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The Impact of Roads on Poverty Reduction

A Case Study of Cameroon

Marie Gachassin
Boris Najman
Gaël Raballand

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Abstract

Many investments in infrastructure are built on the belief that they will ineluctably lead to poverty reduction and income generation. This has entailed massive aid-financed projects in roads in developing countries. However, the lack of robust evaluations and a comprehensive theoretical framework could raise questions about current strategies in Sub-Saharan Africa. Using the second Cameroonian national household survey (Enquête Camerounaise Auprès des Ménages II, 2001) and the Cameroon case study, this paper demonstrates that investing uniformly in tarred roads in Africa is likely to have a much lower impact on poverty than expected. Isolation from a tarred road is found to have no direct impact on consumption expenditures in Cameroon. The only impact is an indirect one in the access to labor activities. This paper reasserts the fact that access to roads is only one factor contributing to poverty reduction (and not necessarily the most important in many cases). Considering that increase in non-farming activities is the main driver for poverty reduction in rural Africa, the results contribute to the idea that emphasis on road investments should be given to locations where non-farming activities could be developed, which does mean that the last mile in rural areas probably should not be a road.

This paper—a product of the Transport Unit, Africa Region—is part of a larger effort in the department to assess the impact of rural roads on development. 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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Marie Gachassin[1], Boris Najman[2], Gaël Raballand[3]

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[1] CES (CNRS and University of Paris I), marie.gachassin@gmail.com,
[2] CES (CNRS and University of Paris I), bnajman@univ-paris1.fr,
[3] The World Bank, graballand@worldbank.org.

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1. Introduction

A very strong impetus has recently been given to infrastructure investments in Sub-Saharan Africa. For the period 2008-2010, the Chinese EXIM bank committed around $20 bn in infrastructure for financing railway rehabilitation in Nigeria, Angola as well as building dams in Ethiopia for instance. The African Development Bank will spend over $5 bn in the next three years, of which over 60% in infrastructure (mainly roads, energy and water). The World Bank committed in 2009 more than $7 bn in Sub-Saharan Africa (with almost $1.5 bn in roads). Aid to Africa is planned to double in the near future of which investments in infrastructure are likely to be the bulk of it.

Among infrastructure, roads are considered of first interest to reduce poverty due to the widely accepted consensus that transport infrastructure has a significant, positive and substantial impact on economic growth and poverty as it enhances the connectivity of isolated and remote areas (World Bank, 1994; World Bank, 2009.1; Pomfret, 2006).

In the last decades, there has been a pendulum in aid agencies between investments in infrastructure and in social sectors. The massive investments in infrastructure of the previous decades did not provide the promised results, especially in Africa. Is it likely to change at the time when a scaling up of investments in roads and in infrastructure in general is expected? Despite a recent impetus in investments in roads, transport prices on the continent remain the highest in the world (Teravaninthorn et al. 2008), Africa's share in world's trade has decreased and poverty has not declined in most rural areas in Sub-Saharan Africa. The suggested ineluctability of a poverty reduction impact through roads investments has thus to be questioned and is investigated in this paper using the Cameroon case study.

Literature on the poverty impact of roads is relatively abundant. Poverty is generally modeled as a direct function of isolation without relying on any theoretical framework; while Deaton (2009) stresses the importance of correctly defining theoretical mechanisms to test in econometric studies. The impact is usually found to be significant: easier/improved road access does reduce poverty (Deininger and Okidi, 2002; Fan, Nyange and Rao, 2005; Jalan and Ravallion, 2002).

However, the majority of these works do not solve the endogeneity bias affecting the poverty-isolation relationship. In fact, road location is non arbitrary and people do not randomly settle next to roads once they have been constructed. Moreover such studies make comparisons and generalizations difficult (Estache, 2009). In particular, Van de Walle (2009) points out the fact that "`Knowledge about [roads] impacts and the heterogeneity in those impacts continues to be limited"'. Roads projects evaluations performed by Khandker, Bakht and Koolwal (2009) in Bangladesh and Mu and van de Walle (2007) in Vietnam provide good examples of a willingness to provide more robust and reliable evaluations of roads' impact that tackle efficiently the endogenous nature of road placement. The former use a difference-in-difference methodology associated with household-level fixed effects. The later combine the difference-in-difference with a propensity score method to yield unbiased estimates under the assumption that a time variant selection bias due to initial observables is at work.

Such methodologies require panel data that are often hard to obtain. Household surveys are generally available but their lack of temporal dimension explains the direct modeling of poverty as a function of road access. Robust estimates on cross-section data require the use of instrumental variables. Gibson and Rozelle (2003) provide the only example to our knowledge with their instrument that "measures the year in which the Papua New Guinea (PNG) national highway system penetrated into each of PNG's districts". They assume that any newly created national highway stimulates the feeder roads network, and thus reduces the traveling time to the nearest road. As the national highway building in PNG was from coast to inland, without any wealth considerations, the authors argue that their instrument is uncorrelated with poverty at the household level. However, we consider this direct modeling not completely relevant because we believe that is not the road *per se* that affects poverty but the fact that the road leads to some services or facilities. As Njenga and Davis (2003) claim "isolation reduces physical access to vital services such as markets, information sources, social and political networks as well as health and educational services while access to these services is crucial for improving poor people's livelihoods".

The explicit recognition of the indirect impact of road access on poverty, using cross-section data for the year 2001 in Cameroon, constitutes the first contribution of this paper. The literature on poverty and isolation defines three channels through which road access contributes to reduce poverty: access to inputs and output markets, access to education and

health services and access to labor opportunities. In the paper, we look at all three channels with a focus on the third one. We assume that access to roads has a different impact on incomes, depending on the type of activity carried out. We underline that poverty reduction depends on the type of activity the household is involved in. Some activities could be considered as a poverty trap. Our particular interest lies in the difference between agricultural and non-farming activities since agriculture represented 61% of total employment in Cameroon in 2001 and constitutes the major activity in which poor households are involved.

Our second contribution lies in the use of data from the second Cameroonian national household surveys ("Deuxième Enquête Camerounaise Auprès des Ménages", ECAM II) from which the infrastructure side has been poorly (if not) used in the literature. It covers all the dimensions of poverty and introduces the basis of a monitoring and evaluation system of households' livelihoods. The three national households surveys (the first was in 1996 and the last one in 2007) are also at the core of the reduction poverty plan for Cameroon, since poverty in Cameroon is of major concern since the 80s[4]. Economic growth began to recover from 1994 but the first national household surveys revealed that 50.5% of the Cameroon population lived under the poverty line in 1996. In 1998/99, private consumption was stagnant thus highlighting the fact that economic growth did not reach population and more importantly the poorest part of it[5].

Finally, unlike the majority of cross-section analyses of poverty and road access, our results do not call for huge, widespread investments in roads to fight against poverty. We demonstrate that road access, proxied by the time (in hours) needed to reach the closest tarred road, has no direct impact on consumption expenditures at the household level when we control for the three channels identified by the literature. Our results from a simultaneous estimate of consumption and labor activities determinants contribute to the idea that emphasis on roads investment should be given to locations where non-farming activities could be developed, which seriously questions the big push in infrastructure in Sub-Saharan Africa, all

[4] While before 1985 Cameroon exhibited average annual growth rate of 7% thanks to a continuous development of the agricultural production and the exploitation of oil resources, after 1986 and the drop of oil and other exports rates, the economy suffered from a strong degradation (contraction of the economy of 8.2% of GDP and negative growth rate for the year 1986/87). The structural adjustments measures put in place did not suffice to deal with the adverse consequences of the shock. Between 1985/1986 and 1992/1993 consumption per capita fell by 40% and the investment rate was divided by 2 (27% to 13%). Employment and the supply of social services (health, education and other infrastructures services as roads) have also been seriously damaged.

