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Are Rural Road Investments Alone Sufficient to Generate Transport Flows?

Lessons from a Randomized Experiment in Rural Malawi and Policy Implications

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Abstract

This paper draws lessons from an original randomized experiment in Malawi. In order to understand why roads in relatively good condition in rural areas may not be used by buses, a minibus service was subsidized over a six-month period over a distance of 20 kilometers to serve five villages. Using randomly allocated prices for use of the bus, this experiment demonstrates that at very low prices, bus usage is high. Bus usage decreases rapidly with increased prices. However, based on the results on take-up and minibus provider surveys, the experiment demonstrates that at any price, low (with high usage) or high (with low usage), a bus service provider never breaks even on this road. This can contribute to explain why walking or cycling is so widespread on most rural roads in Sub-Saharan Africa. In terms of policy implications, this experiment explains that motorized services need to be subsidized; otherwise a road in good condition will most probably not lead to provision of service at an affordable price for the local population.

This paper is a product of the Transport Department, Africa Region. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at graballand@worldbank.org.

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1. Introduction

This paper draws lessons from a randomized experiment in rural Malawi, which has one of the highest population densities for a Sub-Saharan African country[2]. In order to understand why rural roads – passable for vehicles in rural areas – may not necessarily lead to the provision of regular bus services, a minibus service was subsidized over a six-month period over a distance of 20 kilometers to serve five villages[3].

Like Hine and Rutter (2000) mentioned, "in the quest to tackle rural poverty, feeder road investment is a favoured solution of many donors." Feeder roads are proposed as a potential way to take people out for poverty in rural areas (AICD 2009). With this end in view, a benchmark called the rural access index (RAI), which is the proportion of rural people who live within two kilometers (typically equivalent to a 20-minute walk) of an all-season road, has been set.[4]

Measuring the cost of being isolated is a growing subject of research in economics and development. Ravallion and Jalan (1997) confirmed the existence of spatial poverty traps and the need for households to reach some asset thresholds before they will participate in markets. Therefore, rural roads investments seem to be critical. Indeed, rural road development enhances access to markets for both inputs and output through a reduction in transaction and trade costs (transport and logistics costs). The greater availability (both monetary and physically speaking) of inputs increases their use by farmers. Consequently, agricultural productivity can increase. Rural roads also allow producers to achieve additional productive opportunities, leading to a rise in production that is highlighted by numerous studies. Stifel and Minten (2008) find, in the case

[2] According to official population estimates in 2002, population density was more than 90 inhabitants per sq.km.

[3] This location was selected in order to make multiple trips per day, and given that the road was not in a very good condition, there was a need to be close enough to the market center.

[4] An all-season road is a (gravel or bitumen paved) road that is passable all year by the prevailing means of rural transport (often a pick-up or a truck which does not have four-wheel-drive). Predictable interruptions of short duration during inclement weather (e.g. heavy rainfall) are acceptable, particularly on low volume roads (Raballand et al. 2010). Despite major measurement difficulties of the RAI, it is required for World Bank project teams to report it on a bi-annual basis and assess the number of people covered at 2 kilometers in the project area.

of Madagascar, that isolation (defined as travel time during dry season from the commune center to the nearest urban center) implies lower agricultural productivity, increased transport and transaction costs and increased insecurity. The authors found a major jump of per capita consumption from the least remote quintile to the second quintile and therefore a negative relationship between isolation and poverty.[5]

So far, most development partners and governments in SSA have mainly relied on the assumption that most households in rural areas in Africa are not connected to markets by paved or passable roads for motorized transport and therefore need a road passable for a truck/bus. Many investments in rural roads seem to be built on the assumption that they will lead to market provision of transport and thus, poverty reduction and income generation. Estache (2010) points out a lack of rigorous evidence on these assumptions; namely there is a lack of randomized impact evaluations in the field of investments in roads, which call into question these assumptions and limit the ability to quantify the economic and even social benefits of the provision of rural roads.

