Reinventing the Wheel: The Economic Benefits of Wheeled Transportation in Early Colonial British West Africa

Isaías Chaves*  Stanley L. Engerman†  James A. Robinson‡

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Abstract

One of the great technological puzzles of Sub-Saharan African economic history is that wheeled transportation was barely used prior to the colonial period. Instead, head porterage was the main method of transportation. Though early colonial officials regarded this as highly inefficient, the consensus amongst historians is that rather this was a rational adoption to the underlying conditions and factor endowments. In this paper we undertake the first systematic investigation of the relative costs of these different forms of transportation and calculate the net economic benefits and ‘social savings’ represented by the introduction of railway and motor transportation into British West Africa. While we find that the net benefits of the introduction of railways in the Gold Coast (Ghana) were positive, they are modest and rather similar as a proportion of national income to those calculated for the UK and US in the 19th century. Though these findings reject the hypothesis that building railways was not economically rational in the Gold Coast, they can easily account for why it did not happen prior to the colonial period since African states were likely unable to enter international capital markets to raise the large amount of capital required for the initial fixed cost of production.

Very Preliminary and Incomplete

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*Department of Political Science, 616 Serra St. Encina Hall West, Room 100, Stanford University, Stanford, CA 94305-6044, email: ichaves@stanford.edu.
†University of Rochester, Department of Economics and Department of History, Harkness Hall, University of Rochester, Rochester, NY14627, email: enge@troi.cc.rochester.edu.
‡Harvard University, Department of Government, IQSS, 1737 Cambridge Street N309, Cambridge, MA 01238; e-mail: jrobinson@gov.harvard.edu.
1 Introduction

Today Sub-Saharan Africa is the poorest part of the planet. Though it is debated just when the gap between Africa and the rest of the World developed it is clear that Africa lagged behind Eurasia in terms of many of the key building blocks of economic growth. Though one can see this in many of the factors that go to determine income, for example literacy and human capital, it is perhaps most evident in technology. The basis of the modern economic growth which emerged in Britain in the late 18th century was technological innovation and the Industrial Revolution had itself built on a long incremental series of innovations in agriculture and elsewhere in the economy which had made it possible. Many of these innovations did not take place in Africa. For example, outside of Ethiopia, Sudan, and Somalia, no African country innovated systems of writing, and only Ethiopia innovated the plow. Also conspicuously absent from the region was the wheel. The fact that wheeled transportation was not used in Sub-Saharan Africa until the early colonial period is paradoxical because it is well established that African societies knew about the wheel starting in the early modern period onwards.¹ They did not have to reinvent the wheel, only adopt it. Law (1980) documents many cases where Europeans gave gifts of wheeled transportation to different African kings, and wheeled carriages were in use and were produced in Dahomey from at least the 18th century. Nevertheless, wheeled vehicles did not spread out of ceremonial uses with the exception of a small amount of military use. Why did African societies not adopt a technology which seemed to promise huge economic benefits in terms of reduced costs of transportation?² That such cost savings existed was certainly believed by early colonial officials and Europeans in the 19th century who noted this failure to adopt the wheel. In the absence of wheeled transportation the majority of goods were transported by head porterage. Sir Gerald Portal noted in 1903

“As as animal of burden man is out and out the worst. He eats more, carries less, is more liable to sickness, gets over less ground, is more expensive, more troublesome, and in every way less satisfactory than the meanest four-footed creature that can be trained, induced, or forced to carry a load.” (quoted in Clifford, 1920,

¹See Piggott (1983) for a history of the use of wheeled transportation and Bulliet (1975) for how the introduction of the camel into the trans-Saharan trade led to the abandonment of the use of wheeled transportation on that route.

²As Austen and Headrick (1983) point out this does not exhaust the puzzles surround the non- adoption of the wheel in Africa since neither potter’s wheels nor spinning wheels were adopted either.
The consensus view about the absence of wheeled transportation on the development of West Africa is well summed up by the report that the British MP W. Ormsby-Gore made to Parliament in 1926 after extensive travels the previous year through Britain’s West African colonies. For instance commenting on transportation difficulties in various parts of Nigeria where he went he notes (1926, pp. 24-25)

“The Province of Ogoja contains an estimated population of between 600,000 and 700,000 people who are producing little or nothing for export, and a low standard of life obtains. Until Ogoja is opened up by a network of roads ... there can be little trade with its consequent stimulus to production, and the real development of the Province has not yet begun.”

