"FOR THE PUBLIC BENEFIT"

RAILWAYS IN THE BRITISH CAPE COLONY

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"For the public benefit"? Railways in the British Cape Colony[1]

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Built mostly to support the early mining industry, the Cape Colony's railways reduced the cost of transport to the interior and increased labor productivity in the Colony from 1859 to 1905 by, we calculate, 30 percent. Little of the gains went to the state-owned company: the Cape parliament seems always to have seen the railways as a means to development. But the politically overrepresented western parts of the Colony gained much more than underrepresented areas like Basutoland or the Transkei. While boosting the economy, the railways also had distributional effects, with consequences for racial segregation in twentieth-century South Africa.

Keywords: railways, infrastructure, public goods, South Africa, social savings

JEL-code: N4, H4, O1

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1. Introduction

> Roads and railroads were for the public benefit, and in their construction they should not look forward to profit. (MP Robert Godlonton in the Cape Legislative Council, 1870)[4]

Late nineteenth-century economic growth and globalization were driven largely by the railways. This was particularly true of developing countries which, unlike the industrialized countries, had still to develop good transport infrastructure and well-integrated markets. South Africa at the beginning of the railway era had seen the growth effects of globalization only along strips of coastal land or close to navigable rivers. Across the periphery countries economic activity often followed the railway tracks and shaped the economic geography of many countries even long after railways had ceased to operate.

Railway construction was not spread evenly throughout the developing world. In Latin American countries, for instance, the density of the rail networks, per square mile and per capita, varied widely according to the degree of integration into the international economy and level of income per capita (Bignon *et al*. 2015). In sub-Saharan Africa, because of huge cross-country differences in ruggedness, climate, natural endowments and institutions, railway density varied even more markedly: some colonial governments built a complex network of interconnected railways, others only a few separate lines linking main ports with the interior. By 1910, 45 percent of sub-Saharan Africa's railway lines were in the Union of South Africa,[5] and the sum of its railways and those in Portuguese East Africa, South West Africa, and Northern and Southern Rhodesia[6] made up 67 percent of sub-Saharan Africa's rail network (Mitchell 2003a). We may assume that, as in other regions of the world, the economic effects of globalization were felt most strongly in the regions with the largest and densest rail networks.

In this paper we make a preliminary approach to analyzing the effects of the Cape Colony railways during the late nineteenth and early twentieth century globalization period. This railway system was among the largest and most dense in sub-Saharan Africa and, as we show below, the rail transport sector share of Cape GDP was amongst the highest in the world before

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[4] *Debates*, Vol. III (1870), p. 241.
[5] The four British colonies of the Cape, Natal, Transvaal and Orange River became the Union of South Africa in May 1910.
[6] Now Mozambique, Namibia, Zambia and Zimbabwe.

1910. Across the developing world, railways boosted growth primarily by reducing transport costs. The size of the reduction depended on two factors: the cost advantage over the next best alternative, and the amount of freight and number of passengers transported. The Cape railways were not notable for the former (compared with other African countries, where the main alternative was head porterage), but the high volume of Cape rail traffic (relative to GDP) had large resource saving effects.

The boom in mining production weighted the Colony's economy heavily towards rail transport. Its railways were built to connect its main ports and farming districts first with the Kimberley diamond fields and then with the Witwatersrand goldfields in the neighboring Transvaal. By reducing the cost of transport to the interior, the railway eased the movement of labor, capital goods, foodstuffs and other necessities to the mining centers. This transformed the Cape from a traditional agrarian society into a dynamic economy attractive to immigrants. Diamond exporting became easier and the Kimberley district flourished, as did providers of basic items. Estimates show that the Cape's GDP grew at a yearly rate of 4.77 percent between 1870 and 1909 (Greyling and Verhoef (2015). In helping to remove restrictions to the expansion of mining production, the railways enabled the development of some of the Africa's biggest industrial hubs.

With the exception of a few private lines, the Cape railways were built and managed by the colonial government. In contrast with their sizeable social benefits, the railway company was not a significant source of net revenues for the government. Debates in the Cape Legislative Council show that the railways were seen neither as a source of revenue nor as a political or military tool but as an instrument for the economic development of the Colony. This contrasts with other developing economies where railway expansion was left in the hands of private companies seeking big financial returns (as in most Latin American countries; Bignon *et al*. 2015), or where publicly owned railways were used as a cash-cow by the government (as in colonial India; Bogart and Chaudhary 2012).

Cape districts and sectors of the economy, hoping for a bigger share of the railway social benefits, lobbied parliament for railways for their constituencies. The final distribution of railway lines, reflecting to some extent differences in political influence, benefited some areas at the expense of others. Miners and their suppliers, notably white farmers of the politically overrepresented Western Cape, seem to have been able to capture a very large share of railway

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gains, while regions without railway lines, such as the Transkei or Basutoland,[7] mostly populated by blacks, despite being relatively close to the mining areas could neither become their suppliers nor benefit from the diamond boom. We argue that the absence of railways in these regions, combined with the increasing restriction of laborers' movements under early segregation policies, was one of the origins of their stagnation and gradual marginalization.

Our paper contributes to three literatures. The first is the literature on the economic growth and development of the Cape Colony during the first era of globalization (Greyling and Verhoef 2015; Cilliers and Fourie 2016; Cilliers and Mariotti 2016; Fourie et al. 2016). Boshoff and Fourie (2016), in the first quantitative study of how improvements in transport boosted the Colony's economy, examine South African market integration into the global economy and estimate 1872 as the date when the region's wheat markets were integrated with those of Britain's. The railways, they argue, clearly played an important role, but they are unable to quantify the size of its impact.

The second is the literature on the large and persistent effects of railway construction on the economies of developing countries during the first globalization (e.g. Coatsworth 1979; Ramírez 2001; Summerhill 2005; Herranz-Loncán 2011, 2014; Chaves *et al*. 2013; Zegarra 2013; Bogart *et al*. 2015). Many of these studies are based on the social saving methodology. Others use detailed archival data to provide a microeconomic perspective on railway growth effects in various countries worldwide (e.g. Tang 2014; Donaldson 2016; Jedwab *et al*. 2016; Jedwab and Moradi 2016). We measured the broad resource saving effects of the railways in the Cape Colony and compared them with estimates for other developing countries, leaving for future research the microeconomic analysis of the local effects.

The third is the literature on the political economy of infrastructure provision and management (Summerhill 1998; Bogart and Chaudhary 2015). While railways in many periphery countries were built by foreign private capital (see e.g. Bignon *et al*. 2015), the Cape is an interesting example of a large network owned and managed by the government. Bogart (2010) shows that increasing state ownership reduced efficiency in most countries, with varying effects according to whether the increase was through nationalizations or new construction. Bogart and Chaudhary (2012), however, show that the move toward state ownership of India's large public railway system decreased operating costs and helped make the railways a source of public

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[7] The Transkei is now incorporated into the Eastern Cape Province and Basutoland is now Lesotho. The Transkei territories were gradually annexed to the Cape Colony between the late 1870s and early 1890s. Basutoland was part of the Colony between 1871 and 1884 and was transferred to the direct authority of the British government thereafter.

revenue. This, they argue, was as a result of an undemocratic colonial government, a fiscal system heavily reliant on railway revenues, and a regulatory environment that was not conducive to private competition. The situation was totally different in the Cape, where the colonial government expanded the network from the start despite being unlikely to recoup the large resources invested in it. Here the railways, we suggest, were never seen as a potential source of revenue but were used to encourage the Colony's development, and to benefit those groups, such as the mine owners and wheat farmers of the Western Cape, whose interests were best represented in parliament. The contrast between colonial India and the Cape Colony illustrates the different effects of railway public ownership under very different social and political circumstances.

2. The development of Cape railways

Construction on the first railway at the Cape started in 1859 but progress was slow until the early 1870s.[8] At that date the only line in operation was a 57-mile line between Cape Town, Wynberg and Wellington. The government acquired this line in 1872, only a few years after the discovery of diamonds at Kimberley (1866), and from then on the construction and operation of the network remained a public undertaking by the Cape Government Railways (CGR).[9] With the diamond rush and later the discovery of gold on the Witwatersrand in 1886, construction accelerated rapidly. The Cape Colony's rail network initially consisted of three trunk lines connecting the ports of Cape Town, East London and Port Elizabeth with the diamond producing area around Kimberley. It was gradually enlarged with numerous branch lines and by 1910, when the CGR was incorporated into the Union Government Railways, it had reached a length of more than 3,300 miles. Together with the railways of the Transvaal and the Orange River Colony, it was by far the largest and densest network in Africa, both per square mile of surface area and per capita, and one of the largest outside Europe and the US. Figure 1 shows

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[8] Our data were obtained from several sources: various years of Cape of Good Hope government documents: the *Debates in the Legislative Council (1870–1895)*, the *Report of the General Manager of Railways (1906–1909)* and the *Statistical Register of the Colony of the Cape of Good Hope (1900–1910)*; the *1890 Agricultural Journal of the Department of Agriculture of the Cape Colony*; the *Union of South Africa's Official Year-Book of the Union, No. 2, 1918*, published in 1919; and the *Census of the British Empire, 1901, Report with Summary and Detailed Tables for the Several Colonies…, 1906* (see Supplementary material for full details). These documents are referred to in the paper as the *Agricultural Journal*, the *Debates*, the *Report of the General Manager*, the *Statistical Register*, the *Official Year-Book* and the *Census*.

