THE POVERTY REDUCTION IMPACT OF RURAL ROADS: A SYSTEMATIC REVIEW

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ABSTRACT

The systematic review, funded by the Department for International Development, UK (DFID) and conducted by Cardno IT Transport investigated the question, 'Does the extension of the rural road network have a positive impact on poverty reduction and resilience for the rural areas served? If so how, and if not why not?' [1]. This paper draws significantly from excerpts from the original Systematic Review.

The evidence has provided a strong direct relationship between rural transport infrastructure and reducing transport costs and increasing traffic volumes. In addition, there is strong evidence that over the medium to long term, this leads to an increase in employment, income and consumption, and expansion of the agricultural sector. There is evidence to suggest that the health impacts are generally positive, but increased connectivity is also shown to lead to an increase in communicable diseases.
With respect to marketing activity, the evidence base presents a mixed conclusion whereby communities closer to the transport improvement benefit but negative impacts are found in distant areas. There is a weak evidence base with regard to educational impacts. Not enough studies provided a sufficiently long-term measurement of impacts to test the 'resilience' of local communities in their ability to absorb benefits over time and after periods of external shocks.

1. REVIEW APPROACH AND METHODOLOGY

Based on the principles of Systematic Reviews, a structured search strategy was developed to identify relevant literature. This involved the development of a set of key words and filters most relevant to the review question. Sixty-one sources were searched, including traditional bibliographic databases, organisational websites, online book catalogues, dissertation listings and sources of grey literature. A total of approximately 5,500 separate research documents were found from the initial search. These references were then screened on title and abstract and 120 references were judged to be qualified for screening, data extraction and quality appraisal of full reports.

Of these, a total of 56 studies were accepted for analysis in the Systematic Review.
The review then adopted a numerical narrative approach to the synthesis of findings - each study was analysed in depth with data recorded and detailing the specific attributes and findings of the study. This provided an overall framework for the studies to be considered holistically.

1.1. Studies Included in the Review

The studies included in the review adopted a range of different approaches, data collection procedures and methodologies.

2.1.1 *Approaches*

The studies can be grouped into the following three general approaches:

- Historical impact of road investment relating to specific roads and locations (19 studies).
- Marginal impact of road investment based on historical national and regional data (9 studies).
- Cross-sectional accessibility models and comparisons (28 studies)

2.1.2 *Methods of Analysis*

A range of analysis methodologies have been used:

- Simple historical, cross-sectional and stratified comparisons
- The 'double-difference' approach
- Simple regression analysis
- Multi-stage and more complex forms of econometric modelling

2.1.3 *Geographical Areas*

The study countries include a wide representation of geographical areas.

- Approximately 55% of studies were featured in Sub-Saharan Africa
- Approximately 20% of studies were from East Asia and the Pacific region
- Latin America is represented by approximately 10% of all studies.
- South Asia is represented by approximately 10% of all studies.
- There were two references (approximately 4% of all studies) from Middle East and North Africa
- There was one reference (approximately 2% of all studies) from Europe and Central Asia.

2. SUMMARY MAP OF EVIDENCE

In terms of reporting results, the studies were found to be very heterogeneous. In general there was very little consistency between formats or measures for reporting the different types of outcome. Hence it was not possible to estimate 'average effects' or, in most instances, a 'range of effects'.

However, aggregating the data of findings can draw the following summary findings

- **Traffic flows:** six studies reporting data on traffic flows recorded an increase in traffic. However, there was a very wide range of response, ranging between a 21% increase [2] and 312% increase [3].
- **Transport costs and tariffs:** nine studies provided data on the change in transport costs, fares and tariffs derived from road improvements. The largest difference in tariffs was the 31-fold ratio in costs (per ton/km) between head-

loading and transporting by truck [4]. The range in changes in tariffs as a result of improving existing accessible roads varied from a 50% reduction in tariffs in one case [5] to little or no change in another [6].

