

Market intervention in a backward economy: railway subsidy in Brazil, 1854–1913¹

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The implications of government transport subsidies for economic growth in the nineteenth century have long captivated economic historians. Extant research on subsidies focuses largely on transport policies in the United States and Canada.² There is comparatively little work on similar policies in relatively backward economies, and none measuring the economic consequences of public transport subsidies elsewhere in the Americas.³ Throughout Latin America internal improvements during the nineteenth century—often financed from abroad—appeared only on the heels of government subsidy arrangements. Brazilian railways serve as a major case in point. Market intervention and foreign investment were hallmark features of the Brazilian economy through the turn of the century. This was especially true of railway development. No sector of activity manifested greater government involvement, or higher levels of foreign investment, than railways. Central and provincial authorities first provided subsidies to nascent railway projects in the 1850s. Designed to accelerate the pace of railway construction, subsidies took the form of guaranteed minimum dividends to investors. As a policy instrument for attracting and channelling funds into desperately needed infrastructure, government-supplied dividend guarantees worked. Lacking even a single railway in 1852, Brazil had some 20,000 kilometres of track by 1900.

Attentive to the guarantees provided to investors in nineteenth-century Brazilian railways, historians have explored the questions of public policy and foreign ownership.⁴ Many assessments gainsay the government's policy on at least one of two grounds. The first discredits the subsidies as inefficient and wasteful for having impelled the construction of rail

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² Fogel, *Union Pacific Railroad*; Fleisig, 'Union Pacific Railroad'; *idem*, 'Central Pacific Railroad'; Mercer, 'Building ahead of demand'; *idem*, *Railroads and grant policy*; Ransom, 'Social returns'; George, *Government subsidies*; Carlos and Lewis, 'Profitability of early Canadian railroads'.

³ An exception among studies of relatively backward economies is Feeny, *Political economy of productivity*.

⁴ For the best of these studies at the provincial level during the empire see Lewis, *Public policy and private initiative*.

lines in regions where traffic conditions and prospects did not warrant them. This view holds that railways established under guarantee putatively came at an unjustifiably 'high social cost', merely affecting resource savings to the Brazilian economy.⁵ The second indicts the policies for increasing the foreign presence in the economy. A representative characterization of railways in the region avers that 'more often than not foreigners built and owned them, and did so where they would best complement the North Atlantic economies instead of Latin America's'.⁶ The latter view, rooted in the prevailing *dependentista* perspective, eyes foreign investment with suspicion bordering on xenophobia. Together, the two criticisms underscore the presumed central failure of government subsidies: they rewarded investments that did little for Brazil.

Criticisms of Brazilian railway policy stand on a meagre empirical base. This article reassesses those characterizations by providing the first detailed evaluation of the efficacy of the guaranteed dividends. In Brazil, all six of the major railways built under the guarantee scheme generated large gains to the economy before 1913. While the government's subsidy scheme was effective in tapping domestic and overseas savings, not all of the railways built with guarantees needed subsidies to attain profit levels sufficiently large to secure investment. Among the railways constructed under the guarantees, foreign-owned companies did not fare disproportionately well in terms of profits. Regulation pushed charges down on all the railways, but relatively less so on the privately owned Brazilian lines. High social rates of return on guaranteed railways, and the varying profit experiences across lines, stemmed from the political factors that gave rise to the guarantee policy in the first place. In particular, the manner in which the public goods problem was solved by Brazilian political institutions favoured Brazilian constituencies over British investors in railway projects.

These conclusions are based on a body of quantitative evidence that sheds new light on four main questions about the working of Brazil's policies. First, how profitable were the investments in guaranteed railways? Second, were government subsidies necessary for the financial success of each company? Third, were the benefits these railways created through cheap transport sufficiently greater than the costs of securing them to justify the policy? Finally, did the nature of ownership in the context of Brazil's polity have any bearing on the observed differences in performance among railways? In answering these questions the article proceeds in the following manner. Section I provides a brief overview of Brazilian railway policy and relates it to each of the six railways considered here. The second section presents estimates of the private profits realized by each of those companies in Brazil until 1913, and contrasts them with the profits that each company would have received in the absence of the subsidies implicit in the guarantee scheme. Section III shifts the focus to the externalities created by railways. It expands the measure of private

⁵ Villela and Suzigan, *Política do governo*, p. 321; St Angel, 'British investment', pp. 13-4.

⁶ Burns, *Poverty of progress*, p. 135.

profits to include a conservative estimate of the benefits each railway created by reducing transport costs in the region it served. Section IV provides a public choice perspective on government rate regulation in determining different levels of profit across railways. The conclusion discusses the implications of these results for the current understanding of the political economy of Brazil before 1914.

I

Brazil's constitutional monarchy promoted transport improvements that channelled benefits to key supporters of the government in the country's south-centre and north east. The first railway legislation was enacted in 1835 under the regency (1831-40). Motivating that law, and the body of legislation elaborated before the end of the century, was the pressure to reduce transport costs for the benefit of Brazilian agriculture. Owners of slaves and land comprised the pre-eminent political constituency until the end of the monarchy (1889), and landowners remained a key force under the republic that ensued.⁷ Before 1850 railway policy failed to yield results. Throughout much of Brazil high overland transport costs posed a formidable obstacle to the extension and integration of product markets. Although the far north was well served by several rivers, by the end of the eighteenth century most of the population had settled well south of the Amazon basin. There topography presented an unbending natural barrier to transporting the country's agricultural produce. The coastal escarpment running from the north east to the far south impeded communications between the littoral and the interior. Geography joined with the prevailing tropical conditions to hinder the construction and maintenance of sorely needed turnpikes.⁸ As a result, animal-drawn carts and mule trains produced overland freight services by traversing crude roads and trails from the interior to the coast until the construction of the first rail lines.

Neither entrepreneurial deficiencies nor insufficient information were to blame for the delay in constructing railways in Brazil. Rather, prospective investors at home and abroad failed to respond to the new opportunities because they did not expect an adequate return from the railway investment that the government sought. Brazil's early railway concessions set the maximum rates that could be charged for freight and passenger services, yet did nothing to secure returns to shareholders.⁹ Within Brazil, railways required heretofore unimaginably large funds. The large capital indivisibilities inherent in the technology meant that investors could not capture all the benefits conferred by the railway projects. Moreover, instability associated with the regency and the early years of the Second Reign (1840-89) further discouraged investment. The resources required

⁷ Graham, *Patronage and politics*.

⁸ Brazil possessed few macadamized roads at mid-century. Most roads at the time were mere mule paths.

⁹ Lei no. 101, 31 Oct. 1835; Decreto, 4 Nov. 1840. The appropriate annual volumes of *Collecção das leis do império do Brasil* published railway legislation.

to quell the revolts of the 1830s and early 1840s rendered subsidies for internal improvements unfeasible. Although regional revolts waned by 1845, it was only with the first provision of guaranteed dividends by the imperial government in 1852 that investment was forthcoming.¹⁰ Thereafter, both central and provincial governments in Brazil worked to satisfy landowners' demands for cheap transport by offering guaranteed minimum dividends to railway projects. Early guarantees were project specific, but follow-up legislation in the 1870s and 1880s, most notably the railway law of 1873, expanded central government guarantees to all of Brazil.¹¹ Guaranteed dividends in Brazil overcame negative perceptions of the country's prospects on the part of investors. The subsidies implicit in the guarantee policy reduced the perceived risk and permitted the railway either to obtain capital that it would not have received, or to obtain it more cheaply than would have otherwise been possible.¹²