[9] The only exceptions were a private, narrow-gauge, mining railway between the Namaqualand copper mines in the O'Okiep area and the sea, which was built in the 1860s as a horse-drawn railway, gradually adapted to steam, and closed in 1945, and the 205-mile line between Worcester and Mossel Bay, completed in 1906 and managed by the New Cape Central Railway company until its takeover by the South African Railways in 1925.

how it grew and table 1 compares the size it had reached by 1912 with the size of other countries' networks.

[INSERT FIGURE 1 AND TABLE 1]

Figure 1 shows two main periods of intense railway building in the Cape Colony before 1910, firstly between 1875 and 1885 when the government built the trunk lines linking Cape Town, Kimberley, Port Elizabeth and East London, and secondly during the early years of the twentieth century, right after the end of the second Anglo-Boer War. In the second expansion, investment was concentrated on branch lines that would act as feeders to the trunk lines or as connections between them, on the link with the Witwatersrand through Bloemfontein, and on extending the main trunk line beyond Kimberley along the border of the Cape Colony to provide an alternative link to the gold-producing areas of the Transvaal. Figure 2 shows the CGR network in 1907 and other railways and proposed lines. The construction of branch lines continued through the late 1920s, bringing the total network length to over 5,000 miles.

[INSERT FIGURE 2]

Like railways in other resource exporting countries, those of the Cape Colony were used mainly to carry freight, although passenger traffic was also sizeable, amounting for almost one-third of total revenues (figure 3). The *Report of the General Manager* for 1908 provides data on the composition of freight revenues between 1903 and 1908, with the biggest categories being general products (36 percent of total revenues), agricultural goods (25 percent), and coal and coke (13 percent). Given that none of these categories accounted for a large share of the Cape Colony's exports, these percentages indicate that the railways were used largely to supply the needs of production areas in the interior.

[INSERT FIGURE 3]

From 1873 to 1908 the Colony's railway traffic kept pace with diamond production in the Kimberley area, decreasing only in 1905, when international competition caused a crisis in the diamond market. During the diamond boom, as figure 4 shows, and even leaving aside the 1900–1902 peak, the result of increasing transport requirements associated with the second Anglo-Boer War, rail freight transport accounted for an exceptionally high share of the Cape GDP.[10]

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[10] By contrast, the effect of the gold production boom is less evident, since the CGR had to compete with lines going to Portuguese East Africa and Natal for the Witwatersrand trade.

[INSERT FIGURE 4]

3. The social savings of the Cape Government Railways

In this section we explain how we estimate the direct benefits the Cape economy obtained from the railways through saving transport costs. We do this by estimating social savings, which measure "how much extra society would have to pay to do what it did after an innovation, without it" (Leunig 2010, p. 776). If we assume transport prices are equal to marginal costs, we can estimate social savings as:[11]

$$SS = (P_{ALT} - P_{RW}) \times Q_{RW} \tag{1}$$

where P_{RW} is railway transport prices and P_{ALT} is prices of the next best alternative transport (under the counterfactual of no railways) in the year of reference, and Q_{RW} is that year's rail transport output. The social saving method, created by Fogel (1964) and Fishlow (1965), is based on some oversimplified assumptions and has been criticized on several empirical and theoretical grounds (see a summary in Leunig 2010). It therefore cannot replace a careful estimate of the growth effect of railways using measures of local changes in market access (see e.g. Donaldson and Hornbeck 2016). However, it is one of the few alternatives in historical contexts where local information is scarce.

Social savings give an upward-biased estimate (due to the implicit assumption of a price-inelastic transport demand) of the rise in consumer surplus provided by railways, which is a standard measure of welfare gains under competitive conditions. In the absence of perfect competition in the railway sector, the estimate should be increased by the potential supernormal profits of the railway company (net of the opportunity cost of capital and amortization expenses) to obtain a complete measure of welfare gains. Thus, correcting social savings for the elasticity of demand and adding railway companies' profits gives a measure of the total direct income gains the economy obtained from railways. This measure should be equivalent to the rise in total factor productivity directly provided to the economy by railways (Crafts 2004; Leunig 2010, p. 782), but will actually be a lower estimate, since social savings exclude all indirect benefits the economy obtained from railways, such as increased productivity associated with scale and agglomeration economies that the railways made possible. The next subsections

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[11] This assumption is rather heroic, but it is usual in social saving estimates when there is insufficient data to estimate marginal costs (Leunig 2010, p. 776).

present social saving estimates for the Cape Colony railways' freight and passenger transport in 1905, a year in which the GDP share of railway revenues was sufficiently representative of the period 1873–1908 (see figure 4).

3.1 Freight traffic

To estimate social savings we need to know the amount of freight transported and the 1905 unit prices of rail transport and alternative means of transport had there been no railways, i.e. counterfactual transport. As in estimates for other countries, we use a restricted concept of social savings which excludes improvements in the alternative means of transport.[12] To calculate the social savings, we assume that, in the absence of the railway, freight traffic would have been moved by road.

We obtained road transport prices for the period in two ways. Firstly, we estimated the differences in 1890 between the prices of four agricultural products (barley, maize, oat hay, and wheat) in three South African cities that were not connected by rail in that year (Kimberley, Johannesburg and Bloemfontein).[13] Although differences between commodity prices do not allow for a very precise estimation of transport costs (see Buringh *et al.* 2016), they have already been used by other authors (e.g. Donaldson 2016; Temin 2013) and their level is consistent with evidence from other sources (see below). According to this information, in 1905 prices, average grain trade costs per ton-mile were 0.031 pounds sterling between Bloemfontein and Kimberley (about 100 miles), 0.026 pounds between Bloemfontein and Johannesburg (about 250 miles), and 0.014 pounds between Kimberley and Johannesburg (about 300 miles). These costs suggest that road transport unit prices tended to decrease with distance, although the evidence is too sparse to confirm this.

Secondly, we collected direct information on road transport prices from various sources. For instance, the *Report of the General Manager* for 1906, estimating the competition that ox-wagons still represented for railways, reported a price of 29 pence for transporting 100 lb (pounds) of general goods from Port Elizabeth to Grahamstown, which would be equivalent to

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[12] As originally designed by Fogel (1965), the social saving analysis should allow for adjustments in the counterfactual economy in the absence of railways (improved roads or canals, for instance). But because of scarcity of information and methodological difficulties most social saving estimates ignore possible improvements and use the *actual* situation of alternative transport in the year of analysis.

[13] Our agricultural price data come from several issues of the *Agricultural Journal*, which provides monthly prices; we use the average over the 12 months of the year 1890. Data on rail freight traffic and prices are from the *Report of the General Manager for 1906*. Lack of data obliged us to exclude from the calculation the transport of livestock, vehicles and parcels at high speed, which accounted for approximately 12 percent of the total revenues of (low and high speed) freight transport between 1891 and 1908.

0.033 pounds sterling of 1905 per ton-mile over a distance of 80 miles. Rhind (1995) and Pirie (1993) also supply some evidence of prices charged by ox-wagon carriers in various areas of the Cape. Transformed into pounds of 1905 per ton-mile, these data are equivalent to £0.024 between Robertson and Worcester (30 miles); £0.026 between Port Elizabeth and Humansdorp (54 miles); and £0.013 between East London and Elliot (155 miles).[14] If we adjust all these observations to a log cost function of distance (figure 5), and apply the estimated function to the average distance travelled by rail freight in 1905 (197 miles), the resulting rate for ox-wagon transport is £0.020 per ton-mile, i.e. triple the average rail freight cost of about £0.007.[15]

[INSERT FIGURE 5]

Table 2 shows that the social saving of rail freight transport amounted to 12 percent of the Colony's GDP in 1905. Table 3 compares this figure with estimates for other countries and shows the main determinants of the social savings: the size of each country's railway sector and the difference between the prices of rail and alternative transport in each country. The table shows that the freight social saving in the Colony was lower than in other primary exporting countries that also built dense rail networks during the first globalization, such as Mexico or Argentina, but higher than in other sub-Saharan African countries.[16] The Colony's advantage over the latter may be explained entirely by the very large size of its railway sector, since traditional road transport in the Cape was relatively competitive, compared not only with the cost of head porterage but also with the cost of road transport in Latin American countries.