- **Income and consumption:** 27 studies investigated the impact of transportation on income and consumption. Of these, 21 (78%) reported significant increases in income and consumption, with the remaining six studies finding no significant change. The largest effects were found in African countries with low road densities; for example one study on Ethiopia found that good access could increase the consumption growth rate by 9% a year [7] while another study on Uganda found a benefit-cost ratio of 7.16, where spending US$10,000 (2013 prices) on rural roads would lift 261 people out of poverty [8].
- **Agricultural output:** 10 studies analysed the effects of rural roads on a range of agricultural outputs. A significant increase was found in seven studies; for example improved rural roads were estimated to lead to a 27% increase in output in Ethiopia [9]. However, no significant change in agricultural output was found in three studies [10] [11] [12].
- **Agricultural inputs, costs and prices:** nine studies analysed the effects of improved accessibility on agricultural inputs, costs and prices. Significant beneficial effects were identified in all the studies, although with substantial variations. For example, a threefold comparative increase in extension services was found in Morocco [13], while a study in Ethiopia found that fertiliser use increased by 2.5 times between villages with poor and good accessibility [14]. A study in Ghana found that bringing vehicle access closer by 5km would increase farm-gate maize prices by 11.4% [15]; however improving an existing accessible road by the same distance would increase the prices by just 0.08% [16].
- **Agricultural land values:** four studies examined the effects of accessibility on land values. One study found no effect of improving roads on land values [17], while three studies found that better accessibility increased land values [18] [19]. For example, there was a 15% increase in land values associated with project roads compared with a control in Nicaragua [20].
- **Agricultural marketing:** six studies investigated the effects of accessibility on agricultural marketing. Two identified favourable effects of better accessibility on marketing [21] [22] (i.e. market frequency and range of goods on sale); two other studies found that communities on adjacent roads that had not been improved would suffer, with a decline in market activity and higher consumer prices [23] [24]. Finally, two studies identified substantial market inefficiencies that were not necessarily to do with road construction [25] [26].
- **Employment:** 15 studies analysed the effects of accessibility on employment. With the exception of one study (on Honduras) [27], all others found that better access led to much greater non-agricultural employment. This appears to be a key factor in the association between poverty reduction and road investment.
- **Health:** 15 studies investigated the effects of accessibility on health. Twelve identified the beneficial effects of improved accessibility on health outcomes. These included an increase in vaccination rates [28], attendance at hospitals

[29] [30], use of modern birth attendants and use of latrines [31], and lower leprosy incidence [32]. However, three studies identified negative effects, principally an increase in HIV [33] [34] and diarrheal E coli infection rates [35].

- **Education:** Five studies considered the effects of better accessibility on education outcomes. Three found beneficial effects [36] [37] [38], with increasing school attendance, and greater school choice and school completion rates. However, two studies found no significant effect [39] [40].

3. CONCLUSIONS AND RECOMENDATIONS

3.1. Outline of Evidence

4.1.1 *Impact of Rural Road Interventions*

In respect to the sub-question 'what are the conditions, and what type of rural road interventions, are most likely to have a positive, or minimal, impact on poverty reduction and resilience in the local population?'**,** most of the studies record positive impacts to better accessibility, with a minority recording weak or zero impacts. On balance, it appears that better rural accessibility will:

- positively increase incomes and consumption, reduce poverty, strongly increase traffic, reduce transport costs, increase the use of fertiliser and modern inputs and hence increase agricultural output, strongly increase the opportunity to gain non-agricultural work, increase access to health centres, improve the use of health services, and possibly increase school attendance and completion rates
- increase the risk of spreading infections such as HIV/AIDS and E coli for diarrhoea as well reduce economic activity in nearby communities located on routes that have not received road investment.

The highest positive impacts on poverty and incomes relate to improving accessibility in Ethiopia, Uganda, Tanzania, Madagascar and Peru. All of these countries have very low road densities and low rural access indicator (RAI) scores.

In contrast, less impact was identified for Vietnam, Indonesia, Sri Lanka, the Philippines and Thailand, which have higher road densities and higher RAI scores. Hence there is some evidence to suggest that the greatest opportunities for a large impact are where the coverage of the existing road network is poor.

Unfortunately, the studies are very weak in their analysis of different road engineering solutions. None of the studies that investigated the effects of specific road investments or national road programmes examined how individual road length affected impact. However, this issue was covered by the cross-sectional approaches.

In general, the studies offer little guidance as to the standard of road interventions that would maximise income generation and reduce poverty. However, Fan et al. (2004a), on Uganda [41], suggest that money spent on feeder roads (i.e. basic access roads) would lift three times as many people per shilling out of poverty compared with building higher standard murram (gravel) or tarmac roads. An analysis presented for China (Fan and Chan-Kang, 2004) also suggests that lower-

quality roads would be much more effective in reducing poverty than higher-standard ones [42]. However, in both these cases, the function of roads cannot be separated from their engineering design. Escobal (2002) for Peru also explored the effects of improving trails, as well as motorised rural roads. However although a significant effect on incomes was identified for the latter, a positive but non-significant effect was observed for the former [43].

Unfortunately, there is insufficient evidence in the literature to adequately respond to issues pertaining to 'resilience', with particular emphasis on the ability of local beneficiaries to maintain benefits over the long term or to absorb exogenous shocks. The studies have not investigated the impact of the interventions over the long term, and of course, there is difficulty in evaluating the impact of 'shocks' with some methodologies, including the double-difference approach.

