

# Roads Impact on Poverty Reduction

## A Cameroon Case Study

Marie Gachassin<sup>1</sup>, Boris Najman<sup>2</sup>, Gaël Raballand<sup>3</sup>

December 2009

### Abstract

Many investments in infrastructure are built on the belief that they will ineluctably lead to poverty reduction and income generation. This entailed massive aid-financed projects, especially for the transport sector in developing countries. However the lack of robust evaluations raises the issue of a "one-size-fit-all" approach: Investing uniformly in Africa is likely to have a lower impact on poverty than expected. We use the second Cameroonian national household survey (Enquête Camerounaise Auprès des Ménages II, 2001) to address this question. Isolation from a tarred road is found to have no direct impact on consumption expenditures but a significant indirect one lies in the access to labor activities. Considering that diversification outside the agricultural sector is the main driver for poverty reduction in rural Africa, our results contribute to the idea that emphasis on roads investment should be given to locations where non-farming activities could be developed.

**Keywords:** Roads, Poverty, Labor, Infrastructure, Cameroon.

**JEL:** I32, J22, O11

---

<sup>1</sup> CES (CNRS and University of Paris I), [marie.gachassin@gmail.com](mailto:marie.gachassin@gmail.com),

<sup>2</sup> CES (CNRS and University of Paris I), [bnajman@univ-paris1.fr](mailto:bnajman@univ-paris1.fr),

<sup>3</sup> The World Bank, [graballand@worldbank.org](mailto:graballand@worldbank.org).

We are grateful to the National Institute of Statistics of Cameroon for having provided the ECAM II data; the French Embassy and in particular Colonel René BASSET for the police stations location. We are also grateful to Mathilde Maurel and Karine Marazyan for their helpful suggestions, and to the participants of the 2009's JD CES-CERDI-LEO.

# 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 \$20bn in infrastructure for financing railway rehabilitation in Nigeria, in Angola as well, and building dams in Ethiopia and other places. The African Development Bank will spend over \$5bn in the next three years, of which over 60% in infrastructure (mainly roads, energy and water). The World Bank spends more than \$5 bn a year in Sub-Saharan Africa (with more than \$1.5 bn in roads). Moreover aid to Africa is planned to double in the near future (G8 commitment in 2008); infrastructure investments will be of crucial importance.

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. Within this context, the rural access index (RAI) (proportion of rural people who live within two kilometers (typically equivalent to a 20-minute walk) of an all-season road<sup>4</sup>) has been set as the most important indicator for the World Bank in its current and future investments in road transport.

The difficulty of implementing robust evaluations techniques on such projects makes these investments are still built on the belief that they will necessarily lead to income generation. However, the massive investments in infrastructure of the previous decades did not provide the promised results. This ineluctability has thus to be questioned. Our paper therefore addresses the relevance of a "one-size-fits-all" approach for roads investments in Africa as we believe that investing uniformly may have a lower impact on poverty than expected.

Literature on the poverty impact of roads is relatively abundant. Poverty is generally modeled as a direct function of isolation and the impact is usually 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

---

<sup>4</sup> 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.

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 Bakht, Khandker 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. 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.

However such methodologies require panel data that are often hard to obtain. On the contrary household surveys for one year are generally more available and their lack of temporal dimension explains the direct modeling of poverty as a function of road access. Robust estimates on cross-section data and such a specification require the use of an instrumental variable strategy. Gibson and Rozelle (2003) provide the only example 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 to be irrelevant 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 but with a particular focus on the third one. We assume that access to roads has a different impact

on labor, depending on the type of activity carried out. We also underline that poverty reduction depends on the kind of activity the household is involved in. In fact some activities may 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 survey ("Deuxième Enquête Camerounaise Auprès des Ménages", ECAM II) collected in 2001, 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. These 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. In fact, 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. Economic growth began to recover from 1994 but the first national household survey (1ère Enquête Auprès des Ménages, ECAM I) 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 does not reach population and more importantly the poorest part of it<sup>5</sup>.

Finally, unlike the majority of cross-section analyses of poverty and road access, our results do not call for huge, widespread and uniform investments in roads to fight against poverty. First 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. Moreover the labor channel proves to be the main driver of road access impact on poverty. We thus perform a

---

<sup>5</sup> The informations are drawn from the report on ECAM II.

simultaneous estimation of our poverty and labor activities equations using our road access indicator as an identifying variable. Considering that diversification outside the agricultural sector is the main driver for poverty reduction in rural Africa, our results contribute to the idea that emphasis on roads investment should be given to locations where non-farming activities could be developed.

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 the empirical issues we have to cope with and the econometric methodology we select. Section 5 first provides estimates of our poverty equations. It then turns to the presentation 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.

### ***2.1. 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 (Bakht, Khandker and Koolwal, 2009).

## ***22. The Market Access Channel***

The greater availability of inputs and their reduced prices due to lower transport costs increase productivity. Bakht, Khandker and Koolwal (2009) estimate the impact of two roads projects in Bangladesh on seven household outcomes<sup>6</sup> 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<sup>7</sup> 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. Bakht, Khandker and Koolwal (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”.