[INSERT TABLES 2 AND 3]

3.2 Passenger traffic

Besides freight, we also estimated the social savings of rail passenger transport. As is customary in these exercises, this should take into account people's savings not only in cost but also in time (Leunig 2010, pp. 776–7). To calculate time savings we introduce some assumptions about

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[14] Road transport prices seem to have been much higher some decades earlier. In 1873 some were reported that would be equivalent to 0.048 to 0.062 pounds of 1905 per ton-mile on several long-distance routes from Port Elizabeth (*Debates* 1873, p. 72). See also Ross (1998, p. 335) on the transport of copper to the sea in Namaqualand.

[15] Alternatively, if we assume constant returns to scale in road transport and calculate the simple average of all the available figures the result will be very similar (0.023 pounds of 1905 per ton-mile) and, if we just take the direct evidence on prices (ignoring the information on agricultural price differences) the resulting average will be only slightly higher (0.024). A possible source of downward bias in our estimate of road transport fares, though, is the fact that most available evidence refers to grain transport, whereas higher prices may have been charged for transporting other goods, such as industrial products.

[16] Jedwab and Moradi (2016), though, provide much higher social saving estimates for Ghana in 1931, amounting to 27 percent of GDP.

the share of traveling time to deduct from the passengers' working time in the absence of railways, as well as their average hourly wage. Given the lack of precise data, and to make our estimate comparable, we follow the procedures applied in research on Latin America (see Herranz-Loncán 2014). Thus, we base our estimation on three assumptions: i) in the absence of railways, first-class passengers would have used stagecoach transport and second and third class passengers would have used carts or horseback, or walked; ii) the value of the working travel time of second and third class passengers can be estimated as the average hourly wage of unskilled workers, and that of first-class passengers as the average hourly wage of skilled workers; and iii) only about half of the time savings were savings in working time. Table 4 shows that the total social saving that results from applying these assumptions amounts to 4.13 percent of GDP by 1905. While we recognize the significant error margin in this estimate,[17] we note that this is one of the highest percentages from a primary exporting country. In countries like Argentina, Mexico or Brazil, for instance, the percentage ranged from 2 to 4.4 percent, and in other sub-Saharan African countries it was negative (Chaves *et al*. 2013; Herranz-Loncán 2014).

[INSERT TABLE 4]

3.3 From social savings to additional consumer surplus

The sum of our estimates of freight and passenger social savings of the Cape railways in 1905 amounts to £6.78 million, or 16.1 percent of the Colony's GDP. As noted above, this is an upward biased estimate (due to the assumption of null demand elasticity) of the additional consumer surplus that the economy obtained from railways. To get an unbiased estimate of that surplus, these figures must be corrected by the elasticity of demand of freight and passenger transport. Unfortunately, there is no information on unit prices and quantities transported by the CGR before 1903, and the sample of observations (1903–1908) is too small to allow us to estimate a demand function. As a second-best option, for freight we use a set of elasticity estimates for a number of Latin American primary exporting countries in the same period, which range from -0.5 to -0.8 (Herranz-Loncán 2014). For passengers, again using Herranz-

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[17] There are several possible sources of bias in this figure, arising both from the scarcity of empirical evidence and the assumptions made. Potentially most important is the assumption of identical behavior for second and third class passengers. If second class passengers were assumed to behave like first-class ones (i.e. to use stagecoaches as alternative to railways) passenger social savings would increase to 8.3 percent of GDP. The estimates are also highly sensitive to the stagecoach rates, based on an insufficiently representative sample. Therefore, a large error margin must be allowed for the figures in table 4.

Loncán (2014), we assume that transport demand elasticity was approximately -1 for the first class (since rail travel had a certain luxury component) and that, in the absence of railways, all second and third class passengers would still have travelled by some means, because they journeyed mainly from necessity. This would be equivalent to assuming a null elasticity to the increasing cost of traveling for the lower classes. The estimates of consumer surplus of rail freight and passenger transport that result from applying these elasticities to the social saving figures are shown in table 5.[18]

According to these figures, the aggregate consumer surplus of freight and passenger transport of the Cape railways can be estimated as 9.7 to 11.2 percent of GDP. To measure the total direct income gain the Cape economy obtained from railways, we increase these figures by the amount of extraordinary profits (net of opportunity cost and amortization of capital) that accrued to the railway company. According to the *Report of the General Manager* for 1905, the CGR's net operating revenues were £1.073 million that year – 3.7 percent of the accounting value of its capital.[19] By comparison, the interest rates of railway bonds and most Cape Government debt issues were set at 3.5 or 4 percent (*Statistical Register* for 1903). Given that net revenues should cover both the amortization of equipment and infrastructure and the opportunity cost of capital, any return below 5 percent of capital would have been too low to make the CGR a source of profits for its owners (in this case, the colonial government). Although the real and the accounting value of capital may have been different due to the prevailing accounting procedures and inflation, it is difficult to imagine a sufficiently large difference to move this percentage to the zone of significant positive profits. We therefore assume that the figures in table 5 account for the Cape economy's entire direct income gain from railways in 1905.

As noted earlier, this amount would also be equivalent to the rise in total factor productivity directly provided by railways from the year they began operating to the year of reference of the estimates. These TFP gains accounted for 10.9 to 12.6 percent of the increase in the Cape's GDP between 1873 and 1905. If we extract from GDP growth the share that is merely labor accumulation, the result represents the Cape's aggregate increase in labor productivity over that

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[18] The ratio of the additional consumer surplus to the social savings is given by $[(\phi^{1-\varepsilon}-1)/(1-\varepsilon)(\phi-1)]$, where ε is the absolute value of the elasticity of transport demand and ϕ is the ratio of alternative transport prices to rail transport prices; see, for instance, Fogel (1979).

[19] Data on capital for the whole period are from the *Report of the General Manager for the year 1905*. The yearly population of the Colony is estimated as a log interpolation between census figures, taken from the *Official Year-Book*. We deflate the yearly differences in the capital account with Verhoef et al.'s (2014) CPI and accumulate the resulting deflated figures over time. We use GDP and CPI figures from Verhoef et al. (2014).

period.[20] According to the usual growth accounting decomposition, that labor productivity growth was the combined result of increase in capital per capita and TFP gains. We can therefore estimate the total direct contribution of railways to the Colony's labor productivity over that period by using the sum of the railway TFP gains (table 5) and the impact on labor productivity of the per capita growth of railway capital.

[INSERT TABLE 5]

Between 1873 and 1905 railway capital per capita grew at a yearly rate of 4.52 percent. To transform this rate into an estimate of what railway capital accumulation contributed to labor productivity growth, we multiply it by the factor income share of railway capital, i.e. (assuming zero profits) the average ratio of railway net revenues to nominal GDP from 1873 to 1905, which was 3.32 percent.[21] The product is 0.15 percent, or 13.2 percent of the Cape labor productivity growth rate. The sum of this percentage and the TFP contribution amounts to 29.2 to 31.5 percent of the increase in labor productivity in the Cape economy between 1873 and 1905. In other words, railways directly accounted for approximately 30 percent of the increase in income per capita or labor productivity in the Cape Colony between the beginning of the railway era and the end of the diamond boom. Despite the high error margin of this figure, due to the insufficient empirical data and the numerous assumptions introduced in the estimation, it is a fairly robust indication of the essential role that railways played in the growth and transformation of the Cape's economy during this period. Moreover, this figure excludes the indirect effects of the railway, such as agglomeration economies arising from the urban concentrations that railways made possible. So, economic growth in the Cape Colony during the first globalization seems to have been, to a significant extent, directly associated with investment in the railway.

But were those gains sufficient to justify the amount of capital invested? Comparing our estimate of railway benefits for 1905 with the value of capital we can obtain the social rate of return for that single year. Although this cannot replace a complete estimate of the social rate of return for the whole life of operation of the railway system, or at least for a sufficiently long period, it may at least provide a preliminary approach to estimating the levels the rate reached during the diamond cycle. We estimate that railway capital was £33.20 million in 1905 (see

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[20] For simplicity, from now on we assume that the growth rates of labor productivity and per capita GDP were the same. We use GDP and CPI figures from Verhoef *et al.* (2014). We estimate the yearly population of the colony as a log interpolation between census figures, taken from the *Official Year-Book* (1919).