In fact, there is some empirical evidence that calls into question current transportation strategies in Sub-Saharan Africa. Using the second Cameroonian national household survey (Enquête Camerounaise Auprès des Ménages II, 2001) and the Cameroon case study, Gachassin et al. (2010) demonstrate that investing in tarmac roads is likely to have a low impact on poverty. For example, isolation from a tarred road is found to have no direct impact on consumption expenditures in Cameroon. The paper reasserts the fact that access to roads is only one factor contributing to poverty reduction (and not necessarily the most important). Considering that increase in non-farming activities is the main driver for poverty reduction in rural Africa, the authors suggest that emphasis on roads investments should be given to locations where non-farming activities could be developed, which does mean that the last mile in rural areas should not be probably a road with a high road level of service (except in peculiar cases of high agricultural potential areas).

[5] Quoted in Raballand et al. (2010).

One of the main weaknesses of the current approach regarding road investments is the fact that it is built on the strong assumption among policy makers that the existence of a road in good condition in rural areas will enable service providers to come and serve rural areas. In most cases, transport services economics is completely neglected, assuming that road condition is the main determinant of transport costs.

A notable exception was Hine and Rutter (2000), who, based on surveys in almost 100 villages in Ghana and Malawi at the end of the 1990s, found that "vehicle accessibility alone does not guarantee […] transport service access". Moreover, Lall (2009), which, in the case of Malawi, demonstrated, based on trucking surveys and computation of vehicle operating costs in SSA, that *both* infrastructure quality and market structure of the trucking industry are important contributors to differences in transport costs. Lall (2009) points out costs due to poor feeder roads are exacerbated by low volumes of trade between rural locations and market centers. With empty backhauls and journeys covering small distances, only a few transport service providers enter the market, charging high prices to cover fixed costs and maximize markups.

Raballand et al. (2010) find in field surveys in Uganda, Cameroon and Burkina Faso that load consolidation at the local level decreases the need for a road accessible by truck to every farm and it decreases investment needs and increases value-added for farmers. From a cost-benefit analysis, load consolidation (or agglomeration) is probably the most effective since it mainly reduces road public investment to the secondary network and enables decrease of transport costs due to increased predictability of volumes and strengthened competition between operators.

In the case of this paper, through a randomized evaluation, a passenger bus line was introduced between a rural cluster of villages and a town that serves as a regional trading hub. The study was implemented in rural Malawi, more than two hours by car from the nearest urban location. While most residents of the villages had been to the regional market town (96 percent) and most had been a passenger on a bus prior to the project (81 percent), no regular motorized passenger transportation existed along the road between the market town and the project villages prior to this study. Prior to this study, travel outside of the village cluster was infrequent and most transport was pedestrian or by bicycle. This particular market town offers dozens of stores providing domestic goods and agricultural inputs. There is also a weekly market in the town that brings traders from disparate areas to sell their goods.

In the study, after a baseline survey, households were randomly assigned to one of seven bus pass categories, with each category assigned a unique price between zero and 500 Malawi kwacha (US$3.57). Over the course of the project, take up of the bus was recorded (See Goldberg et al., 2010 for a full set of results).

There were significant differences in take up based on the price level assigned to a household. Even small positive prices (far below the marginal cost of a ride) lead to substantial declines in demand for a bus ride.[6]

The experiment demonstrates that households from villages are not willing or cannot afford to pay more than the break-even point for the bus operator[7]. There are two important policy implications of these findings. First, if a bus service is not subsidized, a road in relatively good condition may continue to be used mainly by bicycles and pedestrians. Second, if subsidies are not possible in most rural areas in Malawi (or more generally in SSA), there may be a need to adjust more carefully investments to the potential demand and link it to the types of services provision used in the areas.

The second section describes the experiment protocol and data. Then, results are presented in terms of take up and potential revenues for a bus operator at different prices. The fourth section discusses the policy implications of the results and the final section concludes and presents some ideas for future research in this area.

2. Description of the data and experiment

[6] This concurs with findings from Hine and Rutter (2000), who found out that, for these reasons of affordability of transport services, the poorest segment of rural areas populations continue to walk and do not necessarily benefit from rural roads investments.

[7] Results could have differed if the experiment would have been longer (over a year). However, we also think that results over six months are significant.