[5] Information are drawn from the report on ECAM II.

the more as investments in roads assumes that services will automatically reduce their prices, which is far from reality in most regions in Sub-Saharan Africa, especially rural areas.

The paper is structured as follows. Section 2 presents a brief literature review of roads impact studies. Section 3 introduces the data and some descriptive statistics to illustrate the relevance of our study. The Section 4 highlights econometric methodology we select and the empirical issues we have to cope with. Section 5 provides results of the simultaneous estimations. Section 6 discusses the main policy implications and Section 7 concludes.

2. A Literature Review of Roads Impact: Three Channels

The literature on the poverty impact of roads defines three main channels: the human capital, the market access and the labor activities channel. We present here these three approaches putting a particular attention on the third one.

The Human Capital Channel

A first transmission channel of roads' impact is to facilitate provision of basic needs to the poor such as health and education. A common feature of poor people is that they suffer from inadequate access to some human capital facilities that are essential to escape from poverty. Actually Davis and Njenga (2003) point out "poverty reduction needs more than economic mechanisms to be effective". Roads appear as complementary input for these provisions of human capital formation facilities to be effective (Gannon and Liu, 1997). Roads projects evaluations provide evidence on that topic. Rural roads rehabilitation in Vietnam improved primary school completion rates and enhanced the treatment of broken bones (Mu and van de Walle, 2007). Road development in Bangladesh led to higher girls' and boys' schooling (Khandker, Bakht and Koolwal, 2009).

The Market Access Channel

The greater availability of inputs and their reduced prices due to lower transport costs increase productivity Khandker, Bakht and Koolwal (2009) estimate the impact of two roads projects

in Bangladesh on seven household outcomes[6] by household fixed-effects method. For the two projects under consideration, road development allowed to significantly reduce the price of fertilizer. Transport costs also decreased significantly. Controlling for soil fertility (and thus for non random placement of roads), Minten and Stifel (2008) show that crop yields for the three major staple items in Madagascar (rice, maize, and cassava) are lower in isolated[7] relative to non-isolated areas. Fan, Rao and Zhang (2004) provide a more macro example on Uganda in which shortened distances to feeder roads significantly increase the agricultural labor productivity.

The improved access to output markets leads to a rise in income thanks to greater opportunities of sales or higher prices. Gibson and Rozelle (2002) provide simple correlation between access to roads and prices that farmers receive for their crops: the rate of price decline is around seven percent for each extra hour to the nearest transport facility. Escobal and Ponce (2002) assess the impact of roads projects in Peru by propensity score matching techniques and demonstrate that rehabilitation entails an income increase. Khandker et al (2009) prove that road development entails higher agricultural production, higher wages, and higher output prices. Jacoby and Minten (2008) estimate the willingness-to-pay for a reduction in transport costs on cross-sectional data collected in a small region of Madagascar. As this region is relatively homogenous but faces great variations in transport costs to the same market, the problem of non random placement of roads is solved. They found that "A road that essentially eliminated transport costs in the study area would boost the incomes of the remotest households—those facing transport costs of about $75/ton—by nearly half, mostly by raising nonfarm earnings".

It is also worth noting that 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.

[6] Household daily transport costs, Input price: fertilizer (taka/kg), Daily agricultural wage (men), Laspeyres Price Index, Laspeyres Quantity Index, Monthly employment hours: adult men, Monthly employment hours: adult women, HH per capita expenditure, Boys' schooling, 5-17 years: HH average, Girls' schooling, 5-17 years: HH average.

[7] Isolation is here defined as the travel time to nearest city.

The Labor Activities Channel

There is a general consensus, well documented, on the idea that transport infrastructure reduce poverty by creating employment and new job opportunities (Jacobs and Greaves, 2003; Fan, 2004). First the construction and maintenance of a road is labor-intensive operations and can provide job opportunities to people living around. However these projects are only occasional and cannot represent a long term strategy for reducing poverty. Second the provision of roads entails a greater and/or cheaper availability of labor markets. For example, Mu and van de Walle (2007) show that road projects in Vietnam increased employment opportunities by 11% for unskilled labor.

The literature also provides insights on the relationship between road access and the diversification of income sources. The evidence highlights two opposed views. On the one hand, diversification occurs in remote areas as a way to deal with the local demand for multiple goods and services (Barrett, Reardon and Webb, 2001). Facing huge transaction costs, it is more profitable for households living in poorly connected regions to diversify their activities so as to satisfy their own demand. On the contrary, many studies point out that connectivity to markets develops multi-activities since opportunities to diversify are greater. An illustrative example is found in Gibson and Rozelle (2003): in Papua New-Guinea, each extra hour to reach the nearest road induces a 2.6 percent reduction in the number of activities.

Literature on road access and labor also deals with diversification outside the agricultural sector. It is widely considered as an efficient way to escape from poverty. In fact, while the majority of the poor live in rural areas where the main activity is agriculture, there is huge evidence that nonfarm activities are a major source of income and employment for the very poor in developing countries. Smith, Gordon, Meadows and Zwick (2001) show that road rehabilitation projects in Uganda extended job opportunities in the service sector. In Tanzania, this kind of project developed job opportunities for non-agricultural employment (Lanjouw, Quizon and Sparrow, 2001). Mu and van de Walle (2007) find similar results: households affected by a road project are less likely to rely on agriculture or forestry as their main source of revenues and switch to the service sector.

3. Roads and Poverty in Cameroon

Overview

Due a great diversity of climates, terrain and vegetation, Cameroon has several natural advantages that could help to sustain its development. Moreover the 402 km of coast boarding the Guinea Gulf ease trade for Cameroon as well as its closer neighbors. In fact Cameroon is among the ten richest countries in Sub-Saharan Africa. Cameroon's wealth comes from oil and wood resources as well as a diversified agricultural production both in terms of food-producing (maize, cassava, plantain banana, macabo, rice, millet, sorghum, groundnuts, etc…) and cash-crop (cocoa, coffee, cotton, rubber, banana, pineapple, etc…) that makes its agriculture the most prosperous in Central Africa.

The primary sector (agriculture) represented 22% of GDP in 2001; the industry sector was 33% and services 45% of GDP. However employment does not exhibit a similar pattern. In fact in 2001, 60.6% of total employment was in agriculture, 9.1% in industry and 23.1% in services (World Bank, 2009.3).

Figure 1 below presents the evolution of the poverty rate in Cameroon between 1996 and 2007. While poverty at the national level significantly declined between 1996 and 2007 (from 53.3% to 39.9%), this phenomenon encompasses heterogenous situations. Decrease of poverty rate mainly came from the reduction that occurred in urban areas where the proportion of households below the poverty line was 41.4% in 1996, 17.9% in 2001 and 12.2% in 2007. On the contrary, poverty rate in rural areas only lost 4 percentage points over the period.

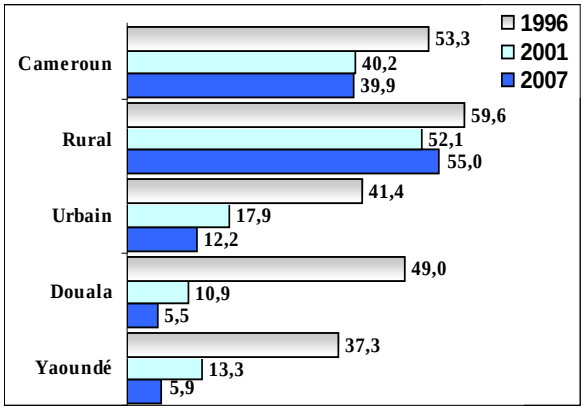

Figure 1: Poverty rate. Sources ECAM I, II and III

Figure 2 represents the main road network in red and the secondary network in green, which is the overall tarred network in Cameroon.