[21] This figure is the average over 1873–1905 of the yearly ratios between the net returns of the railways from *Report of the General Manager* for the year 1905 and nominal GDP from Verhoef *et al.* (2014).

footnote 23). Thus the social returns of the railways that year represented a respectable 12.3 to 14.2 percent of the capital invested. These figures are in line with the social returns of railways in other countries with low population density, such as the US and Brazil, and are much higher than those estimated for Canada and Uruguay (Mercer 1982; Carlos and Lewis 1992; Summerhill 2003; Díaz Steinberg 2016).[22] Given that our estimate of railway benefits excludes the possible indirect effects, it seems safe to say that the Cape economy obtained satisfactory social returns from the capital invested in the rail network.[23]

4. The distribution of the Cape railway benefits

As noted above, after 1872 almost all Cape railways were owned by the government of the Colony and managed by a public company, the CGR. Public ownership of railways before World War 1 was not rare in developing countries, especially in the European overseas colonies. Public construction and management of railways could serve different aims. Bogart and Chaudhary (2012), for instance, have shown how the colonial government in India used railways for public revenue. By 1913, railways accounted for 35 percent of the total income of the British Raj, making up for the government's inability to develop the tax system and obtain similar returns from other sources.

The case of the Cape was very different. Despite becoming the largest single unit of the Colony's public administration,[24] the CGR seems never to have been a significant source of net revenue for the colonial government, whose tax system was heavily dependent on custom duties. This was the consequence of the low level of CGR's financial returns during the whole life of the company. Figure 6 shows the evolution of the ratio of the CGR's net operating revenues to the accounting value of capital. This ratio remained below 5 percent with the exception of six years; as noted earlier, the average for the whole period was just 3.7 percent. Under those circumstances, the railway could hardly become a big source of revenue for the

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[22] The significance of this comparison depends on the representativeness of the Cape railways' social rate of return in 1905 for their whole operating period (1873–1910). The ratio of CGR net operating revenues to accounting capital in 1905 was 3.70 percent, very similar to the average over the period 1873–1908 (3.74 percent). If we deflate net revenue and capital figures and express them in 1905 pounds, the 1905 ratio becomes 3.23 percent and the average for 1873–1908 is 2.83 percent.

[23] A thorough assessment of the social profitability of railways should be based on a comparison of those returns with the returns that might have been obtained by investing the capital elsewhere. But it is difficult to imagine any other large project which, as a whole, could have given comparable benefits to the economy.

[24] Between 1906 and 1907 and 1908 and 1909, despite being years of crisis in the railway sector, the average yearly *gross* revenue of the public railway system was £3.3 million, whereas all other public revenue of the Colony together amounted to £4.1 million (*Statistical Register for 1909*).

government, since net revenues had to meet amortization requirements and the opportunity cost of capital, and in fact it was often a financial burden. The *Statistical Register* for 1909 shows public debt interest payments for the budget years 1899–1900 to 1908–09. Railway debt is shown separately only for 1906–07 and 1907–08 but if we assume that in other years it represented the same percentage of total public debt interest payments as in those two budget years (63 percent), then during half of the period 1899 to 1908 railway total costs were higher than gross revenues. Moreover, whereas the railway returns net of debt interest payments were on average 0.21 percent of capital during those years, if we deflate the railway's yearly gains and losses and accumulate them over time, the final result is an accumulated loss of £97,729 (pounds of 1905) by 1908.[25]

[INSERT FIGURE 6]

Low financial returns reflect to some extent the low population density in the Colony. Although not strictly comparable with more rigorous estimates of internal rates of return for other sparsely populated countries, an average return of 3.7 percent of capital is similar to the figures for Canada, Uruguay and some US and Brazilian lines with low railway profitability (Mercer 1982; Carlos and Lewis 1992; Summerhill 2003; Díaz Steinberg 2016). However, the Cape government did not see the railways as a source of public revenue. This option seems never to have been even considered in parliament; the *Debates* from 1870 to 1895 provide little evidence of public concern about the financial returns of the railway company, rather the opposite. Apparently the prevailing opinion matched that of MP Robert Godlonton (cited at the start of this paper) in the early discussions about acquiring the Wellington railway: the railways were for the public benefit rather than for profit.

Most references to the railway in the *Debates* during the last decades of the nineteenth century describe it as a powerful instrument of growth and development, essential for the exploitation and export of the country's natural resources, particularly its minerals, which were key to the Colony's prosperity. The railways not only brought in export revenue but also boosted the farming districts that supplied the mines. They were thus expected to have positive effects on land values, output, immigration and the occupation of empty land.[26] By contrast, we can find no reference whatsoever in the *Debates* to their potential to generate government revenue, and almost no mention of political or administrative objectives that the railway system might serve.

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[25] *Statistical Register for 1909*. We transform the data from budget to calendar years assuming that interest payments were equally distributed along the budget year.
[26] We found many references to this in the *Debates* for various years. See Supplementary material.

Only occasionally did members of the Legislative Council allude to the military interest of some specific lines, usually to reinforce a claim about their economic importance. And from the early 1890s, on several occasions the extension towards the Free State and the Transvaal was described as a means to unify South Africa. Regarding the line from Port Elizabeth to Bloemfontein, MP Mr. Bowker noted that "the time was not far distant when all the Colonies and States of South Africa would be one people", and the best way to bring this about was to vote for this proposed extension.[27]

Given these perceptions, it is not surprising to see frequent interventions in the Legislative Council by MPs keen to bring the railway to their own constituencies. No district wanted to be deprived of railways, since without them, as MP Mr Wilmot observed, "their land must lie dormant" and "neither development nor prosperity [would be] possible".[28] Bringing the railways to certain districts to stimulate their economy was justified even if they might burden the government budget. This was actually the position of Prime Minister Cecil John Rhodes, who stated before the Legislative Council, regarding a railway extension project, that the government "did not expect these railways to pay large interest on the capital expended" and "would be content if they paid their working expenses and [gave] those very promising districts a chance of development".[29]

In other words, there was room for the construction of unprofitable railways for the benefit of specific districts. This developmental approach to railways may partially explain the CGR's low returns. And we can easily understand why debates in the Legislative Council between representatives of different regions about specific railway routes often became heated. For instance, in response to a proposal that the Cape Government be authorized to confer with the governments of the Orange River Colony and the Transvaal to discuss the best northern route for the railways, MP Mr. Joubert warned that the Cape Government should attach "some weight to the point whence the line should be extended". He argued that if the Port Elizabeth line were extended "we should have to give a drawback on our Customs duties" and he asked "what advantage would that be to the Colony?" He said that finding the shortest distance was not the only object: as the western districts produced more than the eastern, more freight could be obtained if the western line were extended, and if this were not done, only European importers would benefit.[30]

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[27] *Debates*, Vol. XXIV (1890), p. 157.
[28] *Debates*, Vol. XXIX (1895), p. 269.
[29] *Debates*, Vol. XXIX (1895), p. 278.
[30] *Debates*, Vol. XXI (1887), pp. 129–30.

It seems therefore that the Cape parliament was fully aware of the potential distributional effects of railway policy decisions. Thus, when the Commissioner of Crown Lands and Public Works tabled the Railways Bill on 13 June 1881, a bill that would extend the trunk line from Cape Town into Griqualand West (i.e. the Kimberley area), he noted that the "position of the colonial railway was remarkably encouraging" and that "the government was justified in coming to parliament and proposing additional railway expenditure". He said there was "very great demand in the country for an extension of the railway system, especially to Griqualand West", because the whole Colony had "shared in the advantages which had been derived from Griqualand".[31] In response, MP Mr. Burger objected to the way the trunk lines were to be extended, particularly when he found that the government proposals "would be most favorable to an already highly privileged part of the Colony, and in this way an injustice was done to a long and shamefully neglected portion of it".[32]

As could be expected, not all districts, economic sectors and population groups had the same capacity to lobby parliament for railways. Differences in political influence could result in biases in railway policy, favoring some regions or sectors at the expense of others. As a consequence, the social gains of the Cape railways benefited some more than others. Recent research has found persistent spatial effects of railways in other African countries (Jedwab *et al*. 2016; Jedwab and Moradi 2016). The possible bias in Cape railway policy may have had a similarly long-term effect on income per capita from district to district.

The debates in the Legislative Council provide some scattered evidence of the lobbying activities of certain districts and sectors. For instance, we find evidence of the influence of mining interests in a discussion about completing the trunk line between Cape Town and Kimberley. In 1884 the Orange River and Kimberley Railway Bill was tabled in parliament to allow a private company to construct the remainder of the line. Mr. Upington summarized the reason for this Bill. An attempt had been made to induce the government to pay for the construction of the line from the Orange River to Kimberley, but the government had declined to continue the construction using public funds. Pressure was then brought to bear on the government "by persons connected with the Mining and other industries in Kimberley", who said "it would be of the greatest possible advantage to them to have the railway constructed to Kimberley" and asked the government "to grant them an empowering Bill".[33]

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[31] *Debates*, Volume XV (1881), p. 116.
[32] *Debates*, Volume XV (1881), p. 118.
[33] *Debates*, Volume XVIII (1884), p. 231.