The study was conducted between the July and December 2009 in a rural area in central Malawi. The sample site includes a cluster of five villages located 17 kilometers from a market town which offers a large weekly market, a health clinic, and access to further means of transport. In total, 542 households were listed in the five villages (in a complete census). A circular circuit track connects three of the five villages, with the other two villages within 10 minutes walking distance. This track was identified to serve as the bus route to use in picking up passengers. While there is some evidence of irregular transport on the road between the village cluster and the market town, there was no evidence of a bus or any other mode of transport intended for passengers that operated along the road connecting the village cluster and the market town.[8]

We report on the second phase of a two part design.[9] Of the originally listed 542 households, 514 households were successfully interviewed and were eligible to participate; 406 of these households are included in the second phase analysis. Participation in phase one and phase two was by random assignment. After selection, a baseline survey was conducted interviewing both men and women. After the completion of the baseline survey, a meeting was called at each of the five villages. At the meeting, a household-level lottery was explained. One member of each household was asked to select a ticket from a bucket. Each ticket contained a number to signify the price of one round trip on the project bus. Prices of a round trip included the following categories: MK 0, MK 10, MK 20, MK 50, MK 100, MK 300, MK 500.[10] After the household member was assigned the lottery ticket, the number was recorded and the price

[8] This road was identified as in a good condition for buses to run (during the dry season).
[9] The first Phase included conducting a listing of all households in the village cluster area and randomly sampling 100 households in four villages to participate in the first phase of the project which did not randomize the price, rather randomized overall accessibility.
[10] All households that participated in the first phase (randomly selected) were allocated MK 0.

was stamped on a bus pass unique to that household.[11] Bus ridership records were kept by a supervising member of the field team and we report on these here.

In addition to collecting data on individuals and households, we also conducted in-depth interviews among minibus owners and drivers, of which two were providing bus services to the market town (not from the cluster of villages included in this study). Minibus owners and drivers near the market town were interviewed in order obtain a broader understanding of the market for transportation in Ntchisi district.

3. Results

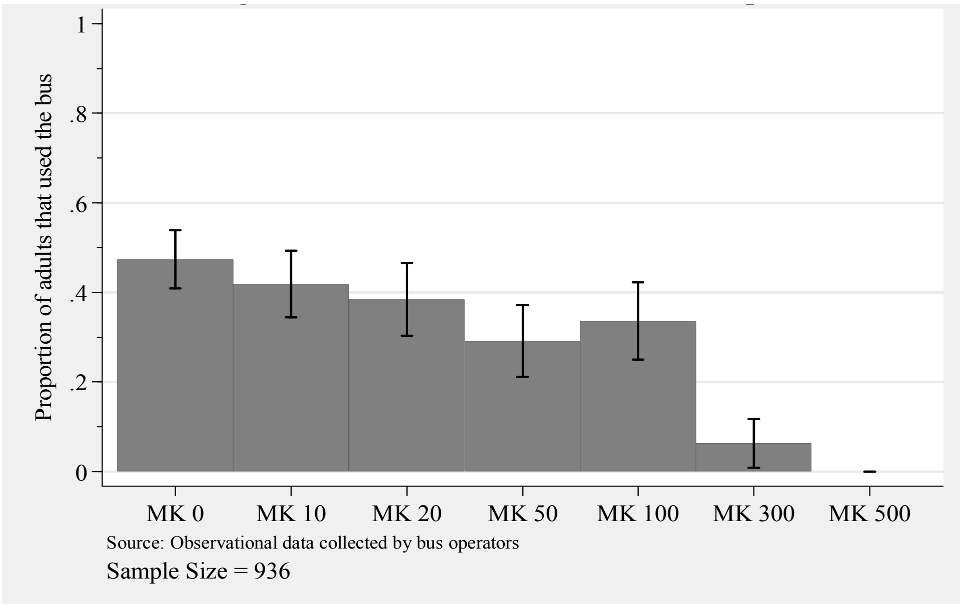
Results are presented in two parts: the first one relates to the take-up of the bus and presents what is the affordability level in this area and bus use when it is subsidized. The second part tries to assess if there is any price level, at which the bus provider would recover operational costs and then make private bus provision a viable option for transport firms.

Take-up of the bus service

At the household level, more that 60 percent of households used the bus at least once with an average of 2.85 inbound rides. We focus on individual take-up in Figure 1. This figure presents proportion of individuals who used the bus at least once by randomly assigned price. There is a sharp decrease in ridership among those required to pay a positive price, especially prices above 100 Kwacha. These results are similar among men and women (not shown).

[11] One bus pass was valid for all adult members of that household. The bus pass contained a photo and name of the adult members of the pass holder's household and the price of each round trip to the market town.

Figure 1: **Bus Service Take-up according to Prices**[12]



[12] Results are based on the individuals that participated in Phase 2.