4.1.2 *Range and Scale of Impacts*

On the other hand, the review has not been able to provide a satisfactory conclusion to the question 'what is the likely range and scale of impact for different interventions?' as it was not possible to identify different outcomes sufficiently for different types of intervention in the vast majority of studies. For improvements in accessibility, or rural road building in general, a very wide range of impacts was observed and the results were not expressed in a uniform way, so it was difficult to present a range or scale of impact. In addition, coupled with the very extreme heterogeneity of the data and findings it was not possible to compare the impacts of different interventions between the studies.

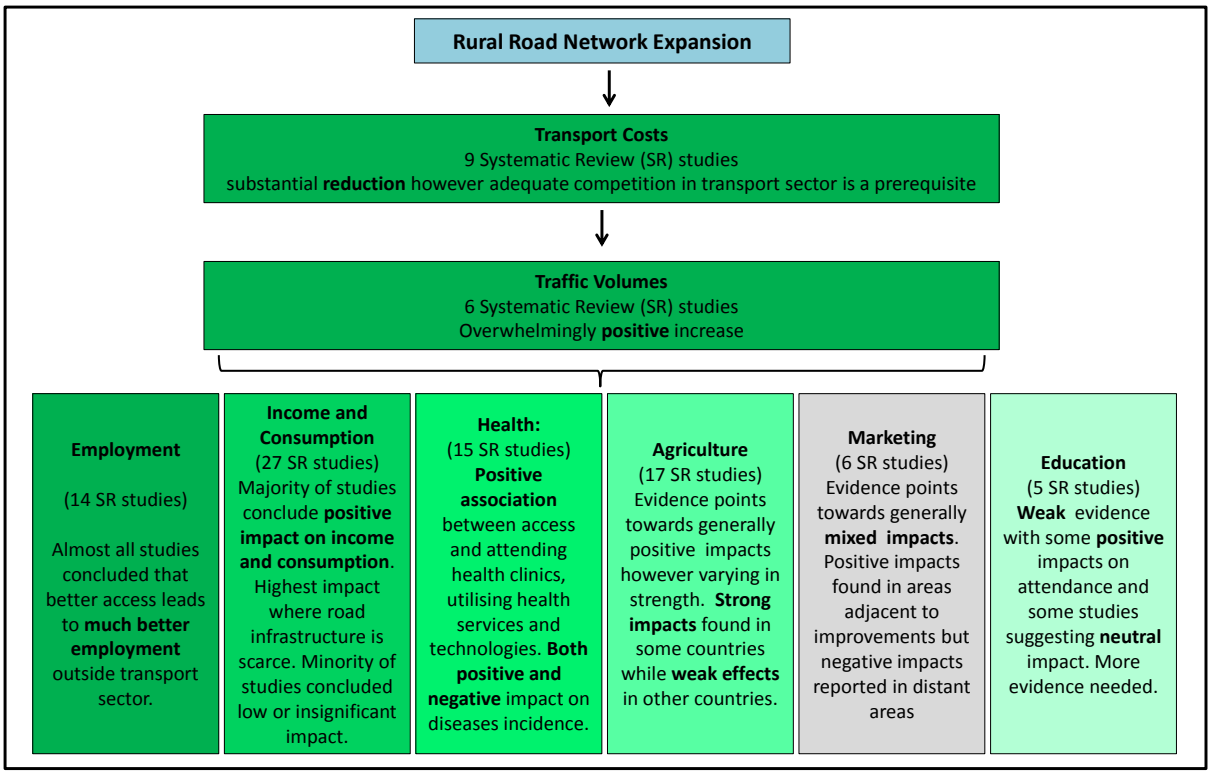
4.1.3 *Theory of Change*

With respect to 'What is the most appropriate theory of change of rural road impacts that can assist with planning rural road interventions?' this review has been able to confirm some of the pre-existing theories based in the existing evidence.

The link between road interventions and transport costs has been established by this review. Road investment is shown to have a direct effect in reducing transport fares and tariffs. However, this is insufficient in itself to provide a strong mechanism of change that can be used for transport planning. Classic economic theory predicts the effect of reduction in transport costs to be an increase in supply, and this has been evidenced by at least five studies in this review. With regard to the longer-term impact on poverty change, the review has found very strong positive impacts on employment, income and consumption, and quite strong positive impacts on health care take-up (but with some negative impacts on disease incidence) and agricultural activity. Mixed conclusions can be reached with respect to marketing. The evidence base for an impact on education is weak.

From these connections, we can establish an appropriate theory of change as presented in the following diagram. The major weakness in the theory of change is the inability to link the causal relationships between the impacts.

Figure 1 Theory of Change for the impact of Rural Road Improvement



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