---

<sup>6</sup> 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.

<sup>7</sup> Isolation is here defined as the travel time to nearest city.

### ***23. The Labor Activities Channel***

There is a general consensus, well documented, on the idea that transport infrastructures to reduce poverty by creating employment and new job opportunities (Jacobs and Greaves, 2003; Fan, 2004). First the construction and maintenance of a road are very 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 rehabilitation roads projects in Uganda extended job opportunities in the service sector. In Tanzania, this kind of projects developed job opportunities for non-agricultural employment (Lanjouw, Quizon and Sparrow, 2001). Mu and van de Walle (2007) find similar results: households concerned by the road project are less likely to rely on agriculture or forestry as their main source of revenues and switch to the service sector.

### **3. The Data**

Due a great diversity of climates, reliefs and vegetations (beaches, deserts, mountains, rainforests, and savannas), 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 richer countries in Sub-Saharan Africa. The Cameroonian 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 the Cameroonian agriculture the richer in Central Africa.

The primary sector (agriculture) represented 22% of GDP in 2001; the industry sector was 33% and services represented 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 (WDI 2009).

#### ***31. 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<sup>8</sup>, covering all the dimensions of poverty, from revenues to human capital and 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 50000 for urban, between 10000 and 50000 for semi urban and less than 10000 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

---

<sup>8</sup> 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 and other rural activities, Retrospective non food expenditures of the households, Daily expenditures of the households, Prices

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<sup>9</sup> 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<sup>10</sup> households in rural ones are sampled with the same drawing procedure from the selected clusters. Finally 11533 households from 612 clusters have been sampled and 10992 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 at which distance (in kilometres) they are from the nearest tarred road, and how much time (in minutes) is needed to reach it with their usual mean 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 results do not change. The same questions are asked for primary public schools, health centres and food markets.

### ***32. 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

---

<sup>9</sup> Yaounde and Douala.

<sup>10</sup> Extrême Nord, Ouest and Nord Ouest.

the density of tarred roads in Cameroon is less than one meter<sup>11</sup> of tarred road per squared kilometer of arable land<sup>12</sup>. 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 commercialization centres. The total network under consideration is long of 24 310 kilometres, almost the half of the entire Cameroonian road network. The Road Fund's argument is that thanks to this development strategy "many areas will be disclosed 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.

**Table 1 : Main Perceived Constraints to Reduce Poverty**

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

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<sup>13</sup>.

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

<sup>11</sup> 0.00000679 kilometers

<sup>12</sup> The tarred network measures 4047.8 km (Fonds Routier du Cameroun). Data on arable land come from WDI Online.

<sup>13</sup> A household is considered as poor if its per unit consumption expenditures per year is less than 232,547 CFAF.

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

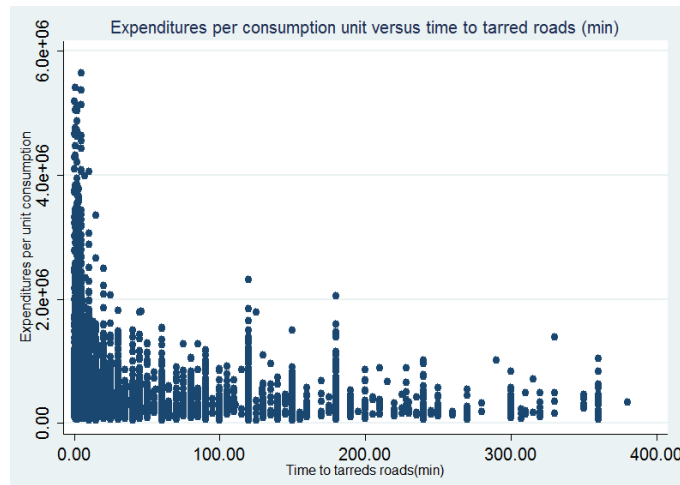
Agro-ecological Zones	Poverty Rates	Activity Rates	Access to the closest tarred road	
			Time (min)	Distance (km)
Yaounde	7.9%	20.7%	4.16	0.57
Douala	8.6%	30.3%	5.39	0.67
Other Cities	17.8%	29.9%	8.6	1.96
Rural Forest	29.0%	35.0%	77.54	38.20
Rural High Plateau	33.6%	40.7%	53.77	14.54
Rural Savannah	40.6%	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 average distance is 1.36 kilometres in urban zones against 25.92 kilometres 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 2 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 area, even though the activity rate is higher poverty is dominant. This is because the main activity is agriculture with a very low revenue and a small productivity.

Figure 1: Expenditures per consumption unit versus time to tarred roads



## 4. The Conceptual Framework

### 4.1. Poverty and Road Access

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  $i^{\text{th}}$  household’s (log) welfare ratio being less than zero<sup>14</sup> from the estimated parameter, and thus the predicted incidence of poverty and the simulated poverty gap and poverty severity measures.