Table 1: Bus Use in Response to Prices[13]

	Adult used bus		Total Inbound Rides	
	(1)	(2)	(3)	(4)
MK 10	-0.06	-0.05	-0.28	-0.26
	(0.06)	(0.05)	(0.24)	(0.22)
MK 20	-0.09	-0.08	-0.34	-0.33
	(0.06)	(0.06)	(0.25)	(0.23)
MK 50	-0.18***	-0.15**	-0.63**	-0.56**
	(0.06)	(0.06)	(0.25)	(0.23)
MK 100	-0.14**	-0.15**	-0.74***	-0.77***
	(0.06)	(0.06)	(0.21)	(0.20)
MK 300	-0.41***	-0.43***	-1.20***	-1.26***
	(0.05)	(0.05)	(0.19)	(0.20)
MK 500	-0.47***	-0.49***	-1.32***	-1.35***
	(0.04)	(0.04)	(0.18)	(0.18)
Male		0.02		0.41***
		(0.04)		(0.14)
Head of household		0.14***		0.46***
		(0.04)		(0.17)
Married		0.09**		0.22*
		(0.04)		(0.13)
Adults in the household		-0.01		-0.08
		(0.02)		(0.06)
Children in the household		-0.00		0.04
		(0.01)		(0.04)
Constant	0.47***	0.41***	1.32***	1.55***
	(0.04)	(0.11)	(0.18)	(0.40)
Mean of dep. variable	0.339	0.340	0.844	0.847
Number of observations	936	933	936	933
R2	0.094	0.155	0.053	0.124

note: This table presents OLS regressions on bus use for adults (18 years or older). Heteroskedasticity-robust household-clustered standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

[13] Results are based on the individuals that participated in Phase 2.

The coefficients show that the likelihood of using the bus service declines monotonically with price. Other variables that significantly predict using the bus including being the head of the household, being married, and indicators of economic status (asset index or producing food; not shown). Controlling for other individual and household characteristics do not significantly affect the price coefficients.

Prices were also important in the types of trips individuals made. Figures 2 and 3 present the reasons for making a trip (as asked on rider logs on the bus) separately by men and by women among those who could ride the bus for free and those who had to pay some positive price.

Figure 2 Trip Purposes for Women

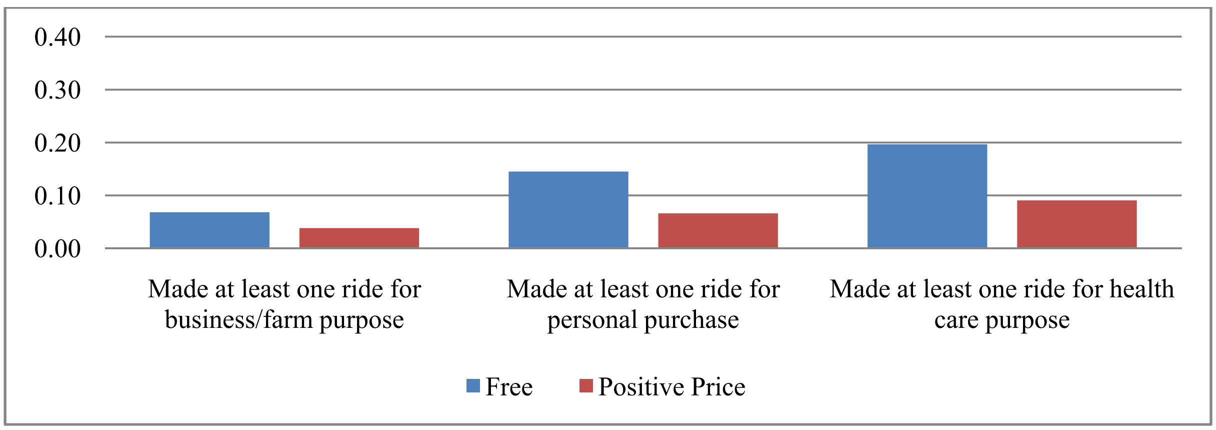
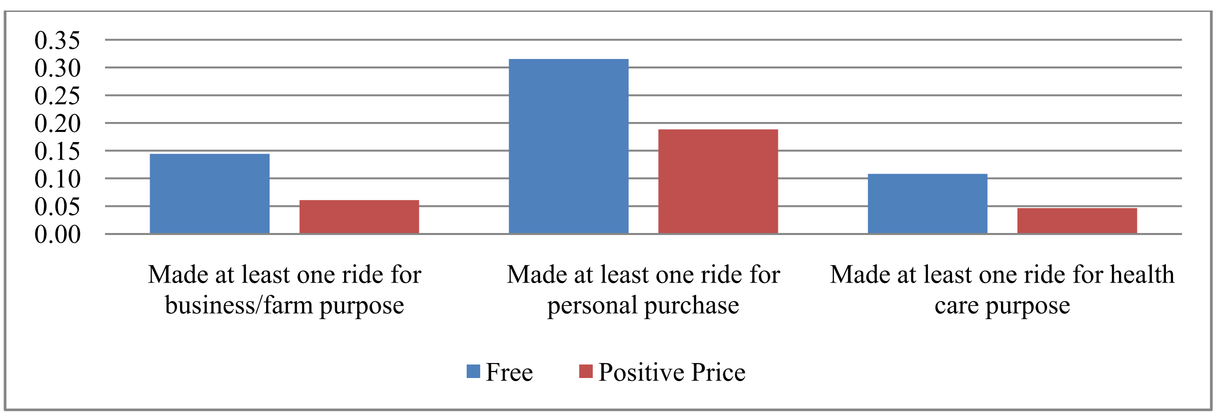