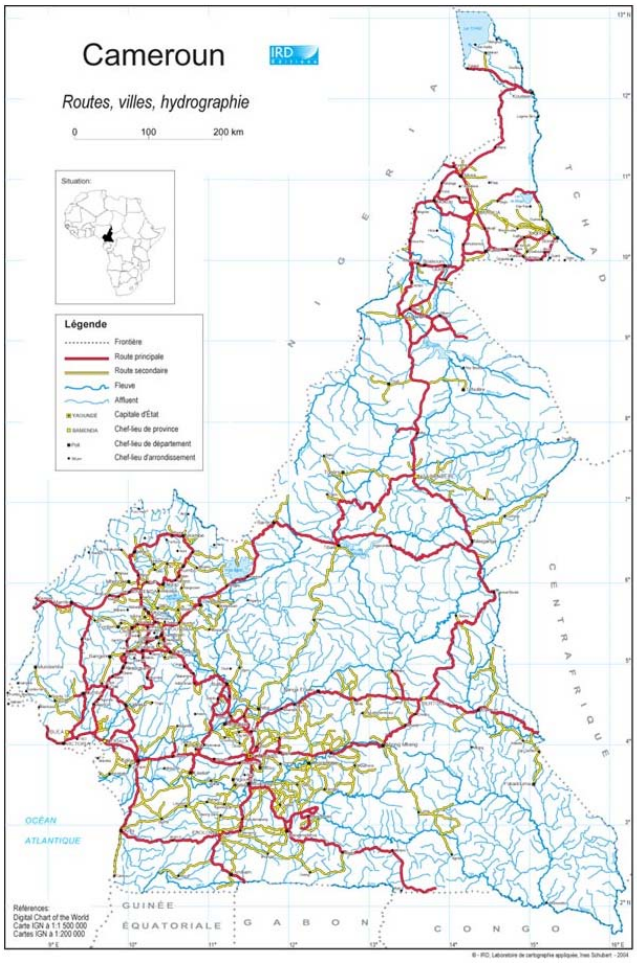

Figure 2: Tarred road network

The provinces of East; Center and Adamaoua, as well as North and Extreme North that are mostly rural suffer from a road network deficit compared to the other regions.

The 2001 Cameroon National Household Survey (ECAM II)

The aim of ECAM II survey is poverty measurement and analysis. The survey focuses on 16 fields of study[8], covering all the dimensions of poverty, from revenues to human capital and

[8] Household's composition and characteristics, Health, Education, Employment and activities income, Fertility, natality and general mortality, Anthropometry and vaccinal coverage, Housing and equipment, Migration, Accessibility to primary infrastructures, Subjective poverty, Familial non farming business, Capital, Agriculture

access to infrastructures. Both objective and subjective poverty are under consideration. Information has been collected at both the household and the individual level, but there is no data at the community level.

The National Institute of Statistics of Cameroon (NIS) defined 32 strata according to three modalities, urban (12), semi urban (10) and rural (10) which depend on the number of inhabitants per district: more than 50,000 for urban, between 10,000 and 50,000 for semi urban and less than 10,000 for rural. Rural and semi urban strata are considered as equivalent by the NIS. The ECAM II is based on the 1987 census (Recensement Général de la Population et de l'Habitat) which defined 612 counting zones or clusters. In urban strata, the sampling proceeds in two stages or degrees. The clusters are first sampled according to a single random drawing; then in each urban cluster 18 or 12[9] households are selected according to the same procedure. In rural strata, the sampling selection follows three degrees. First, districts are sampled proportionally to their size in households in 1987. Second in each district, clusters are drawn from a single random drawing, and then 18 households in semi urban strata and 36 or 27[10] households in rural ones are sampled with the same drawing procedure from the selected clusters. Finally 11,533 households from 612 clusters have been sampled and 10,992 were interviewed.

The survey organization was designed to correctly collect the needed variables to calculate final consumption, the living standards indicator. Daily purchases were collected during respectively 10 or 15 days in rural and urban areas and have been completed with data on retrospective expenditures. The survey ran during three months in order to take into account potential seasonal variations.

The access to roads is measured through two questions. Households are asked how far (in kilometers) they are from the nearest tarred road, and how much time (in minutes) is needed to reach it with their usual means of transport. In the paper, we use the time needed to reach the nearest tarred road because it is the more precise measurement of isolation taking into account the main of transport. We also controlled for the use of a motorized transport but our

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and other rural activities, Retrospective non food expenditures of the households, Daily expenditures of the households, Prices.

[9] Yaounde and Douala.

[10] Extrême Nord, Ouest and Nord Ouest.

results do not change. The same questions are asked for primary public schools, health centers and food markets.

Descriptive Statistics

Cameroonian households closely relate the fact of being poor to the ease of accessing a developed and well-maintained tarred roads network. Whatever the poverty status, the first reported root of poverty in Cameroon is the lack of employment. The next causes reported by the households surveyed are decreasing or insufficient revenues and the lack of roads. Indeed the density of tarred roads in Cameroon is less than one meter[11] of tarred road per squared kilometer of arable land[12]. In order to overcome this issue, the Road Fund Cameroon plans to increase the tarred network by 75% during the 15 next years. An initiative also concerns the rural network, which connects the production areas to local markets or commercial centers. The total network under consideration is long of 24 310 kilometers, almost the half of the entire Cameroonian road network (see Figure 3). The Road Fund's argument is that thanks to this development strategy "many areas will be open to trade and a great progress will be made in the fight against poverty, insecurity and malnutrition".

The households surveyed share this argument, as showed in Table 1, which presents the three major actions reported by households when they are asked about the first initiative to fight against poverty. Employment is by far the first action against poverty underlined by surveyed people. Therefore, we decided to dedicate an important place to the relation between poverty and labor in our analysis.

[11] 0.00000679 kilometers

[12] The tarred network measures 4047.8 km (Fonds Routier du Cameroun). Data on arable land come from WDI (World Bank, 2009.3).

Table 1 : Main Perceived Constraints to Reduce Poverty

First action against poverty	
Create employment	45.51%
Roads construction	11.49%
Ease access to education	6.26%
Source: Authors'calculation and ECAM II	

Concerning dissatisfaction about roads, households quote remoteness (53.23%), difficulty of access (18.67%) and roads condition (10.98%) as the first ones, whatever the poverty status[13].

The statistical analysis of our data confirms these subjective views. Among the 10 992 households surveyed 25.15% are poor. As it is in all developing countries, poverty in Cameroon proves to be a rural phenomenon since 34.7% of rural households are poor (against only 13.6% of the urban ones) and 75.6% of the poor live in rural areas. More precisely, poor households primarily live either in the rural Savannah or the High "Plateau" zones. Table 2 presents for each agro-ecological area the corresponding poverty rate, the average time and the average distance to reach the closest tarred road.

Table 2 : Roads' Access, Poverty and Activity across Agro-ecological Zones

			Access to the closest tarred road	
Agro-ecological Zones	**Poverty Rates**	**Activity Rates**	**Time (min)**	**Distance (km)**
Yaounde	7.9%	20.7%	4.16	0.57
Douala	8.6%	30.3%	5.39	0.67
Other Cities	17.8%	29.9%	8.6	1.96
Rural Forest	29.0%	35.0%	77.54	38.20
Rural High Plateau	33.6%	40.7%	53.77	14.54
Rural Savannah	40.6%	38.7%	68.88	29.22
Urban	13.6%	29.7%	6.89	1.36
Rural	34.7%	38.4%	65.32	25.92
Source: Authors'calculation and ECAM II				

Poverty and bad access to roads appear to be typically rural issues. Poverty rates in the rural areas range from 29% to 40.6% against only 13.6% for cities. The average time to reach the nearest tarred road varies from almost 7 minutes in urban areas to an hour for rural ones. The

[13] A household is considered as poor if its per unit consumption expenditures per year is less than 232 547 CFAF (354 euros).

average distance is 1.36 kilometers in urban zones against 25.92 kilometers in rural areas. We performed mean-comparison on the time and distance variables, among poor/non poor groups and according to the living area. On average the access to a tarred road is significantly easier for an urban household (than for a rural one) and for a non poor household (than for a poor one). The difference between poor and non poor households remains significant even if we divide the sample between urban and rural areas. However the difference is stronger in the rural area. Figure 3 provides a first convincing illustration of the fact that isolated, remote areas tend to be poorer. A negative correlation appears between the per unit consumption expenditures and the ease of accessing a tarred road proxy either by the time or the distance.