Later he comments (p. 29)

“In British West Africa there is still too much of the most obsolete and expensive form of transport. I refer to the wide use of head porterage.”

Indeed, as late as 1980 one could read in a textbook treatment

“At first, head porterage had to be used for carrying imports; and palm oil was sent to the coast by the curious and expensive method of barrel-rolling. Porterage was a social evil, a political danger and an economic waste.” (Church, 1980, p. 152).

The fact that such an incredibly labor intensive system of transportation should be used in a continent widely argued to be ‘labor scarce’ (Herbst, 2000, Austin, 2008) only deepens the puzzle. Portal’s view was widely shared by early colonial officials who not only took it for granted that the absence of wheeled transportation was disastrously inefficient but they produced numbers to prove it.

For the most part these officials gave no explanation for why African’s chose not to adopt a technology which they regarded as massively superior to the alternatives in use. The only explanation sometimes given was that, at least in the forest zone of Africa, the presence of the tsetse fly meant that draught animals could not be used. This, they claimed, made wheeled
transportation unusable. This view is clearly stated by McPhee (1926), though it appears everywhere. McPhee’s argument is in fact rather equivocal however since the relevant chapter of his book attempts to show in some detail that road and rail transportation were far superior to head porterage. He seems to take it for granted that Africans could not have built motorable roads or railways. He also explicitly points out on the basis of Lugard’s 1919 report on the amalgamation of Northern and Southern Nigeria for Northern Nigeria that

“Strangely enough, although there are over 3,000,000 cattle, 176,000 donkeys, 113,000 horses and 4,000 cattle, yet such a thing as a cart may be said to be unknown.” (McPhee, 1926, p. 121)

Therefore, though the argument about the tsetse fly is obviously relevant, it can only be a very partial solution to the puzzle. McPhee’s discussion was augmented by Hopkins (1973) who in addition argues that the cost of building roads through the forest zones was so high that this also made wheeled transportation uneconomical. Ogunremi (1975) also claims that head porterage was economic efficient since labor was not really scarce considering how unproductive the available economic alternatives were and he claims that the calculations by Lugard and others are misleading because they ignore the huge capital costs involved in constructing roads and railways. In essence McPhee to an extent, but certainly Hopkins and Ogunremi, respond to the puzzle of the non-adoption of wheeled transportation by asserting that it is not a puzzle and that in fact it was an economically rational decision given the circumstances.³

There are some obvious problems with these existing explanations. First, and most obviously, none of them is based on any real calculation or what was or what was not economically rational. Second, while it is obviously correct that the impact of the tsetse fly made it difficult to use draught animals in large parts of central Africa, ⁴ wheeled transportation was not used in areas where there was no tse-tse either. This is true not just in Southern Africa but also in the Sahel and Northern Nigeria. Third, as Portal’s remark notes, humans were very unhealthy as well, so what is relevant is the relative health not the absolute health of animals in the tse-tse zone. Finally, Hopkins’s claim that wheeled transportation was not adopted in the forest zone because roads were uneconomical to build runs into the problem that African polities in the forest zone did indeed build such roads. Most notably, Wilks (1989) discusses in detail the

³See Acemoglu and Zilibotti (2001) for an elegant formalization of this idea.
⁴Witness the enormous and costly lengths which the Oyo Empire had to go to to keep thier cavalry safe from the ravages of tse-tse (see Law, 1977).
great roads of the Asante Empire in the Gold Coast in the first half of the 19th century. Yet the Asante state did not use wheeled transportation.

In this paper we try to address the economic rationality of the introduction of wheeled transportation in British West Africa, particularly motor vehicles and railways, with the data available in early colonial sources. In this version of the paper we present results only for the introduction of railways in the Gold Coast at two dates 1909 and 1925-26. In future versions we will present results for motor roads and motor transportation and extend these to Nigeria and Sierra Leone. In fact, such technological innovations involve a lot more than wheels, including among other things the internal combustion engine and the steam engine. Along the way we can also look more directly just at the wheel, since we have estimates of the costs of using wheeled carts. Nevertheless, roads and railways appear to be much more interesting and in consequence this will be our main focus.