Figure 3 Trip Purposes for Men



Among both men and women, there are differences in the types of rides made. In particular, those who were offered a free ride were more likely to go for personal purchases, farm or business reasons, and for health reasons. The difference in health care visits is particularly strong among women, with those at zero price being more than ten percentage points more likely to have used the bus for a health care visit than those at any of the positive price levels.

The findings concur with what was found in Malawi in the late 90s where collection of farm inputs, trips to markets and to health centers were respectively the fourth, fifth and sixth purposes of trips (behind visiting friends, funerals and post office/public telephone) (Rutter et al. 2000).

Bus providers

The interviews with transport operators reveal that most of the operators operate on long-distance routes with a minimum distance of 48 kilometers (maximum of 140 kilometers). Buses were, on average, 14 years old, and in most cases allowed to carry a maximum of 16 people.

One of the major constraints identified by providers is the quality of the road. Providers tend to operate on paved roads or maintained dirt roads. Most rural networks, such as the route leading to the project site, are not accessible during the rainy season.

When asked about travels, a typical route to and *from* the market town involves a single bus making travels each leg of the trip twice a day, with one trip on Sundays. This route is along a paved road that stretches approximately 50 kilometers. The bus typically waits 1 to 2 hours before departure, leaving once there is a minimum of 10 passengers. The price of a one way ride is MK300 and passengers may board and get off at official and unofficial intermediate stops. It should be noted that the existing bus route, being along a primary road, does not provide direct access to remote villages. Residents of the rural villages in our sample site need to walk to the originating depot of the bus route or walk/bike to the paved road in order to board the bus.[14]

[14] There are also special considerations with cargo. An average of three to four people brings cargo per full minibus. The general rule is that small cargo – items that can be stored on a passenger's lap – can go for free. The content of

In four out of six cases the conductor is hired, and in five out of six cases paid, by the owner of the minibus. It appears that owners are interested in hiring conductors themselves in order to monitor the ability of drivers to generate side-profits. Increased monitoring ability can help to collect additional fees from intermediate passengers, thus bringing the owner's interests in line with those of the driver, i.e. to value routes with intermediate stops. Longer bus routes, while incurring higher costs, are more attractive than local rides if sufficient rents can be shared by the owner and driver in picking up intermediate passengers.

The three main factors regarding the assessment of profitability of a route are: seasonality of a route (or not), high demand, and prices of existing modes of transport. The reason why certain owners opt for certain routes which do not stand out by several of these criteria has to do with the location of the owner. Most owners are uncomfortable with lack of monitoring possibilities and thus chose to have their bus run on a route starting or ending at their place of residence. Local bus ownership can thus be seen as foundation for servicing remote areas.

Furthermore, the quality of the road network is a decisive factor mentioned by 50 percent of the sample in determining the actual route. In the case of evaluating a route on which no bus is running, the evaluation of the road condition increases in importance.