Although the names of these "persons" are not recorded, it is probable that Rhodes was involved. He had moved to the diamond fields in 1871 and built up a business empire that led to the establishment of De Beers Consolidated Mines in 1888. But he was also active in politics, becoming a member of the Cape parliament in 1880 and Prime Minister in 1890. Given his interests in the diamond mines, he might well have lobbied for completion of the last part of the line to Kimberley. But similar links could also be found to certain farming interests. In 1877 MP Mr. Neethling noted angrily that he had "always thought that the present Government would sympathize with the farming population, because more than one member of the Cabinet was connected with agriculture".[34]

It is difficult to quantify the influence of districts or sectors on railway policy decisions, but we have two sets of evidence. The *Report of the General Manager* for 1905, for example, provides detailed traffic information by station and freight category. From this we can see which districts carried the most railway traffic and which were net suppliers and net importers of each category of commodity. The first thing we note from these data is the centrality of the Kimberley diamond fields in the railway system. Apart from Cape Town, Port Elizabeth and East London, in 1905 Kimberley was the station that generated by far the highest revenue. The Kimberley district received much more freight than it supplied. The very high value-to-weight ratio of diamonds meant that a cheap transport method was needed not so much to dispatch the product as to supply the production area with industrial commodities, construction materials, fuel and foodstuffs. In other words, railways were necessary to support a growing settlement around the mines. According to 1905 traffic data, the Cape rail network was used mostly to supply Kimberley district.

By 1911 the Kimberley district, with just 3.3 percent of the Colony's population, was the destination of very high percentages of certain categories of rail freight. It had negative balances in almost all categories, and in each of those categories its imports accounted for very high shares of the sum of imports of all Cape Colony districts with deficit, such as 15 percent of general merchandise, 13 percent of grain of South African origin, 23 percent of other South African agricultural produce, 44 percent of flour, meal, malt and bran of South African origin, 51 percent of South African timber, 52 percent of firewood, and an impressive 79 percent of South African coal and coke. Looking at these figures another way, we find that per person in 1905 the Kimberley district received, through the railways, 457 kg of cereals, flour, meal, malt or bran, 14.5 kg of wine and spirits of South African origin, 265 kg of other agricultural

[34] *Debates*, Vol. X (1877), p. 278.

produce, and 354 kg of firewood. These rail deliveries supplied a huge share of the Kimberley population's needs – clear evidence that the growth of the area was due largely to the railway.

Railways, therefore, removed the restrictions to the growth of Kimberley (as they did with the Witwatersrand) while dramatically reducing, at the same time, the effect of distance as determinant of domestic trade flows. Thanks to railways, the growth of Kimberley did not depend on the supplying capacity of the closest regions; rather, the traffic data shows that its main suppliers were the port cities and several districts that close to Cape Town, and far from the diamond fields. Table 6, based on traffic data, shows the districts that were the main domestic suppliers of certain foodstuffs in 1905, and the percentage of the total inter-district railway deliveries they supplied.

[INSERT TABLE 6]

Apart from Port Elizabeth and East London, the districts in table 6 belong to the Western Cape, and all of them except for Oudtshoorn are in the vicinity of Cape Town, i.e. at the maximum possible distance from Kimberley. Although we cannot know the specific origins of Kimberley's imports, all seems to indicate that the diamond district was provisioned with industrial commodities and foodstuffs that were either imported from other countries or produced mainly in the western rather than the (much closer) eastern part of the Cape. The railways negated the advantage of proximity to the mining districts. The priority given to the connection between Cape Town and Kimberley enabled the distant (but arguably more competitive) Western farmers to become the main suppliers of the country's needs and, together with the mining districts, to enjoy an exceedingly large share of the benefits of railways.

The second set of evidence we have of the results of railway policy is what the decisions did to regions that remained almost completely deprived of railways, the most extreme cases being Basutoland and the Transkei which, despite their high demographic density, received almost no railway investment during the period under analysis.[35] This may have caused not just economic stagnation but actual decay. Keegan (1986, p. 200) notes that in the late 1870s "Basutoland quickly emerged as an indispensable provisioner of the Diamond Fields… The trains of laden transport wagons making their way through the Free State to the Diamond Fields were a

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[35] The only exceptions were two short branch lines that crossed the border to connect Maseru (1905) in Basutoland and Butterworth (1906) in the Transkei to the network, but without making further advances into the territory. The Butterworth line was extended to Mthatha only in 1916.

common sight at the time". But railways soon brought competition, not only from the western parts of the Colony but also from America and Australia. In March 1887 Robert Germond, a missionary at Thabana Morena in Basutoland, noted that the railway had "profoundly modified" the region's economic situation. He said that Basutoland:

> produces less and finds no outlet for its products. Its normal markets, Kimberley and the Free State, purchase Australian and colonial wheat… Basutoland, we must admit, is a poor country… Last year's abundant harvest has found no outlet for, since the building of the railway, colonial and foreign wheat have competed disastrously with the local produce. (Germond 1967, p. 469)

The price of grain plummeted. After the construction of railways, a *muid* of grain (approximately one hectoliter), which had once been worth up to 20 shillings, could be sold for no more than 4 shillings (Eldredge 1993). The discovery of gold on the Witwatersrand in 1886 brought some brief relief. But when the railway line reached Johannesburg in 1893, it brought with it "cheap Australian flour, just as had happened at Kimberley some years earlier" (Keegan 1986, p. 209). The Transkei, which had started to supply food to the mining areas in the 1860s and 1870s, was similarly affected. As the rail network reached the mines these districts became more or less isolated from the national market and their living standards declined (Juif *et al*. 2014). Inability to access the interior markets diminished their surplus-generating capacity and reduced their control over the disposal of the surplus (Bundy 1972).

Lack of railways in Basutoland and the Transkei meant that an area of almost 19,000 square miles and a population of 1,183,492 people in 1904 was disconnected from the transport network. Demographic pressure was especially intense in the Transkei, where population density reached 118 in 1904; in contrast, the Colony's average density was only 9. Figure 2 shows how the railways bypassed the most densely populated regions, which were those with the biggest black populations. The routes that were proposed in those areas were never built, and were never intended to connect to the main network.

Both Basutoland and the Transkei were harmed by being isolated from the direct routes from the main ports to the mines, by the ruggedness of their territory, and by their history of political resistance. The Transkei's interests were also negatively affected by a political system that deprived most of its population of representation: in 1904 the Transkei had 35 percent of the Colony's population but in 1907 it had only 3.8 percent of the registered voters. The Transkei was also underrepresented in parliament, with just 4 out of 107 seats in the House of Assembly

in 1907 (3.7 percent).[36] The rest of the Colony, with 65 percent of the population, had over 96 percent of the registered voters and seats.

Not coincidentally, 40 percent of the seats in the House of Assembly and the Legislative Council were held by the Western regions, which had only 22 percent of the population and, as table 6 shows, included some of the areas that benefited most from the transport cost reduction brought about by the railways.[37] Under these circumstances, voices in favor of the construction of railways in Basutoland or the Transkei were unlikely to be heard in parliament. Neither the Kimberley miners nor the white farmers of the Western Cape had any interest in railway lines crossing those regions, since they were not on the routes between the mining areas and the ports or the western farming districts. And, although South African unification was mentioned in some of the speeches in favor of railways crossing the Orange Free State border, nobody alluded to the possibility of using railways to integrate the Transkei with the rest of the country.

To sum up: railways brought prosperity to the country but not evenhandedly, partly because of uneven political representation. Race also played a part here. Only 2 percent of the underrepresented Transkei population were white, but the rest of the Colony was 35 percent white and the Western Cape 51 percent.[38] The racial bias in the political system increased dramatically with the annexation of the Transkei, which substantially altered the Colony's racial composition and was followed by the gradual disenfranchisement of most of the Cape black population through successive laws passed between 1887 and 1894 (four of those years being under Rhodes's leadership). The underrepresentation of black districts was mirrored by the gains from the railways. In the whole Colony in 1904 the black population was 3.2 times the size of the white one, but only 1.9 times in districts with railway access and 1.2 in the districts that supplied most of the country's foodstuffs (table 6).

The racial bias of railway policy was never made explicit in the political debate. Quite the contrary. In the Legislative Council in 1870, for example, MP Mr. Chase used the example of India to support his plea for more railways. He was reported as saying that

> in India, where a good deal of bigotry existed amongst the people, it had in a great
> measure been done away with, and the inhabitants, among whom the prejudice of caste

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[36] Cape of Good Hope (1910) *Statistical Register of the Province of the Cape of Good Hope, 1909*, p. 9. In the Legislative Council, the Transkei districts did not have a specific representation but were integrated into the Eastern electoral province.

