amounted to more than the explicit prerail shipping rates. The second step is to assume a costless extension of the

¹⁸ The 1910 average minimum daily wage in agriculture was P\$ 0.26, according to El Colegio de México, *Estadísticas económicas del Porfiriato: fuerza de trabajo y actividad por sectores* (Mexico, n.d.), p. 148. The second-class fare plus time cost per kilometer for rail travel amounted to P\$ 0.02431, calculated from the data in Table 2. Thus, a 67-kilometer trip cost P\$ 1.63 by rail, as opposed to P\$ 2.41 on foot. One implication of these results is that only the relatively prosperous saved by taking the train. The second-class savings estimate uses P\$ 1.08 per day as the assumed opportunity cost of time spent in traveling. If the average minimum daily agricultural wage (P\$ 0.26) were used instead, the cost of walking 67 kilometers (in 2.3 days) would be only P\$ 0.60 (versus P\$ 1.63 by train) and the savings estimate would drop from a positive P\$ 3.9 million to a negative P\$ 4.5 million. Indeed, for any assumed opportunity cost of travel time below P\$ 0.70 per day, the social savings estimate would be negative. Since it is not likely that more than a small minority of the Mexican population actually earned more than P\$ 0.70 per day, very few indeed could actually have gained in pecuniary terms by using rail transportation. For most Mexicans the price of a second-class rail passenger ticket took more days' labor to pay for than would have been required to walk the same distance.

¹⁹ On prerail freight transport, see Coatsworth, "The Impact of Railroads," chap. 4.

wagon-passable federal highway system from less than 5,000 kilometers in 1877 to approximately 250,000 kilometers in 1910.²⁰ The third is to select a low, dry-season, and very efficient rate for prerail freight charges: approximately 0.10 pesos per ton kilometer in current pesos of 1877.²¹

The savings estimate would be straightforward were it not for difficulties with the index of general prices. The price index used to deflate the passenger estimate is an index of consumer prices in Mexico City. Using this index probably exaggerates the hypothetical rise in wagon transport costs between 1877 and 1900. It also may exaggerate the rise in rail freight costs between 1900 and 1910. The result is an estimate, in 1900 pesos, overdeflating rail costs and overinflating wagon charges and yielding an exaggerated savings estimate. Two savings estimates are therefore presented. Estimate "A" uses the Mexico City consumer price index; "B" uses a real-wage index to inflate wagon costs and an index of railroad revenues per ton kilometer to deflate railroad freight charges. Estimate "B" may be taken as a lower bound because it assumes that the cost of other wagon inputs would have risen as slowly as real wages even when confronted with the task of duplicating the railroads' output. Since the wagon freight business was highly competitive, there were no barriers to entry, and mule trains offered a close substitute, there were no monopoly rents to provide a cushion against a rise in the cost of animals, feed, and equipment.²² The Mexico City consumer price index and the two indices used for estimate "B" are found in Table 3. The index of railroad revenues per ton kilometer shows almost no trend from 1890 to 1910, suggesting that marginal costs remained stable or fell slightly in this period.²³ Both "A" and "B" estimates of direct social savings on railroad freight services are presented in Table 4.

The "A" estimate amounts to 455.4 million pesos; or, relative to Mexico's 1910 GDP, an astonishing 38.5 percent. The lower-bound "B" estimate is 291.3 million pesos, or 24.6 percent of GDP. This lower-bound estimate for 1910 Mexico may be compared to the *upper-bound* estimates of

²⁰ This crude estimate is based on Fishlow's data, which indicate a maximum "feasible" capacity of somewhat less than 20,000 tons of freight per route mile for the United States in the 1850s; Fishlow, *Railroads*, p. 93. Applying this estimate to Mexico yields a required minimum of 167,000 route miles, or approximately 250,000 kilometers of highway to accommodate the 3.5 billion ton kilometers of freight shipped by rail in 1910.

²¹ Reports of highway directors in Fomento, *Memoria*, vol. 2, *passim*, list dry-season rates for freight transport, which varied from P\$.058 to P\$.221 per ton kilometer. The average rate of the fourteen indicated was P\$.152. Using P\$ 0.10 (more than 50 percent less than the *average* 1878-79 rate) exaggerates the efficiency of the prerail freight transport system and thus reduces the savings estimate.

²² Calderón, *La República restaurada*, pp. 596-601.

