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TITLE Some limitations to the opportunities for road investment to promote rural development

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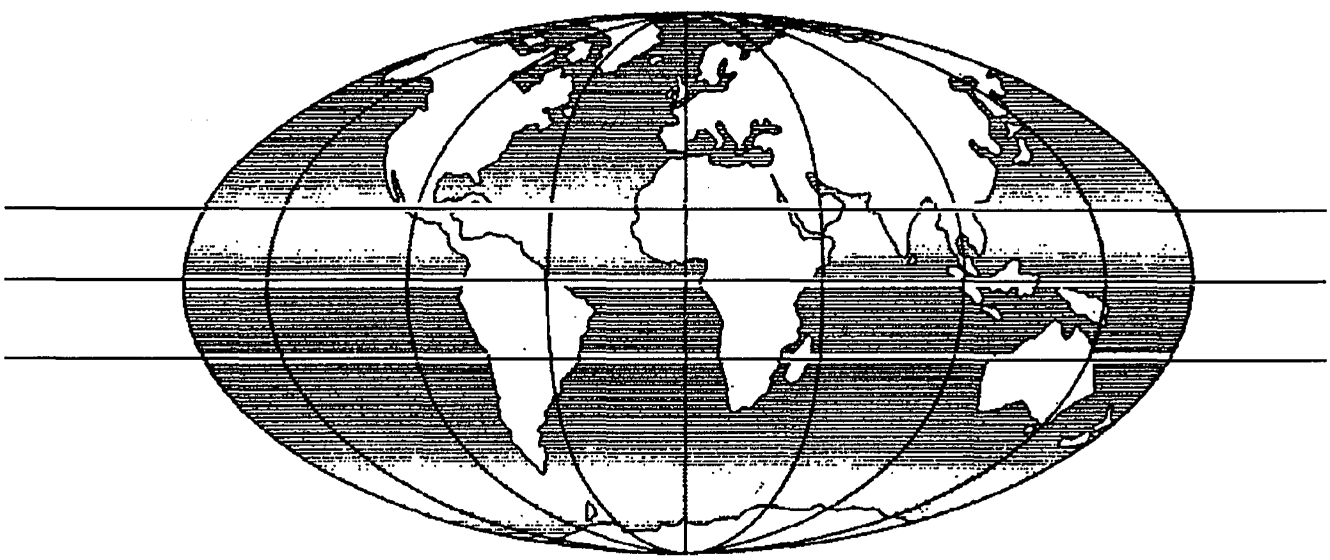

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Limitations des occasions d'investissement routier pour la promotion des développements ruraux

Some limitations to the opportunities for road investment to promote rural development

Algunas limitaciones de las oportunidades de inversiones viales para promover el desarrollo rural

Une étude effectuée dans la région de l'Ashanti, au Ghana, suggère que l'amélioration de la surface des routes aura peu d'effet sur l'agriculture. Il est très probable que l'agriculture profitera des investissements routiers si la conséquence de ces derniers est le remplacement du portage par le transport par véhicules. L'application d'un modèle aléatoire du réseau routier, associée à une étude cartographique, suggère que des investissements routiers supplémentaires dans la plus grande partie du Ghana, du Kenya et de l'Inde auront peu d'impact sur le développement agricole, parce que les populations rurales de ces pays habitent déjà tout près d'un accès à des véhicules.

A study in the Ashanti Region of Ghana suggests that agriculture will be little affected by the improvement of road surfaces. Agriculture is most likely to benefit from road investment if this leads to the replacement of headloading by vehicle transport. The application of a random model of the road network, coupled with a study of maps, suggests that further road investment in much of Ghana, Kenya and India will have little impact on agricultural development because their rural populations already live close to vehicle access.

Un estudio en la region Ashanti de Ghana indica que el majoramiento de superficies viales se hará poco efecto en la agricultura. Es el mas probable que la agricultura beneficiará de la inversion vial si ésta conduce a hacer transportar por vehiculo en vez de cabeza humana. La aplicacion de un modelo aleatorio de la red vial junto con un estudio de mapas, indica que para gran parte de los paises de Ghana, Kenia e India las inversiones adicionales en el sector vial influirá poco en e desarrollo agrario, porque sus poblaciones ya se encuentran en proximidades de acceso para vehiculos.

INTRODUCTION

This paper is concerned with the circumstances in which road investment will, in the first instance, promote agricultural development, and subsequently encourage rural development in general. The extent to which rural populations already have vehicle access is critical to any assessment of the role of road investment to promote rural development. Using a simple model of the road network an analysis is made of how well the network serves the population and land area. The importance of seasonal disruption and the role of road investment in opening new areas are also discussed.