[37] These percentages include the western, south-western and north-western electoral provinces (*Statistical Register 1909*, pp. 4 and 9).

[38] We add population and seats for the western, south-western and north-western electoral provinces. Data from *Statistical Register 1909*, pp. 4 and 9.

prevailed in its extremest degree… now commingled in the common vehicle, cheapness and convenience having banished exclusiveness. Railway extension at both ends of the Colony was something he should like to see carried out with all speed, and it was his firm belief that until they had more railway communication the Colony would never be what it should be.[39]

But the political economy of the Cape, with its increasing underrepresentation of the predominantly black regions, meant that Mr. Chase's hopes were never fully realized.

To overcome the isolation that prevented them from competing as suppliers of the economic hubs, the people of the Transkei could of course migrate there, and some did. Impoverished black farmers left home and went to work as laborers on white-owned farms or in the mines. But, gradually, restrictions on movement and especially permanent settlement (notably in the Glen Grey Act promulgated by Rhodes in 1894) stopped black migrants moving to those areas permanently. Early segregation policy thus joins distance from the railway as a force explaining the economic decay of Cape regions such as the Transkei and Basutoland.

5. Conclusion

More than 30 years ago, Pirie (1982, p. 221) observed that railway systems in southern Africa, "while promoting growth in some localities… had and continue to have some debilitating effects". He said the benefits of railways "are not evenly spread and at the same time as being an agent of development, rail investment has been associated with underdevelopment". Our research investigated how this happened in the Cape Colony.

From the mid-nineteenth century, globalization and the discovery of diamonds at Kimberley transformed the Colony into a prosperous exporting region with a steadily increasing GDP and eventually one of the largest and densest rail networks on the continent. By reducing transport costs to the interior, the railway eased the movement of labor and goods to the diamond fields, and later to the Transvaal goldfields. The contribution to economic growth was enormous: we estimate that railway may explain about 30 percent of the increase in income per capita in the Cape during the diamond-mining period (1873–1905). This is a very large share for a single investment and a clear indicator of the transformative power of the railways.

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[39] *Debates*, Volume III (1870), p. 232.

But the transformation did not benefit everyone. The railways supplied the mining centers with overseas goods imported through the port cities and agricultural produce from the western parts of the Colony. Suppliers in the closer eastern regions, such as the Transkei and Basutoland, lacked railways and could not compete. Government economic policy of the time had a lot to do with this. Unlike the case of colonial India, where railways brought high returns for the state, in the Cape the returns hardly covered the amount the government invested and the railways were explicitly used to encourage development. However, uneven distribution of political representation meant that only certain regions and sectors benefited. Those with access to the political apparatus, notably the owners of the diamond mines, with the western farmers as their political allies, could get their demands met. Underrepresented regions, with predominantly black populations, were largely excluded from the benefits of the mineral boom. The Cape Colony's railways brought prosperity but also, indirectly, racial segregation. South Africa's twentieth century racial inequality, it seems, arrived partly via the tracks of its nineteenth century railroads.

Supplementary material

Supplementary material is available at *EREH* online.

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**Figure 1: Length (in miles) of the Cape Government Railways network (1873–1910)**

Source: Official Year-Book of the Union, No. 2, 1918

Figure 2: Map of Cape Colony rail network in 1907 with size of black population by district
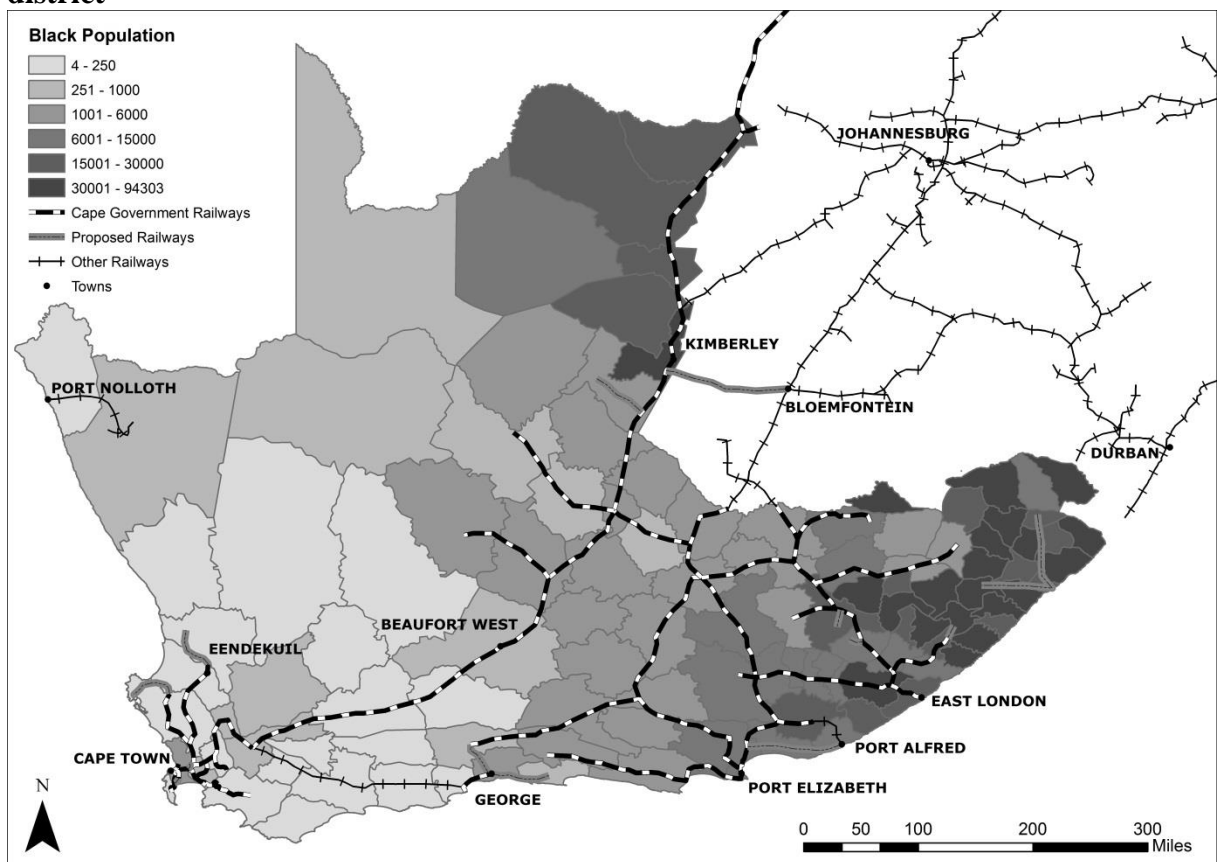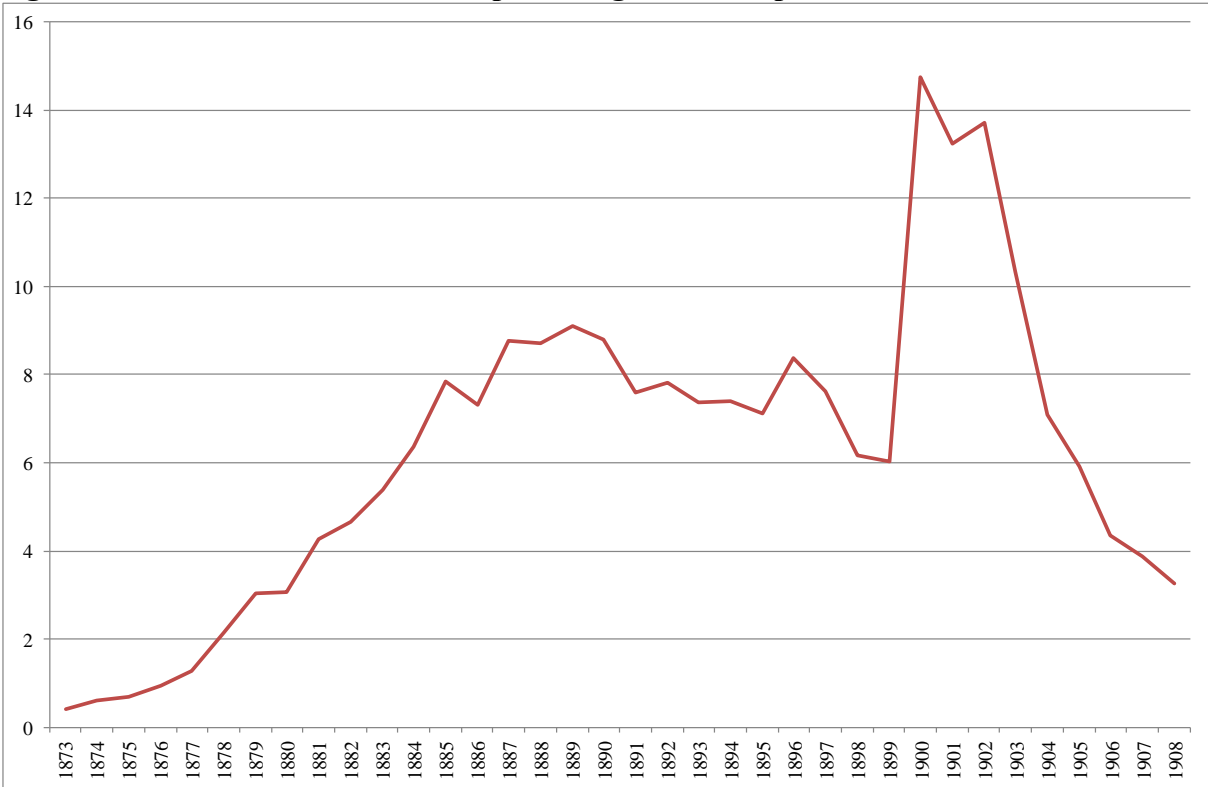

Map of the Cape Colony railroads, 1907. Districts with black population are from 1911 Union of South Africa Census.