²³ It may also be observed that the railroad industry was highly competitive. The major trunk lines from the center of the country to the northern border and parallel lines from the interior to most major ports competed directly. This competition and increased government intervention in the industry might have driven tariffs slightly below marginal costs during the first decade of this century. This possibility suggests yet a further source of downward bias in the social savings estimate.

TABLE 3
WAGON AND RAILROAD COST INDICES, 1877-1910
(1900 = 100)

Year	Mexico City Wholesale Price Index	Index of Real Wages	Index of Railroad Revenues Per Ton Kilometer
1877	68.7	95.7	709.9
1878	—	—	717.7
1879	—	—	753.4
1880	—	—	710.5
1881	—	—	709.4
1882	—	—	426.1
1883	—	—	256.3
1884	—	—	212.4
1885	—	85.6	164.8
1886	77.9	93.1	203.8
1887	68.8	94.3	179.7
1888	81.0	88.5	152.1
1889	87.5	96.5	132.3
1890	85.3	94.5	120.2
1891	84.8	84.8	104.2
1892	97.7	82.5	91.4
1893	105.7	97.6	104.5
1894	93.2	101.1	113.3
1895	93.1	102.4	104.8
1896	102.2	100.4	98.2
1897	102.8	107.9	105.3
1898	88.5	114.9	109.8
1899	85.5	110.1	106.8
1900	100.0	100.0	100.0
1901	122.8	101.1	99.7
1902	120.8	99.1	87.4
1903	125.7	114.1	94.9
1904	106.8	109.9	95.3
1905	121.3	102.9	96.0
1906	135.9	99.2	95.8
1907	133.9	100.8	96.4
1908	131.9	97.5	95.4
1909	143.6	94.0	106.8
1910	165.7	84.7	113.9

Source: El Colegio de México, *Estadísticas económicas del Porfiriato. Fuerza de trabajo y actividad por sectores* (Mexico, n.d.), pp. 156, 172; and Coatsworth, "The Impact of Railroads," Table IV.6, p. 106.

Fogel for the United States in 1890, because both take into account the possibility of an efficient technological adjustment to the absence of railways (5,000 miles of additional canals in Fogel's case, 245,000 kilometers of additional highways in Mexico). Had *existing* alternatives to the railroad been used as the basis for estimation, the calculations would have had to employ higher mule train transport rates for more than 90 percent of the railroads' output. Thus, had the method adopted by Fishlow or by Hawke been adopted here, the Mexican estimates would have been still higher.

It is a well-known axiom of new economic historians that nothing can

TABLE 4
ESTIMATES OF DIRECT SAVINGS ON
RAILROAD FREIGHT SERVICES, 1910
(in millions)

<i>Estimate "A"</i>	
(a) Ton kilometers of freight moved.....	3,456.1
(b) Cost of wagon shipment at P\$ 0.10 per ton kilometer (equal to P\$ 0.146 in pesos of 1900 deflated by Index I).....	P\$ 503.4
(c) Actual railroad freight earnings (deflated by Index I).....	P\$ 48.0
Estimate "A": (b) - (c) = P\$ 455.4	
<i>Estimate "B"</i>	
(a) Ton kilometers of freight moved.....	3,456.1
(b) Cost of wagon shipment at P\$ 0.10 per ton kilometer (equal to P\$ 0.104 in pesos of 1900 adjusted by Index of real wages).....	P\$ 361.2
(c) Actual railroad freight earnings (deflated by railroad-cost Index).....	P\$ 69.8
Estimate "B": (b) - (c) = P\$ 291.3	

save a quarter of GNP, let alone nearly 40 percent. A lower-bound estimate with zero price elasticity of demand (as here) is not a lower bound at all. It is, to use Fogel's term, a "least upper bound."²⁴ A *true* lower bound would have to correct for a positive price elasticity of demand for transportation. And a truly convincing lower bound would have to employ an upper-bound estimate of elasticity.

A relatively crude upper-bound estimate of the price elasticity of demand in Porfirian Mexico has been constructed by multiple regression on the following equation:

$$R = a + b_1K + b_2F + b_3Y + b_4P, \text{ where}$$

R = Ton kilometers of freight shipped annually,
K = Number of kilometers of track in operation,
F = Earnings per ton kilometer of freight shipped,
Y = National income, and
P = Population.