We use two simple methodologies to examine this issue. The most conventional is the social savings analysis introduced by Fogel (1964) to examine the impact of the railways on the costs of transportation in 19th century US. There are many well known problems with this methodology, and in our context the rather obscure treatment of fixed costs seems particularly problematical. This is why we prefer an alternative calculation where we tackle fixed costs directly which we call the net economic benefits of the new transportation technologies. As in happens both methodologies give very similar results. These results are that both the net benefits and the social savings of the introduction of the railways in the Gold Coast were rather modest. For example, in 1909 we calculate that the social savings associated with the introduction of the railways between Sekondi and Kumase was 2.1% of GDP. In 1925-26, by which time the railway had been extended to include the line from Kumase to Accra, this had risen to 9.3% of GDP. Though these numbers do no support the idea that the railways were an inappropriate technology in the Gold Coast (which would have required negative social savings) they are rather modest and indeed similar to numbers calculated for the UK and USA in the mid 19th century. Therefore they do not really support the hyperbole of Lugard and others about the economic irrationality of existing methods of transportation. It may be that even

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5The early colonial officials who deplored the backward state of transportation in Africa seem not to have been aware of these roads. McPhee (1926, pp. 106-107) for example notes “At the beginning of the last century no proper roads existed anywhere in West Africa ... The earliest roads, not much better than rough tracks which were liable to be obliterated within a year by forest growths, were military roads. Thus Sir Garnet ... Wolsley constructed a road into the heart of Ashanti during the War of 1873-1874. Throughout the whole century very little progress was made.”
though the methods were rational, the inability of African states to access international capital markets with which to cover the very large fixed costs involved in transportation infrastructure is what made the existing system an equilibrium.

The paper proceeds as follows. In the next section we discuss some of the estimates of the costs of transportation made by colonial officials and administrators in the early 20th century. This evidence is typically very incomplete since it is not clear exactly what is involved in the calculation or how representative any of the information is. Section 3 discusses the data which we use to construct our estimates. Section 4 presents the method by which we calculate the net economic benefits of the introduction of the railway and compares this to the social savings methodology. It then moves to make some preliminary estimates. In section 5 we merely mention the issue of externalities which neither method attempts to tackle. Section 6 concludes.

2 Contemporary Discussion and Existing Evidence

British colonial officials were in little doubt that the lack of wheeled transportation was a major impediment to economic progress in West Africa. To demonstrate this they produced a whole range of different numbers which were then constantly repeated over the years. These are summarized in Table 1.

Unfortunately, in all the cases we have found it is never clear exactly how these estimates were constructed and what went into them. Ormsby-Gore’s numbers, for example, are introduced by noting that (1926, pp. 29-30)

“At Zaria, in Northern Nigeria, I was provided with some carefully compiled figures regarding the cost of different forms of transportation per ton mile. head porterage in an area where labour is plentiful and cheap works out at 2/6 per ton mile; motor transport at 1/- per ton mile; donkey transport at 11d; camel transport at between 9d and 10d; while the railway takes baled cotton from Zaria to Lagos at under 2d per ton mile.”

These numbers were widely reproduced (see, for example, Hailey, 1938, p. 1540). Yet Ormsby-Gore gives no further information about who gave him these figures or what sources they used to calculate them. Clearly, taken at face value, these numbers suggest that head porterage was extremely inefficient. According to these numbers, while the cost of shipping
freight by railway was 2 pence per ton mile, head porterage cost 2 shillings and 6 pence, or was 16 times more costly!

Sir Frederick Lugard (1922, p. 461) similarly regarded head porterage as extremely inefficient:

“For uncounted centuries the African has been his own beast of burden, and a simple calculation shows that the cost of land transport by such means with a wage rate of 9d. per day is about 3 shillings per ton mile.”

This number is also very widely reproduced. In a footnote Lugard notes that this calculation is based on assuming that a porter carried 65lbs and could walk 12 miles a day; he then adjusted the estimate upwards to allow for sickness and supervision. He also observes that “for bulky loads the cost is much more.” Elsewhere Lugard (1922, pp. 462-463) remarks that “a railway train of average capacity and engine power will do the work of 13,000 carriers at one twentieth of the cost.”

Other contemporary calculations suggest similar things about the relative efficiency of different forms of transportation. For example, the numbers contained in House of Commons (1909) come from an extensive survey of methods of transportation in the entire British empire undertaken by the Secretary of State for the Colonies. In this survey, undertaken in 1907, the Governors of the different colonies were requested to provide answers to a standardized set of questions about the nature of transportation in their colonies. The information provided for the Gold Coast, presented by E.F.W. Wilkinson, acting director of public works, suggests that transportation by head porterage cost from 3 shillings and one pence to 5 shillings per ton mile (House of Commons, 1909, p. 43). These figures are as much as twice those for Zaria, perhaps indicating the relatively labor scarcity of the Gold Coast in that period. They are however consistent with Lugard’s numbers.