As remoteness from a tarred road increases, households' consumption decreases. In rural areas, even though the activity rate is higher, poverty is dominant. This may be explained by the fact that the main activity is agriculture, which generates low income and productivity.

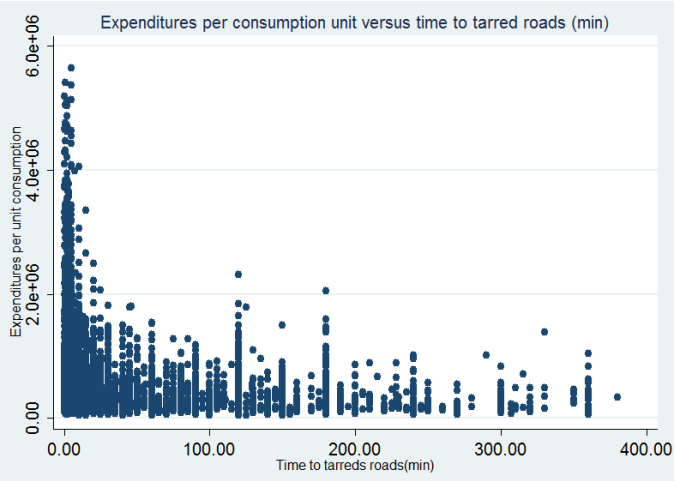

Figure 3: Expenditures per consumption unit versus time to tarred roads

4. The Conceptual Framework

Poverty, Road Access and Labor

Our poverty variable is built following Gibson and Rozelle (2002, 2003) who use the "(log) nominal consumption expenditure per adult equivalent", also known as the Welfare Ratio. This allows keeping a continuous variable while it is still possible to derive the probability of

the i^{th} household's (log) welfare ratio being less than zero[14] from the estimated parameter, and thus the predicted incidence of poverty and the simulated poverty gap and poverty severity measures.

Road access is proxied by the time in hours needed to reach the closest tarred road, at the household level. We control for the education and health channel thanks to two variables: the time to reach the closest primary school and the time to reach the closest health centre, both at the household level. The access to markets is also proxied by the time to reach the closest food market at the household level.

Concerning the labor opportunities channel, we alternatively introduce three types of activities dummies[15] as explanatory variables to control for the household-head labor supply (Kalugina and Najman, 2004); as described in Figure 4.

ECAM II provides detailed information about labor activities carried out within the household but we focus our analysis on the household-head under the assumption he/she is the major contributor to the household's revenues. We follow the literature on road access and labor opportunities as presented in Section 2 as well as the specific design of labor in Cameroon to define our activities dummies.

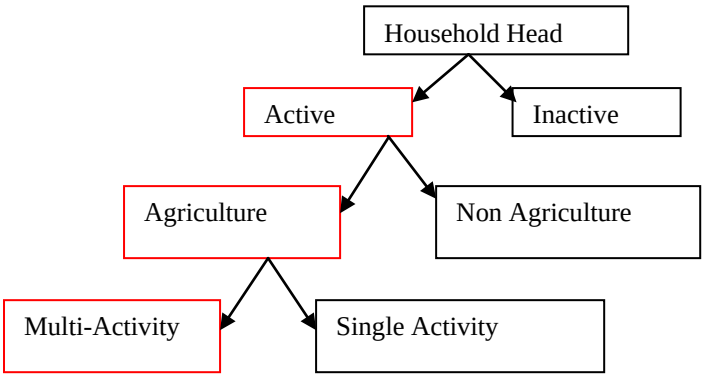

Figure 4: Labor categories

[14] Normalizing consumption by the poverty line implies that $\ln(c_i/z) < 0$ for poor households; c_i : consumption expenditures and z the poverty line.
[15] Details will be provided in the next sub section.

We first built a binary variable that takes the value 1 if the household-head is active (0 if he is inactive[16]). Road access is supposed to entail labor opportunities. Therefore we expect that our road access variable (which in fact proxies isolation) will have a negative impact on this variable if our "Active" dummy really captures the opportunity of employment.

The World Bank Agriculture and Rural Development Department explains that "`Agriculture employs nearly one-half of the labor force in developing countries. Indeed, a high share of rural communities and especially the rural poor are directly or indirectly dependent on agriculture through farming, food processing, fishing, forestry, and trade."' (World Bank, 2009.2). Cameroon fits this overview since the agricultural sector represented 61% of total employment in 2001 (World Bank, 2009.3), about 41% of the household-heads in our sample are involved in agriculture. The proportion rises to 66.82 % among poor households and to 78.72 % among rural poor households.

We build binary variables to assess the impact road access has on the involvement in agriculture and diversification outside from this sector. Indeed, on the one hand diversification outside from agriculture is at the core of the debate on rural poverty; on the other hand, road access is found to significantly influence the diversification of income sources according to the brief literature review in Section 2. Our first agricultural dummy equals 1 if the household-head declares his main activity to be agriculture (0 if he declares it is not in agriculture)[17]. The second variable concerns the household-heads primarily involved in a farming activity and equals 1 for multi-active heads, 0 for the single-active ones. This variable aims at testing if diversification as a multiplication of income sources in addition to a main agricultural activity helps to reduce poverty and the impact isolation has on this decision.

Econometric specification

Our intuition is that road access *per se* does not have a direct impact on consumption expenditures at the household level. The impact should only be indirect and what matters is

[16] Retired, students, unemployed, disabled, other inactive.
[17] We also use two other dummies. The first restrict the sample to the single-active household-heads and equals 1 if he is involved in a farming activity; 0 otherwise. The second equals 1 if the household-head is a single-active farmer; 0 if he is a multi-active farmer or involved in non-farming activities. We find similar results with these alternative measures.

the facility or the market the road allows people to reach. To test this hypothesis, we simultaneously estimate equations of consumption expenditures and labor activities using Three-Stage Least-Squares on the following specification:

$$\text{Welfare Ratio} = \alpha_{wr}.z + \beta_{wr}.z_{wr} + \gamma_{wr}.\text{Labor} + u_{wr}$$
$$\text{Labor} = \alpha_{l}.z + \beta_{l}.z_{l} + \gamma_{l}.\text{Roads} + u_{l}$$

where $E(u_{wr} \mid exog)=E(u_{l} \mid exog)=0$ and *exog* contains all variables other than *Welfare Ratio, Labor* and *Roads*. We run 3 sets of estimations with the variable *Labor* alternatively being each of our labor categories as defined previously. The coefficient is γ_{wr} supposed to be non significant if road access has no a direct impact on consumption.

Empirical Issues and solutions

Including the control variables for the human capital, markets and labor channels deals with the omitted variables issue that otherwise will raise the problem of an upward bias in estimating γ_{wr}.

The other empirical issue potentially at work behind the relationship under consideration is endogeneity (van de Walle, 2009). A first cause of endogeneity lies in the measurement error issue of accessing roads. Our data contains information about both the time and the distance to the closest tarred road. The time variable takes into account the most common mean of transport used to access the road. Assuming this fully captures the relevant differences in access to tarred roads among households, we thus prefer the time variable to the distance one. We want to stress that the coefficient of this time variable has to be interpreted as the effect of isolation from a tarred road.