The results of multiple regression on the logarithms of the variables are reported in Table 5. The first equation uses a proxy for national income, annual exports (Y_A), and uses data for the entire period from 1878 to 1908. The second equation uses GDP estimates constructed by Leopold Solís (Y_B) and covers only the period for which these estimates are available (1895-1910). The price elasticity of demand is estimated by the regression coefficient b_2 , which is .558 in the first equation and .428 in the second. Repeated experiments with the form of the equation produced nearly identical results, with elasticity always below .75.²⁵ Taking this fig-

²⁴ Fogel employs this term in a discussion summarizing the results published in his book and after considerable debate on the nature of his estimates. See Robert William Fogel, "Railroads and American Economic Growth," in Fogel and Stanley L. Engerman, eds., *The Reinterpretation of American Economic History* (New York, 1971), 196n.

²⁵ While the Durbin-Watson test yielded negative results at the 95 percent level (indicating a low level or absence of serial correlation), repeated manipulation of the form of the equation (eliminating

TABLE 5
ESTIMATING PRICE ELASTICITY OF
DEMAND FOR TRANSPORTATION, 1878-1910

(1) Log R = -17.63	+	.634 Log K (.11217)	-	.558 Log F (.22046)	+	.047 Log Y _A (.72236)	+	3.11 Log P (3.36815)
R = .9956, R ² = .9913								
(2) Log R = -12.66	+	.877 Log K (.98945)	-	.428 Log F (.29875)	+	.473 Log Y _B (.34358)	+	2.16 Log P (2.92066)
R = .9941, R ² = .9882								

ure as a maximum estimate of the price elasticity of demand produces minimum social-savings estimates of between P\$ 127.6 million and P\$ 135.8 million, or 10.8-11.5 percent of Mexican GDP in 1910.

Table 6 illustrates the sensitivity of the social savings estimate to alternative assumptions about the price elasticity of demand for transportation. The social savings fall rapidly as elasticity rises. Taking 0.75 as an upper-bound estimate, rather than 0.5 which is closer to actual results, reduces the social savings in both cases by an amount equal to 5 percent of GDP. Comparison with contemporary work in developed countries suggests it is reasonable to reject demand elasticity figures higher than 0.75. Most of the empirical studies of demand elasticity have yielded estimates below unity.²⁶ Demand is believed to be even more inelastic in less developed regions.²⁷ It is most likely that demand for freight services in Mexico more than a half-century ago was less elastic than in the United States or Britain today.

To judge the significance of these lower-bound estimates, they may be compared with increments in GDP in the Porfirian era. Between 1895 and 1910 Mexico's GDP rose from P\$ 746.5 million to P\$ 1,184.1 million, a total increase of P\$ 437.6 million. The social savings on freight in 1910, at a minimum of P\$ 127.6 million, account for 29.1 percent of this increase in GDP. In per capita terms, however, GDP rose by a smaller amount, P\$ 350.1 million. The social savings are equivalent to 36.4 percent of this productivity gain in the Mexican economy over the period. Taking into account that the social savings estimate constitutes an extreme lower bound, it is likely that railroads accounted for as much as half of the economic growth of the Porfirian economy.²⁸

the population variable, adding a time trend, fixing parameters, and the like) was undertaken in order to check for multicollinearity. The regression coefficients remained quite stable through every run, with the estimated price elasticity below 0.75 in every case.

²⁶ George W. Wilson, "Notes on the Elasticity of Demand for Freight Transportation," *Transportation Journal*, 17 (Spring 1978), 11; Dean Worcester, Jr., "On Monopoly Welfare Losses: Comment," *American Economic Review*, 65 (Dec. 1975), 1016, Table I; Leonard W. Weiss, *Case Studies in American Industry* (New York, 1967); James Sloss, "The Demand for Intercity Motor Freight Transport: A Macroeconomic Analysis," *Journal of Business*, 44 (Jan. 1971), 62-68.

²⁷ See P. E. Stonham, "The Demand for Overseas Shipping in the Australian Export Trade," *Journal of Transport Economics and Policy*, 3 (Sept. 1969), 333-49.

²⁸ For GDP estimates, see Solís, "La evolución," p. 12. For population, see El Colegio de México, *Estadísticas: fuerza de trabajo*, p. 25.