In a first step, we model our poverty indicator as a direct function of our road access variable to test if a direct effect exists outside the channels identified by the literature: access to education and health facilities, access to markets (inputs and output), and access to various types of labor activities. The below equation describes our model:

$$\text{Welfare Ratio} = \alpha \cdot \text{PovertyControls} + \gamma \cdot \text{Roads} + \sum_i \beta_i \cdot \text{Channel}_i + u_{wr}$$

with  $i$ =access to markets, access to human capital facilities, access to labor opportunities.

<sup>14</sup> 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.

Including the *Human Capital*, *Markets* and *Labor* variables deals with the omitted variables issue that otherwise will raise the problem of an upward bias in estimating  $\gamma$ . The access to markets is proxied by the time to reach the closest food market 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. Concerning the labor opportunities channel, we alternatively introduce three types of activities dummies<sup>15</sup> as explanatory variables to control for the household-head labor supply (Kalugina and Najman, 2004); as described in Figure 2.

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 reverse causality issue may also mar our estimates. The localization choices of a household alongside a road and the mean to access roads are highly endogenous decisions respective to the poverty status of the household. Our data do not permit 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.

A last root of endogeneity can be found in a simultaneous determination issue coming from unobservable determinants. The construction of a road is an all but 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 rural phenomena (see Table2), we believe that

---

<sup>15</sup> Details will be provided in the next sub section.

unobserved characteristics can jointly determine wealth and isolation at the regional, district or cluster levels. We deal with this problem by introducing fixed effects at the district level.

Finally we also use an instrumental variable approach to solve for 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<sup>16</sup> of fixed and mobile "Gendarmeries" companies at the province level. Our assumption 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 km<sup>2</sup> 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 of one year (in 2000). The current road access is in fact determined by the previous prevailing network density. A higher 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.

---

<sup>16</sup> For each province: Number of "Gendarmeries" companies over the surface area.

## 42. Labor Activities and Road Access

We consider that labor activities constitute the major channel for road access in terms of poverty reduction<sup>17</sup>. This intuition is besides confirmed by the first estimations results in Table 3.

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 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 2: Labor categories



We first built a binary variable that takes the value 1 if the household-head is active (0 if he is inactive<sup>18</sup>). 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

---

<sup>17</sup> Roads may also have an impact on migrations; it is easier for people to move than to develop some activities on a local basis. Because we lack panel data and good answers about migration decision we were not able to take into account migrations (rural exodus) in our analysis.

<sup>18</sup> Retired, students, unemployed, disabled, other inactive.

rural communities and especially the rural poor are directly or indirectly dependent on agriculture through farming, food processing, fishing, forestry, and trade." Cameroon fits this overview since the agricultural sector represented 61% of total employment in 2001 (WDI, 2009), 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 agriculture)<sup>19</sup>. 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.

Selection bias issue directly arises from this sequential definition of activities categories. Before choosing between the agricultural sector and another one, the individual (here the household-head) has to first enter the labor market to become active. The inactive part of the population is thus *de facto* excluded from the sample. A double-selection bias is potentially at work in the sample of household-heads that are mainly involved in the agricultural sector: such an individual has in fact to first enter the labor market (no observations for the inactives) and then to choose the farming sector (no observations for the non agricultural sector). We are aware of these issues and deal with in our simultaneous estimates.

---

<sup>19</sup>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.

### 43. Simultaneous Equations

Our first intuition that road access *per se* does not have a direct impact on consumption expenditures at the household level is confirmed by the estimates results presented in Table 3. The impact is only indirect and what matters is the facility or the market the road allows reaching. Controlling for the empirical issues previously highlighted, our first results will demonstrate that this hypothesis holds in the Cameroonian framework (see the next section). In addition we performed estimates on our three labor categories, using a probit model as defined in Wooldridge (2002). These highlight the significant and important influence of road access/isolation on labor opportunities<sup>20</sup>. We then use our road access proxy as an identifying variable<sup>21</sup> to implement a three-stage estimation of the following system of simultaneous equations:

$$\begin{aligned}\text{Welfare Ratio} &= \alpha_{wr}.Z + \beta_{wr}.Z_{wr} + \gamma_{wr}.\text{Labor} + u_{wr} \\ \text{Labor} &= \alpha_l.z + \beta_l.z_l + \gamma_l.\text{Roads} + u_l\end{aligned}$$

where  $E(u_{wr} | exog) = E(u_l | exog) = 0$  and *exog* contains all variables other than *Welfare Ratio*, *Labor* and *Roads*. We estimate this model through Three-Stage Least-Squares. This generalizes the Two-Stage Least-Squares method to take account of the correlations between equations in the same way that Seemingly Unrelated Regression (SUR) generalizes Ordinary-Least-Squares.

We perform estimations of this model for each *Labor* variable, using external instruments defined in the previous section to deal with the potential endogeneity of our road access indicator due to the endogenous nature of roads placement. Once again, 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 labor activities is only through the effect of isolation at the household level.

To deal with the selection bias issue we highlighted in Section 42, we follow Wooldridge (2002). The selection problem can be modeled as follows:

---

<sup>20</sup> Not reported here due to space considerations; available on request.