A second root of endogeneity can be found in a simultaneous determination issue coming from unobservable determinants. The construction of a road is a non-random decision. In fact, this choice is subject to various demands, such as geographic and topographic conditions. As poverty and bad access to roads prove to be a rural phenomena (see Table 1), we believe that unobserved characteristics can jointly determine wealth, job opportunities and road access at the regional, district or cluster levels. We deal with this problem by introducing fixed effects at the district level as well as for the three rural areas of the country.

A reverse causality between the *Welfare Ratio* or *Labor* and the *Roads* issue may also mar the estimates. The localization choices of a household alongside a road and the means to access roads are highly endogenous decisions respective to the poverty status of the household. Our data do not permit us to control for the localization choices. However we argue that reverse causality in terms of means to access the road is not the phenomenon that drives endogeneity in our data. Whatever the poverty group, the main mean of access to a tarred road is walking. More convincing is the fact that the respective shares for the use of a care are 36.07% for the poor-households group against only 20.50% for the non-poor group.

We use an instrumental variable approach to solve the endogeneity of road localization. A road may be constructed in a given region because this is characterized by some economic potential that in turn shapes the poverty situation of the region and then the poverty status of households living in that region. An appropriate instrument has to explain why a given household benefits from a satisfying access to tarred roads but it should not be correlated with the level of consumption expenditures of this household.

Our first instrument is the density[18] of fixed and mobile "Gendarmeries" companies at the province level. We follow the macro literature that considers military spending as “the only plainly exogenous major influence on the economy” (Hall, 1986; 1990). The argument in our context is that the decision to settle a gendarmerie station should be totally exogenous from any other consideration than the sovereign defense mission accruing to the state. In fact governments have to provide protection to their citizens, whatever their wealth, religion or community... and the regions they live in. But the presence of a "gendarmerie" station requires a developed road network to ensure more effective police interventions. Households in areas with many "gendarmerie" stations per km² should then face a better access to roads in the sense that the road density should be higher. We obtained the data on "gendarmerie" stations at the district level from the French Embassy in Yaoundé and used the list of the 612 sampled clusters in ECAM II to construct our instrument.

Our second instrument is the tarred road density by province lagged one year (in 2000). The current road access is in fact determined by the previous prevailing network density. A higher

[18] For each province: Number of "Gendarmeries" companies over the surface area.

density will lead to a reduced time at the household level. Considering that we control for unobserved heterogeneity at the district level thanks to fixed effects, we argue that any residual impact on these instruments on our poverty indicator is only through the effect of isolation at the household level.

Another empirical issue lies in the potential reverse causality between the consumption indicator and the *Labor* variable is the "Multi-Active Agriculture" dummy. Indeed incentives to diversify income sources may be due to the vulnerability of specialized poor households. The simultaneous estimates using three-stage least squares solve for that.

Finally a selection bias issue directly arises from the sequential definition of our labor categories: The household-head has first to decide whether or not enter the job market and then he has to choose the sector of activities. We follow Wooldridge (2002) to model this issue:

$y_1 = x_1\beta_1 + u_1$

$y_2 = 1\ (x\delta_2 + v_2)$

The assumptions are that (x, y2) are always observed and y_1 is observed only when $y_2 = 1$; (u_1, v_2) are independent of x with zero mean; v_2 is normally distributed (0, 1); $E\ (u_1|\ v_2) = \gamma_1\ v_2$.

We can thus write that:

$E\ (y_1|\ x, y2) = x_1\beta_1 + E\ (u_1|\ v_2) = x_1\beta_1 + \gamma_1\ v_2$

If γ_1 is null, there is no selection problem. If γ_1 is different from zero, using iterated expectations on the previous equation, we have:

$E\ (y_1|\ x, y2) = x_1\beta_1 + \gamma_1 E\ (v_2|x, y2) = x_1\beta_1 + \gamma_1\ h(x, y2)$,

with $h(x, y2) = h(x, 1) = \lambda(x\delta_2)$ the inverse Mills ratio on the selected sample. A consistent estimator of δ_2 is obtained from the probit estimation of the selection equation. We thus implement this methodology to get the two inverse Mills ratios from the probit estimations of the probability the household-head is active on the one hand; and the probability he is primarily involved in agriculture on the other hand. We then introduce these variables as explanatory variables, respectively in the labor equation for the labor category "Agriculture" and in the labor equation for the labor category "Multi-Active Agriculture".

5. Results

The estimates presented in Tables 3 to 5 are made using fixed effects at the district level, but these are not reported due to space consideration.

"Active" or "Inactive"?

Determinants of consumption expenditures

The household's size and composition variables have the expected impacts. Larger households tend to have a lower level of consumption. Compared to a household whose head lives in couple and has children, a couple without children has a higher level of consumption. The single people dummy may be interpreted according to two competing intuitions. As a single person does not have to share his/her income with other people, she benefits from a higher level of consumption as illustrated by the positive and significant impact of this dummy. The average level of instruction in the household has the positive expected effect on consumption expenditures since instruction leads to higher-paid job opportunities; but the impact is non significant at the cluster level. On the contrary the part of working-age people affected by malaria in the cluster significantly lowers consumption.

As expected an active-headed household has a higher level of consumption compared to an inactive headed-household. Our assumption of a non direct impact of road access on consumption is also verified.

Determinants of the probability of being active

Female household-heads have a higher probability of being active. Compared to no instruction, having received a primary or a secondary (first cycle) instruction does not influence the probability of being active. On the contrary this probability is higher for household-heads with a secondary (second cycle) or a tertiary instruction.

The major result concerning this side of the model is the very surprisingly positive and significant impact of our road access proxy. Isolation has a positive and significant impact on the probability of being active.

This acts against this assumption that a better road access entails more job opportunities. However, one should note that the labor variable under consideration here only partly proxies for employment opportunities, since the reference group encompasses both unemployed and other inactive household-heads. Irrespective of this issue, another potential explanation can be found in the very particular shape of employment in Africa. In Africa in general and thus in Cameroon the issue of activity and employment lies in a lack of sufficient revenues and underemployment rather than a conventional unemployment status. A large part of the employment is in fact corresponding to informal or agriculture activities with an average little number of worked hours or low productivity activities and therefore procures small revenues. In South Saharan Africa about 30% of the population is actually under-employed (Africa development indicators, 2008-09). Finally a large part of the activity category consists in agriculture activities[19] on which isolation has a positive and significant impact as we will see in the Table 4.

[19] As a robustness test, we performed the same estimates on the rural sub-sample. Our results broadly hold: the only exception is the non significant impact of road access on the probability of being active. See Tables 6 to 8 in Appendix 2.