Figure 3: CGR freight revenues as a percentage of total traffic revenues, 1873–1908 (%)
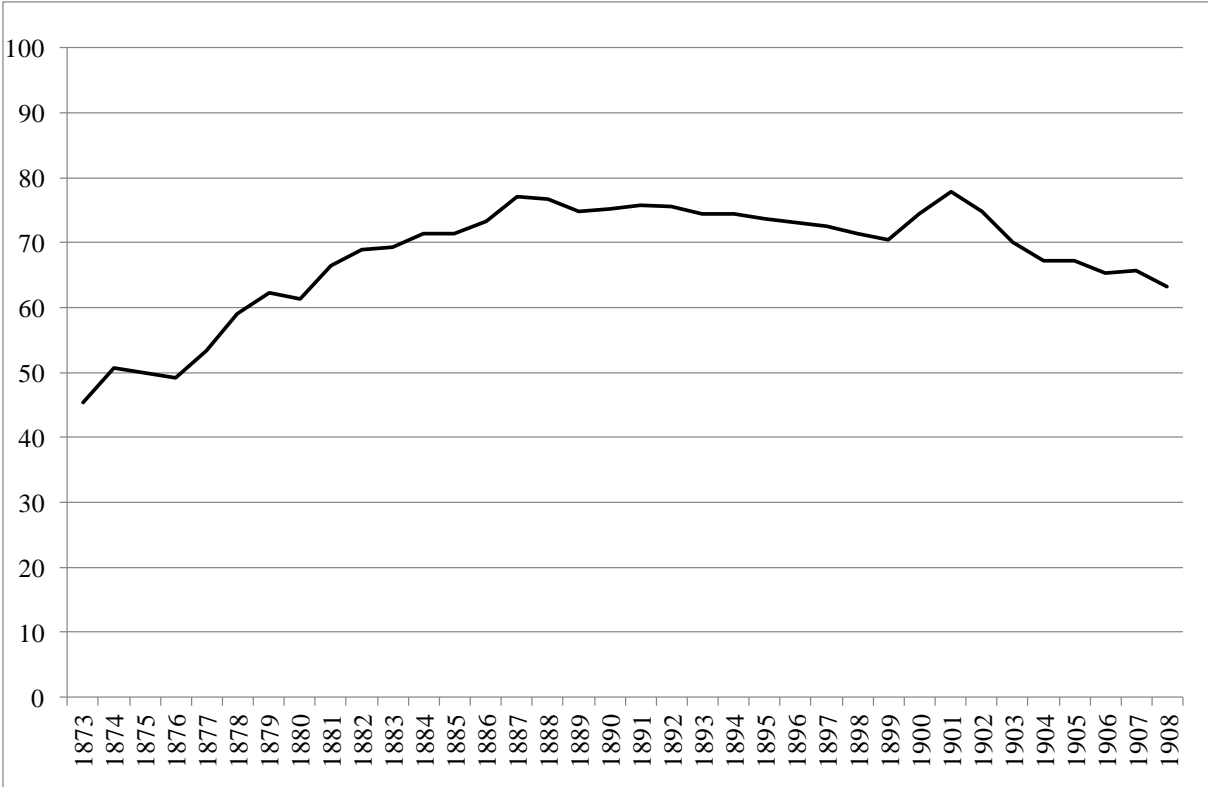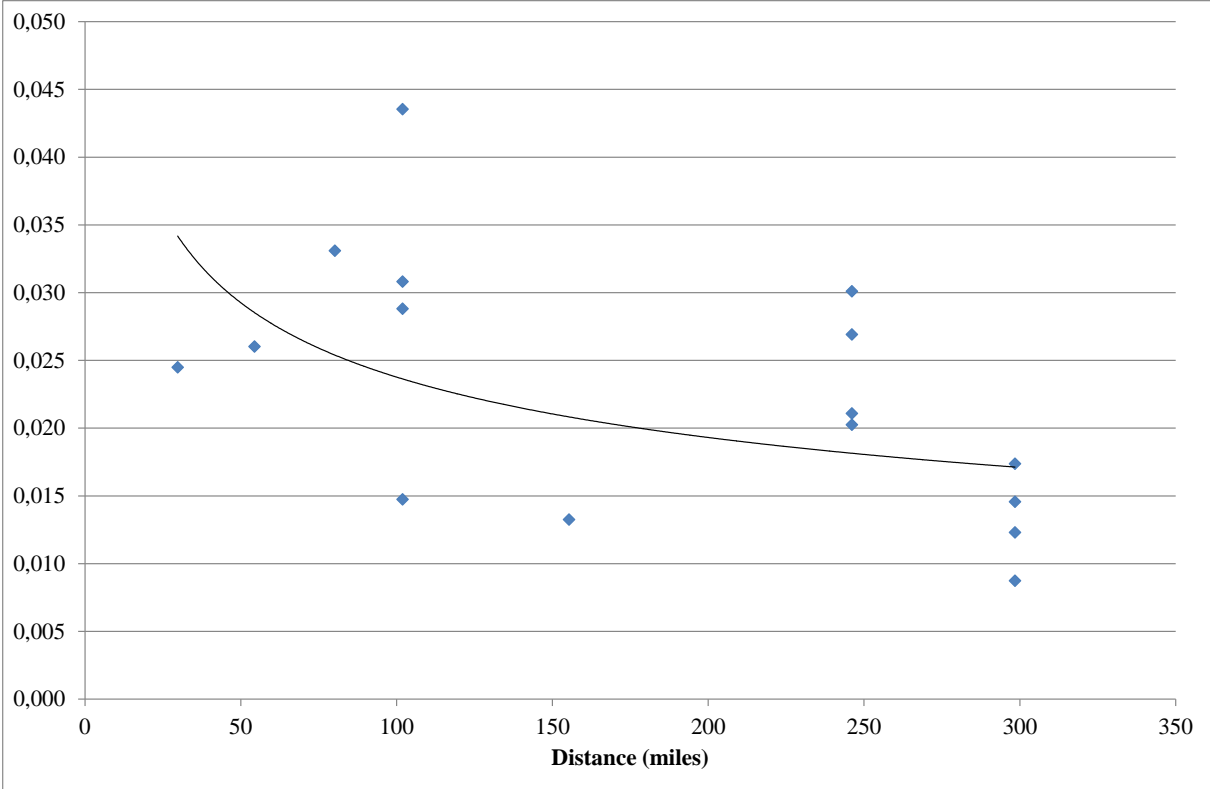

Source: Report of the General Manager of Railways for the year 1908.

Figure 4: CGR traffic revenues as a percentage of the Cape's GDP, 1873-1906 (%)

Sources: Traffic revenues from *Report of the General Manager of Railways for the year 1908* (1909), and GDP figures from Verhoef *et al*. (2014).

Figure 5: Road transport costs in South Africa (pounds sterling of 1905 per ton-mile)

Sources: Agricultural Journal (1890), *Report of the General Manager of Railways for the year 1906*, Rhind (1995) and Pirie (1993). Transport prices (or agricultural price differences) are expressed in pounds sterling of 1905 by using the CPI provided by Verhoef *et al*. (2014).