<sup>21</sup> We also use a set a household-head's characteristics as identifying variables (gender, age, instruction level as referred by the vector  $z_l$ ).

$$y_1 = x_1\beta_1 + u_1$$

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

The assumptions are that  $(x, y_2)$  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:

$$E(y_1 | x, y_2) = x_1\beta_1 + E(u_1 | v_2) = x_1\beta_1 + \gamma_1 v_2$$

If  $\gamma_1$  is null, there is no selection problem. If  $\gamma_1$  is different from zero, using iterated expectations on the previous equation, we have:

$$E(y_1 | x, y_2) = x_1\beta_1 + \gamma_1 E(v_2 | x, y_2) = x_1\beta_1 + \gamma_1 h(x, y_2),$$

with  $h(x, y_2) = h(x, 1) = \lambda(x\delta_2)$  the inverse Mills ratio on the selected sample. A consistent estimator of  $\delta_2$  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 6 are made using fixed effects at the district level, but these are not reported due to space consideration.

### 5.1. Welfare Ratio Estimates

The first column presents the estimates of the Welfare Ratio model without any of the control variables for road access nor the fixed effects at the district level that control for unobserved heterogeneity neither the instrumental variable approach. At this step, unobserved heterogeneity is only taken into account through the three rural fixed effects.

#### 5.1.1. Household size, structure and characteristics

The household’s size and composition variables have the expected impacts. Larger households tend to be poorer. Compared to a household whose head lives in couple and has

children, a couple without children has a higher level of consumption; a single parent with children has a lower consumption. The single people dummy may be interpreted according to two competing intuitions. On the one hand, one can argue that a single person does not have to share his/her income with other people, leading to a higher level of consumption. This could explain the positive and significant impact in column (4). On the other hand, being a single person means that there is only one income source in the household; this increases its vulnerability. The negative impact we obtain in column (1) can be interpreted as the illustration of this vulnerability. The average level of instruction in the household has the positive expected effect on consumption expenditures since instruction leads to higher-paid job opportunities. We obtain a similar impact at the cluster level.

### ***512. Road access***

In this first simple specification the road access variable has a negative and highly significant impact on our poverty measure. According to this, isolation is a determinant factor of poverty at the household level: isolated, remote households tend to be poorer in the sense of a lower consumption level. However this significant impact does not resist to the inclusion of our control variables for the channels of road access's impact and the unobserved heterogeneity at a more disaggregated level. Once we take into account the market, human capital and job channels, the time to reach the closest tarred road turns to be insignificant for two over three specifications. The labor activities channel proves to be the main one in our data<sup>22</sup>. Whatever the labor category under consideration, the "usual" determinants of poverty such as the household's characteristics or the human capital controls at the cluster level keep similar impacts both in terms of magnitude and significance.

### ***513. Labor activities***

Households with an active head (column (2)) tend to be richer (to have a higher level of consumption) compared to those with an inactive head. The level of consumption tends to be lower for households whose head is primarily involved in the agricultural sector compared to the non agricultural one (column (3)). The positive coefficient for the "Multi-active" dummy illustrates the widespread consensus that diversification helps to reduce poverty.

---

<sup>22</sup> The time (in hours) to reach the closest primary public school, health centre and food market have no significant impact.

However it cannot be interpreted as a casual effect due to a potential endogeneity issue<sup>23</sup>. It is only an illustration of the negative correlation between poverty and diversification in a broad sense.

Column (4) focuses on the agricultural sector as the primary activity the household-heads are involved in and analyses the differences between single-active and multi-active heads. The level of consumption expenditures of a household headed by a multi-active farmer tends to be higher compared to a single-active farmer-headed one. This result illustrates the assumption that the diversification of income sources helps to reduce poverty thanks to a lower vulnerability to shocks or simply to higher revenues. The control variables at the household and cluster levels exhibit generally similar impacts than previously. Here again the isolation variable has no significant impact on the level of consumption expenditures.

These preliminary results highlight that it is not road availability *per se* that helps to reduce poverty, but the opportunities open up by roads. Among them, labor opportunities and more precisely diversification outside from agriculture that is to say, escaping from the farming sector, prove to be the main tool to increase consumption levels in Cameroon. As road access impact differs depending on the labor activity under consideration, we argue that road access may have a heterogeneous impact on the different labor activities we defined. We thus deepen our analysis with simultaneous estimations of the Welfare ratio and our three labor variables.

---

<sup>23</sup> Indeed one may argue that the incitation to diversify income sources is due to the vulnerability of specialized poor households. Diversification is thus a consequence of poverty. But once the diversification occurs, income raises leading to higher consumption.