Table 3: Simultaneous Estimates; "Active" *versus* "Inactive"

Dependant variable: Welfare Ratio		**Dependant variable: "Active" HH-head**	
Size	-0.053	Size	-0.003
	(0.007)**		(0.001)*
Number above age 60	-0.084	Number above age 60	0.003
	(0.082)		(0.013)
HH-head Couple without children (D)	0.382	HH-head Couple without children (D)	-0.031
	(0.092)**		(0.013)*
HH-head single parent with children (D)	0.086	HH-head single parent with children (D)	-0.040
	(0.095)		(0.014)**
HH-head single people (D)	0.280	HH-head single people (D)	-0.086
	(0.142)*		(0.015)**
Average level of education	0.125		
in the household	(0.019)**	Time to the nearest tarred road	0.023
"Active" HH-head (D)	2.730	in hours	(0.009)*
	(0.961)**	Male-headed household (D)	-0.044
Time to the nearest tarred road	-1.860		(0.012)**
in hours	(1.180)	Age	-0.001
Time to the nearest primary school	0.389		(0.000)*
in hours	(0.276)	Primary instruction (D)	0.013
Time to the nearest health center	0.665		(0.010)
in hours	(0.442)	Secondary (1st cycle) instruction (D)	-0.004
Time to the nearest food market	0.701		(0.012)
in hours	(0.467)	Secondary (2nd cycle) instruction (D)	0.035
Part of people affected by malaria	-0.488		(0.013)**
in the cluster	(0.242)*	Tertiary education (D)	0.063
Average level of education	-0.100		(0.014)**
in the cluster	(0.182)		
Rural Forest	0.943	Rural Forest	0.102
	(0.701)		(0.040)*
Rural Savannah	0.494	Rural Savannah	0.023
	(0.554)		(0.025)
Rural High Plateaux	0.474	Rural High Plateaux	0.055
	(0.487)		(0.022)*
Constant	-2.592	Constant	0.959
	(1.089)*		(0.054)**
District Fixed Effects	yes	District Fixed Effects	yes
Instrumental Variables	yes	Instrumental Variables	yes
Observations	5938	Observations	5938
R Squared	0.3460	R Squared	0.0661
RMSE	0 .551	RMSE	0 .271
(robust se); *: p<5%; **: p<1%			

"Agriculture" or "Non Agriculture"?

Determinants of consumption expenditures

The household's characteristics, the regional dummies and the control variables for the channels of road's impact on poverty, generally have comparable impacts on consumption than previously.

Here again road access is found to have no direct impact on the level of expenditures. The household-head's involvement in agriculture tends to greatly lower the level of consumption expenditures for his household. The farming sector therefore appears to be a kind of "poverty trap" for Cameroonian households as this activity is unable to provide sufficient revenues to help increase consumption.

Determinants of the probability the main activity is agriculture

As expected, living in rural areas increases the probability of being involved in the farming sector. The structure of the household is not a significant determinant of the decision to enter the farming sector as well as the gender of the household-head. But the probability of working in agriculture decreases further with the level of instruction.

The positive coefficient of the road access indicator highlights the indirect effect of road isolation on consumption. Our explanation is that remoteness from markets forces households to insure their food subsistence by their own means since they cannot rely on trade opportunities. They therefore remain stuck in farming subsistence activities providing only small revenues.

The inverse Mills ratio is not significant: there is no selection bias here. Building on that result we consider that the selection issue potentially at work in the sub-sample of the household-heads primarily involved in agriculture is not double[20], but is only derived from the decision of the main activity, agriculture or not.

[20] Coming first from the decision to enter the labor market and then to chose the agricultural sector.

Table 4: Simultaneous Estimates; "Agriculture" *versus* "Non agriculture"

Dependant variable: Welfare Ratio		**Dependant variable: "Agriculture" HH-head**	
Size	-0.056	Size	0.000
	(0.003)**		(0.002)
Number above age 60	-0.011	Number above age 60	0.023
	(0.033)		(0.017)
HH-head Couple without children (D)	0.251	HH-head Couple without children (D)	0.013
	(0.030)**		(0.016)
HH-head single parent with children (D)	-0.074	HH-head single parent with children (D)	0.027
	(0.028)**		(0.019)
HH-head single people (D)	0.014	HH-head single people (D)	0.004
	(0.037)		(0.020)
Average level of education	0.110	Time to the nearest tarred road	0.154
in the household	(0.008)**	in hours	(0.011)**
"Agriculture" HH-head (D)	-0.981		
	(0.130)**		
"Multi-Active" HH-head (D)	0.021	"Multi-Active" HH-head (D)	-0.016
	(0.020)		(0.011)
Time to the nearest tarred road	-0.208	Male-headed household (D)	0.022
in hours	(0.349)		(0.016)
Time to the nearest primary school	0.060	Age	0.002
in hours	(0.081)		(0.001)**
Time to the nearest health center	0.134	Primary instruction (D)	-0.072
in hours	(0.139)		(0.014)**
Time to the nearest food market	0.122	Secondary (1st cycle) instruction (D)	-0.149
in hours	(0.144)		(0.016)**
Part of people affected by malaria	-0.333	Secondary (2nd cycle) instruction (D)	-0.230
in the cluster	(0.123)**		(0.018)**
Average level of education	0.096	Tertiary education (D)	-0.291
in the cluster	(0.065)		(0.020)**
Rural Forest	0.758	Rural Forest	0.471
	(0.263)**		(0.050)**
Rural Savannah	0.384	Rural Savannah	0.515
	(0.206)		(0.031)**
Rural High Plateaux	0.258	Rural High Plateaux	0.273
	(0.174)		(0.028)**
Constant	-0.186	Constant	-0.425
	(0.149)		(0.070)**
		Mills	Not sign.
District Fixed Effects & IV	yes	District Fixed Effects & IV	yes
Observations	5405	Observations	5405
R Squared	0.2698	R Squared	0.5222
RMSE	0.585	RMSE	0 .330
(robust se); *: p<5%; **: p<1%			

Multi-Active Agriculture" or "Single Active Agriculture"?

One can first note that the inverse Mills ratio is here significant, emphasizing the selection issue bias coming from the decision to exclude the non agricultural sector from the sample of active household-heads.

Once again there is no direct impact of road access on consumption. The isolation variable has a positive and significant impact on the probability a farmer household-head diversifies his activity. This supports the argument of an autarky behavior: isolated households tend to diversify their activity to fit their own demand. However the main result is the non significant impact of the "Agriculture Multi" dummy on the level of consumption expenditures. The diversification[21] status of a household-head primary involved in agriculture thus implies no differences for the consumption expenditures of the household. As a consequence access to a tarred road as no impact on the consumption level of the households whose heads are primarily involved in agriculture.

This is an important finding as it highlights the pessimistic situation of farmers in Cameroon for which this sector truly constitutes a poverty trap. This result is in line with the study by Beegle, De Weerdt and Dercon (2008) on Tanzania. They show that staying in agriculture is associated with lower growth than exiting the sector. So the only way to increase the level of consumption for farming households seems to be a diversification outside agriculture.

These results are of major importance in terms of policy recommendations. Road investment in areas where non-farming activities cannot be developed is useless as long as the main activity remains agriculture. Indeed as plot size in Cameroon is limited on average to less than one hectare (Raballand et al., 2010), a farmer's transport requirement is usually minimal and does not necessarily involve massive investments in infrastructure because most farmers cannot fully load a truck (and pay for this service) and, even if productivity would significantly be higher, the production threshold would not be reached by most individual farmers.

[21] However one should note that we are unable to identify the nature of the secondary activity. Consequently part of the multi-active household-heads may actually be involved in a secondary farming activity.

Table 5: Simultaneous Estimates; "Multi Agriculture" *versus* "Single Agriculture"

Dependant variable: Welfare Ratio		**Dependant variable: "Agriculture Multi" HH-head**	
Size	-0.061	Size	0.010
	(0.004)**		(0.004)*
Number above age 60	-0.011	Number above age 60	0.047
	(0.033)		(0.036)
HH-head Couple without children (D)	0.257	HH-head Couple without children (D)	0.023
	(0.036)**		(0.038)
HH-head single parent with children (D)	-0.111	HH-head single parent with children (D)	-0.041
	(0.040)**		(0.045)
HH-head single people (D)	0.103	HH-head single people (D)	-0.091
	(0.054)		(0.060)
Average level of education	0.085	Time to the nearest tarred road	0.107
in the household	(0.016)**	in hours	(0.039)**
"Agriculture Multi" HH-head (D)	0.030		
	(0.206)		
Time to the nearest tarred road	-0.031	Male-headed household (D)	0.014
in hours	(0.024)		(0.047)
Time to the nearest primary school	0.031	Age	0.003
in hours	(0.022)		(0.002)
Time to the nearest health center	0.012	Primary instruction (D)	-0.125
in hours	(0.023)		(0.039)**
Time to the nearest food market	-0.003	Secondary (1st cycle) instruction (D)	-0.248
in hours	(0.018)		(0.081)**
Part of people affected by malaria	-0.339	Secondary (2nd cycle) instruction (D)	-0.645
in the cluster	(0.178)		(0.180)**
Average level of education	0.107	Tertiary education (D)	-1.092
in the cluster	(0.043)*		(0.273)**
Rural Forest	0.308	Rural Forest	1.544
	(0.204)		(0.426)**
Rural Savannah	-0.064	Rural Savannah	1.207
	(0.080)		(0.322)**
Rural High Plateaux	-0.159	Rural High Plateaux	0.819
	(0.082)		(0.198)**
Constant	-0.031	Constant	-2.470
	(0.242)		(0.834)**
		Mills	Sign.**
District Fixed Effects	yes	District Fixed Effects	yes
Instrumental Variables	yes	Instrumental Variables	yes
Observations	1855	Observations	1855
R Squared	0.3644	R Squared	0.1506
RMSE	0.428	RMSE	0.445
(robust se); *: p<5%; **: p<1%			