For our purposes at the moment the most interesting comparison is between head porterage and the railways. These oft quoted numbers suggest that head porterage was about 16 to 20 times as costly as the railway. Yet it is not clear how these numbers were constructed. Most crucially, it is not clear whether they factor in the large fixed cost of constructing the railway

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6Forms of transportation other than head porterage were very important in different pre-colonial contexts. For instance Hill (1972) describes how tobacco produced in Katsina in Northern Nigeria was shipped as far south as Ilorin using donkeys and the great kola trade between Nigeria and Ghana was also carried out mostly by donkey (Lovejoy, 1982). In subsequent work we shall examine the comparisons between these forms of transportation with head porterage and railways in greater detail.
or whether they are based just on the variable cost. Since it is precisely the large cost of constructing modern transportation systems in West African conditions which Hopkins (1973) argued made them economically irrational we need to make sure that these costs are indeed taken into account.

3 The Data

Surveys for colonial railways were carried out in 1893-94 in Sierra Leone and during the tour of Governor Sir Gilbert Carter in Lagos in early 1893. Both the Sierra Leone and Lagos railways were started in 1896 and construction on the Gold Coast railway was begun in 1898. The Sierra Leone railway ran Southeast from Freetown and reached Pendembu in 1908. The first railway in the Gold Coast went inland from the port of Sekondi towards the Asante goldfields and reached Kumase in 1903. The second line, linking Kumase and Accra was started in 1909 and completed in 1923. The first railway in Nigeria was from Lagos and reached Jebba on the Niger river in 1909. The second railway liked Kano to the port of Baro on the Niger and was completed in 1911. All the lines were built and operated by the colonial government.\(^7\) We focus on the Gold Coast from now on since it is for the Gold Coast Railways only that we have been able to make some preliminary calculations. In later versions of the paper we will extend the analysis to Nigeria and Sierra Leone.

Our main source of data on the costs of constructing, maintaining, and running the railway, the amount of freight hauled\(^8\) and the revenues generated from freight, is the various reports of the Government of the Gold Coast. In particular we focus on two years, 1909, just after the completion of the Sekondi-Kumase line and 1924-25, after the extension to Accra was opened. Our data comes from the 1909 Report of the General Manager upon the Government Railways, and the 1925 Gold Coast Railway Administrative Report for the Year 1925-1926.

These sources of information gives us extensive data to calculate the amount of freight which was carried on the railways in these two years. Subsequently we will extend this for later dates. The basic data which we need for our calculations is presented in Table 2. This shows that in 1909 there was 168 miles of track and 56,454 tons of goods were hauled. From detailed information of how many tons of goods were carried between each of the stations

\(^7\) For a contemporary discussion of the pros and cons see House of Commons (1924).

\(^8\) We also have detailed data on the number of passengers who used the railway and the revenues thus generated. However, we have not used this data yet because we focus on the counterfactual of head porterage and it is not clear how to deal with passenger traffic in this case.
on the line between Sekondi and Kumase in Government of the Gold Coast (1909a) we can calculate the total number of ton miles as 3,763,552. By 1925-26 (the year ending March 31, 1926) the length of track had increased to 394 miles and 796,888 tons of freight were hauled, a very large increase. Row four of Table 1 reports the data on the total revenues of the railway and the next row reports the % of these that were attributable to freight transportation (the rest being accounted for by passenger traffic). The next row shows expenditures, in essence the cost of running and maintaining the railway. The final row shows the total capital outlays at the two dates.

To compare it to the cost of using head porters we need data on how much a head porter could carry and the rate of pay. Though information on this is much less systematic than the data from the railways, there seems to be a lot of consensus on what the right numbers are. Ormsby-Gore (1926, p. 133) notes

“there is a considerable body of labour temporarily employed on road and railway construction. The supply of voluntary labour for the latter purposes has always provided inadequate in Nigeria, and recourse is had to compulsory or “enlisted” - sometimes called “political” - labour for these essential public works and services. All the railways and most of the roads in Nigeria have involved the use of this compulsory labour ... Such compulsory labour is recruited by the native authorities. It is only called upon to work for a definite period, usually, and never more than, one month at a time. It is paid, usually at a rate of 9d. per day ... Unpaid compulsory labour legalized under the Roads and Rivers Ordinance of Northern Nigeria is only used for keeping clean roads and rivers within local boundaries when called upon to do so by the Resident.”

