Road Safety and Economic Development in Cameroon: An Analysis of the Kuznets Curve

[1]Nodem Meli Clement[*], [2]Marie Louise Simone Nyonkwe Ngo Ndjem, [3]Douanla Meli Steve

[1,2,3]Cities and Rural Areas Research Laboratory, National Institute of Cartography, Ministry of Scientific Research and Innovation, Faculty of Economics and Management, University of Yaoundé

Abstract

This article analyses the situation of road safety in Cameroon and its relationship with the country's level of economic development. The approach of Kuznets (1955) is applied to road accidents in Cameroon over a period from 1977 to 2016. The article identifies a Kuznets relationship for road accidents. The results of the analysis show that there is an inverted U-shaped relationship between road accidents and GDP per capita in Cameroon. The results of the analysis show that there is an inverted U-shaped relationship between road accidents and GDP per capita in Cameroon. Precisely the improvement of living conditions has first of all a negative impact on road safety up to a certain point called the inflection point which corresponds to a growth rate of GDP per capita between 7 and 8%, from this point on the improvement of living conditions positively influences road safety.

Keywords: Road Insecurity, Economic Development, Kuznets Curve, Cameroon.

1. Introduction

The various sectors of the economy in general and the transport sector in particular are undergoing a modernization process characterized today by increasingly advanced mechanization. But despite these various innovations, road traffic is experiencing an exponential growth in the number of traffic accidents. According to a study published by [1], traffic accidents caused the deaths of about 1,170,694 people worldwide and of all deaths, 1,029,037 or 87.9% occurred in low-income countries and 12.1% in high-income countries. Both developed and developing countries are affected by road accidents. For example, in developed countries, studies focus on the crash cost aspects associated with loss [2], human cost [3] and property damage [4].

Cameroon is no exception to this reality. Indeed, between 2009 and 2013, the average annual number of road accidents, regardless of the type of accident (fatal, material and human), in Cameroon was about 3247; with about 4794 injuries per year and about 1242 deaths per year [5]. These figures appear to be high given that Cameroon's car park (all types of vehicles) is estimated at about 528,923 cars [6] and the national road network is estimated at about 99,000 km [7]. The resulting conclusion is that road accidents have gradually become a public health problem in Cameroon.

Recent studies have shown a relationship between income per capita and road traffic fatalities ([8]; [9]; [10]; [11]; [12]). All of these studies, although different in terms of the estimation techniques used or the data, conclude that there is an inverted U-shaped relationship between income per capita and road traffic fatalities. This relationship is similar to the Kuznets curve, which suggests a relationship between income per capita and income inequality. The objective of this article is to verify the existence of a Kuznets curve that relates income per capita and road accidents in Cameroon, and to determine the factors associated with this relationship. The article is organized as follows Section 2 provides a theoretical review of the Kuznets curve and its application to road accidents. Section 3 reviews the empirical work while section 4 presents the data and model used. Section 5 discusses the results and conclusions of the study.

2. The Kuznets Curve Theory In Road Accident Analysis

In his article, [13] examined the influence of economic growth on income inequality. Kuznets collected data on income inequality and economic growth in three developed countries: the United States of America, the