6. Main Policy Implications

Rural Africa is usually characterized by semi-subsistence, low-input, low-productivity systems. Lukanu et al. (2007) gives the example of the southern Niassa province of Mozambique and explains that most smallholders give priority to cultivating food crops for consumption and what is left over is used to cultivate cash crops. Therefore, for most households involved in agriculture, a better access to roads could still leave them in a poor condition because they do not have the necessary endowments (land, skills, labor) to increase production and surplus. There is probably a threshold effect for roads in low economic density regions and therefore we question the possible impact of rural roads on economic development and poverty reduction (Raballand et al. 2010).

Our results underline that it is of the utmost importance that roads investments are planned in locations where non-farming activities can be developed. As Beegle, De Weerdt and Dercon (2008) underline "how to deliver poverty reduction if the main engine of growth appears to be elsewhere". It is indeed now increasingly documented that non-farming incomes (rather than farming) have a major impact on poverty reduction (Barret et al. (2001)). A particular example for Cameroon is the work of Gockowski et al. (2004). They show that horticulture provides a pathway for intensification among smallholders in southern Cameroon driven by growth in urban market demand and high relative prices.

The implication for roads planning is that a one size fits all approach is not effective in addressing the problems of all regions of all African countries. Government and donors probably need to adapt an approach that supplies the appropriate road for a rural area, realizing that a large tarred road may not be required and should take more into account the economic potential of the region and do not preclude that roads investment has a quasi-automatic impact on poverty reduction.

Moreover, the idea of scaling up in roads investment assumes that investment in roads will lead to reduced transport prices and neglect market structure of behavior of provider of transport services, which seems to be problematic for aid effectiveness (Arvis et al. 2010). However, infrastructure is only one component of the production function of the service

provider and the link between roads condition and transport prices is far from being automatic, at the international corridor level (Teravaninthorn et al. 2008) as well at the local level (Raballand et al. 2010).

7. Conclusion

This paper questions main development actors' belief that improved road access automatically leads to poverty reduction. This faith in a certain poverty reduction impact of roads already fueled the previous massive investments in transport infrastructure in Africa but the promised results have not been reached.

Contrary to the plethora of empirical studies that directly model poverty as a function of isolation, we found that road access has no direct impact on the consumption expenditures of Cameroonian households when we control for the various channels identified by the literature. The impact is only indirect: it's not road availability per se that helps to reduce poverty, but the opportunities opened by roads, more specifically labor opportunities outside the agricultural sector.

The simultaneous estimate of consumption expenditures and the probability for a household-head to be active reveals a quite surprising effect of road access. Isolation from a tarred road is found to increase the probability to be active. On the contrary, literature on this specific topic expects and shows that improved road access entails more job opportunities (Jacobs and Greaves, 2003; Fan, 2004). We explain our counter-intuitive result as the consequence of three facts. Firstly, considering both unemployed and inactive people are encompassed in the reference group, our variable may not be a right proxy for employment opportunities. Secondly, activity in Africa often consists in underemployment and lack of sufficient revenues rather than conventional unemployment. Finally a large part of the activity category consists in agriculture activities on which isolation has a positive and significant impact (Table 4).

The simultaneous estimate presented in Table 4 highlights the negative impact of an involvement in the farming sector on the level of consumption expenditures. It also demonstrates that isolation from a tarred road and thus from markets and trade opportunities

has a significant and positive impact on the probability to get involved in farming activities. Agriculture thus acts as a poverty trap for Cameroonian households and the lack of a developed and dense road network keeps them captive in that sector. These results are in line with the argument of a beneficial impact of improved road access on the opportunity to diversify outside the farming sector. Although we cannot use similar methodologies as in Lanjouw et al (2001), Smith et al (2001) or Mu and van de Walle (2007), our results in the Cameroonian context confirm their own findings for Tanzania, Uganda and Vietnam.

Our last estimates exhibit a non-significant effect of the diversification status of farmers' household-heads. Households headed by a multi-active farmer exhibit no significant difference in their consumption level compared to a single-active farmer. On the contrary, isolation has positive impact on the probability that these household-heads diversify their activity, which refers to the autarky argument presented in the literature review. Unfortunately, we cannot identify the secondary sector and we believe that in general these activities remain in the farming sector, which could explain our result of a non-significant impact on the consumption level.

These results emphasize that investing uniformly for roads in Africa is likely to have a lower impact on poverty than expected. Their efficiency for poverty reduction relies on an appropriate design, taking into account the real needs of road users.

But the question of roads investments as an efficient poverty reduction tool also requires a discussion on their governance capacities. In many African countries, roads are built not for economic reasons but rather for political allegiance and the high risks of embezzlement may render ineffective any well-thought road project.

Finally the interrelation between road access and migration has still to be studied in depth. Beegle, De Weerdt and Dercon (2008) find that migration to more connected areas is associated with higher consumption growth. Fafchamps and Schilpi (2008) show that better access to paved roads in some regions reduces migration. However, the availability of roads and thus access to other areas that may be more connected may induce more internal migration in the form of seasonal or temporary migration.

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Appendix

Appendix 1: Summary Statistics

	Obs	Mean	Std. Dev.	Min	Max
Welfare Ratio	10991	.4867298	.7136692	-2.425216	4.621913
Household's size and composition					
Size	10991	5.134929	3.518971	1	38
Number above age 60	10991	.2551178	.5485235	0	6
Dummy, HH-head in Couple with children[A]	10991	.5549995	.4969885	0	1
Dummy, HH-head in Couple without children	10991	.1140024	.3178286	0	1
Dummy, HH-headsingle parent with children	10991	.149304	.3564041	0	1
Dummy, HH-head single people	10991	.1815121	.3854595	0	1
Household's Characteristics					
Average level of education	8727	2.670905	1.317237	1	7
Time to reach the nearest tarred road	10319	.2111728	.4081593	0	13.36667
Household-Head's Characteristics					
Dummy , Male-headed household	10991	1.243927	.4294687	1	2
Age	10991	42.92412	15.06109	13	99
Dummy , No instruction [A]	10991	.2685834	.4432429	0	1
Dummy , Primary instruction	10991	.314894	.4644948	0	1
Dummy , Secondary (1st cycle) instruction	10706	.1857837	.3889502	0	1
Dummy , Secondary (2nd cycle) instruction	10803	.1130242	.316637	0	1
Dummy , Tertiary education	10991	.0791557	.2699939	0	1
Channels controls					
Dummy, HH-head active	10875	.8650115	.341727	0	1
Dummy, HH-head agriculture	9407	.4090571	.491686	0	1
Dummy, multi-active	9367	.2618768	.4396794	0	1
Dummy, HH-head agriculture multi-active	3838	.338197	.4731576	0	1
Time to reach the nearest primary school	10906	.3267467	.4174181	0	8.683333
Time to reach the nearest health center	9889	.4474045	.6141364	0	8.366667
Time to reach the nearest food market	10954	.4039985	.6246352	0	8.333333
Regional Characteristics					
Share of people affected by malaria	10991	2.785574	.9441693	1.017241	6.555555
Average level of education	9158	.1101484	.0861446	0	.44
Dummy, Urban[A]	10991	.4525521	.4977662	0	1
Dummy, Rural Forest	10991	.1497589	.3568512	0	1
Dummy, Rural Savannah	10991	.1865162	.3895404	0	1
Dummy, Rural High Plateaux	10991	.2111728	.4081593	0	1
Semi Urban	10991	.1944318	.3957807	0	1
Instrumental Variables					
Tarred Road Density	10991	.0136201	.0075429	.0007403	.0293937
"Gendarmerie" Density	10991	.000199	.0001423	.0000275	.0005046