TABLE 6
DIRECT SOCIAL SAVINGS ON FREIGHT SERVICES FOR
ALTERNATIVE VALUES OF PRICE ELASTICITY OF
DEMAND FOR TRANSPORTATION

Elasticity	"A" Estimate of Social Savings		"B" Estimate of Social Savings	
	Millions of 1900 pesos	Percent of 1910 GDP	Millions of 1900 pesos	Percent of 1910 GDP
-0-	\$455.4	38.5	\$294.5	24.9
0.5	196.9	16.6	176.9	14.9
0.75	135.8	11.5	127.6	10.8
1.0	95.6	8.1	112.2	9.5
1.5	53.2	4.5	75.9	6.4

UNMEASURED BENEFITS

The social savings approach fails to measure some indirect benefits of railroad development. Minuscule passenger savings conceal the railroad's contribution to labor force mobility and geographic redistribution. The railroads carried 15.8 million passengers a total of more than a billion passenger kilometers in 1910. While these passengers could have walked or traveled by stage at no extra pecuniary cost, they preferred the railroad because it was more comfortable, less traumatic, and safer. The old luxury *diligencias* could not match the comfort of second-class, let alone first-class rail travel. The cost of prerail travel for Mexico's poor included the anguish of permanent separation from home and family ties and the uncertainties of following old news over long distances. The railroad's speed did not save its passengers much money, but it did allow them to travel hundreds of miles from their homes (or back) in a matter of hours rather than weeks. In a society that still depended on word-of-mouth communication, railroads carried the people who spread the news of higher wages and a better life elsewhere. And there were fewer risks. For obvious reasons, train robberies were far less common than stagecoach holdups and highway muggings. The comfort, speed, and relative safety of the railroads made the decision to leave home a far less serious affair than it had ever been.

It would be foolhardy to attempt an estimate of that portion of the benefits of labor force redistribution during the Porfirian era that should be attributed uniquely to the railroad. Too many of the numbers would be too uncertain, and insurmountable problems of separating supply and demand are involved. Assuming that wage differentials reflected differences in productivity between regions, it is likely that the benefits were large.²⁹ The region that experienced the most rapid growth during the Porfirian era was precisely the sparsely populated northern tier of states where migrants formed a large proportion of the work force by 1910.³⁰

²⁹ See El Colegio de México, *Estadísticas: fuerza de trabajo*, pp. 147-54.

³⁰ While substantial migration from the center to the north of the country took place during the Porfiriato, the railroads also played a role in moving labor to the sisal plantations of Yucatan. Planta-

The estimate of social savings from railroad freight carriage also fails to capture indirect benefits. The most significant of these unmeasured benefits were those that accrued from the railroad's unique, pioneering role in stimulating foreign interest in Mexico's resources. Railroad construction constituted the first large-scale foreign direct investment project in Mexico, as in a number of other regions. No other type of foreign direct investment combined, in quite the same way, the expectation of high returns with the risk-diminishing official guarantees and subsidies offered to railroad entrepreneurs. The output of foreign and domestic enterprise stimulated by cheaper transport rates is captured in the social savings estimates. But the resources attracted by the railroads' effect on foreigners' perception of the risks involved in Mexican projects are not included. Nor is the contribution of the railroads to market integration, the stimulus to exploration and discovery of new mineral deposits, or the impact on legislation that responded to the peculiar needs of foreign investors for new and more precise definitions and better enforcement of property rights. These hidden and unmeasured benefits of Mexico's railroad boom strengthen still further the axiom of the indispensability of the railroads in Mexico's economic growth between 1880 and 1910.

CONCEALED COSTS—LEAKS AND LINKAGES

The difficulty of measuring the hidden benefits of Mexico's railroad boom is compounded by the problem of specifying and estimating the concealed costs. The overt costs of construction to private companies and the government are readily available; using the lower-bound explicit social savings estimates as the denominator, a rough calculation of the social rate of return on the largest of the private lines, the Mexican Central, runs in excess of 50 percent per year by 1900.³¹ The concealed costs, however, cannot be measured by conventional cost-benefit methods. The impact of the railroads on the structure of output and on institutional development was different in Mexico than in the advanced industrial economies of the North Atlantic. Here, the railroads' costs may have outweighed the benefits.

Railroads promoted Mexican economic growth largely by reinforcing the country's comparative advantage in the production of minerals (and,

tion labor here, as well as in Campeche, Chiapas, and parts of Oaxaca, appears to have involved considerable coercion; forced laborers were transported to these areas from the center and north, especially from Sonora, where Yaqui Indians were captured in large numbers during a prolonged period of warfare. Railroads did stimulate henequen production (and demand for labor) in Yucatan, as they did the production of other plantation crops in the rest of the south. Migration was inhibited, however, by the absence of direct rail links (which existed to the north) and by the reputedly unhealthy climate of these areas.