Prices for buses depend on length, origin and destination for the trip, ranging between MK300 and MK700. If a route is neither frequented by matolas nor minibuses originally, drivers will start with what they perceive as low prices given their own assessment of demand and gradually raise them or have focus groups in which they ask people about their willingness to pay. However, most drivers report that they would shy away from such a route due to uncertainty of demand.

Seasonality is one of the most important factors which lower profit, as named by half of respondents. In this context, seasonality should be interpreted as routes becoming impassable during rainy season and demand fluctuations that coincide with the agricultural calendar. Legal

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the cargo is rarely monitored by the driver. However, common types of cargo include crops, especially groundnuts, and bottle crates. Larger cargo may be charged between 15 and 50 percent of a regular passenger price, but enforcement of this charge is discretionary. Only a rough 50 percent of cargo will be charged to the passengers.

restrictions regarding maximum capacity, competition, and illegal callers are further threats, the latter being specifically mentioned by operators in the market town. There are also other costs for minibus providers including membership fees, repairs, and fuel.[15]

Using accounting costs of the bus incurred during this study and the predicted demand found in this analysis, we are able to estimate profits and any requisite subsidies that would be necessary to promote bus operation between remote areas and market towns.

In order to predict total costs, we include a fixed cost bus rental or investment term (θ) and fuel costs that have two components, one which requires travel to pick up passengers (fixed) and one that varies based on the level of demand.

$$TC= \theta+\gamma[\omega(0,d)+(\omega(Q,d)\cdot\varphi(Q,B)] \qquad (1)$$

Where $\omega(Q,d)$ is a measure of fuel efficiency for the bus with demand, Q, and round-trip travel distance d and $\varphi(Q,B)$ is a ceiling function of number of bus trips required to meet demand with a maximum number of passengers per trip, B. γ is the price of fuel. Marginal cost of an additional passenger is therefore:

$$MC= \gamma\cdot\omega'(Q,d)\cdot\varphi'(Q,B) \qquad (2)$$

Based on the cost of bus operation incurred by this study we set the cost parameters[16] as the following:

$\theta = 7000$

$d = 34$ kilometers

$\gamma =$ MK213

[15] Fees collected by the Minibus Association, maintenance cost, and fuel prices also have to be taken into account when assessing profitability. While fees for being part of the Minibus Association are mandatory and amount to MK200 up to MK750 per day, most operators do not see a benefit of being member. The only benefit mentioned by two of the drivers is the regulation of bus departure order; official callers prevent line-skipping – the first bus in line is first one to be allowed to start. Owners are responsible for the majority of repairs, though drivers are usually responsible for the replacement of tires. Tire replacement usually occurs twice annually. This is of importance to servicing remote areas, since the probability of tire damage increases along dirt and ungraded roads. The driver will be less inclined to seek out rural routes as a result. Fuel prices reflect both distance and location of purchase. Again, bus service in more remote areas leads to increased costs of bus operation due to a lack of infrastructure, in this case, filling stations.

[16] All parameters are in Annex 1.

$\omega(Q,d)=[0.29+0.0015Q]d$

$\varphi(Q,B)=\min\{n\in Z \mid n\geq Q/B\}$

$B = 14$

Due to the non-linearity of the bus trip function, $\varphi(Q,B)$, marginal costs spike at the points where an additional bus trip is required. The marginal cost of adding an additional bus trip is substantial. The fixed costs of the bus imply that carrying the first passenger costs MK11,200 (US$75). Each additional trip beyond the first trip implies a MK2100 cost increase. The marginal cost of adding an additional passenger to an existing bus trip, i.e. increasing passengers from 2 to 3, is a minimal MK10.86. Therefore, our model suggests that fixed costs matter a great deal in achieving low marginal costs.

Total revenues are estimated based on the inverse demand curve for bus use (equation 2). For demonstration, we assume a linear demand curve; however, we utilize regression estimates for the demand curve in our profit calculations.

$$p=\propto/\beta-1/\beta\ Q \quad (3)$$

Total revenue is thus

$$TR=(\propto/\beta-1/\beta\ Q)Q \quad (4)$$

and marginal revenue

$$MR=\propto/\beta-2/\beta\ Q \quad (5)$$

Based on estimated total cost and total revenues, we see no point at which the bus would generate positive profit. Table 2 shows the revenue estimates based on demand estimates assuming a non-linear demand curve. We base the demand estimates of an unconditioned regression of Phase 2 bus rides on dummies for price levels. The base demand at MK0 would be 28 passengers per day, falling to 0.21 passengers per day at MK500 price. Based on the costs of this project and the estimated demand, we see that profit is maximized between prices MK100 and MK300, but is nevertheless negative.