9d. a day is the figure which is widely quoted from all over British West Africa for the cost of a head porter from around 1910 right through to the middle of the 1920s, though head porterage was surely much less prevalent in 1925. In Sierra Leone Ormsby-Gore (1926, p. 58) reports from his visit a higher number which was 1/3 per day in the Colony and 1/- per day in the Protectorate.

Just as there is a consensus on wages, there is also a consensus that a head porter could carry more or less 60 pounds. Indeed, this seems to have been more or less the official load used by British colonial officials when they hired porters (Ogunremi, 1975, p. 47). In terms of how far a porter could walk in a day the numbers vary, with perhaps 15 miles being the
consensus. In Sierra Leone Ormsby-Gore (1926, p. 58) reports that a porter usually carried 45 to 50 lb of weight and could walk 12-15 miles per day. House of Commons (1909, p. 42) suggests that in the Gold Coast

“The motor lorries carry about 1 ton to 2 1/2 tons; a cask of palm oil weighs 17 3/4 cwt.; a cask of cocoa weighs about 12 cwt; a hand truck carries from 15 to 20 cwt with 6 to 8 men to a truck; head loads are about 60 lbs.”

Moreover “casks, hand trucks and head loads get over 20 miles per day”. The chief commissioner for the Northern Territories of the Gold Coasts reported that although “native rates impossible to gauge” the government paid “10d. a day for loads of 50 to 60 lbs., 1d. a day of which goes to the chief who provided the carriers.” In terms of how far a porter walked, the commissioner noted “At present natives are content to do 10 to 15 miles a day.” For Northern Nigeria (pp. 22-23) the situation was similar with 60 lbs being mentioned as the normal head load and wages for hammock men being 9d. and for a laborer 9d. to 1 shilling per day. In Sierra Leone “Head loads 60 to 100 lbs. Hand carts 1 ton to 30 cwt.” (House of Commons, 1909, p. 102). Though no information is provided on the wage paid to head porters in Sierra Leone in this report it is noted that a barrel roller is paid 1 shilling per day.

To judge if these wage rates are reasonable we can compare them to other information which is readily available. For example, Oyemakinde (1974, p. 318) notes that workers who were recruited by compulsion to build the railways in Northern Nigeria between 1911 and 1915 were paid 9 d. per day, while in Yorubaland, where workers freely took up such employment, they were usually paid 1s. per day.

The report detailing the costs of railway construction in the Gold Coast, Nigeria and Sierra Leone (House of Commons, 1904) reports information on the daily wage rate of unskilled workers who were used in railway construction. These were 10d. a day in Sierra Leone, 1s. a day in Lagos and 1s. 3d. a day in the Gold Coast.

All in all these scattered numbers are quite consistent with each other and for the period around 1909 they suggest that Lugard’s number of 3 shillings per ton mile is a reasonable figure for the cost of head porterage. Ormsby-Gore’s 1926 figures suggest that this number is reasonable for 1925-26 as well.9

9An important issue to be considered in thinking about the applicability of the social savings approach to colonial West Africa is the nature of the labor market. Coerced, or ‘political’ labor was used to build roads and railways and slaves were also extensively used for head porters and no doubt supplied by chiefs to help railway
To get some sense of how big the cost differences between different methods of transportation were it is useful to have something to compare the costs to. The most obvious normalization is with respect to GDP. In the Gold Coast we can take advantage of the estimates of GDP in 1891, 1901 and 1911 of Szereszewski (1965). We use his 1911 number to normalize our 1909 estimates. To our knowledge no estimate of GDP in the Gold Coast exists for 1925. Szereszewski’s (1965) numbers imply that real GDP grew by 7.5% per year between 1891 and 1911 a very rapid rate of growth which coincides with the expansion of the cocoa industry. It is possible that this rate continued until 1925 but unlikely given the war years. This issue requires much greater work in the future but for the moment we assume that the average rate of real GDP growth between 1911 and 1925 was 5%. To calculate GDP in nominal terms in 1925 we need data on prices. To do this we used data on the prices of consumption goods from the 1909 and 1926/26 Blue Books to calculate that consumer prices increased by around 50% over this period (Government of the Gold Coast, 1909b, 1925-26b).

4 Was Head Porterage Economically Efficient?

Though the calculations discussed previously are interesting, they fall very far short of a systematic treatment of the issue. Moreover, one could easily imagine that colonial officers, anxious to legitimize their ‘civilizing mission’ in Africa, may have been inclined to over-emphasize the technological backwardness of Africa.

