

Effects of the Road Network on Regional Economic Development in Burkina Faso

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Abstract

This article assesses the effects of the road network allocation on regional economic development in Burkina Faso. Having completed three (03) estimates from the generalized method of moments (GMM) in system on a panel of 13 regions on the period from 2006 to 2013, the results show that the road network is a determinant factor of regional commodity production in Burkina Faso and this, through its positive effects on productivity on productive capital and labour. In addition, it revealed that asphalt roads admit more positive effects on commodity production, on productive capital and labour productivity than untarred roads. Regarding the last, they contribute positively and weakly to regional commodity production and in labour productivity. However, this category does not have positive effects on labour productivity. Thus, a policy of strengthening their length and quality is necessary in order to benefit from all the benefits of regional roads.

Keywords: Regional economic development, road network, effects, Burkina Faso.

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1. Introduction

Numerous studies emphasize the importance of a better regional distribution of road infrastructure to ensure the connection of regions and strengthen the productivity of the economy (Kuroda and al., 2007). Thus, the question of the contribution of transport infrastructure in general and road infrastructure in particular has been the subject of several studies since the work of Smith (1776) and Meade (1952) and therefore, it appears that the road capital is a key instrument for promoting economic growth. In this regard, the economic models relating to the productive role of expenditure on public infrastructure in general and expenditure on road infrastructure in particular in economic growth have as their starting point in the endogenous growth model. In this context, the role of road infrastructure in promoting economies stems from the analysis of the determinants of economic growth (Aschauer, 1989a and 1989b; Barro, 1990; Barro and Sala-I-Martin, 1996).

Other approaches have highlighted the poor economic and spatial distribution of public spending on infrastructure transport (Droin 1991; Mody and Reinfeld, 1995; Barro, 1997; Alesina. et al (2005) and OCDE (2008). To these authors, investment in transport infrastructure must respond to progressive development and guarantee optimal spatial distribution since, beyond an investment threshold, it is neither financially nor economically profitable to anticipate the future. On this subject, if there are many works in developed countries, in the developing ones, they are still limited.

Concerning South Sahara African countries, empirical studies generally amount to the evaluation of direct and indirect effects of public infrastructure spending on economic growth (Dumont and Mesplesomps, 2000; Sirpe, 2003; Agbor and Taiwo, 2014; Sigue, 2018). However, none of this work allows us to say whether, in general, the regional allocation of road infrastructures contributes to explain economic development and regional interdependence.

This is the reason why this article aims to assess the effects of the disparity in the regional allocation to the road network on the economic development of regions in Burkina Faso. This choice is justified by the fact that in Burkina Faso, the road network has experienced a slight increase over the past ten years, but presents a disparity in its spatial distribution. More specifically, the first step is to estimate the effects of the regional road network on the Gross Domestic Product (GDP) of the regions. Secondly, it comes to measuring the impact of the road network area on productivity of the productive capital and labour.

2. Analysis methodology

With reference to the objectives of the article, the endogenous growth model of Barro (1990) inspires the global empirical linear model adopted. This model considers transport infrastructure as a factor of production in the same way as productive capital and labour. In addition to the traditional factors of capital and labour, road capital is introduced into the model as a flow of public expenditure and then regarded as a public good.

This work falls within the framework of the theory of endogenous growth, which to a certain extent, makes it possible to explain the mechanism of transmission of public expenditure on the economy. In this regard, expenditure on road infrastructure occupies an important place and considered as a determining instrument of economic growth.

1.1. Specification of theoretical models

Effect of road capital on regional market production

Just as Fritsch (2001) has shown that the departmental road network positively influences regional production in France, Sirpe and Sigue (2019) have also been able to establish within the framework of endogenous growth theory, a unidirectional causality ranging from spending on public infrastructure towards economic growth in Burkina Faso. Thus, agreeing with these authors, it can be considered that for the case of Burkina Faso, spending on road infrastructure is, in addition to private factors, an important factor for market production. From there, we consider that the regional production levels are relative to the one hand regional endowments in productive capital and labour and on the other hand, to the regional road network. This consideration allows us to say that when the private factors are equal between two regions and that the latter have different endowments in road capital, they will have different levels of development. So, consider the following regional production function:

$$Y = f(K, L, R_r) \tag{1}$$

With Y regional market K production, the region's productive capital, L the level of employment and R_r the regional allocation to the road network. It is important to specify that the endowment in road network be broken in paved roads (RR) and (RT) earth roads in order to highlight their contributions to regional production. By taking the logarithm of the production function above, we obtain the following linear econometric model:

$$\ln(Y) = \beta_0 + \beta_1 \ln(K) + \beta_2 \ln(L) + \beta_3 \ln(R_r) + \varepsilon \tag{2}$$

In the equation (2), $\beta_0, \beta_1, \beta_2$ et β_3 respectively represent the elasticities of production with respect to productive capital, labor, the road network and ε error terms.