[A]: Reference Group

Appendix 2: Rural Sample

Table 6: Simultaneous Estimates; "Active" *versus* "Inactive"

Dependant variable: Welfare Ratio		**Dependant variable: "Active" HH-head**	
Size	-0.052	Size	-0.001
	(0.011)**		(0.001)
Number above age 60	-0.312	Number above age 60	0.023
	(0.135)*		(0.013)
HH-head Couple without children (D)	0.457	HH-head Couple without children (D)	-0.015
	(0.128)**		(0.014)
HH-head single parent with children (D)	-0.003	HH-head single parent with children (D)	-0.002
	(0.108)		(0.014)
HH-head single people (D)	0.914	HH-head single people (D)	-0.082
	(0.250)**		(0.019)**
Average level of education	0.096		
in the household	(0.025)**	Time to the nearest tarred road	0.013
"Active" HH-head (D)	8.556	in hours	(0.007)
	(2.138)**	Male-headed household (D)	-0.010
Time to the nearest tarred road	-0.939		(0.008)
in hours	(0.736)	Age	0.000
Time to the nearest primary school	0.226		(0.000)
in hours	(0.195)	Primary instruction (D)	0.014
Time to the nearest health center	0.309		(0.007)*
in hours	(0.277)	Secondary (1st cycle) instruction (D)	0.016
Time to the nearest food market	0.303		(0.007)*
in hours	(0.286)	Secondary (2nd cycle) instruction (D)	0.032
Part of people affected by malaria	-0.263		(0.011)**
in the cluster	(0.301)	Tertiary education (D)	0.067
Average level of education	-0.385		(0.018)**
in the cluster	(0.346)		
Semi Urban	0.911	Semi Urban	-0.061
	(0.237)**		(0.015)**
Rural Savannah	-7.459	Rural Savannah	-0.100
	(1.960)**		(0.098)
Rural High Plateaux	-6.285	Rural High Plateaux	-0.066
	(2.545)*		(0.109)
Constant	0.000	Constant	1.042
	(0.000)		(0.096)**
District Fixed Effects	yes	District Fixed Effects	yes
Instrumental Variables	yes	Instrumental Variables	yes
Observations	3001	Observations	3001
(robust se); *: p<5%; **: p<1%			

Table 7: Simultaneous Estimates; "Agriculture" *versus* "Non Agriculture"

Dependant variable: Welfare Ratio		**Dependant variable: "Agriculture" HH-head**	
Size	-0.056	Size	0.002
	(0.005)**		(0.003)
Number above age 60	-0.062	Number above age 60	0.021
	(0.046)		(0.023)
HH-head Couple without children (D)	0.294	HH-head Couple without children (D)	0.010
	(0.046)**		(0.024)
HH-head single parent with children (D)	-0.054	HH-head single parent with children (D)	0.007
	(0.045)		(0.028)
HH-head single people (D)	0.204	HH-head single people (D)	-0.019
	(0.064)**		(0.035)
Average level of education	0.087	Time to the nearest tarred road	0.069
in the household	(0.014)**	in hours	(0.013)**
"Agriculture" HH-head (D)	-0.982		
	(0.155)**		
"Multi-Active" HH-head (D)	-0.020	"Multi-Active" HH-head (D)	-0.056
	(0.029)		(0.015)**
Time to the nearest tarred road	-0.374	Male-headed household (D)	0.059
in hours	(0.269)		(0.025)*
Time to the nearest primary school	0.226	Age	0.002
in hours	(0.195)		(0.001)**
Time to the nearest health center	0.309	Primary instruction (D)	-0.068
in hours	(0.277)		(0.018)**
Time to the nearest food market	0.303	Secondary (1st cycle) instruction (D)	-0.155
in hours	(0.286)		(0.023)**
Part of people affected by malaria	-0.322	Secondary (2nd cycle) instruction (D)	-0.282
in the cluster	(0.186)		(0.030)**
Average level of education	-0.224	Tertiary education (D)	-0.377
in the cluster	(0.143)		(0.037)**
Semi Urban	-0.143	Semi Urban	-0.506
	(0.096)		(0.026)**
Rural Savannah	-0.831	Rural Savannah	-0.246
	(0.377)*		(0.159)
Rural High Plateaux	-0.349	Rural High Plateaux	0.173
	(0.517)		(0.179)
Constant	1.868	Constant	0.832
	(0.573)**		(0.155)**
		Mills	Not sign.
District Fixed Effects	yes	District Fixed Effects	yes
Instrumental Variables	yes	Instrumental Variables	yes
Observations	2846	Observations	2846
(robust se); *: p<5%; **: p<1%			

Table 8: Simultaneous Estimates; "Multi Agriculture" *versus* "Single Agriculture"

Dependant variable: Welfare Ratio		**Dependant variable: "Multi-Active Agriculture" HH-head**	
Size	-0.063	Size	0.020
	(0.004)**		(0.004)**
Number above age 60	-0.008	Number above age 60	0.098
	(0.034)		(0.034)**
HH-head Couple without children (D)	0.255	HH-head Couple without children (D)	0.055
	(0.038)**		(0.036)
HH-head single parent with children (D)	-0.090	HH-head single parent with children (D)	-0.106
	(0.038)*		(0.044)*
HH-head single people (D)	0.135	HH-head single people (D)	-0.110
	(0.055)*		(0.057)
Average level of education	0.075	Time to the nearest tarred road	0.123
in the household	(0.017)**	in hours	(0.022)**
"Agriculture Multi" HH-head (D)	0.203		
	(0.150)		
Time to the nearest tarred road	-0.012	Male-headed household (D)	0.226
in hours	(0.058)		(0.047)**
Time to the nearest primary school	0.020	Age	0.004
in hours	(0.027)		(0.001)**
Time to the nearest health center	0.004	Primary instruction (D)	-0.155
in hours	(0.032)		(0.030)**
Time to the nearest food market	-0.013	Secondary (1st cycle) instruction (D)	-0.487
in hours	(0.026)		(0.054)**
Part of people affected by malaria	-0.365	Secondary (2nd cycle) instruction (D)	-1.370
in the cluster	(0.184)*		(0.117)**
Average level of education	-0.008	Tertiary education (D)	-2.129
in the cluster	(0.073)		(0.197)**
Semi Urban	0.179	Semi Urban	-2.078
	(0.067)**		(0.147)**
Rural Savannah	-0.175	Rural Savannah	-0.078
	(0.506)		(0.453)
Rural High Plateaux	-0.309	Rural High Plateaux	-2.368
	(0.625)		(0.589)**
Constant	0.074	Constant	-1.619
	(0.533)		(0.480)**
		Mills	Sign.**
District Fixed Effects	yes	District Fixed Effects	yes
Instrumental Variables	yes	Instrumental Variables	yes
Observations	1679	Observations	1679
(robust se); *: p<5%; **: p<1%			