**Table 3: Welfare Ratio Estimates**

	(1) <sup>24</sup>	(2)	(3)	(4)
<b>Household's size and composition</b>				
Size	-0.055 (0.002)**	-0.059 (0.002)**	-0.058 (0.003)**	-0.062 (0.004)**
Number above age 60	-0.015 (0.025)	0.001 (0.025)	-0.006 (0.026)	0.004 (0.033)
Dummy, head-HH in Couple without children	0.213 (0.024)**	0.222 (0.024)**	0.221 (0.024)**	0.259 (0.037)**
Dummy, head-HH single parent with children	-0.140 (0.021)**	-0.131 (0.021)**	-0.143 (0.022)**	-0.119 (0.034)**
Dummy, head-HH single people	-0.061 (0.027)*	-0.045 (0.027)	-0.031 (0.029)	0.113 (0.053)*
<b>Household's Characteristics</b>				
Average level of education	0.127 (0.007)**	0.124 (0.007)**	0.124 (0.007)**	0.084 (0.015)**
Time to reach the nearest tarred road in hours	-0.050 (0.008)**	0.024 (0.035)	0.029 (0.035)	0.010 (0.059)
<b>Channels controls</b>				
Dummy, HH-head active		0.125 (0.024)**		
Dummy, HH-head agriculture			-0.198 (0.021)**	
Dummy, multi-active			0.042 (0.017)*	
Dummy, HH-head agriculture multi-active				0.097 (0.022)**
Time to reach the nearest primary school in hours		-0.014 (0.021)	-0.012 (0.022)	0.018 (0.029)
Time to reach the nearest health center in hours		-0.033 (0.022)	-0.013 (0.022)	-0.008 (0.029)
Time to reach the nearest food market in hours		-0.028 (0.021)	-0.021 (0.021)	-0.022 (0.028)
<b>Regional Characteristics</b>				
Part of people affected by malaria	-0.163 (0.076)*	-0.213 (0.094)*	-0.248 (0.099)*	-0.328 (0.175)
Average level of education	0.158 (0.011)**	0.198 (0.017)**	0.190 (0.018)**	0.135 (0.051)**
Dummy, Rural Forest	-0.130 (0.022)**	0.065 (0.077)	0.187 (0.077)*	0.270 (0.213)
Dummy, Rural Savannah	-0.020 (0.025)	-0.315 (0.048)**	-0.204 (0.049)**	-0.068 (0.083)
Dummy, Rural High Plateaux	-0.216 (0.020)**	-0.174 (0.043)**	-0.122 (0.044)**	-0.193 (0.078)*
Constant	0.073 (0.038)	0.082 (0.101)	0.165 (0.103)	0.008 (0.244)
District fixed effects	No	Yes	Yes	Yes
<b>Observations</b>	6922	6240	5669	1976
<b>R Squared</b>	0.35	0.43	0.45	0.36
<b>RSME</b>	0.55	0.52	0.51	0.44
<b>Robust se in parentheses; * p&lt; 5%; ** p&lt; 1%</b>				

<sup>24</sup> (1): No Control; (2): "Active" HH-head Control + IV; (3): "Agriculture" HH-head (versus non agriculture) + IV; (4): "Agriculture Multi-Active" HH-head (versus Agriculture Single-Active) + IV

## ***52. Simultaneous Estimates***

### ***521. “Active” or “Inactive”?***

On the whole, the household’s characteristics, the regional characteristics and the control variables for the channels of road’s impact on poverty, keep comparable impacts than these from Table 2, column (2).

In particular an active-headed household has a higher level of consumption compared to an inactive headed-household but the coefficient is here about six times higher than previously.

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)

**Table 4: Simultaneous Estimates; “Active” versus “Inactive”**

<b>Dependant variable: Welfare Ratio</b>		<b>Dependant variable: "Active" HH-head</b>	
Size	-0.055 (0.003)**	Size	-0.003 (0.001)*
Number above age 60	-0.004 (0.027)	Number above age 60	0.002 (0.013)
HH-head Couple without children (D)	0.254 (0.027)**	HH-head Couple without children (D)	-0.031 (0.013)*
HH-head single parent with children (D)	-0.069 (0.031)*	HH-head single parent with children (D)	-0.032 (0.014)*
HH-head single people (D)	0.032 (0.039)	HH-head single people (D)	-0.083 (0.015)**
Average level of education in the household	0.122 (0.007)**	Time to the nearest tarred road	0.025 (0.009)**
Dummy, HH-head active	0.864 (0.267)**	Male-headed household (D)	-0.051 (0.012)**
Time to the nearest primary school	-0.013 (0.021)	Age	-0.001 (0.000)
Time to the nearest health center	-0.028 (0.018)	Primary instruction (D)	0.011 (0.011)
Time to the nearest food market	-0.025 (0.016)	Secondary (1st cycle) instruction (D)	0.002 (0.013)
Part of people affected by malaria in the cluster	-0.221 (0.098)*	Secondary (2nd cycle) instruction (D)	0.052 (0.014)**
Average level of education in the cluster	0.189 (0.016)**	Tertiary education (D)	0.088 (0.015)**
Rural Forest	-0.015 (0.086)	Rural Forest	0.105 (0.040)**
Rural Savannah	-0.325 (0.049)**	Rural Savannah	0.025 (0.025)
Rural High Plateaux	-0.211 (0.047)**	Rural High Plateaux	0.057 (0.022)**
Constant	-0.584 (0.266)*	Constant	0.953 (0.055)**
Observations	5838	Observations	5838
R Squared	0.3460	R Squared	0.0661
RMSE	0.551	RMSE	0.271

(robust se); \*: p<5%; \*\*: p<1%

### 522. “Agriculture” or “Non Agriculture”?

Here again the household’s characteristics, the regional characteristics and the control variables for the channels of road’s impact on poverty, generally keep comparable impacts than these from Table 2, column (3).