Government subsidies to transport were common in the nineteenth century, and guaranteed dividends were not unique to Brazil. Numerous countries implemented policies to garner railway investment. Among the policies employed around the world were dividend guarantees, low-cost loans, land grants, and construction outright by the government. At mid-century the nature of Brazil's guaranteed dividend policy had much in common with local aid to railways in the United States, and similar policies in India, Russia, Tuscany, France, and Sweden.¹³ As a subsidy arrangement, dividend guarantees differed markedly from the US practice of granting land to railways. Land grants were commonly used to subsidize large trunk lines extending to the west. The reduction in transport costs attributable to the railway bestowed benefits on nearby land, and the land grants permitted the railway to internalize part of the externality it created. In Brazil, where property rights in land were poorly defined and survey and title virtually non-existent before the 1890s, the government rarely awarded land grants to railways. Instead it guaranteed that investors would earn a minimum return on their shares each semester. The guarantee arrangement with each railway set a minimum dividend rate on an agreed value of the firm's capital. When the railway's net earnings failed to attain the prescribed level, the government aided the company by paying to it the difference between its profits and the legislated rate of return. When the company achieved net earnings in excess of the prescribed dividend level by a sufficient margin, the additional profits were divided with the government in order to reimburse any guarantee payments. Even higher dividends occasioned the lowering of freight and passenger rates. While the specific arrangements adopted in Brazil varied from line to line, guarantees provided subsidized, need-based loans to railways. Only the nominal value of the guaranteed

¹⁰ The railway law of 1852 maintained the prescribed rates; the major difference between it and the earlier concession was the guarantee of a minimum dividend: Pessôa, *Estudo descritivo das estradas*, pp. 3-4.

¹¹ Decreto 2450, 24 Sept. 1873; Decreto 6995, 10 Aug. 1878; Decreto 7959, 29 Aug. 1880.

¹² Mercer, *Railroads and land grant policy*, pp. 19-26.

¹³ Fishlow, *American railroads*, pp. 191-2; Galvão, *Notícia sobre as estradas*, p. 21.

dividend payments that had been received was repaid to the government, and the value of the subsidy was the interest that the railway escaped. The *quid pro quo* of the guarantee was rate regulation. With controls on freight and passenger fares, the minimum dividend policy created a rate-of-return band for guaranteed railways.

Evaluating in retrospect the need for subsidies involves two criteria.¹⁴ The first is that the market rate of return exceeds the private return to the railway, with the subsidy being just enough to equate the private rate to the market rate. The second is that the social rate of return on the railway exceeds the market rate of return. Railways that met these two criteria were desirable because they increased economic activity. Yet they were difficult to effect because investors could do better by placing their funds elsewhere. Subsidies pulled the expected private rates of return closer to the social returns from the railway, prompting investors to undertake the project. Other ways of getting an investor to build a railway existed, prominent among them being outright government ownership. On occasion, the Brazilian government constructed and operated railways. While the share of the railway sector owned by the government grew steadily until 1913, relatively few lines were initiated under government ownership. More typically in Brazil the government used guaranteed dividends as the preferred means of promoting railway investment.

The analysis of subsidies here focuses on six major railways. Three types of ownership arrangements prevailed in Brazil: private ownership by foreigners, domestic private ownership, and Brazilian government ownership. These six companies represent the diversity of regional distribution and ownership arrangements prevalent before 1914. The British-owned railways include the San Paulo Railway, the Great Western of Brazil Railway, and the Leopoldina Railway Company. The privately owned Brazilian lines are the Companhia Paulista and the Companhia Mogiana. The government-owned Central do Brazil (formerly the Estrada de Ferro Dom Pedro II) began as a privately owned company, but was taken over when it failed. Of the six companies, three (the Mogiana, Paulista, and San Paulo) operated wholly or predominantly within the state of São Paulo, which is roughly proportional to the overall concentration of rail track and rail transport services in that region. While the government-owned Central do Brazil also partly served São Paulo, via the old São Paulo-Rio de Janeiro line running up the Paraíba valley, it operated largely within the states of Rio de Janeiro and Minas Gerais, as did the Leopoldina Railway, which also extended northward into the state of Espírito Santo. Despite its name, the Great Western served Brazil's north east, ultimately operating lines that it either owned or leased from the federal government in the states of Pernambuco, Alagoas, Rio Grande do Norte, and Paraíba.¹⁵ Each of these companies first

¹⁴ Engerman, 'Railroad subsidies'.

¹⁵ Two notable absences circumscribe the regional scope of the analysis, although the sample provides geographic diversity that is sufficient to detect key differences. The first regional gap is due to the absence of complete series of reports from any of the cluster of railways south of São Paulo. The second stems from the dearth of information on any representative lines from among the

constructed its rail lines under one of several government arrangements for guaranteed dividends. All six companies eventually came to own or operate lines that were initially constructed under legislation from both the pre- and post-1873 periods. The Central do Brazil, Mogiana, and Paulista railways, along with the San Paulo Railway Company, originated under early project-specific guarantee laws, but later incorporated lines that had been established with guarantees provided by the more general 1873 legislation. The Great Western participated in the guarantee policy under the 1873 law, but went on to incorporate some lines that had been established through earlier, project-specific guarantees, along with some government-owned lines.

By 1913 the lines owned and leased by the six companies accounted for the bulk of the output of the railway sector, producing almost 70 per cent of Brazil's freight service (measured in units of ton kilometres). In addition to the six railways examined here, other foreign and domestic private companies operated guaranteed railways in Brazil, and the government itself owned and operated lines other than the Central. Regrettably, the information required to provide a comprehensive treatment of those companies remains beyond reach.

Guarantee arrangements differed across railways. The first to be constructed was the Estrada de Ferro Central do Brazil, known originally as the Estrada de Ferro Dom Pedro II (hereafter referred to as the Central). It was designed to connect the port of Rio de Janeiro with the fertile Paraíba valley, and promoters constructed it with a guaranteed minimum dividend of 7 per cent, 5 per cent of which came from the imperial government, with 2 per cent from the province of Rio de Janeiro. It first entered operation in 1858, but failed in 1865, and the imperial government bought out the shareholders and took over the financing, expansion, and operation of the railway.¹⁶ The British-owned San Paulo Railway connected the port of Santos to the interior market of Jundiaí. Constructed with a 5 per cent guarantee from the imperial government, it earned an additional 2 per cent from the province of São Paulo. The line opened to regular traffic in late 1867, and collected guaranteed dividends from the government until 1873.¹⁷ Performance improved after 1873 and the company began to share its profits with the province, repaying all the guarantees by 1887. Profit splitting ended in 1889 when the company renounced its claim on any future guaranteed dividends.¹⁸ The San Paulo Railway never extended its line beyond Jundiaí, expanding only in 1904 when it acquired a small feeder line, the Companhia Bragançana.¹⁹

railways north of Espírito Santo and south of Alagôas. These fanned out through the state of Bahia and, like many of the government-owned lines in the south, by 1913 were leased to a French concern.

¹⁶ El-Kareh, *Filha branca de mãe preta*, pp. 117-28; Figueira, *Memória histórica da Estrada*, pp. 45-50; Pessoa, *Guia da Estrada*.

¹⁷ da Camara, *Chemins de fer*, pp. 5-23; Lewis, *Public policy*, p. 12; Pinto, *História da viação pública*, pp. 182-3; San Paulo Railway, *Report of the Board of Directors*, 2/1889 (hereafter *RSPR*).

¹⁸ Lewis, *Public policy*, p. 12; Pinto, *História da viação pública*, pp. 182-3.

¹⁹ See *RSPR*, 1904.