³¹ The method employed for calculating the social rate of return is discussed in Lloyd Mercer, "Rates of Return for Land Grant Railroads: The Central Pacific System," this JOURNAL, 30 (Sept. 1970), 602-26. But see also Peter D. McClelland, "Social Rates of Return on American Railroads in the Nineteenth Century," *Economic History Review*, 2nd. ser., 25 (Aug. 1972), 471-88.

to a lesser extent, fibers) for export. Like many backward regions of the world in the nineteenth century, Mexico's economy grew most rapidly in those sectors oriented toward the production of primary products in response to foreign demand. Limitations on the facts available make it impossible to isolate the unique contribution of the railroads to this process, because other variables (technological change embodied in foreign direct investment, changing terms of trade, and the like) contributed to the same outcome. That railroads contributed mightily to this process, however, may not be doubted.

Freight rates on Mexican railroads discriminated heavily in favor of export products throughout the Porfirian era. Not only were export products given lower rates, but products sold in large quantities on the domestic market were charged less when shipped in bond to port or border crossings. This explicit discrimination occurred because both the railroad companies and the Mexican government wanted it so—the companies to stimulate freight-producing enterprise in the uninhabited mountains through which their lines had to pass; the government, to enrich the treasury through taxes on exports. The policy was a success.³²

On the Mexican Central Railway, the country's longest, minerals and fibers amounted to only 16.3 percent of total freight tonnage in 1885, one year after the completion of the company's main line from Mexico City to the U.S. border.³³ In fiscal 1908 that percentage had increased to 58.2 percent.³⁴ The actual shift toward export freight was greater than these figures indicate because, in 1885, salt accounted for nearly 40 percent of all mineral tons shipped, while in 1908 less than 2 percent. Between 1885 and 1908 minerals and export fibers carried by the Mexican Central increased 75 times, while other freight increased in tonnage a little more than 10 times. In the latter year, moreover, substantial quantities of products not readily distinguishable from domestic freight (and not included in these figures) were carried to ports or to the northern border for export. These included large quantities of coffee, chick-peas, chicle, India rubber, and livestock. If it were possible to estimate import freight or domestic freight destined for use in the export sector, this imbalance would appear even greater. Similar freights were reported by the country's other major trunk-line system, the Mexican National Railroad.³⁵ As a measure of the benefits received by the export sector, the distribution of freight tonnage is biased downward still further, because it does not take into account discriminatory rates that made the railroads cheaper for exporters than anyone else. It is likely that the export sector derived at least three-fourths of the benefits to consuming industries of railroad operation in Mexico by 1910.

³² Coatsworth, "The Impact of Railroads," chap. 5.

³³ Mexican Central Railroad Company, *Annual Report* (ms. version), *AHSCT*, 10/3175-1.

³⁴ Mexican Central Railway Company Limited, *Annual Report, 1907-1908*, p. 21.

³⁵ Mexican National Railroad Company, *Annual Reports, 1887, 1908*.

TABLE 7
IMPORTED INPUTS, MEXICAN CENTRAL RAILROAD, 1891-1906

Year	In Thousands of Pesos	Average Rate of Exchange	In Thousands of U.S. Dollars	Imported Inputs as a Percentage of Total Operating Costs
1891	1,997	128.83	1,550	42.67
1892	1,984	143.13	1,386	39.67
1893	1,942	160.04	1,213	37.80
1894	2,099	192.69	1,089	38.45
1895	1,757	188.94	930	31.38
1896	1,978	188.65	1,048	29.33
1897	3,031	209.39	1,448	34.33
1898	3,323	214.41	1,550	36.27
1899	4,458	206.57	2,158	42.85
1900	5,686	204.18	2,785	47.99
1901	5,650	208.64	2,708	45.17
1902	7,096	239.95	2,957	46.77
1903	7,664	236.80	3,237	40.46
1904 ^a	3,340	220.82	1,512	33.36
1905 ^b	4,421	207.31	2,133	25.12
1906 ^b	6,401	199.83	3,203	32.31

^a January to June only.

^b Fiscal year ending June 30.

Sources: Mexican Central Railroad Company, *Annual Reports*, 1891-1906.

Backward linkages, especially those with an industrial twist, had little effect on the development of Mexican industry. The railroads were constructed and operated with rails, locomotives and rolling stock, spare parts, iron bridges, and supervisory and engineering personnel imported from abroad. On occasion, even fuel (coal and wood), ties for laying tracks, and unskilled labor were imported. Paying in gold for most of these imported inputs while earning their revenues in depreciating silver currency until the monetary reform of 1906, the railroad companies adopted every conceivable measure to reduce their consumption of imports.³⁶ As Table 7 shows, however, not even the largest of the companies succeeded in reducing its dependence on external supplies. In the fifteen-and-a-half years during which the Central reported its foreign purchases, 38 percent of its operating costs went for imported inputs.