There are only three notable differences. First the controls for the access to health and markets turn to be significant determinants of consumption, with the expected positive sign. Second the multi-active dummy loses its significant impact on the household’s level of consumption expenditures.

More important is the robust effect of the “Agriculture” dummy across Table 3 column (2) and Table 5, while the impact is now quite larger. 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” labor activity for Cameroonian households.

The control variables in the labor activity model have quite different impact in Table 5 compared to Table 4. First none of the household structure’ characteristics has a significant impact. As expected, living in rural areas increases the probability of being involved in the farming sector. Age has here a significant impact as well as all the instruction dummies. The probability of working in agriculture decreases further with the level of instruction.

The positive coefficient of the road access indicator highlights the fact that isolated Cameroonian households are stuck in farming subsistence activities. Remoteness from markets leads households to insure food subsistence by their own means since they cannot rely on trade opportunities.

The impact of road access is almost six times higher for this model than for the “Active” one (0.152 against 0.025). For non agriculture activities, a 10% decrease in time to reach the closest tarred road increases consumption expenditures by almost 1.46%.

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<sup>25</sup>, but is only derived from the decision of the main activity, agriculture or not.

---

<sup>25</sup> Coming first from the decision to enter the labor market and then to chose the agricultural sector.

Table 5: Simultaneous Estimates, “Agriculture” (vs “Non Agriculture”)

Dependant variable: Welfare Ratio		Dependant variable: HH-head agriculture	
Size	-0.056 (0.003)**	Size	-0.000 (0.002)
Number above age 60	-0.009 (0.030)	Number above age 60	0.015 (0.023)
HH-head Couple without children (D)	0.237 (0.029)**	HH-head Couple without children (D)	0.004 (0.017)
HH-head single parent with children (D)	-0.072 (0.028)**	HH-head single parent with children (D)	0.019 (0.021)
HH-head single people (D)	0.003 (0.034)	HH-head single people (D)	-0.016 (0.028)
Average level of education in the household	0.107 (0.008)**	Time to the nearest tarred road	0.152 (0.012)**
Dummy, HH-head agriculture	-0.959 (0.121)**	Dummy, HH-head multi-active	-0.013 (0.011)
Dummy, HH-head multi-active	0.032 (0.020)	Male-headed household	0.014 (0.019)
Time to the nearest primary school	0.016 (0.021)	Age	0.002 (0.001)*
Time to the nearest health center	0.053 (0.022)*	Primary instruction	-0.075 (0.014)**
Time to the nearest food market	0.040 (0.017)*	Secondary (1st cycle) instruction	-0.159 (0.018)**
Part of people affected by malaria in the cluster	-0.323 (0.102)**	Secondary (2nd cycle) instruction	-0.239 (0.019)**
Average level of education in the cluster	0.137 (0.022)**	Tertiary education	-0.309 (0.021)**
Rural Forest	0.617 (0.106)**	Rural Forest	0.505 (0.055)**
Rural Savannah	0.274 (0.088)**	Rural Savannah	0.534 (0.033)**
Rural High Plateaux	0.163 (0.062)**	Rural High Plateaux	0.294 (0.032)**
Constant	-0.144 (0.123)	Constant	-0.431 (0.070)**
		Mills	0.139 (0.125)
Observations	5164	Observations	5164
R Squared	0.3124	R Squared	0.5173
RMSE	0.567	RMSE	0.328

(robust se); \*: p<5%; \*\*: p<1%

### ***523. “Agriculture Multi” or “Agriculture Single”?***

In a preliminary version of the paper we used the multi-active dummy as a dependant one to perform similar simultaneous estimates. However neither the impact of this variable on the Welfare Ratio nor the impact of road access on the probability to be multi-active were significant. This may be due to our inability to identify the second activity. More importantly is our belief that diversification our income sources depend on the nature of the main activity. This belief and the huge share of household-heads involved in the farming sector drove the construction of the “Agriculture Multi” versus “Agriculture Single” dummy.

The potential endogeneity bias of the labor category under consideration (see footnote 23) is here solved thanks to the simultaneous estimation in three-least squares.

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.

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<sup>26</sup> 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 has no impact on the consumption level of the households whose heads are primarily involved in agriculture.

This is a very important finding as it highlights the very 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 Weerd 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

---

<sup>26</sup> 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.

activity remains agriculture. Indeed as plot size in Cameroon is limited on average to less than one hectare (Raballand et al., 2009), 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.