Table 2: Revenues Estimates

	MK0	MK10	MK20	MK50	MK100	MK300	MK500
Price	0	10	20	50	100	300	500
Demand vs. MK0[17]	0.00	-0.28	-0.42	-0.61	-0.75	-1.26	-1.34
Bus rides to market town in one month	1.35	1.07	0.93	0.74	0.60	0.09	0.01
Bus rides to market town per day	0.023	0.018	0.016	0.013	0.010	0.002	0.000
Adult Population	1200	1200	1200	1200	1200	1200	1200
Total adult market town bus rides per day	27.93	22.18	19.29	15.22	12.38	1.96	0.21
Total Revenue	0.00	221.76	385.79	761.22	1237.68	587.14	103.45
Marginal Per Passenger Revenue	0	10	8.50	24.66	38.50	-332.40	-2337.85
Average Per Passenger Revenue	0	10	20	50	100	300	500
Projected Profit (Daily)	-13583	-13296	-13099	-12681	-10082	-10624	-11097

Notes: Values in Malawi Kwacha. Demand estimates are based on coefficients from unconditional regression of the total phase 2 bus rides on a set of dummies for each price level.

Our findings suggest that subsidizing a daily bus to the market cluster included in this study would be costly. We see that a daily subsidy of MK10,082 (US$67) would be at least needed to achieve a breakeven point for the bus operator (for a roundtrip). This finding is crucial since there is a usual plea to call for competition in transport services in rural areas in order to curb transport prices. This experiment demonstrates that competition, in this case, is impossible to get and, even worse, one operator can never break-even.

The requisite subsidy is due to both supply and demand factors. On the cost side, high fixed costs of bus rental and discontinuities in costs caused by the discrete jump in costs once a bus becomes full drive up the cost of bus operation. On the revenue side, we find that population density and significant price sensitivity drive down aggregate demand for the bus service to the point where the bus route would not be profitable for a private firm[18].

[17] Calibration over the full sample.

[18] This is similar to the findings of Rutter et al. (2000) and Hine and Rutter (2000) with, for instance, an inverse relationship between loading times and population density: in low population density districts, loading times are longer, which is detrimental to the quality of services.

4. Policy implications

The results from the experiment in Malawi present several policy implications as well as future directions for research. Notably, infrastructure upgrade and rehabilitation should not be the only answer to connectivity problems in rural areas; transport services provision should also be looked at in details.

There are two possible major objectives with subsequent different public interventions[19]:

1. Ensure motorized service provision (bus/truck),
2. Ensure non-motorized service provision.

In the first case, the results of the experiment clearly demonstrate that a mix of public interventions between road investments and service subsidies needs to be found. Assuming USD$ 3,000 per kilometer to maintain an earth road in a passable condition for a minibus for the year (rainy season excepted), in this case, USD$ 60,000 have to be spent[20] (which is equivalent to over USD$ 100 per household). Service provision subsidies in this case would be approximately equivalent to USD$ 12,000.[21] Assuming that this would be possible to implement, 20% of the recurrent costs should be aimed at subsidizing a bus operator to make it break-even.[22] Not subsidizing services would be equivalent to a waste in road investment since villagers will either walk on this road or use intermediate means of transport (IMTs), such as bicycles or motorcycles and, therefore, a high level of service[23] for the road would not be needed.

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[19] Due to the existence of poverty traps (Azariadis and Stachurski, 2005) and the need to increase rural growth, subsidizing transport services could be justified in order to increase the economic impact of rural roads.
[20] Hine and Rutter (2000) gave the figure of over 50 USD per head.
[21] Assuming that a bus service during a period of six months.
[22] It would be obviously crucially important to determine how service provision would be subsidized and update regularly the amounts in order to limit waste.
[23] Level of service generally describe traffic conditions in terms of speed and travel time, volume and capacity, traffic interruptions, comfort and safety.

In the second case, road level of service (technical standard, width…) should be reduced[24] aiming at ensuring passability of intermediate means of transport, which would mean the importance of working exclusively on critical points/obstacles (small bridges for instance).