Figure 1. Six of Brazil's main railways in operation c. 1910

Sources: Duncan, *Railways in Brazil*; 'Carta da Viação Ferrea do Brasil'

The Companhia Paulista's guaranteed dividend of 7 per cent came wholly from the provincial government in São Paulo.²⁰ So heavy was the demand for its services that when it opened in 1872 it almost immediately proved not to need the guarantees. Half of its profits in excess of 10 per cent went to the province until 1876. The Paulista soon renounced its claim on provincial guarantees, and reimbursed the province between 1874 and 1882. The company expanded continually, constructing new track and acquiring a British-owned line, the Rio Claro Railway, in 1891.²¹ The Companhia Mogiana's guaranteed dividends on two branches also came from the province, and it further enjoyed central-government guaranteed dividends stipulated in the imperial railway legislation of 1873.²² It completed guarantee repayments to the provincial government in 1886.²³ Thereafter some of its constituent lines continued to be worked under central government guarantees and the Mogiana received those guarantee payments until 1913.

Established under the 1873 legislation, the Great Western of Brazil opened to traffic in 1881. Like most of the railways in Brazil's north east, it collected guaranteed dividends during every year it operated until the turn of the century.²⁴ In 1900 the Brazilian government began to purchase guaranteed railways in the north east that had never returned a profit.²⁵ Most of the financially less remunerative lines in the region had long been under consideration for government 'recapture'.²⁶ The Great Western leased many of these lines, along with some that had been owned and operated by the government itself since the 1880s.²⁷ As part of these arrangements the Great Western renounced its claim on dividend guarantees after 1900.²⁸ In contrast, the Leopoldina Railway began as a Brazilian-owned company.²⁹ The route first opened to traffic in 1874, and incorporated smaller lines during the 1880s.³⁰ Saddled with an untenable debt load by the late 1880s, the Leopoldina reorganized and changed its name in 1891.³¹ By 1892 it had failed, and was placed in receivership by the courts.³² Bondholders of the Leopoldina and its

²⁰ Costa, *Viação ferrea do Brazil*, pp. 287-8; Debes, *A caminho do oeste*; da Camara, *Chemins de fer*, pp. 27-8; Mattoon, 'Companhia Paulista'; Pinto, *História da viação pública*, pp. 36-46; de Saes, *As ferrovias de São Paulo*, pp. 54-67.

²¹ Companhia Paulista, *Relatório, 1894* (hereafter *RCP*).

²² Costa, *Viação ferrea do Brazil*, pp. 79-81; Pessoa, *Estudo descritivo*, pp. 158-60; Great Western of Brazil Railway, *Report, 1881-1900* (hereafter *RGW*).

²³ Pinto, *História da viação pública*, p. 185.

²⁴ Costa, *Viação ferrea do Brazil*, pp. 79-81; Pessoa, *Estudo descritivo*, pp. 158-60; *RGW, 1881*.

²⁵ Rodrigues, *Resgate das estradas de ferro*, passim.

²⁶ de Queiros, *O resgate da estrada*.

²⁷ On the government-owned lines in the north east, see Rego, *Inquérito sobre as estradas de ferro*.

²⁸ *RGW, 1901*. By 1909 it had incorporated the lines of the defunct Imperial Brazilian Natal and Nova Cruz Railway Company Limited, the Alagoas Brazilian Central Railway and its branch line the Central de Pernambuco, the Recife and San Francisco Railway, the Paulo Affonso, the Sul de Pernambuco, and the Conde d'Eu railways. Pinto, *História da viação pública*, pp. 111-41; Brazil, Ministério da Viação e Obras Públicas, *Relatório, 1909, 2*, pp. 107-20 (hereafter *RMVOP*).

²⁹ Costa, *Viação ferrea do Brazil*, p. 325.

³⁰ Jacob, *Minas Gerais no XXo século*, pp. 487-97.

³¹ *Statist*, 29 (1892), pp. 438-9.

³² Siqueira, *Resumo histórico*, pp. 12-8.

connecting lines hammered out a reorganization agreement in London and Brazil, and the railway was reborn as the Leopoldina Railway Company in 1898.³³ The new company, owned largely by British shareholders, operated with guarantees from both the federal government and the state of Minas Gerais.³⁴

II

The profit performance of the railways serves to address two issues. The first is the need for the subsidies. Whether or not shareholders in Brazilian railways needed guarantees to achieve competitive rates of return is revealed through recourse to two measures of profits. The first is the private profits realized by the railway, inclusive of guarantee payments, while the other is the profits of the railway under the assumption that it had been constructed and operated without the guarantees. This measure tests the hypothesis that the unaided private rate of return on the investment would have been less than the market rate of return. It reveals the extent to which the investment project actually required, *ex post*, a subsidy.

The second issue is the distribution of the gains that railways created in Brazil. The question of who captured those gains engages a central issue in the historiography. Whether or not foreign railways succeeded in earning high profits reveals the extent to which they might have directly contributed to Brazilian underdevelopment by siphoning off resources. On the other hand, Brazilian privately owned railways, like the British companies, received government profit guarantees as well. The extent to which the Brazilian companies enjoyed profits that were higher than those received by foreigners suggests the degree of preferential treatment they perhaps had received at the hands of their government. Moreover, since the Brazilian government itself owned and operated railways, the level of profits on those lines helps to reveal whether they served as revenue-producing instruments of fiscal policy, or instead generated extra rents for the shippers who used them.

Railway companies in Brazil had mixed experiences in terms of profitability. There are several different measures that serve to assess the private profits these railways earned. Estimates of the crude accounting rates of return for the railways, prepared separately and not presented here, reveal that all of them typically enjoyed positive net revenues. Most earned negative or small but positive profits only in the early years of their operation. Profits fell badly on all railways during the rapid inflation and exchange rate depreciation of the early 1890s. British lines petitioned for several consecutive years to put freight schedules on a sliding scale tied to the milrêis-sterling exchange rate before the government provided

³³ *Statist.*, 39 (1897), p. 531.

³⁴ Lines within the new system included, in Minas, the original Leopoldina lines; in Rio, the Príncipe do Grão Pará, the Cantagallo, the Sumidouro, the Carangola, the Macahé and Campos, and the Barão de Araruama lines; and in Espírito Santo the São Eduardo ao Muniz Freire, the Sul de Espírito Santo, and the Caravellas line: Brown, *South American year book*, pp. 71-8.

any relief. Eventually all the São Paulo lines were permitted to employ such sliding schedules.³⁵ The low profits obtained by railways in the early years of high inflation effectively transferred income to the consumers of freight services, then to regulated rates and a rising price level.

Four factors militate against relying solely on the accounting measure of profit to assess the guarantee policy. The first is the peculiarities of nineteenth-century railway accounting in Brazil, and these were several. Railway capital was rarely depreciated, leading to an overstatement of the capital stock. Operating costs often included both replacement expenditures and new capital outlays, which should have appeared in the capital account. That they did not leads both to an understatement of net revenues and to further distortions in the measures of capital. The second factor is the very nature of the cost and earnings profiles of railways. Railways embodied investments that were long in maturing. The impulse to new production in the regions served by the railway, and the associated increase in the volume of traffic over time, meant that profits in early years could be consistently low or even negative, yet quite high in later years. While such 'construction ahead of demand' helps to reveal the developmental impact of the railway, widely varying annual rates of return across the years make it difficult to assess correctly the 'average' return to the line for the period under consideration. Third, contributing to the varying returns each year was the working of the Brazilian guarantee scheme. Lines that proved privately successful in the long term and repaid their dividends to the government in effect enjoyed a subsidy in the form of an interest-free loan. This made their profits appear high when they were receiving subsidies, and low in the years when they repaid them. Railways which did not repay their guarantees until many years after they had initially received them (or which in some cases never repaid them at all) clearly came out ahead by having to repay no more than the nominal value of the total payments received. Finally, in addition to the practical difficulties in accounting for profits on Brazilian railways, it turns out that the very measure of the annual accounting rate of return is inherently biased in an indeterminate direction.³⁶

The internal rate of return provides the correct summary measure of the 'average' profitability of the railway. It properly discounts and weights each year's revenues, costs, and capital outlays, and takes into account the value of the railway at the end of the period. The internal rate of return is the level of profitability for which the present value of the railway is zero:

$$PV = \sum_{t=0}^T \frac{(R_t - C_t - I_t)}{(1 + r_t)^t} + \frac{V}{(1 + r_t)^T} \quad (1)$$

³⁵ Mattoon, 'Companhia Paulista', p. 149.