Table 6: Simultaneous Estimates, “Agriculture Multi” (vs “Agriculture Single”)

Dependant variable: Welfare Ratio		Dependant variable : Household-HH Agr Multi	
Size	-0.063 (0.004)**	Size	0.009 (0.004)*
Number above age 60	-0.011 (0.034)	Number above age 60	0.045 (0.036)
HH-head Couple without children (D)	0.254 (0.036)**	HH-head Couple without children (D)	0.024 (0.038)
HH-head single parent with children (D)	-0.092 (0.037)*	HH-head single parent with children (D)	-0.034 (0.045)
HH-head single people (D)	0.113 (0.054)*	HH-head single people (D)	-0.087 (0.060)
Average level of education in the household	0.083 (0.015)**	Time to the nearest tarred road	0.109 (0.039)**
Dummy, HH-head agriculture multi-active	0.235 (0.142)	Male-headed household (D)	0.008 (0.047)
Time to the nearest primary school	0.017 (0.022)	Age	0.003 (0.002)
Time to the nearest health center	-0.000 (0.019)	Primary instruction (D)	-0.117 (0.038)**
Time to the nearest food market	-0.017 (0.016)	Secondary (1st cycle) instruction (D)	-0.240 (0.080)**
Part of people affected by malaria in the cluster	-0.354 (0.176)*	Secondary (2nd cycle) instruction (D)	-0.648 (0.179)**
Average level of education in the cluster	0.117 (0.039)**	Tertiary education (D)	-1.015 (0.272)**
Rural Forest	0.275 (0.205)	Rural Forest	1.572 (0.425)**
Rural Savannah	-0.075 (0.080)	Rural Savannah	1.232 (0.322)**
Rural High Plateaux	-0.195 (0.080)*	Rural High Plateaux	0.837 (0.197)**
Constant	-0.109 (0.233)	Constant	-2.534 (0.832)**
		Mills	1.008 (0.258)**
Observations	1855	Observations	1855
R Squared	0.3547	R Squared	0.1501
RMSE	0.431	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. 2009).

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 Weerd 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 main 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.

## **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 drove the previous massive investments in transport infrastructure in Africa but the promised results had 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. However an indirect significant (but small) effect goes through the labor activities channel, which is the main driver for poverty reduction according to our results. These first-step results made it clear that it is not road availability *per se* that helps to reduce poverty, but the opportunities opened by roads, more specifically labor opportunities. The impact of road access remains significant on the sub-sample of household-heads mainly involved in agriculture. Our assumption of a heterogeneous impact of isolation on the different labor activities we defined has been validated by a deeper analysis.

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 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 5).

The simultaneous estimate presented in Table 5 highlights the negative impact of an involvement in the farming sector on the level of consumption expenditures. They also demonstrate 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, while this effect was positive and significant in the last column of Table 3. The use of this binary variable in Table 3 may be damaged by the endogeneity of the multi-activity status but the simultaneous estimate solves for that issue. 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. However 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. Indeed the cumulative non significant impact of road access on consumption through the probability to be a multi-active farmer (Table 6) and the significant impact through the non farming sector (Table 5) highlight that priority should be given to locations where the development of non-farming activities is possible. If such activities cannot be extended, one may expect another and more delayed impact of road access on poverty through its effect on migration. Beegle, De Weerd and Dercon (2008) find that migration to more connected areas is associated with higher consumption growth. Fafchamps and Schilpi (2008) show that a better access of paved roads in source regions reduces migration. However the availability of roads and thus to other areas that may be more connected may induce more internal migration in the form of seasonal or temporary migration. The interaltion between road access and migration has still to be studied in depth.

Finally, the question of roads investments as an efficient reduction poverty 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. Hence road investments apart from high risks of embezzlement are not aimed to reduce poverty.

## References

Bakht, Z., S.R. Khandker and G. B. Koolwal (2009), “The Poverty Impact of Rural Roads: Evidence from Bangladesh”, *Economic Development and Cultural Change*, 57, 685–722.

Barrett, C. B., T. Reardon, and P. Webb (2001), “Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications”, *Food Policy*, 26(4).

Beegle, K., J. De Weerdt, and S. Dercon (2008), “Migration and Economic Mobility in Tanzania: Evidence from a Tracking Survey”, World Bank Policy Research Working Paper 4798.

Block, S., and P. Webb (2001), “The dynamics of livelihoods diversification in post-famine Ethiopia”, *Food Policy*, 26(4).

Davis, A. and P. Njenga (2003), “Drawing the road map to rural poverty reduction”, *Transport Reviews*, 23(2), 217–241.

Deininger, K., and J. Okidi (2002), “Growth and poverty reduction in Uganda, 1992-2000: Panel data evidence”, World Bank, Washington DC and Economic Policy Research Council, Kampala.

Direction de la Statistique et de la Comptabilité Nationale (2002), « Conditions de vie des populations et de la pauvreté au Cameroun en 2001. Rapport principal de l’ECAM II ».

Escobal, J., and C. Ponce (2002), “The Benefits of Rural Roads: Enhancing Income Opportunities for the Rural Poor”, *Grade Working Paper* 40.

Estache, A. (2003), “On Latin America's Infrastructure Privatization and its Distributional Effects,” Washington DC: The World Bank, Mimeo.

Estache, A. (2009), “Lessons from Impact Evaluations of Infrastructure Projects, Program and Policies”, Mimeo.

Fafchamps, M. and F. Schilpi (2008), “Determinants of Choice of Migration Destination”, World Bank Policy Research Working Paper 4728.