United Kingdom and Germany. On the basis of the data collected, he describes the evolution of inequality and growth in these three countries. He concludes that there is a relationship between economic growth and income inequality. According to Kuznets, the mechanism that describes the role of growth on income inequality is industrialization. The result of the first stage of this transition, when the majority of the population is still employed in the relatively poor agricultural sector, then some workers migrate to the richer city and are employed in the industrial sector is the growth of inequality.   However, when the majority of workers move to the city and only a small part of the population remains in agriculture, inequalities are reduced. Income distribution becomes more unequal in the early stages of income growth, but eventually returns to greater equality as growth continues. This change in the relationship between income per capita and income inequality observed empirically can be represented by an inverted U-shaped curve known as the Kuznets curve, for which Simon Kuznets was awarded the Nobel Prize in Economics in 1971
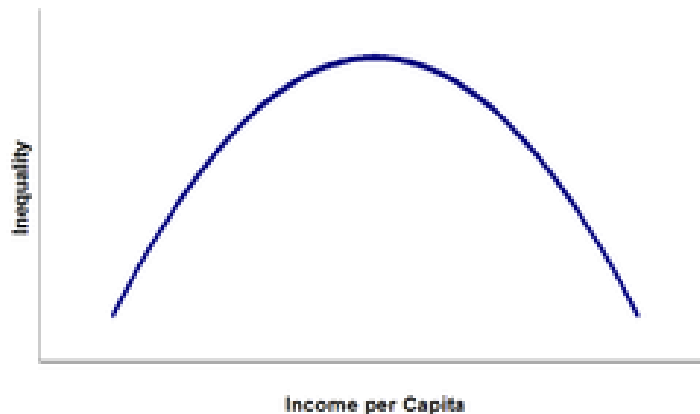

Figure1: Kuznets curve

In 1991 the Kuznets curve took on a new existence. It is used to describe the relationship between environmental quality and GDP per capita in time and space. Economic studies using environmental data from developed countries have been able to show that the more a country developed, the more its quality of life deteriorated and then improved. Specifically, it has been shown that the level of environmental degradation by certain pollutants and income per capita are related to each other forming an inverted U-curve like the Kuznets curve. The logic of the EKC in pre-industrial economies characterized by low levels of income per capita and where economic activity is subsistence farming, environmental conditions are relatively unaffected by economic activity. But as the economy becomes more industrialized and developed, environmental damage increases due to greater use of natural resources and high pollutant emissions, with priority being given to production at the expense of the environment. However, as growth continues there is an increase in people's expectations for clean water; improved air quality and cleaner habitats. In other words, environmental issues become a priority over production. During the post-industrial phase in these economies, cleaner production techniques generally based on information and services are increasingly used to protect environmental quality ([14]; [15]).
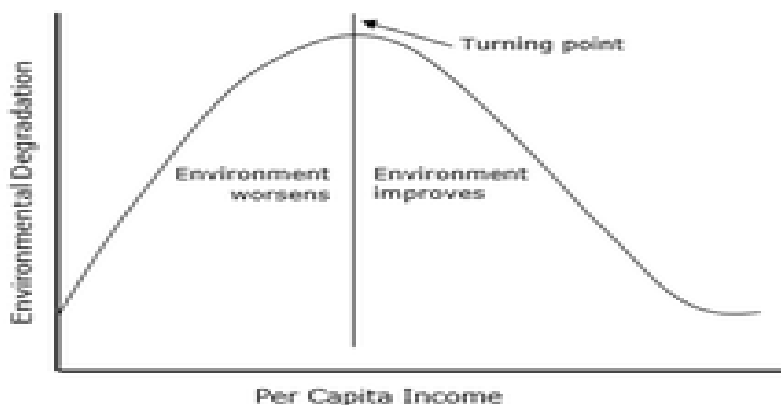

Figure 2: Environmental curve of Kuznets

Recent studies have shown an inverted U-shaped relationship between GDP per capita and the number of road deaths. In other words, an increase in revenue levels is initially associated with an increase in road fatalities, but decreases once revenue levels exceed a threshold. Three theoretical explanations supporting the EKC hypothesis have been identified in the literature. These are: the scale of economic activity; changes in the composition of economic activity; and increased demand for environmental quality (road safety) as incomes rise ([16]; [17]). Increased income has two effects on the relationship between economic growth and road mortality. The first effect is called the scale effect. Indeed, economic growth generally translates into increased demand for transport services [8]. Previous studies have shown that the main factor in the growth of road crashes is the increase in the number of vehicles per capita ([9]; [11]). The second effect is known as substitution effect, which refers to the shift from walking, which represents a high level of exposure to road mortality, to driving, which represents a low level of exposure [18]. At higher income levels, when the number of vehicles increases, this leads to a reduction in the overall risk of death.