Mexican railroads alone could not have added much stimulus to the already industrialized economies of the United States, Great Britain, France, and Germany through their demand for these inputs. What is important, however, is that they provided virtually no stimulus for Mexican industry through backward linkages. To the contrary, they reinforced the

³⁶ "A constant effort has been made to curtail, as much as possible, the purchase of material in the United States and Europe and, wherever practicable, to make purchases in Mexico," the President of the Mexican Central reported to his stockholders (*Mexican Central, Annual Report, 1894*, p. 10). The Mexican National President reported a similar policy to his stockholders the year before (*Mexican National, Annual Report, 1893*, p. 8).

existing disadvantage of Mexico with respect to the advanced economies of the North Atlantic. It is precisely because Britain and the other railroad developers had already achieved considerable industrial development before the coming of the iron horse that they were able to capture the indirect benefits of backward linkages from their own railroad booms and become suppliers of railroad technology and equipment to the rest of the world. Fogel is right, perhaps, to emphasize the "continuous stream of technological advances" in the developing economy of nineteenth-century America. In Mexico, where there was no such stream, railroads contributed far more to economic growth but did so precisely by mortgaging the country's future to an increasing dependence on the North Atlantic economies.³⁷

In 1910 Mexican railroads earned gross revenues of P\$ 103.5 million in current pesos.³⁸ On a conservative estimate, P\$ 58.4 million, or 56.5 percent of gross earnings, were spent abroad. The components of this leakage are summarized in Table 8. The first component, imported inputs, is estimated by applying the Mexican Central's ratio (37.64 percent of operating costs) to the whole system in 1910 to yield P\$ 21.4 million, or 20.7 percent of total railroad gross earnings. The import expenditures of foreign personnel are estimated at P\$ 5 million from data in the files of the National Railways of Mexico, on the assumption that foreign personnel had an average propensity to consume imports equal to 0.5.³⁹ Profit remittances and dividend payments are estimated on the assumption that, apart from the government's share of the National Railways, 95 percent of such service payments were made to foreigners.⁴⁰ In the table, an additional com-

³⁷ Backward linkages to industrial development in the United States, Britain, and Germany contrast sharply with the Mexican case; Rainer Fremdling, "Railroads and German Economic Growth: A Leading Sector Analysis with a Comparison to the United States and Great Britain," this JOURNAL, 37 (Sept. 1977), 583-604. A parallel case is that of Peru, where backward linkages were also negligible; Miller, "Railways and Economic Development in Central Peru," pp. 44-47. The Spanish case provides a further contrast; Tortella found that forward as well as backward linkages to the industrial sector were small, and he attributes the collapse of the Spanish banking system in the 1860s to government policies that diverted resources to railroad construction from more productive investment in other sectors of the economy; Gabriel Tortella Casares, *Los orígenes del capitalismo en España* (Madrid, 1973), chaps. 3-5.

³⁸ Calculated from the 1910 annual reports of all Mexican railroads under federal concession, in *AHST*.

³⁹ In 1910, 4.1 percent of the employees of the National Railways were foreigners, two-thirds of whom were represented among the 5 percent highest paid. The 1,074 foreigners earned 14.7 percent of all wages paid by the company. Their average wage was P\$ 6.49 per day; that of Mexican employees, P\$ 1.58. The wage data are in the ms. version of the company's *Annual Report, 1909-1910*, *AHST*, 10/2329-1.

⁴⁰ In 1910 six major companies that accounted for more than 85 percent of all railroad earnings spent exactly one-third of their gross receipts for service payments on their bonded debt and dividend payments to stockholders. (The companies were the Interoceanic, the Mexican, the National Railways of Mexico, the Sonora, the Tehuantepec National, and the United of Yucatan.) The Mexican government earned P\$ 1.4 million in dividends (it owned no bonds) from the National Railways in 1910. This estimate assumes that 95 percent of the remaining interest and dividend payments (P\$ 17.2 million) left the country. The same percentage is applied to the interest and dividend payments of the rest of the railroad companies (estimated at one third of gross receipts). The annual reports of

TABLE 8
ESTIMATED LEAKAGE ABROAD OF RAILROAD REVENUES
AND SUBSIDY DEBT SERVICE, 1910
(in millions of current pesos)