³⁶ Accounting rates of return equal the true economic rate of return only if the depreciation schedule is the time-rate-of-change of the present value of the cash flow stream. To the extent that the stream is not constant, the accounting return can depart dramatically from the true return. In the case of railways, cash flow streams are rarely constant. See Stauffer, 'Corporate rates of return', pp. 466-7.

where PV is the present value of the railroad, R is operating revenues in each year, C is operating costs, I is capital expenditures, t is a time subscript indicating the year of operation, T is the time period corresponding to the final year considered (1913), V is the value of the railway in the terminal period, and r_i is the internal rate of return.³⁷

Revenues (R) and costs (C) for the six railways come directly from company reports and are deflated by the wholesale price index for Rio de Janeiro.³⁸ The accounts of the British-owned railways, usually kept in pounds sterling, were converted to milr eis.³⁹ Annual investment expenditures (I) for each company are the first difference of the deflated, end-of-year capital stock series. Those figures derive from the total assets reported in each company's balance sheet. The capital stock is taken to equal the sum of outlays on construction and physical assets. The accounts themselves contain a number of potential sources of dilution. Securities, particularly on the Brazilian-owned lines, were often issued at discount and may have been used on occasion as payments to contractors, although no evidence exists to suggest that shares or bonds of the railways themselves were ever used to pay dividends. Each railway's book value was thus adjusted to include the value of all track, structures, rolling stock, furniture, and the like, while excluding non-earning assets (e.g., stock put up by the firms' directors), and assets of dubious value (unpaid debts to the company). Refinements of this sort proved impossible on the San Paulo Railway, and its book value proxies the capital stock. Since its book value changed to reflect the doubling of track, and the acquisition of the Bragantina line, it is likely that this provides a reliable measure of investment expenditures. For all railways, both operating expenditures (C) and investment expenditures (I) in these reports contain part of the capital outlays. Replacements and new investment often appeared, in varying degrees, under operating costs. However, since both categories of expenditures appear in the numerator of equation (1), the total capital expenditures, irrespective of accounting category, enter into the identity in the proper manner.

The internal rate of return permits ready comparison between the profits inclusive of subsidies and the hypothetical unsubsidized profits. The unaided rate of return differs from the aided rate by stripping from the net earnings stream both the government guarantee payments and, where appropriate, repayments by the firms. The difference between the two measures equals the subsidy implicit in the guarantees.⁴⁰ To estimate

³⁷ Since there is no closed-form solution for r , it is calculated in expression (1) using numeric techniques. Because the expression is a polynomial it has multiple positive real roots, or more than one real positive r for which PV is zero. In practice the minimum positive real value for r is obtained here by finding the value of r for which slightly increasing and decreasing r causes PV to change sign.

³⁸ Cat ao, 'New wholesale price index'. The index is extended backwards from 1870 to 1855 by regressing it on an index of consumer prices in Rio de Janeiro.

³⁹ This was done taking care to use the companies' accounting rates of exchange for the period 1885-94, during which accounting rates departed from the market rates.

⁴⁰ This comparison embodies an important assumption, namely the separability of guarantees from rate regulation. If the rate regulation were lifted and railways permitted to set rates freely, it is likely that the unaided return would increase.

the hypothetical unaided internal rate of return, equation (1) is modified as:

$$PV = \sum_{t=0}^T \frac{(R_t - C_t - I_t - G_t)}{(1 + r_i)^t} + \frac{V}{(1 + r_i)^T} \quad (2)$$

where G is the stream of net guaranteed dividend payments in any period (guaranteed dividends received from the government minus any dividends repaid to the government).⁴¹ Table 1 presents the estimates of the aided and unaided internal rates of return computed in this way, by railway.

Table 1. *Aided and unaided internal rates of return on Brazilian railways*

<i>Railway</i>	<i>Period</i>	<i>Unaided internal rate of return (%)</i>	<i>Aided internal rate of return (%)</i>
Estrada de Ferro Central do Brazil (Dom Pedro II)	1855-1913	4.6	6.4
San Paulo Railway Company	1867-1913	7.9	8.4
Companhia Mogiana	1875-1913	9.0	10.2
Companhia Paulista	1872-1913	12.7	12.9
Great Western of Brazil	1880-1913	4.3	7.3
Leopoldina Railway Company	1898-1913	7.7	8.1

Note: The rates of return are computed for each railway in accordance with the procedure outlined in the text. Unaided rates of return exclude dividend payments from the government and repayments by railways. The aided rates of return include both.

Whether or not the unaided rates of return on these railways would have been sufficient to attract the needed capital depends on the opportunity cost of those funds, as revealed by the returns on similar investments. In Brazil a limited range of long-term investment options was available in this period. Because of the guaranteed dividends, these railways were relatively riskless for individual shareholders. A relatively riskless alternative for investors was to hold government debt, issued both in Brazil and in Europe. Observations of the earnings-price ratio for various Brazilian government bond series from 1854 to 1913 range between 4.6 per cent and 8.2 per cent. These rates indicate the instantaneous return on relatively riskless investment alternatives to railways.⁴² Although there was some variability in these returns, particularly during the financially unstable 1890s, the typical rate hovered between 5 and 7 per cent per annum.

In the light of return on bonds, only the Great Western and Central do Brazil demonstrated a need for subsidies based on their unaided profits. Of course after 1865 the Central was a government-owned line, and it did not really 'need' any particular return. None of the state railways in Brazil were run for profit. The Central regularly incurred operating losses. Yet it concentrated the benefits of cheap transport in

⁴¹ G , the guarantee, is positive in the case where the company receives payments from the government, and is negative when the company makes repayments to the government.

⁴² These are end of year quotations from the *Jornal do Comércio* and the *Investor's Monthly Manual*.

one of the politically most important regions of the country. By contrast, its losses were spread between all taxpayers. The degree to which the Central's rate of return diverged from that of the privately owned lines indicates the success that its customers had in extracting low freight rates from the government. The other four railways enjoyed unaided profits that exceeded the rates of return on bonds. Their average earnings were sufficiently large to make the subsidies unnecessary when considered *ex post*. The excess of the subsidized rate of return over the unsubsidized return was inefficient, but relatively small. The 'unnecessary' nature of the guaranteed dividends on those railways in no way diminishes their role. Guaranteed dividends settled the nerves of investors who were confronted with an opportunity to undertake projects with unknown prospects. While subsidies were redundant in these cases, the commitment to make them served an important purpose at the outset. It assuaged investor concerns, attracting railway investment that Brazil otherwise would have had to pay much more to obtain, if this were even possible. Whether or not the subsidies to railways comprised a net loss to Brazil depended on the social rates of return on the capital invested in each railway.

III

Gauging whether a subsidy was justified requires that the market rate of return exceeds the profits of the railway, and that the railway's social rate of return exceeds the private benefits enjoyed by its owners. The internal rate of return presented in the previous section provides a measure of the 'average' profitability during the period under consideration. However, it misses the larger set of benefits created by the railway through the reduction in transport costs. To remedy this omission, two measures of the social return on the investment in each railway are estimated: the social rate of return, and the benefit-cost ratio. Both add to the profits of the railway a measure of the external benefits arising from the savings on transport costs. High social rates of return reveal a railway that is desirable because of its contribution to raising the level of income and output in the region it serves. If the issue of under- or over-investment in a particular railway project were a matter of concern, the marginal social rate of return would be the desired measure.⁴³ Whether or not 'too much' or 'too little' was invested in the guaranteed railways is an interesting question, but it is not addressed here. The average social rate of return indicates whether the benefits conferred by the railway exceeded returns to investments in other projects available at the time.⁴⁴

⁴³ Only under specific conditions can the average social rate of return be taken to be, or manipulated to equal, the marginal rate: McClelland, 'Social rates of return'.