Efforts to reduce road safety may have been one of the driving forces behind the decrease in road fatalities. On the demand side, low-income people are less able to invest in road safety, even though there is a perceived need and demand for improved road safety. They are more concerned about other public health risks and material needs. However, as income levels rise, there is an increased demand for safety, allowing more road users to switch to safer modes of transport (e.g. from motorcycles to cars). On the supply side, at low income levels, societies are less able to devote resources to building the social institutions needed to regulate road safety policy. Once the economy has grown sufficiently, higher income levels can increase public demand for the implementation of road safety policies aimed at reducing road crashes and increasing safety (such as motorcycle helmet and seatbelt laws).

3. Empirical Review of Work Verifying the Existence of a Kuznets Curve for Road Accidents

[9] Determined the impact of economic growth on the rate of injury and property crashes on different road users in a sample of 44 countries in 2005. They considered that early increases and decreases in road mortality and injury crash rates are related to the level of national income. [7] noted that the increase in fatalities and injuries is related to growth in low income countries, whereas the increase in income per capita in rich countries appears to reduce the number of fatalities and injuries. At an income level of between $1,500 and $8,000, growth does not lead to additional fatalities. This is due to the ability of developed countries to improve road safety management. [8] studied the relationship between growth and traffic fatalities using data from industrialized countries over the period 1962 to 1990. They found that the relationship between growth and fatalities is non-linear. Growth leads to an increase in fatalities and then there is a decrease in the number of deaths per accident. The inflection point is between 2600 and 3600. For [8] using panel data from 88 countries over a period from 196 to 1999 they showed that the income per capita level at which fatalities decrease is $8600.

In other similar areas of research [19] have studied how corruption in a country affects income per capita and fatalities using a negative binomial fixed-effects model. They found an inverted U-shaped relationship of fatalities. The results also reveal that after controlling for other variables, fatalities decrease significantly with the level of public sector corruption. The evolution of the level of corruption is analyzed and presented as one of the main sources of the Kuznets curve. In another study, [20] verify the effect of wealth distribution on the relationship between the evolution of fatal accidents and the level of income per capita by using the GINI index as an indicator of income inequality. They found that the road death rate is positively related to income inequality [21], on a study in India, demonstrated an inverted U-shaped relationship between fatalities and growth using time series data. [22], using data from Lithuania for the period 1971-2005, found an inverted U-shaped trend in road deaths for the 0-19 age group with a peak around the year 1991

4. Research Methodology

4.1 The data

The database here is from the World Bank and consists of 40 observations over a period from 1977 to 2016 in Cameroon. The variable RF represents the road accident rate, GDPCR measures the growth rate of

income per capita. The variable UnR is the unemployment rate, InfR is the inflation rate, PGR is the population growth rate and FATR is the growth rate of mortality in Cameroon.

Table 1: Descriptive statistics of variables

Variable	Obs	Mean	Std Dev	Min	Max
RF	40	20.21	0.665	18.85	21.39
GDPCR	40	6.132	8.880	-9.900	25.18
GDPRCR2	40	114.5	173.9	0.00367	634.1
UnR	40	37.18	14.21	18.68	79.80
InfR	40	5.519	6.802	-3.207	35.09
PGR	40	4.429	0.738	3.709	5.622
FATR	40	14.10	1.853	10.08	16.75

4.2 Justification and choice of model

To verify the relationship between income per capita and road accidents in Cameroon, the article proposes the following equation which translates a quadratic relationship of the Kuznets curve [23]. We therefore have this equation:

$$RF = \beta_0 + \beta_1 GDPCR + \beta_2 GDPCR^2 + \beta_3 UnR + \beta_4 InfR + \beta_5 PGR + \beta_6 FATR + \mu \ \textbf{(1)}$$