1. Purchase of imported inputs.....	P\$ 21.4
2. Imports consumed by foreign personnel.....	2.5
3. Profit remittance and interest payments.....	34.5
Total Leakage of Railroad Revenues.....	P\$ 58.4
4. Interest on railroad subsidy portion of external public debt.....	4.5
TOTAL LEAKAGE.....	P\$ 62.9

Source: See text.

ponent is added. Aside from payments made directly from railroad revenues, the Mexican government was paying interest on that portion of its foreign debt originally contracted to subsidize railroad construction. These service payments came to no less than P\$ 4.5 million in 1910.⁴¹ Altogether, then, Mexican railroads generated a foreign exchange outflow equal to at least P\$ 62.9 million, or 3.8 percent of GDP in 1910 and 23.7 percent of the value of exports in that year.⁴²

INSTITUTIONS

In the industrial countries railroads have been credited with a series of positive institutional effects, ranging from improvements in corporate management to innovations that increased the efficiency of capital markets.⁴³ The significance of the railroad to these developments, of course, has been challenged by historians who argue that the institutional effects credited to railroads would have taken place without them, given the level of development already achieved by the industrial nations. Without such prior development, the unique contribution of railroad enterprise to institutional development might have been much larger. Two factors prevented such an outcome in the case of Mexico. First, the prior development of the advanced nations gave them an institutional advantage that extended from dominance of long-term capital markets to corporate organization. In part, this prior development explains the capacity of for-

these six companies are in *AHSCT*. Data on the government's share of National Railways revenues are found in *The Mexican Year Book: A Statistical, Financial, and Economic Annual, Compiled from Official and Other Returns, 1911* (New York, 1912), p. 167; and Nicolau d'Olwer, "Las inversiones extranjeras," in Cosío Villegas, ed., *Historia moderna de México: El Porfiriato, la vida económica*, vol. 2, pp. 1074-76.

⁴¹ Coatsworth, "The Impact of Railroads," chap. 5.

⁴² Export data are in *El Colegio de México, Estadísticas económicas del Porfiriato: comercio exterior, 1877-1911* (Mexico, 1960), passim. In fiscal 1909-10, Mexican exports were valued at a total of P\$ 265,727,730.

⁴³ Leland H. Jenks, "Railroads as an Economic Force in American Development," this *JOURNAL*, 4 (May 1944), 1-20; Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, 1977), chaps. 3-6.

eign enterprise to respond rapidly to the opportunities created by railroad construction. The predominance of foreign capital in the revival of Mexican mining is the case in point.

Second, what may be called the Gerschenkron Syndrome was of particular importance. Rather than stimulate imitative innovations in Mexican private-sector institutions parallel to those that took place earlier in the developed countries, railroad construction created great pressure for modernization on the Mexican public sector. Here, as in other Latin American countries, the appropriate symbol of this effect is nationalized transport: state enterprise created largely to socialize the losses required of railroads to sustain exports. Mexico, a late recipient of railroad technology, regulated private railroads earlier than did most of the developed countries. Railroads had their chief institutional effects channeled differently than in the advanced economies, not through the experience of private entrepreneurs but through the bureaucratic development of official agencies. This contribution to what some political scientists call "political development" was of greater importance than the impact on business organization in the private sector. It promoted the development of a public sector characterized by greater autonomy, as well as the emergence of modern business enterprise in a substantially more politicized environment.⁴⁴

Railroads had a direct impact on the balance of social forces in Mexican society and, simultaneously, on the distribution of wealth. Their initial impact was to make landholding profitable in large areas where the traditional Mexican hacienda had been losing ground since the colonial era to competing agrarian institutions, mainly Indian villages and small ranchos. Railroad construction precipitated land-grabbing on a scale unknown since the Spanish conquest. In addition to the usurpation of village lands throughout the Central Plateau (the dimensions of which may never be fully known), tens of millions of hectares of public lands in the sparsely settled northern states of the country and in the Yucatan Peninsula were sold at pre-railroad prices fixed by decree or simply given away in exchange for cursory "surveys."⁴⁵

This expropriation had far-reaching consequences. First, it depressed domestic demand at the precise moment that railroads were providing access to international markets. Exports of agricultural goods increased several times more rapidly during the Porfirian era than consumption of foodstuffs.⁴⁶ Second, usurpation of village lands provided willing hands at low wages for railroad construction projects, as well as for employment in

⁴⁴ See Robert J. Shafer, *Mexican Business Organizations: History and Analysis* (Syracuse, N.Y., 1973), chap. 2.