The conventional method for tackling the issues broached in this paper is that of social savings introduced by Fogel (1964). This approach has been heavily criticized, requires strong assumptions about the nature of the economy, and fails to capture important impacts of transportation innovations (see O’Brien, 1977, Fogel, 1979, Summerhill, 2003, and Crafts, 2004, for extensive discussions of the pros and cons of the approach). From our point of view, the biggest problem with the method is that it requires the assumption that we are studying a perfectly competitive industry in long-run equilibrium so that price (average revenue) is and road construction as well. In the Gold Coast in particular there appears to have been a great labor shortage and the supply of Africans which were forthcoming at the wages that the British were prepared to pay was insufficient to get the work done. Colonial officials therefore induced local chiefs to provide labor (see Thomas, 1973, and Mann, 1995, for studies of forced labor and Mason, 1978 and Swindell, 1992, for specific studies in the context of railway construction). For the moment we set aside this issue based on the premise that since labor could be coerced either to build railways or work as porters, this should not influence the relative benefits of the two methods of transportation. However, this issue needs a lot of further thought.

Since we cannot extract detailed information on the composition of consumption baskets from the Blue Books this number is not derived from proper price indices. This is another area for future research.
equal to long-run average cost. Obviously railways, which involved a huge fixed cost, cannot
be in such an equilibrium. Moreover, in all the West African colonies the prices charged
for freight and passengers were not determined by competition but were set by the colonial
administration. This makes looking at revenues problematical. Nevertheless, despite these
caveats we make some preliminary estimates of the social savings if only because this allows
us to make some comparative statements about the Gold Coast situation.

These problems do however militate against the use of the social saving methodology as
the main focus of attention. The simplest way to proceed is to use direct data on the costs
of different methods of transportation which also includes the cost of maintaining the capital
stock. To this we must add a portion of the fixed cost. The simplest method of doing this is
just to assume a fixed rate of interest, which is reasonable in this period and an amortization
schedule. When the railways were begun in West Africa they were funded out of money set
aside by Joseph Chamberlain, the then Colonial Secretary. This money was for an interest
rate of $2\frac{3}{4}\%$ to be repaid in 50 years. These numbers can form a useful base from which to
start. After that the colonial governments entered the London money market and borrowed at
the going rates of interest. These loans had to be repaid out of the revenues that the railways
generated.

We can derive a simple amortization schedule where we know the original capital investment
in the project $F$, the interest rate of the loan that was incurred to raise this amount of money,$r$ and assume that the payment $A$ is fixed over time. Standard calculations show

$$A = F \frac{r(1 + r)^n}{(1 + r)^n - 1}$$

where $n$ is the number of periods over which the loan is to be re-paid.

We can now define the cost of building and operating the railways when a particular
quantity of transportation services are provided with a little notation. Let $c_t$ be the cost per-
ton mile of transporting goods on the railways in year $t$, which also includes maintenance of
the capital stock, such as track replacement engines and new rolling stock. Let $Q_t$ be the total
quantity of goods moved in tons and let $D_t$ be the average distance a ton was moved in miles.$Q_tD_t$ is therefore a measure of transportation services in ton miles. Thus $c_tQ_tD_t$ is the total

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11 Indeed, it is not just that the colonial administration regulated prices, they also regulated other activities in
ways which heavily influenced the profitability of the railways. For example in 1936 the Gold Coast government
passed Ordinance 38 which prevented the carriage by roads of key export goods, such as cocoa and also key
imports because road transportation was competing with the railways. Sierra Leone adopted a similar measure
the following year (Ordinance 6 of 1937) (see Hailey, 1938, pp. 1559-1560 and Church, 1956).
cost incurred in moving this much freight given how far it was moved. We can express the annual cost of railways transportation in a period as

\[ C_t^R = c_t Q_t D_t + A \]

where \( A \) is the amount of the fixed cost repaid in any period.

A head porter can move a fraction \( \lambda \) of a ton 15 miles in one day. Thus to carry \( Q_t \) tons requires \( \frac{Q_t}{\lambda} \) porters. The daily wage rate of a porter is \( w_t \). Therefore the cost of \( Q_t D_t \) ton miles of transportation services if provided by head porter would be

\[ C_t^H = w_t \frac{Q_t D_t}{15 \lambda} \]

It is crucial to note here that \( Q_t D_t \) is the observed quantity of transportation services provided by the railway. We are assuming that head porters would have carried the same amount of goods, which is unlikely to have been true. Since head porterage was more expensive, as we shall show, it is likely that the amount of goods transported would have actually have been lower. To calculate how much lower, one requires the elasticity of demand for transportation services. At the moment we do not have sufficient information to calculate this for the Gold Coast but we will hope to do so in later extensions of our basic analysis.