⁴⁴ The usefulness of the approach is underscored by a voluminous historical literature using it to offer new insights on the consequences of specific transport projects: Carlos and Lewis, 'Profitability of early Canadian railroads'; Coatsworth, 'Impact of railroads', pp. 140-2; Davidson, 'Benefit cost analysis'; Fishlow, *American railroads*; Fogel, *Union Pacific Railroad*; Mercer, *Railroads and land grant policy*; Ransom, 'Social returns'.

Table 2. *Average social rates of return on Brazilian railways, 1855-1913*

<i>Railway</i>	<i>Period</i>	<i>Unaided social rate of return (%)</i>
Estrada de Ferro Central do Brazil (Dom Pedro II)	1855-1913	18.0
San Paulo Railway Company	1867-1913	15.4
Companhia Mogiana	1875-1913	27.5
Companhia Paulista	1872-1913	26.6
Great Western of Brazil	1880-1913	15.0 (11.4)
Leopoldina Railway Company	1898-1913	15.9

Note: the social rate of return adds an estimate of social benefits to the measure of the internal rate of return in table 1. The parenthetical result for the Great Western employs a social benefits stream derived under the assumption of underutilized resources, as described in the text.

The average social rate of return on the investment in the railway is given by r_i when the present value of the railway is set to zero:

$$PV = \sum_{t=0}^T \frac{(R_t - C_t - I_t - G_t + B_t)}{(1 + r_i)^t} + \frac{V}{(1 + r_i)^T} \quad (3)$$

where B_t is a measure of the external benefits, r_i is the social rate of return, and all other variables are the same as in equation (2) above. No attempt is made here to render a social valuation of V . Table 2 presents the average social rates of return by railway.⁴⁵

The second measure, the social benefit-cost ratio, applies a social rate of discount to the streams of social benefits, private profits, and investment outlays. The benefit-cost ratio is calculated as:

$$B/C = \frac{\sum_{t=0}^n \frac{(R_t + B_t)}{(1 + r_d)^t} + \frac{V}{(1 + r_d)^T}}{\sum_{t=0}^n \frac{(C_t + I_t + G_t)}{(1 + r_d)^t}} \quad (4)$$

where r_d is a measure of the social rate of discount each year. Because guaranteed dividends were a cost to the economy of securing the investment in the railway they appear in the denominator. In spite of conceptual ambiguities involved in determining the social rate of discount, the estimate in equation (4) uses the government bond rate.⁴⁶ Benefit-cost ratios greater than one indicate that the railway was a project that could be justified in terms of the gains it made possible. Benefit-cost ratios less

⁴⁵ Computing the social rate of return here is done with numeric techniques in the same manner as for the internal rate of return.

⁴⁶ Layard and Glaister, eds., *Cost-benefit analysis*, pp. 25-44; Rosenthal, *Fruits of revolution*, pp. 103-10.

than unity show that the railway cost the economy more than it was worth. Table 3 reports the social benefit-cost ratios, by railway.

The social benefits of the railway project in each period (B_t) are the resource savings created by the railway and received by the users of transport services.⁴⁷ No single measure of social benefits prevails in the literature. Two approaches to measuring the magnitude of social benefits from transport improvements are prominent in the literature. Railways shrink the transport cost 'wedge' between suppliers and consumers. The resulting increase in farm gate prices shows up in the relatively scarce factor of production, and the increase in the agricultural producers' surplus reveals itself as higher land values.⁴⁸ Estimating the social benefits in this manner for Brazil is prohibitively difficult. Instead, the method here is to measure the magnitude of the total savings on shipping freight for each railway.⁴⁹ Thus, both the social rate of return and the benefit-cost ratio encompass the streams of producers' and consumers' surpluses created by the railway.

The magnitude of the savings in transport costs depends first on the unit savings, and second on the volume of freight service produced.⁵⁰ Because the unit savings for Brazil prove to be large, a conservative estimate of the social benefits is employed in order to reduce the risk of overstating the gains each railway created. Unit savings each year equal the difference between the ton-kilometre charge for carrying freight by rail, and the prevailing best-practice freight charge in the immediate pre-rail era. Pre-rail charges were high, because animal-drawn carts and mules supplied the bulk of Brazil's overland pre-rail freight service. Pre-rail shipment occurred, however, within a competitive industry. The technology dictated a small unit of production (typically muleteers operating with a modest number of mules), with few barriers to entry and many suppliers. The pre-rail charges, derived from contemporary sources, indicate the marginal social cost of pre-rail freight service. Railway profits, estimated in the preceding section, suggest that rail rates departed systematically from cost. This poses few problems for the analysis here, since on most railways profits equalled or exceeded the competitive rate of return. In those cases the rail charges overstate resource costs, and using them to calculate unit savings merely understates social benefits. On the Great Western and on the Central the regulated freight charges may have been less than cost, with the effect of overstating slightly the unit savings.

The second factor bearing on the magnitude of the social benefits is the level of freight service. This in turn depends first on the volume of freight service actually supplied by rail, and secondly on the volume that

⁴⁷ In this case what is being redistributed would be income from the pre-rail transport sector, to the consumers of transport services in the economy once it had railways.

⁴⁸ Fogel, *Union Pacific Railroad*, pp. 101-3; Mercer, *Railroads and land grant policy*, pp. 227-32.

⁴⁹ The change in the consumers' surplus in the market for freight transport services measures the sum of the increases in consumers' and producers' surpluses in the markets for transportable goods that result from the decline in the cost of shipment.

⁵⁰ Passenger benefits are ignored, which biases downward the measured social benefits from the investment project. Excluding them does not leave out much, however. In fact, most railway revenues stemmed from freight services. Moreover, unit transport cost savings were greater on freight.

would have been supplied in the absence of railways. While actual levels of service derive from rail reports and government surveys, the level of freight service that would have prevailed in the absence of those railways is unobservable. However, it can reasonably be inferred from the actual levels.⁵¹ For each of the Brazilian railways the estimates incorporate two key assumptions: first, the demand schedule for freight services in the market served by each railway was linear, and, second, at the prevailing pre-rail freight charge absolutely no freight was shipped. The social benefits in any year are:

$$B_t = \frac{1}{2} Q_t (P_m - P_{rt}) \quad (5)$$

where Q_t is ton kilometres supplied by rail in year t , P_{rt} the rail charge per ton kilometre in year t , and P_m the ton-kilometre charge for pre-rail shipment. This measure implies that all the freight carried by rail resulted from the reduced cost of shipment. While this is obviously 'wrong'—substantial freight was shipped at pre-rail rates in Brazil, and that is precisely why those rates are available—it ensures that the resulting social benefits stream is not overstated. Indeed, such a strong assumption potentially does serious damage to the magnitude of the estimated benefits. That they will prove to be large under such restrictive conditions inspires confidence in the argument that benefits on the lines that were constructed under the guarantee scheme were sufficient to justify subsidies to railways whose private returns were low.