The Impact of Feeder Road Investment in Ghana

A study of 33 villages in the Ashanti Region in Ghana[1] found little evidence to suggest that agriculture was adversely affected by inaccessibility. The villages were between 8 and 102 km from the regional capital, Kumasi. All but two of them had vehicle access. Accessibility was measured in terms of the transport costs of moving farm produce to each village's district centre and to Kumasi.

If anything, the study found that the more remote villages were more agriculturally developed than the more accessible ones. The more remote villages cultivated larger farms, grew more cocoa, sold a greater proportion of their produce, and devoted a greater proportion of household labour to farming. This was in spite of the fact that they were at a disadvantage in their ability to obtain loan finance. On the other hand their access to modern inputs such as extension advice, tractors, fertiliser or cocoa insecticide was unaffected by their inaccessibility. Villages with good access gained more of their income from non-agricultural activities, such as food marketing, food processing and the provision of rural services.

As in other developing countries, agricultural practice in Ghana is characterised by relatively small volumes of modern inputs

TABLE 1

Examples of calculated and measured rural accessibilities

Country	Ghana (a)	Kenya (b)	All Kenya (c)	India (d)	India (e)
Area (km^2)	16,000	19,500	571,000	3.3M	3.3M
Type of road*	R	R+T	R+T	Me	R
Unit of disaggregation	Ashanti Region	4 zones	39 districts	22 provinces	22 provinces
Average road density	0.27	0.24	0.11	0.07	0.49
Proportion of population more than 3km from road;					
(i) predicted by random model %	20.2	9.48	25.6	57.4	6.7
(ii) observed %	0.9	2.52	8.7	60.0	?
Ratio of predicted (i) to observed (ii)	22	4	3	1	-

Notes: (a) Both observations and random model estimate drawn from maps of Ashanti Region.

(b) Sample: observations and random model estimate drawn from identified hut population.

(c) Random model estimate drawn from district road and track data weighted by district population. Observations based on an analysis of 106 maps ground-weighted by district population and road density data.

(d) Observations based on 1957 National Sample Survey of the location of villages to metalled roads; random model estimate is from 1961 metalled road length and rural population data. All calculations and estimates based on 2 miles (3.2 km).

(e) Random model estimate based on 1980 road length data.

* R - all roads
T - motorable tracks
Me - metalled roads

average density of 0.49 km of roads per km^2. This is the highest road density of any of the larger developing countries. It is only 70 per cent of that of the United States and is higher than that of many European Countries. The random model suggests that at least 93 per cent of the rural population of India lives within 3km of a road (and at least 98 per cent lives within 5km of a road).

The 'all Kenya' estimate shown in the Table suggests that 8.7 per cent of the rural population lives further than 3km from a road or motorable track. However the majority of this 'remote' population (5.5 per cent of the total) is to be found in the dry north and east of the country where it is possible to drive over much of the area by truck or four wheel drive vehicle. Hence the absence of road or track does not necessarily imply a lack of vehicle access.

The data from Ghana, Kenya and India suggests that in these countries, the rural population lives relatively close to vehicle access. The evidence from other countries is less clear cut. In general, densely populated areas in easy terrain are relatively well served with roads. By contrast, well populated areas in mountainous terrain (as in Nepal or the Andean countries) have relatively poor road access. Medium and sparsely populated areas of desert, savanna, or the sahel are not well served with roads although vehicle movement is often not hindered by the natural terrain.

The Existing Pattern of Investment in Minor or Feeder Roads

An examination of the road building programmes of a number of developing countries (including Ethiopia - a country with one of the lowest road densities in the world) suggests that there is increasing emphasis on rehabilitating and upgrading minor roads and tracks rather than on providing completely new access. In practice, it seems (eg insecticide, fertiliser) and by a labour force that lives in the vicinity of the farm. Hence agricultural inputs create a relatively small demand for vehicle transport. Road investment is only likely to induce a response in production when the costs of moving produce to the market are reduced giving rise to higher farmgate prices. On average transport costs were found to account for between 3 and 6 per cent of the final Kumasi market price for maize, yam and plantain; three of the main staple food crops. Crops bound for Kumasi were transported over distances typically between 120 and 200 km.

In order to demonstrate the impact of road investment on the prices received by a farmer at his farmgate, two calculations were made. The first concerned the effect of upgrading a 5 km stretch of motorable track between village and market, assuming that all resultant reductions in vehicle operating costs were passed on to the farmer. It was estimated that the farmgate prices would rise by only 0.1 per cent.