4.1 The Social Savings Approach

The main difference between the approach we described above and the social savings approach is that instead of using information about the cost of operating the railways and directly apportioning the fixed cost, the social savings approach uses information on freight revenues. As we noted earlier this makes sense theoretically in a world where price is equal to long run average costs, but this assumption cannot be true with railways given that the presence of fixed costs implies that the average cost curve would be monotonically decreasing. Nevertheless, as already noted we make these calculations for comparison with the international data because this method has been so heavily applied.

4.2 Some Preliminary results from the Gold Coast

Table 3 contains two sets of estimates, one for 1909 and one for 1925-1926. In both columns the first set of calculations relate to our direct measure of the relative costs of the different methods of transportation the second set social savings. The first row reports total ton miles
of freight transported in the different years. The second row reports our measure of variable cost, essentially expenditures as reported in Table 2. The third row reports our estimates of \( A \), which is the amount of the fixed cost to be apportioned in each year. As noted above this is based on a simple amortization schedule with an interest rate of \( 2\% \) with the capital be repaid over 50 years. The next row simply sums these numbers to give the cost of transporting the observed total ton miles by railways in each of the two years. The next row then calculates, using the estimate of 3 shillings per ton mile how much it would have cost to transport the observed ton mileage by head porter and row. The difference between these two numbers, reported in row 6, is the net economic benefit of railways. This amounted to £439,903 in 1909 and £5,699,518 in 1925-26. Row 7 then reports the total freight revenues from Table 2 and row 8 uses these to calculate the social savings which is row 5 minus row 7. Row 8 shows that social savings in 1909 were £418,059 while in 1925-26 they were £5,626,861. In neither case are these very different from the calculated net benefits. To give some normalization row 9 then reports GDP in current prices in 1909 and 1925, and the final row reports social savings as a % of GDP.

Table 4 then allows us to make some comparisons of the levels of social saving calculated elsewhere in the world. One sees from this that our estimates from the Gold Coast are far below some of the high estimates for Argentina, Mexico or Spain and more similar to the lower estimates form the UK and the USA in 1890.

5 Externalities

All of these simple calculations cannot incorporate the potentially large externalities created by the construction of the railways. That colonial officials believed these existed is evident from contemporary discussion. Harry Johnston, an avid colonizer of Africa, noted in 1889 (quoted in McPhee, 1936, p. 111)

“There is no civiliser like the railway, and to build a railway through an uncivilized country is to centuple its existing trade, or to create commerce if none exists: the railway saps race prejudices and dissolves fanaticism.”

His views are echoed in many places. McPhee (1926, pp. 126-127) even argues that

“Slavery in Northern Nigeria found its chief buttress in the demand for cheap transport in a region where animal transport was not feasible on account of the
the Government built railways, and slave carriage died a natural death, because it became uneconomical.”

Lugard (1922, p. 463) also observed about the construction of the railway in Nigeria that “it has killed the slave trade” and Knowles (1928, pp. 138-152) extensively discusses externalities flowing from railway construction.

How to extend the methodology we used above to include these effects is not obvious, but it is probable that they swamp the direct benefits we have calculated here. We intend to develop this line of analysis more in the next stage of the paper.

6 Conclusions

In this paper we have undertaken some very preliminary calculations to examine the economic benefits of introducing modern methods of transportation into West Africa in the early 20th century. So far our work is very incomplete and preliminary, and we were able to report results only for a comparison between the railways and head porterage in the Gold Coast, for two years, 1909 and 1925-26. Still the results seem to be quite interesting and surprising. Though we do find that railways were economically rational, the direct economic benefits seem to be relatively modest relative to national income. Still, our calculations leave many things out and this should be regarded only as a tentative first pass at the issue.

7 References


Philip.


Gould, Peter R. (1959) *Transportation in Ghana*, Northwestern University, Studies in Geography No. 5.


House of Commons (1904) “Papers Relating to the Construction of the Railways in Sierra Leone, Lagos and the Gold Coast, Cd. 2325.