Unit charges on each railway, taken as the average freight revenue per ton kilometre, are adjusted to 1913 levels using the price index of the previous section. On the São Paulo lines (the San Paulo, Paulista, and Mogiana) the pre-rail freight charge derives from the major trade routes in São Paulo. That rate comes to 0.832 milrêis per ton kilometre when adjusted to 1913 prices.⁵² The pre-rail charges cited by contemporaries for the regions served by the Central and the Leopoldina lines are particularly high, so the São Paulo pre-rail rate is employed there as well. For Brazil's north east, fewer quotations are available. Contemporary observers and government officials did note the typical range of charges imposed. The unit savings employ the lowest of the available pre-rail charges as a likely dry-season rate for the freight carried by the Great Western. That charge comes to 0.706 milrêis per ton kilometre in prices of 1913.⁵³ Special conditions in the region served by the Great Western warrant additional consideration. Throughout the 1870s and 1880s successively severe droughts hit Brazil's north east, profoundly disrupting

⁵¹ Studies of transport projects that calculated social benefits using freight shipments (as opposed to changes in land values) handled the issue in various ways. See Mercer, *Railroads and land grant policy*, p. 237; Davidson, 'Benefit cost analysis', p. 131; Carlos and Lewis, 'Profitability of early Canadian railroads', pp. 415-6; Coatsworth, 'Impact of railroads', p. 140; Ransom, 'Social returns', p. 1046.

⁵² The charge is an average of monthly spot observations for five major routes, reported in the *Correio Paulistano* in 1864. In 1913 the milrêis exchanged for \$0.32 US.

⁵³ Great Britain, *Commercial Reports* (P.P. 1865, LIII), pp. 53-4.

the regional economy. If drought conditions rendered the region's labour and animal resources underemployed for part of this period, then the pre-rail freight rate from 1858 fails to reflect the alternative costs of freight shipment. In the context of underutilized resources, shadow prices diverge from market rates. To adjust for this possibility a second measure of social benefits on the Great Western uses the prevailing non-rail freight charges during the drought period. The freight rate employed in that calculation is 0.421 milréis when adjusted to 1913 levels.⁵⁴

Unit savings derived in this way are calculated every year for each railway. For all lines, rail freight tonnage in each semester or year usually comes from company reports. Where necessary these figures exclude livestock, parcels, and freight shipped on the railways for constructing extensions, or otherwise in the 'service of the line'. Converting tonnage into units of ton kilometres posed a significant challenge, given the relative paucity of information on the average length of haul. For some early years, and all years after 1897, the average haul was given in company reports. For every line in earlier years at least part of the series of average haul had to be either interpolated or extrapolated, as outlined in the appendix. Whenever the average haul was derived in this way it was done in a manner that reduced the chances of overstating the level of freight service.

The social rates of return presented in table 2 reveal that the gains from cheap transport produced by each of these railways were large and positive. All exceed both the private internal rates of return to these same railways, presented in table 1, and the market rates of interest. On the São Paulo railways the presence of strong profits in the context of high social rates of return confirms the general vibrancy of the region's economy in this period.⁵⁵ Large social returns in the context of low private profits, such as the case of the Central, indicate the extent to which the government-owned railway was subject to 'hold-up' in the political arena by shippers seeking cheap freight rates. The social returns on the Central do Brazil and San Paulo Railway were less than those encountered on the Mogiana and Paulista. This is due in part to the fact that both the San Paulo and the Central double- and triple-tracked lengthy sections of line in the 1880s and 1890s. Their respective levels of physical capital were thus relatively large in relation to output levels before 1914, reducing somewhat the social rates of return. The capital-output ratio was also high on the Central because of the decline of export agriculture during the last decades of the century in much of the region it served. The British-owned Leopoldina faced competition from the government-owned Central, and similarly exhibited lower social returns than the San Paulo railways. The social returns on the Great Western were no lower than those on the San Paulo Railway or the Leopoldina, so long as one assumes that the pre-rail charge in the north east is appropriate for

⁵⁴ Coutinho, *Estradas de ferro do norte*, p. 13.

⁵⁵ It should be noted, however, that coffee's share of total shipments on these lines declined with time. What was important was the region's rich agronomic endowment more generally.

calculating the savings on unit costs. Even if the non-rail freight rate prevailing in time of drought is the more appropriate alternative, the social returns indicate benefits of an impressive magnitude to the region. All these estimates for Brazilian railways compare favourably with similar calculations for particular railways in the United States, Canada, Australia, and Mexico.

Table 3. *Benefit-cost ratios on guaranteed Brazilian railways, 1855-1913*

<i>Railway</i>	<i>Period</i>	<i>Benefit-cost ratio 'A'</i>	<i>Benefit-cost ratio 'B'</i>
Estrada de Ferro Central do Brazil (Dom Pedro II)	1855-1913	2.4	1.7
San Paulo Railway Company	1867-1913	3.2	2.2
Companhia Mogiana	1875-1913	2.7	2.3
Companhia Paulista	1872-1913	3.3	2.7
Great Western of Brazil	1880-1913	1.5	1.1
Leopoldina Railway Company	1898-1913	2.0	1.5

Note: benefit-cost ratios are derived as described in text. The 'A' ratio assumes a social rate of discount of 4.59%. The 'B' ratio takes 8.18% to be the social rate of discount.

The benefit-cost ratios for each of the railway projects, presented in table 3, support the conclusions derived from the social rates of return. Because of the uncertainty over which of the government bond yields to employ as the social rate of discount, and breaks in the various bond series, table 3 presents two benefit-cost ratios for each railway. The first (ratio A) discounts both the numerator and denominator of equation (4) using a social discount rate of 4.59 per cent, the lowest non-gold bond yield observed in the period 1856-1913. The second (ratio B) uses a discount rate of 8.18 per cent, the highest observed yield. The two extreme bond rates test the sensitivity of the benefit-cost measures to widely divergent values of the social rate of discount. The resulting benefit-cost ratios exceed unity, irrespective of the discount rate employed. Even though the measure of benefits is understated, the understated gains were as much as three times as great as the outlays on the railway. Benefit-cost ratios are highest for the São Paulo railways, which exhibited the greatest overall traffic densities. Relative to costs, benefits were lower for the Leopoldina and Central, and only on the Great Western did the ratio edge down towards the social break-even point. Since the government-guaranteed dividend payments are excluded from the benefits stream, the social rates of return of table 2 and the benefit-cost ratios of table 3 are unsubsidized, and thus are net of the direct transfers that would inflate their magnitudes. Importantly, in terms of the benefits accruing to the Brazilian economy, all these investments paid for themselves, some several times over, in the decades before 1913.

Railways that were smaller and carried less traffic than the six considered here quite possibly had different experiences. For example, the British-owned lines that were integrated into the Great Western after the turn of the century had poor profit records before 1900. Unsatisfactory financial performance, even with guaranteed dividends, was a perennial

source of complaint from shareholders in some companies.⁵⁶ Occasionally railways engaged in regulatory conflicts with the government, which could reduce their allowable charges under the guarantee programme.⁵⁷ Many small companies operated lines in areas where sufficient traffic levels never developed.⁵⁸ At the same time, shareholders in those troubled companies may have laboured under unrealistic expectations. Observers abroad held the San Paulo Railway in envy, noting that 'it has paid dividends that would make the mouths of shareholders of many of the English railways water'.⁵⁹ The same source went on to blame the poor location of the less profitable lines on Brazilian political influence in locating the concessions for foreign-owned railways. Profitable railways were, of course, located under the same political pressures. None the less, smaller lines with low profits, and low traffic levels, may well have had low social returns. If correct, the regional-distributive content of the Railway Law of 1873 worked to benefit heavily shippers of freight, at the expense both of shareholders and of taxpayers elsewhere in Brazil.⁶⁰

Whether or not the guaranteed investments in railways brought the highest social return possible to Brazil is unknown in the absence of estimates of the social rate of return on alternative projects—realized or forgone—in this period. It is quite likely that other activities that received guaranteed dividends in nineteenth-century Brazil, such as central sugar mills, exhibited social returns that were low or even negative. In those cases, guarantees simply redistributed income within Brazil, instead of saving resources. Moreover, projects that were never realized (such as investments in public education) might well have brought higher returns still. Since those projects are not observed, the return on railway investments can only be compared with returns on projects revealed to be historically feasible. By comparing the social rates of return on these railways with bond yields, and their own private profits, it is clear that all six of the major railways made for impressive material gains in the regions they served.