The second calculation considered the effect of converting a 5 km stretch of footpath to motorable track between village and market. The consequent reduction in headloading costs was calculated to increase farmgate prices by over 11 per cent - a gain some 100 times larger than the previous change.

The Relative Transport Costs of Different Modes

Large changes in transport costs can be expected when human porterage is replaced by motor vehicle. In the Ghanaian example headloading was calculated to be 12.5 times as expensive as motor vehicle transport. There is much less scope if the change is between animal transport and motor vehicle. Clark and Haswell[2] have shown that transport by animal carts and wagons is typically three times as expensive as by motor vehicle, while in a recent Indonesian study, Rogers[3] presents data suggesting that transport by one-tonne light trucks is twice as expensive as by ox-cart.

In practice, the relative costs of different modes depends closely on the size of load and distance to be travelled, there can be substantial economies in vehicle transport if goods are moved some distance and in sufficient quantity. In Ghana, it was estimated that distances were too short and demand too dispersed for motor vehicles to be used between farm and village. It was predicted that savings would arise only if villages formerly inaccessible to motor vehicles were connected to the road network.

The Question of Seasonality in Vehicle Access

Frequently, rural road investment is justified on the basis of providing "all weather" access. The argument used is that many roads and tracks become impassable during the rainy season and so "all weather" roads are required. Unfortunately the actual extent of traffic disruption is rarely quantified and its effects on the local communities are seldom measured. From the point of view of agricultural production, there are grounds for supposing that the need for substantial road investment to provide "all weather" access is often overstated. In the Ghanaian study, little evidence was found to suggest that produce was lost because of impassable roads.

In the author's experience it is uncommon for roads and tracks to be impassable to all motor vehicles for more than a day at a time because of seasonal rains. Of course there are exceptions. For example, areas which have many river channels, seasonal swamp land, plastic clay soils, or are subject to continuous heavy 'monsoon' rainfall. In general rainfall tends to both reduce traffic levels and to alter the traffic mix. Saloon cars and buses curtail trips, leaving trucks and four-wheel drive vehicles to cope with the residual demand. Flooding by rivers in spate usually diverts all vehicle types for a few hours until the river height decreases.

Fares and transport charges often increase in the rainy season; for example, a recent study in Kenya showed that on the "dry weather" roads, fares increased by between 20 and 100 per cent. This was probably a joint response to lower vehicle utilisation, higher variable operating costs and less competition. Nevertheless, even if transport charges are doubled for the relatively short road lengths 'at risk', in general there will be little effect on the prices paid to the farmer.

From the point of view of the agricultural crop cycle, most products are harvested after the major rains and hence in this respect, seasonal disruption may not be that critical. On the other hand, for products like milk, tea and green vegetables that are harvested throughout the year, seasonal disruption may be an important constraint.

A Random Model of the Road Network

At the local level, transport costs are highly dependent on the extent of vehicle accessibility. Hence the quantification of how far rural communities live from vehicle access is critically important when assessing the role road investment plays in promoting rural development. This may be achieved by a detailed analysis of maps, although this can be a lengthy procedure when many maps must be analysed. An alternative is to use a model of the road network which will provide a simple, if crude, method of estimating how well the road network serves the land area.

The model used here assumes that roads can be represented by a set of infinitely long straight lines, distributed at random on a plane. It can be shown that for an area of 'a' km^2 with a road length of 'ℓ' km, the mean distance (m) to the road network is given by

$$m = \frac{1}{2} \times \frac{a}{\ell} \text{ km}$$

The proportion of the area further than a given distance 'd' to the network is then given by the formula:-

$$e^{-\frac{d}{m}}.$$

Thus if an area of 100 sq km has a randomly distributed road network of 25 km in length, then the average distance to the network is:-

$$\frac{1}{2} \times \frac{100}{25} = 2 \text{ km.}$$

The proportion further than 5 km is:-

$$e^{-\frac{5}{2}} = 8.2 \text{ per cent.}$$

Howe[4] has shown that the number of nodes and links on the main road network of six developing countries approximates to the number expected from a random road network distributed throughout each country. Unfortunately this is insufficient evidence to demonstrate the usefulness of the model for areal coverage.