⁴⁵ John H. Coatsworth, "Railroads, Agrarian Protest and the Concentration of Landholding in the Early Porfiriato," *Hispanic American Historical Review*, 5 (Feb. 1974), passim.

⁴⁶ Published estimates of this difference have been exaggerated, however. My research indicates that domestic foodstuff production increased at about the same rate as population, while real exports grew at 5.8 percent between 1880/81 and 1910/11. See John H. Coatsworth, "Anotaciones sobre la producción de alimentos durante el Porfiriato," *Historia Mexicana*, 26 (Oct.-Dec. 1976), 167-87.

the growing export industries. The formation of an agrarian and industrial proletariat, together with a sharp increase in the concentration of wealth and income, made a critical contribution to the development of Mexican capitalism, as well as the expansion of foreign enterprise into Mexico. Third, rapid "commercialization" of agriculture under social conditions like those encountered in Porfirian Mexico are alleged to have very long-run consequences for political behavior.⁴⁷ Whatever else the Revolution of 1910 accomplished, the legacy of authoritarian government remains.

CONCLUSIONS

Conclusions depend on the counterfactual conditions one chooses to view as appropriate, and these depend critically on the time horizon and the level of abstraction appropriate to the questions one wants to answer. If the question is, "What was the unique contribution of railroad technology to the economic growth of Mexico up to 1910?", the appropriate counterfactual is the 1910 Mexican economy without railroads, and the answer to the question may be expressed in comparative static terms as the difference in the GNP between the real economy and the counterfactual one. By 1910 this difference was very large. If stimulus to industrialization through backward linkage was small or the foreign-exchange costs of foreign financing and inputs were high, we may conclude that there is little to add to the benefits already captured in the social savings estimates. Even without these additional benefits, however, railroads had a much larger effect on Mexican economic growth than they did on the economic growth of countries already undergoing industrial revolutions.

The analysis of the railroads' short-run impact might be modified to take into account some wider issues. One could ask not just for a measurement comparing a railroad and a counterfactual nonrailroad economy, but for a measure of the difference between the actual 1910 railroad economy and a Mexican economy in 1910 with railroads financed internally, their inputs limited, perhaps by law, to the products of domestic industry. While the abrupt and massively regressive land tenure effects of railroad construction might be much smaller, or even eliminated, and the nature of institutional development much altered as a result, there is little doubt that Mexico's 1910 GNP would have been lower had the economy been subjected to such constraints against the use of foreign capital and inputs. In the historical long run, however, the short-run costs of slower initial development might have paid high dividends. Export-led growth, which the railroads initiated and sustained, revitalized old barriers and even created

⁴⁷ E.g., Barrington Moore, *The Social Origins of Dictatorship and Democracy: Landlord and Peasant in the Making of the Modern World* (Boston, 1967). For an application to the Mexican case, see John H. Coatsworth, "Orígenes del autoritarismo moderno en México," *Foro Internacional*, 16 (1975), 205-32.

wholly new obstacles to development: low levels of investment in human resources, overcommitment of resources to export-sector capital equipment and infrastructure, public agencies and private activities highly specialized in channeling foreign capital rather than capturing domestic savings, information and communications systems structured to facilitate international transactions rather than local market activity, extreme concentration of wealth (including land) and income, and authoritarian rule.

If the broader issues of Mexican development are posed from the vantage point of today, a different question may be raised: "What were the costs and benefits, over the *historical* long run, of the growth path on which Mexico embarked in the 1870s?" This question makes the impact of the railroads subordinate to more general issues. The appropriate counterfactual in this case is a contemporary Mexican economy displaying the cumulative effects of a different structural and institutional trajectory. The unique contribution of the railroads in moving the economy onto the path actually taken no doubt was related to the magnitude of the social savings they produced. If the counterfactual economy would have eventually achieved greater growth and higher levels of welfare along a different trajectory, then the contribution of the railroads would be negative in the same degree. Precisely because savings were high in the first period, railroads may be seen as foreclosing other possibilities with very large effects over the longer period.

It is not possible, given the current state of theory and methods, to select, specify, and measure an appropriate counterfactual trajectory against which to compare the actual course the Mexican economy took after 1880. While comparison with other countries can provide empirical data to discipline historical insight, the larger issues stand at the frontier between scientific discourse and ideological struggle. Even though the short-run contribution of the railroads to economic growth was large, an evaluation of the long-run impact of this innovation would have to take into account its indirect effects on a long list of variables which combined to create the underdeveloped country Mexico has become.