The private and social returns to railway investment were inherently interrelated. Even though railways created large social returns, realizing those projects required a mechanism that would reduce the gap between those social returns and the expected private return to investors. The state provided this mechanism.⁶¹ Government-guaranteed dividends attracted investments in railway projects that made an important contribution to the Brazilian economy. Only two of the railways studied here needed those subsidies to achieve competitive rates of return, and one of those was government owned for most of the period. The excessive subsidies were not, however, exceptionally large. Only if one could specify a

⁵⁶ *Economist*, 57 (1899), pp. 1495-6; *Statist*, 34 (1894), pp. 327-8.

⁵⁷ *Statist*, 21 (1888), pp. 566-7.

⁵⁸ *Economist*, 57 (1899), p. 609; *Statist*, 34 (1894), pp. 327-8.

⁵⁹ *Economist*, 57 (1899), pp. 756-7.

⁶⁰ Testing this 'low social return-low private return' hypothesis for that subset of railways of lesser importance must await the location of more complete sources for them.

⁶¹ North, *Structure and change*, p. 16.

historically feasible alternative investment project with higher social returns could any of the railways here be considered to have been a drag on the Brazilian economy in any way. Railway technology and investment brought with it the potential to reduce transport costs in Brazil by an impressive degree. The extent to which that potential was realized turned in large part on the rates that each company charged to carry freight.

IV

It is not possible to disentangle completely all the factors accounting for differential profitability on the guaranteed railways. None the less, even after taking into account differences stemming from regional location and endowments, the interrelated factors of politics, regulation, and ownership come to the fore. The financial success that each railway company stood to enjoy, and the benefits accruing to the region it served, hinged on the rates the railway charged. Left unregulated, most railways in Brazil would have been textbook natural monopolies. Railways charging very high rates could succeed in capturing handsome profits for themselves, yet simultaneously reduce the total gain to the economy. From the outset Brazilian policy makers were sensitive to the potential problem of monopoly pricing, and protecting landowners from high rail charges led the government to guard against such monopoly power. Regulating the rates on these railways was an attempt to keep the benefits to consumers of freight transport services high. Supplying the dividend guarantees in the context of regulation allayed investor concerns and ensured for them a portion of the benefits. Individual railway concessions prescribed the maximum allowable rates for freight and passenger services, and rate regulation was a key determinant of profitability.

Considered together, profits, guarantee payments, and rate regulation provide insight into the main distributive and income-creating aspects of the government's involvement in the railway sector. Freight rates were regulated from the outset by a legislature that set rates directly in many cases, and by ministries authorized by the legislature to adjust rates within certain guidelines in the other cases. The analysis of rate regulation here assumes that legislators chose policies that garnered electoral support for them.

Policies adopted by legislators need not necessarily correspond to any criteria of economic efficiency. Only in the case where market failures are widespread would regulation improve efficiency. In Brazil, both the high costs of pre-rail transport and the need to regulate railway rates were sufficiently pervasive that government policies stood to create real gains. An efficient regulatory policy, x , would maximize the social surplus; that is, it would be one where the marginal benefit of regulation equals the marginal social cost of the policy⁶²:

⁶² The basic model of the legislator's choice in a setting of distributive politics is adapted from Weingast et al., 'Political economy of benefits and costs'.

$$P(x) = B(x) - C(x)$$

where the most efficient level of rates, x^* , is set so that

$$B'(x^*) = C'(x^*).$$

Politicians did not share the economy's efficiency criterion. In seeking to garner electoral support they could easily adopt policies that diverge from the most efficient ones. Politicians consider not simply benefits and costs, but the incidence of the various components of costs and benefits in their respective districts. A simple variant of this electoral support model of regulatory policy making disaggregates the benefits of regulation into those internal and external to the district. It also disaggregates the costs within each district that arise as negative externalities. A legislator considers how all of these bear on his political support in choosing x , a regulatory policy:

$$N_i(x) = B_{i1}(x) - C_{i2}(x)$$

where $N_i(x)$ is the political support that legislator i expects from regulatory policy x , $B_{i1}(x)$ are the benefits of the project within the district, and $C_{i2}(x)$ are the indirect costs borne by the district.

In Brazil, the outlays on railway regulation were negligible. In the case where the railway was 'over'-regulated, reducing its revenues below (total) cost, the government had to pay the guaranteed dividends, thus creating a tax burden from the policy. However, in that case the costs were spread across Brazil's tax base, and the district had to bear only part of the burden. The tax incidence is disregarded here.⁶³ The politician equates the marginal electoral gains from the policy to its marginal electoral costs. The key insight here is that indirect costs weighing on districts in Brazil varied with railway ownership. For a railway with predominantly Brazilian owners, the costs within the district were positive, since regulation reduced shareholder profits. In that case, the legislator would choose less regulation. For a railway with predominantly British ownership (or complete public ownership), those costs were zero, no such countervailing force on regulation existed, and tighter control of rates prevailed. With no railway owners among the district's voters, the electoral costs arising from shareholders who receive lower profits were of no concern to the legislator.

Guided by the internal rates of return above, and the simple model of policy choice, the hypothesis that emerges is that ownership and operation of railways by either the state or foreigners is associated with lower freight rates. Indeed, it may reasonably be inferred that the political 'distance' separating each company's shareholders from the regulatory apparatus of the Brazilian government accounts in large part for the differing profit experiences of these railways. That Brazilian shareholders in domestic railways comprised an important political constituency suggests that they

⁶³ Because monetary policy in the 1890s depreciated the exchange rate, increasing dramatically the cost of railway dividend guarantees, the setting aside of the tax argument in the maximand may be considered to be out of place. However, rate regulation was present from the outset in Brazil, while the rapid increase in the cost of guarantees was transitory.

enjoyed some success in resisting downward pressure on rates. It is likely that British shareholders were less effective in this regard because they had less direct representation within the political system. In this context, ownership made a difference in the division of the surplus made possible by the investment. While the rates of return suggest this hypothesis is plausible, it must be completed via the linkage through freight rates. A rough test of the rate-setting hypothesis is specified in the following form:

$$\text{Rate} = \alpha + \beta_1 \text{Export} + \beta_2 \text{State} + \beta_3 \text{Foreign}$$

where Rate is the railway's charge to carry 1 ton for 100 kilometres on various agricultural commodities, Export is a dummy on high unit-value products bound largely for export, State is a dummy for government ownership and operation, and Foreign is a dummy for foreign ownership or operation.

Table 4. *Regression results: determinants of agricultural freight rates on Brazilian railways, 1909*
(Dependent variable: charge per tonne for 100 kilometre haul)

Independent variables	Sample (6 railways)	Sample (19 railways)
Constant	9.57 (7.65) ^a	11.98 (15.5) ^a
Export	14.7 (11.2) ^a	12.4 (12.5) ^a
State	-4.13 (-2.14) ^b	-2.33 (-1.43) ^c
Foreign	-1.52 (-1.04)	-3.8 (-3.3) ^a
R ²	0.61	0.38
N	88	282

a significant at the 1% level

b significant at the 5% level

c significant at the 10% level

Notes: Rates are in Brazilian milr s. In 1909 the milr s exchanged for US \$0.31. The six-railway sample matches the six companies for which profits, social rates of return, and benefit-cost ratios are estimated in tables 1, 2, and 3. The nineteen-railway sample includes all lines for which rates were reported. Export denotes commodities for which a large share was production for export: coffee, rubber, hides, *herva mate* (tea), cacao, and tobacco. Excepted are rice, beans, manioc flour, wheat flour, and corn, along with goods traditionally exported, but by 1909 largely produced for consumption within Brazil, such as sugar and cotton. State indicates railways owned and operated by the government. Foreign is assigned to railways either owned outright by overseas companies, owned by the government but leased to and operated by foreign companies, or some combination thereof. Figures in parentheses are *t*-statistics.