Where β r represent the parameters to be estimated and μ the model error term. Equation **(1)** will be estimated and from the perspective of the existence of a Kuznets curve the relationship that will be tested is that between the road accident rate (RF) and the growth rate of income per capita (GDPCR). It is therefore a question of studying the variation $\dfrac{\delta RF}{\delta GDPCR}$ where β_1 where must be positive and β_2 is negative. In other words, the second derivative of RF in relation to GDPCR must be negative. This second derivative is equal to $2\beta_2$ so we have:

$$\frac{\delta RF}{\delta GDPCR} = \beta_1 + 2\beta_2 GDPCR \ \textbf{(2)}$$

At the point where the road accident rate becomes at its maximum, considered as the inflection point we have:

$$\beta_1 + \beta_2 GDPCR = 0 \ \ \textbf{(3)}$$

The growth rate of income per capita corresponding to this point will therefore be equal to:
$$GDPCR = -\beta_1 / 2\beta_2 \ \textbf{(4)}$$

This will give a positive value that will show an increase in per capita income that will lead to a decrease in the accident rate, thus determining a positive income level. To verify that this is a maximum point, the second derivative must be negative.

5. The Results

Table 2 presents the regression results for equation 1, noting that the coefficients are significant and the probability of the statistical F indicates that the model is significant overall.

Table 2: Model (1) estimation results

VARIABLES	RF
GDPCR	0.0209***
	(0.00596)
GDPCR2	-0.00133***
	(0.000340)
UnR	0.0117***
	(0.00246)
InfR	-0.0157***
	(0.00483)
PGR	0.109
	(0.0661)
FATR	-0.312***
	(0.0205)
Constant	23.81***
	(0.300)
Observations	40
R-squared	0.949

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

According to the hypotheses supported by the Kuznets curve, β_1 the coefficient is positive and the coefficient β_2 the coefficient is negative, which highlights the existence of an inverted U-shaped relationship between the road accident rate in Cameroon and the growth rate of income per capita. The Kuznets curve is therefore verified in the case of Cameroon. Analysis of the effect of the growth rate on the accident rate in Cameroon shows that the inflection point is approximately between 7 and 8%, i.e. the rate corresponding to the level of per capita income at which per capita income will have a favorable influence on the number of accidents. Adjusting the relationship between the road accident rate and the growth rate of per capita income gives an inverted U curve.

The results suggest that per capita income is the cause of road safety in the early stages of a country's development. In other words, the increase in per capita income leads to an increase in the level of motorization and therefore of road traffic. This simultaneous increase in the number of vehicles and the level of road traffic has a positive influence on road accidents. Above a certain growth threshold, the government has sufficient means to implement road safety measures. The implementation of such measures only reflects the individual and collective will of households and the State to reduce the number of road accidents. These sets of measures then result in a decrease in the number of accidents despite a continuous increase in per capita income. Ultimately, the improvement in the country's living conditions makes it possible to reduce the number of road accidents above a certain threshold.

6. Conclusion

The objective of this paper was to test the existence of a Kuznets curve that relates road accidents to per capita income. The theoretical analysis and reports on numerous studies that demonstrate the existence of an inverted U-shaped relationship between road crash fatalities and the level of per capita income. These studies are based on the Kuznets curve, which describes the evolution of income inequality and growth in countries. The study will test the existence of the Kuznets curve using a quadratic relationship that will be estimated with annual data covering a 40-year period from 1977 to 2016. The results of the study of the relationship between per capita income and road accidents in Cameroon using the Kuznets curve revealed the existence of an inverted U-shaped relationship. The adjustment of the Kuznets curve made it possible to determine an inflection point between 7 and 8% of the growth rate of per capita income. The results of the adjustment of the relationship between the growth rate of per capita income and the accident rate in the study show that Cameroon is entering the second phase of the curve, i.e. the phase where the increase in per capita income contributes to the decrease in road accidents. This result is due to the action of public authorities in favor of road safety

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