Like pointed out in Raballand et al. (2010) using Cameroon, Burkina Faso and Uganda examples, there is a continuum of integration to markets for most households in Africa. In some cases, a road may be non-passable for cars, a motorcycle driver may, for instance, dismount the motorcycle and walk it around the trouble spot in the road and then continues his trip. Therefore, from an economic perspective, most rural populations are *somehow* connected to markets whereas most data analysis or policy prescriptions are based off of binary classifications of connectivity as either 0 or 1. Hence, from a public policy perspective, investments in roads might have a lower impact on economic development than expected due to the fact that transport connectivity is only one component of rural development, and sometimes not the most important.[25] It may also explain why despite major investments in rural roads in some countries, poverty reduction has not reduced significantly.

In any case, economic and social data (such as traffic data, vehicle operating costs for minibuses/IMTs, purpose of minibus usage) need to be collected for policy-makers to decide on which investment choice is required to enable which type of service provision, based primarily on demand assessment. Surveying transport demand in the Western part of the country, Zambia JCTR (2008) found that 92% of the local farmers surveyed do not produce more than 50 bags of 50 kilos each of agricultural products in a year, which means that without consolidation, the current demand does not justify transport services to develop.

There is a recurrent lack of data collection on the demand side and many investments are carried out on the multiple assumptions that roads improvement translates into reduced vehicle

[24] Where repressed demand is not high.

[25] Ruijs et al. (2004) find out that the direct effect of transport costs reductions on food prices, such as cereals, requires some nuance and tempered expectations in the case of Burkina Faso, notably due to the organization of markets.

operating costs (VOCs), which are then assumed to be passed to the final users of transport services.

In reality, reduced VOCs do not translate to reduced transport prices (especially where volumes are low) and reduced transport prices do not translate to poverty reduction if the poor cannot afford to use transport services or need other factors to increase production.

From a donor perspective, this experiment demonstrates that a rule of thumb such as the RAI is likely to be an investment waste in many rural areas in SSA since, at best, a motorized service will be provided at an unaffordable price for most households and at worse, no motorized transport will be provided, which means that most households will continue not to go to a trade center/small town or to go by cycling and even more probably by walking.

5. Conclusion and areas for further research

The randomized experiment summarized in this paper is the first of this kind in SSA and illustrates that road condition does not necessarily generate transport provision at an affordable price for villagers and does not necessarily enable minibus providers to break even. It confirms that affordability in rural areas in SSA can be very low and makes service provision profitability unpredictable in most cases.

Therefore, in this context, setting rigid rules on investments across the continent is likely to increasingly add waste since investments are likely to go further and further in remote places where demand may not necessarily justify services provision to break even. On the contrary, there is an increasing need to differentiate allocations/technical solutions and possibly service subsidies to adjust investments to *potential* demand.

Areas for future research are numerous since this is only a start to use such an approach in transport. Moreover, there may be some specificities related to Malawi: Hine and Rutter (2000) found that the use of motorized transport services in Malawi was extremely low compared to Ghana, for instance. Moreover, there may be some area-specific features.

Therefore, it would be important to undertake such experiments in areas with higher population density than this study site to assess the affordability level and *potential* demand and for a longer period of time since some decisions to invest in agriculture could be taken on the fact that bus provision is guaranteed for at least two seasons. Moreover, in an area like Nchtisi, where potential demand/affordability seems to be low, it would be important to have randomized experiments with IMTs: Would a subsidy of bicycles, tractors, and oxcarts generate more demand or not? What would be the break-even point and would villagers then be able to afford a trip to town at the break-even point? Moreover, it could be important to design some incentives for farmers to consolidate transport and assess the impact on transport supply and prices (like presented in Kunaka 2011).

This type of work is crucial in order to design solutions, which would then increase on the ground access to markets/services because, for the time being, despite discourse and massive investments in infrastructure, it may actually not have the expected outcome on access and then crowd out investments in other sectors, where it could have a greater impact on economic and social development.

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Annex 1: Cost assumptions

Cost Assumptions	Unit Cost	Unit
Round trip distance	34	km
fuel efficiency (with one passenger)	0.29	liters/km
round trips per day	2	trips
Bus Rental	6000	daily rental
Driver	1000	per day
Bus Cost	7000	daily rental
Fuel	213	Liter
Loss of fuel efficiency per passenger	0.0015	liters/km
Maximum passengers per bus	14	passengers