Source: Brazil, Minist rio da Via o e Obras P blicas, *Relat rio, 1909*

Table 4 presents the results of two regressions on this specification for two sets of railways in 1909, one of the few years for which a cross-sectional survey of Brazilian freight rates exists. The six railways studied in the preceding sections comprise the first set, while a broader sample of 19 railways comprises the second. In both regressions foreign and state ownership are negatively associated with rates. The results support the hypothesis relating ownership to rates, and, implicitly, to profits, via

the political choice of regulation. Privately owned Brazilian lines enjoyed higher private returns in part because they had higher freight rates. British companies had less room for manoeuvre within Brazil's polity, and could not effectively make demands on Brazil's regulators beyond the guaranteed minimum returns. With lower freight rates, the British railway profits were less than profits on Brazilian-owned railways. The regulation of railway freight rates was an integral element of distributive politics in Brazil.

V

In the second half of the nineteenth century Brazil's guaranteed dividend policy attracted investments in railways that the country had failed to obtain previously. If the requirement that the social returns on these railways exceed the private returns was the sole criterion for evaluation, then subsidies would have been justifiable. Each line generated large benefits for the consumers of its services. With social rates of return that ranged from 11 per cent to almost 28 per cent per year, it is clear that the costs of railway investment were amply rewarded. However, the second criterion—that private profits be less than market rates of return—reveals that a number of Brazil's most indispensable railways enjoyed dispensable subsidies. Only two major railways failed to attain levels of profitability equal to or in excess of the market rates. For the four railways that did not need subsidies, the guarantee payments were a 'giveaway'. Had they not been paid, those guarantees would have accrued to Brazilian taxpayers. However, the magnitude of those transfers was not particularly large in comparison with the conservative measures of social benefits. Given the inability of policy makers to predict perfectly the future course of entire regions and economies, the gap between the subsidized and unsubsidized rates of return on those railways indicates a modest prediction error made by the officials who devised the guarantees.

The distribution of the gains from the railways that were established under the guarantee scheme may be considered in several dimensions. One is the national-versus-foreign division of the surplus produced by the transport investments. Foreigners did not fare disproportionately well in the period before 1914. British-owned railways did not exercise undue power or control over the streams of benefits that they created in Brazil. That is not to say that they did not desire that control. But if they did possess undue influence, it did not translate into unusually high profits relative to the returns to shareholders in privately owned Brazilian lines. As claimants on the residual gains that their railways created, British companies did not take an especially large share. What little power they did exercise—the ability to earn a competitive rate of return on their investments—came not from a privileged position within Brazil, but rather from the efficiency of the London capital market, which demanded over the long run risk-adjusted profits equal to those available elsewhere in the world. The very efficiency of that capital market made it all the easier for the Brazilian government to keep most of the surplus at home, since

all it had to do was guarantee a competitive rate of return. Brazilians assured overseas investors that they would earn at least that, even with rate regulation, by offering security through guaranteed dividends. Regulation worked to capture the rest of the surplus and keep it within Brazil. Indeed, because freight rates were set by Brazilian regulators, it was Brazilian-owned railways that probably enjoyed greater success in counterbalancing downward pressure on those rates by shipping interests. Just like the Brazilian consumers of transport services, Brazilian shareholders formed an influential political constituency. British shareholders, on the other hand, had less direct access to the regulation process, since they had only a limited voice in Brazil's political arena.

Where outright government ownership of railways existed, as was the case with the Central, no mediating institution protected the railway from the continuous clamour for lower freight rates. Government lines were objects of an enduring conflict over their potential use as revenue-generating instruments of fiscal policy versus their role as rent-generating machines of private wealth accumulation.⁶⁴ The gulf between the Central's profits, the market rates of return, and its social rate of return, shows that the last role was the one it ultimately played. With no defences there was little risk that it would ever be employed as a revenue enhancing enterprise by the government in the way that the National Prussian Railways were used.⁶⁵ Because it was government owned, it was the railway most subject to direct pressure for rate reductions, and thus proved to be a useful tool for politicians seeking to reward prominent constituencies. In Brazil, it was the predatory nature of politics, rather than predatory pricing, that kept returns to foreigners and to the government-owned line comparatively low.

The privately owned Brazilian lines fared best in terms of profits, but still created impressive streams of benefits for their customers. To the extent that the distribution of benefits between railways and their customers was skewed in Brazil, it was foreign shareholders who drew the short straw. Indeed, in contrast to the view of railways in Brazil held by adherents to dependency interpretations, the bulk of the rent generated by the investment in railways remained in Brazil.⁶⁶

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Appendix: data sources

The reports of railways organized in Brazil are found in Brazilian collections. For the Companhia Mogiana and the Companhia Paulista, a complete set of reports exists in the library of FEPASA, the state railway system, in the city of São Paulo. For the Estrada de Ferro Dom Pedro II (which later became the Estrada de Ferro Central do Brasil), semester and annual reports are on microfilm in the library of the RFFSA, the national

⁶⁴ Figueira, *Memória histórica*, pp. 889-911; *Statist*, 38 (1896), pp. 986-7.

⁶⁵ Fremdling, 'Freight rates and state budget'.

⁶⁶ See, for example, Burns, *History of Brazil*, pp. 160-1, 169; Evans, 'Continuities and contradictions', pp. 33-5.

railway system, in Rio de Janeiro. The British-owned companies—the Leopoldina, the Great Western of Brazil, and the San Paulo Railway—filed their reports with the London Stock Exchange. These are now held by the Guildhall Library in London. Official published sources in Brazil supplemented the figures available in the reports, and these may be found in the periodicals collection of the Biblioteca Nacional in Rio de Janeiro.

Constructing the internal and social rates of return for the six railways required data series for several variables. Annual estimates of operating revenues, operating costs, capital stock, freight service, and government profit guarantees and repayments for each company were compiled for the years before 1914. For the most part, this information derives directly from company reports. For the three British-owned lines these are the semester and annual reports issued to shareholders. For the Brazilian-owned lines similar information was appended to reports filed by government-appointed inspectors, or 'fiscal engineers'. Government studies and the contemporary railway press supplemented semester and annual company reports when necessary.⁶⁷ In a few instances linear interpolation provided estimates of the capital series for some railways.

Estimating the social benefits stream required measures of freight service for each railway. Output in units of ton-kilometres became widely reported only after 1897. Before then the reporting of output using this measure was irregular at best, requiring an estimate of the average haul. For each of the six railways several specifications of the statistical relationship between average haul and other variables (freight revenues, track in service, and tonnage) yielded weak results. The most significant results derived from regressing the average haul on a time trend. The parameters from railway-specific regressions made it possible to estimate the average haul in the years for which it was missing, subject to the constraint that average haul did not exceed the length of the line in service each year. In the years for which direct observations of output in ton-kilometres were not available, the freight output series is the product of the estimated average haul and the reported freight tons. Tonnage for each railway was available every year, except on the Central from 1858 to 1865. For those years the company's reports partitioned freight into weight, length, and volume categories. The output series used only the freight that was recorded by weight, further understating social benefits.

⁶⁷ These include São Paulo, Secretaria da Agricultura, *Quadros estatísticos das estradas de ferro*; Brazil, MVOP, *Relatório*; and Brazil, MVOP, *Estatística das estradas de ferro*.

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