To validate the model, 22 large-scale maps covering 70 per cent of Ashanti Region were analysed. A set of 25 randomly spaced points was selected for each map and the distance between each point and the nearest position on the road network was measured. A comparison between these measurements and the predictions made using the random model is shown in Figure 1

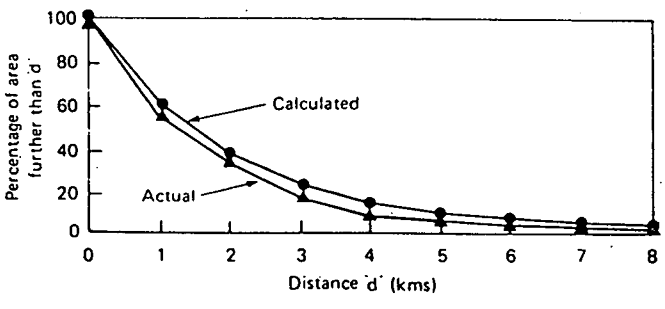

Fig.1 The distribution of area to the road network (Ashanti Region, Ghana)

It can be seen that the random model can give a reasonable representation of areal accessibility. However, if the road density in an area is heavily skewed, the area must be split into zones of similar road density and the model applied to each separately. The zones do not have to be contiguous.

To test the model in a different region with a wide range of road densities a second study was carried out using 25 large-scale maps of Kenya with average road density ranging from 0.035 to 0.55 km per km^2. For the analysis the maps were grouped into 4 zones. Measurement showed that 29.7 per cent of the land area was further than 3 km from the road network, while the random model gave an estimate of 34.3 per cent.

If it is assumed that the rural population is evenly spread within each of the zones then an estimate of the distribution of the population from the road network may be calculated by weighting each random model estimate by its respective population. Observed and random model estimates of the population distribution for the two examples already described are shown in Table 1 together with estimates (based on disaggregation by district and province) for the whole of Kenya and India.

The Ghanaian and Kenyan estimates shown in the Table suggest that the random model will overestimate the proportion of the population living more than a given distance from the road network. A much closer relationship between predicted and observed is found in the Indian 'metalled' roads example, though there are strong grounds for supposing that the Indian National Sample Survey overestimated the distance that the total rural population lived from the network. This is because the observed estimate shown is for villages rather than for population, and it is well known that larger villages are located closer to major roads than smaller villages. In the Ghanaian case, over 90 per cent of the villages with more than 5000 people were located next to major roads while only 13 per cent of villages with 200 people or less were so located.

In practice people are often prevented from clustering around the road network because of scarcities of land and water. In the Ashanti Region, with its ample supplies of both, the rural population can afford to be concentrated next to the road network. By contrast, the large populations of West Kenya and India have to be dispersed over the available land. In the arid areas of North and East Kenya the population is compelled to live close to the water and grazing areas and these are often far from the road network.

Table 1 provides a current estimate of the distribution of India's rural population in relation to the road network. India now has a road network of 1.6M km giving an that national and internationally sponsored rural road building programmes often follow the initiatives of local communities and land owners.

From the point of view of rural development, external help should first go towards providing those facilities such as bridge crossings, culverts and other structures that local communities cannot provide themselves in order to keep basic vehicle access open at a small fraction of the cost of a fully engineered road. It is only when vehicle traffic increases above a certain minimum that engineered roads are required and these may be sensibly assessed on the basis of transport cost savings.

Opening up New Areas

Road investment has a major role to play in opening up those remaining areas of the world that are fertile and yet remain relatively uninhabited. Where land values are low and extensive methods of cultivation are practiced, then new land, (unless adjacent to urban markets or accompanied by other benefits) will not appear that attractive. There are many examples of uncultivated fertile land, lying remote from urban centres, yet located adjacent to roads. Other development inputs (such as housing, water and land clearing) will be required if land is to be made more attractive than existing farmed areas to potential migrants and investors.

Conclusions

Road building is most likely to encourage agricultural development where human porterage is replaced by motor vehicle transport, but it is unlikely to have much effect if it merely improves the quality of road surfaces of existing minor roads and tracks. From the point of view of agriculture the best use of scarce resources is through investment in bridging, minor drainage work and other small scale remedial measures which extend vehicle access and keep routes open to motor vehicle traffic. However, major investments designed to improve marginally the all-weather capabilities of roads may not be cost-effective for the production of most crops, because peak transport demands occur in the drier periods of the year.

The application of a random model of the road network coupled with map analysis suggests that the vast majority of rural populations in countries like India, Kenya and Ghana live close to vehicle access. Hence the impact on agriculture of road building to improve accessibility to the majority of the rural population in these countries is likely to be limited.

Road investment has a part to play in the agricultural development of unpopulated but fertile areas. The best results are likely to be achieved if road investment is planned in conjunction with other development inputs.

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