Figure 6: CGR net operating revenues as a percentage of capital, 1873–1908 (%)
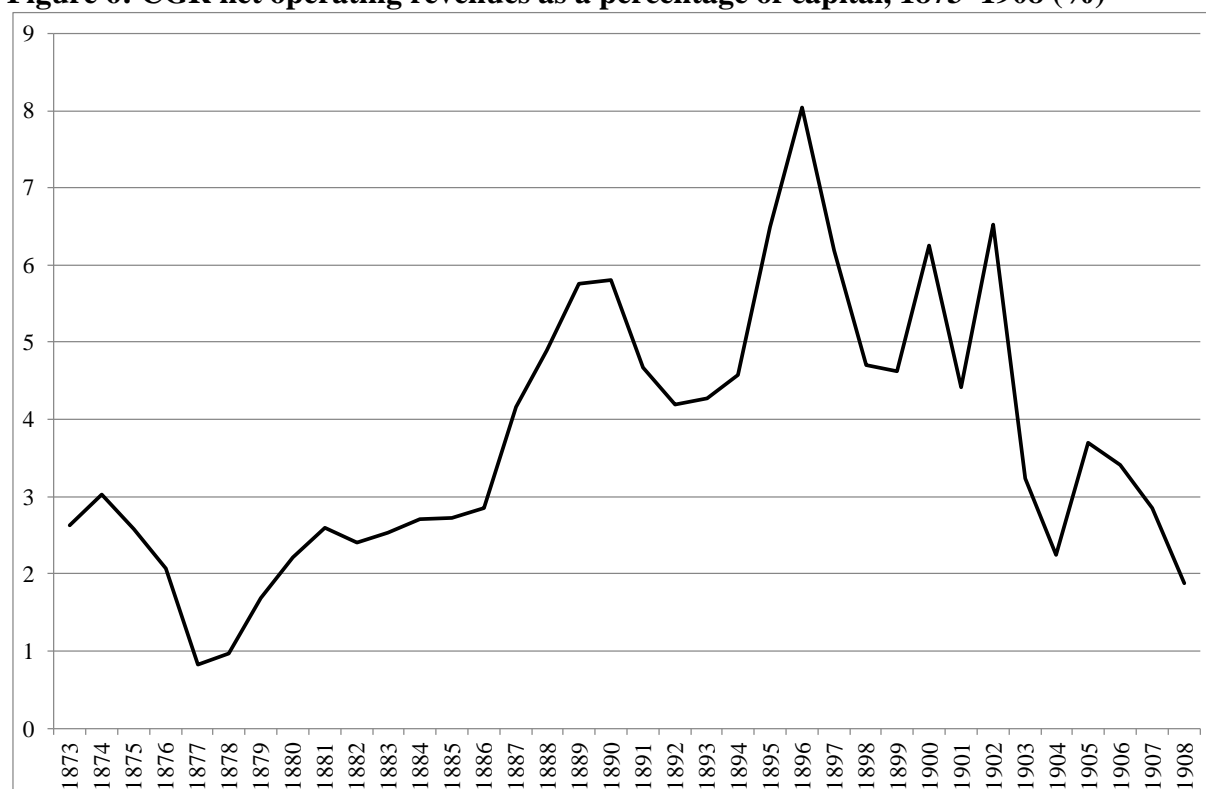
Source: Report of the General Manager of Railways for the year 1908.

Table 1: Cape Colony rail network compared with other countries

	Year	Network length (km)	Km per 10,000 sq. km of surface	Km per 1,000 pop.
Cape Colony	1912	5,621	78.48	2.19
South Africa	1912	12,552	102.70	2.10
Nigeria	1911	438	4.74	0.02
Gold Coast	1911	270	11.33	0.14
Argentina	1912	29,454	111.24	4.27
Mexico	1912	24,963	103.74	1.27
Brazil	1912	23,857	27.60	0.94
India	1912	53,919	217.48	0.18
Japan	1912	11,384	480.92	0.22
United States	1912	397,387	681.90	2.67

Sources: For Cape Colony and South Africa, *Official Year-Book of the Union, No. 2, 1918*. For other countries, Mitchell (2003a,b).

Table 2: Social savings of Cape Colony rail freight (1905)

1. Railway economy	
a) Railway transport (million ton-miles)	361.03
b) Railway transport cost (£ per ton-mile)	0.0065
c) Railway transport cost (million £) (a x b)	2.335
2. Counterfactual economy	
d) Road transport cost (£ per ton-mile)	0.0204
e) Road transport cost (million £) (a x d)	7.377
Social savings (million £) (e - c)	*5.042*
As % of GDP	*12.0*

Sources: See text and, for nominal GDP, Verhoef *et al.* (2014).

Table 3: Social savings of Cape Colony rail freight (1905) compared with other countries

	Year	Rail freight social savings as % of GDP	Rail freight revenue as % of GDP	Ratio of alternative transport price to rail freight transport price
Cape Colony	1905	12.0	5.56	3.1
Mexico	1910	24.3	2.57	10.5
Argentina	1913	20.6	3.63	6.7
Uruguay	1912–1913	3.8	1.44	3.7
Nigeria	1909	1.2	0.15	9.5
Nigeria	1925	6.1	0.58	11.5
Sierra Leone	1925	2.7	0.66	5.2
Gold Coast	1909	0.8	0.56	2.3
Gold Coast	1924–1925	5.9	1.60	4.7

Sources: For the Cape Colony, see Table 2. For other countries, Herranz-Loncán (2014) and Chaves *et al.* (2013).

Table 4: Social savings of Cape Colony rail passenger transport (1905)

	1st class	2nd & 3rd class
a) Railway output (million passenger-miles)	70.771	253.710
b) Railway fare in £ per passenger-mile	0.0058	0.0032
c) Railway output (million £) (*a x b*)	0.408	0.802
d) Unit value of working travel time in £ per hour	0.0523	0.0214
e) Rail passenger transport average speed (mph)	21	21
f) Working travel time by rail (million hours) (50% of *a* at *e* mph)	1.685	6.041
g) Value of working travel time by rail (million £) (*d x f*)	0.088	0.129
h) Counterfactual road transport price in £ per passenger-mile)	0.022	-
i) Counterfactual road transport output (million £) (*a x h*)	1.540	-
j) Road passenger transport average speed (mph)	7	2
k) Working travel time by road transport (million hours) (50% of *a* at *j* mph)	5.055	63.427
l) Value of working travel time by road (million £) (*d x k*)	0.264	1.357
m) Saving on transport costs (million £) (*i – c*)	1.131	-0.802
n) Saving on travel time (million £) (*l – g*)	0.176	1.228
o) Total savings (million £) (m + n)	*1.307*	*0.426*
p) As % of GDP	*3.11*	*1.02*

Sources and notes:

- Aggregate passenger railway output and prices come from the *Report of the General Manager of Railways for the year 1905*. To calculate specific prices and output for each class, we use the ratios between prices for different classes on a sample of long-distance lines between 1903 and 1909, taken from the *Statistical Register of the Colony of the Cape of Good Hope* (1904–1910).
- Railway speed in the network by 1905 is assumed to be similar to the average speed on the main trunk line (Cape Town–Johannesburg) by 1917, taken from the *Official Year-Book of the Union, No. 2, 1918*. The unit value of working travel time for the second and third classes is an average of wages for various classes of workers in the Cape Colony in 1904, from De Zwart (2011); for the first class we use the average of a sample of wages of skilled workers, from the same source. We assume 10 working hours daily. Walking speed as in Herranz-Loncán (2014).
- The stagecoach price is estimated as the average of the prices of travel between Kimberley and Johannesburg in the late 1880s, from Beet (1924), and the much shorter travel between Robertson and Worcester, from Rhind (1995). The speed of stagecoaches is assumed to be seven miles per hour, as in Burman (1984), for short trips from Cape Town before railway transport was available. This speed would be consistent with the time schedule of stagecoach travel between Kimberley and Johannesburg in the late 1880s (allowing for night stops) and only slightly higher than the six miles per hour reported for the route Beaufort West to Hope Town in the *Debates in the Legislative Council* (1881).

Table 5: Additional consumer surplus of Cape Colony rail transport (1905)

Surplus of rail freight (million £)	3.020/3.631
Surplus of first-class rail passenger transport (million £)	0.641
Surplus of second- and third-class rail passenger transport (million £)	0.426
Total	*4.087/4.698*
As % of GDP	*9.7/11.2*

Sources: See text.

Table 6: Net rail deliveries of produce of South African origin from Cape Colony districts to rest of country (1905)

Grain and cereal		Flour, meal, malt and bran		Other agricultural produce	
District	% of total net deliveries	District	% of total net deliveries	District	% of total net deliveries
Malmesbury	36.5	Paarl	29.2	Malmesbury	35.1
East London	28.5	Tulbagh	20.5	Paarl	11.0
Caledon	23.2	Port Elizabeth	19.3	Worcester	9.9
Port Elizabeth	8.8	Cape Town	16.4	Stellenbosch	6.7
		East London	6.0	Oudtshoorn	6.2
		Malmesbury	4.2		
Sum	*97.0*	*Sum*	*95.6*	*Sum*	*68.9*

Source: Own calculation from *Report of the General Manager of Railways for the year 1905*.