Fan, S. (2001), “Infrastructure and Pro-Poor Growth”, Paper prepared for the OECD DACT POVNET Agriculture and Pro-Poor Growth, Helsinki Workshop.

Fan, S., D. Nyange, and N. Rao (2005), “Public Investment and Poverty Reduction in Tanzania: Evidence from Household Survey Data”, International Food Policy Research Institute, DSGD Discussion Paper No. 18.

Fan, S., N. Rao, and X. Zhang (2004), “Public Expenditure, Growth, and Poverty Reduction in Rural Uganda”, International Food Policy Research Institute, DSGD Discussion Paper No. 4.

Fan, S., L. Zhang, and X. Zhang (2002), “Growth, Inequality, and Poverty in Rural China: The Role of Public Investments”, International Food Policy Research Institute, Research Report 125.

Gannon, C., and Z. Liu (1997), Poverty and transport. TWU discussion papers, TWU-30. Washington, DC: World Bank.

Gibson, J., and S. Rozelle (2003), “Poverty and Road Access in Papua New Guinea”, *Economic Development and Cultural Change*, 52(1), 159-185.

Gockowski J., Ndoumbé M. (2004), “The Adoption of Intensive Monocrop Horticulture in Southern Cameroon”, *Agricultural Economics*, 30: 195-202.

Jacobs, G. D., and N. Greaves (2003), “Transport in developing and emerging nations”, *Transport Reviews*, Vol. 23, No. 2, 133-138.

Jacoby, Hanan G, and B. Minten (2008), “On measuring the benefits of lower transport costs”, *Journal of Development Economics*.

Jalan, I., and M. Ravallion (2002), “Geographic Poverty Traps? A Micro Model of Consumption Growth in Rural China,” *Journal of Applied Econometrics*, 17(4), 329-346.

Kalugina E. and Najman B. (2004), “Labor and Poverty in Russia: Monetary Evaluation and Self rated Perceptions”, (in French), *Economie et Statistique*, 367 (February), 83-100.

Lanjouw, P., J. Quizon and R. Sparrow (2001), “Non-agricultural earnings in peri-urban areas of Tanzania: evidence from household survey data”, *Food Policy*, 26(4).

Lukanu G., Green M., Worth S. (2007), “The influence of smallholder labor demand on cultivation of cash crops in northern Mozambique”, *Development Southern Africa*, 24(4).

Minten, B., and D. Stifel (2008), “Isolation and agricultural productivity”, *Agricultural Economics* 39, 1-15.

Mu, R., and D. van de Walle (2007), “Rural Roads and Poor Area Development in Vietnam”, World Bank Policy Research Working Paper 4340.

Raballand, G., Macchi, P., Merotto, D. and Petracco, C. (2009), “Revising the Roads Investment Strategy in Rural Areas -- An Application for Uganda”, World Bank Policy Research Working Paper 5036.

Raballand, G., Kemtsop, G., Taniform, P. and Gachassin, M. (2009) “Revising the Roads Investment Strategy in Rural Areas: An Application for Cameroon”.

Smith, D.R., A. Gordon, K. Meadows, and K. Zwick (2001), “Livelihood diversification in Uganda: patterns and determinants of change across two rural districts”, *Food Policy*, 26(4).

Van de Walle, D. (2009), “Impact evaluation of rural road projects”, *Journal of Development Effectiveness*, 1(1), 15-36.

Wooldridge, J. M. (2002), "Econometric Analysis of Cross Section and Panel Data", The MIT Press, Cambridge.

World Bank (2009), *Africa Development Indicators*, Washington DC

World Bank (2009), *World Development Indicators*, Washington DC

# Appendix

**Table 8: Summary Statistics**

	Obs	Mean	Std. Dev.	Min	Max
Welfare Ratio	10991	.4867298	.7136692	-2.425216	4.621913
<b>Household's size and composition</b>					
Size	10991	5.134929	3.518971	1	38
Number above age 60	10991	.2551178	.5485235	0	6
Dummy, HH-head in Couple with children <sup>A</sup>	10991	.5549995	.4969885	0	1
Dummy, HH-head in Couple without children	10991	.1140024	.3178286	0	1
Dummy, HH-head single parent with children	10991	.149304	.3564041	0	1
Dummy, HH-head single people	10991	.1815121	.3854595	0	1
<b>Household's Characteristics</b>					
Average level of education	8727	2.670905	1.317237	1	7
Time to reach the nearest tarred road	10319	.2111728	.4081593	0	13.36667
<b>Household-Head's Characteristics</b>					
Dummy , Male-headed household	10991	1.243927	.4294687	1	2
Age	10991	42.92412	15.06109	13	99
Dummy , No instruction <sup>A</sup>	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
<b>Channels controls</b>					
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
<b>Regional Characteristics</b>					
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 <sup>A</sup>	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
<b>Instrumental Variables</b>					
Tarred Road Density	10991	.0136201	.0075429	.0007403	.0293937
"Gendarmerie" Density	10991	.000199	.0001423	.0000275	.0005046

<sup>A</sup>: Reference Group