Table 1: Some Contemporary Estimates of the Relative Cost of Methods of Transportation
(cost in shillings and pence per ton mile).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cask Rolling</td>
<td>1s.2d. - 1s.11d.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Trucks</td>
<td>1s.10d.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Porterage</td>
<td>3s.1d. - 5s.</td>
<td>2s.6d.</td>
<td>1s.10d. - 2s</td>
</tr>
<tr>
<td>Motor Lorry</td>
<td>1s.8d.</td>
<td>1s.</td>
<td></td>
</tr>
<tr>
<td>Railway</td>
<td>2d.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donkey</td>
<td>11d.</td>
<td></td>
<td>9d.-10d.</td>
</tr>
</tbody>
</table>

Table 2: Basic Data on the Gold Coast Railways

<table>
<thead>
<tr>
<th></th>
<th>1909</th>
<th>1925-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mile of Track Open</td>
<td>168</td>
<td>394</td>
</tr>
<tr>
<td>Total Freight Hauled (tons)</td>
<td>56,454</td>
<td>796,888</td>
</tr>
<tr>
<td>Total Freight ton miles</td>
<td>3,763,552</td>
<td>43,170,885</td>
</tr>
<tr>
<td>Railway Freight Revenues (£)</td>
<td>185,410</td>
<td>1,102,301</td>
</tr>
<tr>
<td>% of Revenues generated by freight</td>
<td>79.2</td>
<td>77.1</td>
</tr>
<tr>
<td>Total Expenditures (£)</td>
<td>73,914</td>
<td>568,012</td>
</tr>
<tr>
<td>Total Capital Outlays (£)</td>
<td>1,808,323</td>
<td>7,419,086</td>
</tr>
</tbody>
</table>

Table 3: Estimates of the Net Benefits and Social Savings in the Gold Coast.

<table>
<thead>
<tr>
<th></th>
<th>1909</th>
<th>1925-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Freight ton miles</td>
<td>3,763,552</td>
<td>43,170,885</td>
</tr>
<tr>
<td>Total Variable Cost (£)</td>
<td>73,914</td>
<td>568,012</td>
</tr>
<tr>
<td>Fixed Cost (£)</td>
<td>50,716</td>
<td>208,103</td>
</tr>
<tr>
<td>Total Cost (£)</td>
<td>124,630</td>
<td>776,115</td>
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<tr>
<td>Total Cost of Head Porterage (£)</td>
<td>564,533</td>
<td>6,475,633</td>
</tr>
<tr>
<td>Net Benefit (£)</td>
<td>439,903</td>
<td>5,699,518</td>
</tr>
<tr>
<td>Total Freight Revenues (£)</td>
<td>146,474</td>
<td>848,772</td>
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<tr>
<td>Social Saving (£)</td>
<td>418,059</td>
<td>5,626,861</td>
</tr>
<tr>
<td>GDP (in current £)</td>
<td>19,467,000</td>
<td>60,737,040</td>
</tr>
<tr>
<td>Social Savings as a % of GDP</td>
<td>2.1</td>
<td>9.3</td>
</tr>
</tbody>
</table>
Table 4

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Social saving as a share of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>England and Wales</td>
<td>1865</td>
<td>4.1</td>
</tr>
<tr>
<td>England and Wales</td>
<td>1890</td>
<td>11</td>
</tr>
<tr>
<td>France</td>
<td>1872</td>
<td>5.8</td>
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<tr>
<td>Germany</td>
<td>1890s</td>
<td>5</td>
</tr>
<tr>
<td>Spain</td>
<td>1912</td>
<td>23.7</td>
</tr>
<tr>
<td>Belgium</td>
<td>1865</td>
<td>2.5</td>
</tr>
<tr>
<td>Belgium</td>
<td>1912</td>
<td>4.5</td>
</tr>
<tr>
<td>Russia</td>
<td>1907</td>
<td>4.6</td>
</tr>
<tr>
<td>China</td>
<td>1933</td>
<td>0.5</td>
</tr>
<tr>
<td>United States</td>
<td>1859</td>
<td>3.7</td>
</tr>
<tr>
<td>United States</td>
<td>1890</td>
<td>8.9</td>
</tr>
<tr>
<td>Argentina</td>
<td>1913</td>
<td>26</td>
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<tr>
<td>Colombia</td>
<td>1927</td>
<td>7.9</td>
</tr>
<tr>
<td>Mexico</td>
<td>1910</td>
<td>38.5</td>
</tr>
<tr>
<td>Brazil</td>
<td>1913</td>
<td>18</td>
</tr>
</tbody>
</table>