In the economic literature, it is widely recognized that the road network affects economic growth, thanks in particular to its positive impact on the productivity of capital and labour factors in the long term (Meade, 1952; Aschauer, 1989a and 1989b; Barro, 1990; Barro and Sala-i-Martin; Kopp, 2007). Thus, it is imperative to take into account these two aspects to better understand the transmission mechanisms of the effects of road network on regional economic growth.

Effect of the road network on the productivity of private factors

The effect of the road network on the productivity of productive capital and labour can be measured by reformulating the equation (2). That is $\frac{Y}{K}$ the productivity of productive capital and $\frac{Y}{L}$ that of labor.

$\frac{Y}{K} = g(K, L, R_n)$ and $\frac{Y}{L} = h(K, L, R_r)$. The linearized econometric form of these equations gives:

$$\ln\left(\frac{Y}{K}\right) = \alpha_0 + \alpha_1 \ln(K) + \alpha_2 \ln(L) + \alpha_3 \ln(R_r) + \varepsilon \tag{3}$$

$$\ln\left(\frac{Y}{L}\right) = \varphi_0 + \varphi_1 \ln(K) + \varphi_2 \ln(L) + \varphi_3 \ln(R_r) + \varepsilon \tag{4}$$

The equations (3) and (4) represent the equations of productivity of productive capital and labour respectively.

1.2. Data and variables

The data used in this article are a panel of thirteen (13) regions of Burkina Faso over the period from 2006 to 2013. The availability of data on the regional road network has guided the choice of this period. Data on the work, asphalt roads and untarred roads are obtained at the National Institute of the Statistics and Demography (INSD) through statistical yearbooks from 2008, 2015, 2017 Burkina Faso. The productive capital was made from the Gross Fixed Capital Formation (GFCF) Weighted with the economic weight of each region in the country's GDP. The variables used in this work are listed in Table 1.

Table 1 : Présentation of the variables

Definition of variables	Construction
Regional market GDP	Logarithm of market GDP of regions
Productivity of productive capital	It is obtained as a ratio of market GDP to productive capital. It is taken in logarithm
Labor productivity	It is obtained in relation to market GDP at work. It is taken as a logarithm.
Productive capital	FBCF logarithm for each region
Labour	Logarithm of the work of each region
Paved roads (asphalt roads)	Logarithm of the linear paved road regions
Earth roads (untarred road)	Logarithm of the linear of the earth roads of the regions

Source: constructed by the authors.

1.3. Economic Characteristics of the regions in 2013

The following table 2 concomitantly presents the regional distribution of classified roads, the region's production and the share of paved roads in the region in 2013.

Table 2: economic characteristics of the regions

Regions	Production (in%)	Classified road network (in%)	Asphalted roads (in%)	Share of paved roads in the region (in%)
Mouhoun loop	21.30%	13.62%	9.99%	17.46%
Waterfalls	4.81%	5.83%	3.60%	14.69%
Center	1.46%	2.17%	4.64%	50.90%
Center-East	7.32%	5.95%	6.45%	25.80%
Center-North	5.19%	7.29%	5.49%	17.94%
Midwest	9.18%	10.25%	11.75%	27.28%
Center-South	4.80%	4.52%	5.90%	31.11%
East	8.31%	12.20%	11.31%	22.07%
Hauts-Bassins	17.01%	9.87%	18.01%	43.41%
North	6.84%	7.40%	4.83%	15.55%
Central Plateau	4.42%	4.00%	6.81%	40.52%
Sahel	5.20%	9.73%	3.19%	7.79%
South West	4.16%	7.17%	8.02%	26.62%

Source: author's construction from data of the INSD (2016).

The observation of this table shows that of the thirteen (13) regions, only four are considered potentially productive regions. These are the Boucle du Mouhoun, Hauts-Bassins, Center-Ouest and Eastern regions. These four regions provided 55.8% of the country's production in 2013. Regarding the distribution of classified roads, these regions account for 45.94% of the classified road network on the same date. This percentage is acceptable from a global point of view. On the other hand, the breakdown of regional roads into paved roads and earth roads shows that three regions emerge from the percentage of paved roads in the total of the regional road network. These are the Centre region, Hauts-Bassins and Central Plateau. In these regions, the paved roads occupy respectively 50.90%, 43.41% and 40.52% of the total classified road network of the region. Among these three regions, only the centre has more paved roads in the total of its classified network. As for the other regions, the table shows a clear predominance of earth roads and therefore a low orientation of expenditure on road infrastructure in these areas. The analysis of these in Statistics shows that major urban centres have a high percentage of paved roads in the total of classified roads. For example, in the central region, whose capital is Ouagadougou, the share of paved roads in the region's classified road network was 50.90% in 2013. Yet for the same year, the region produced only 1.46% of the national production. This observation is also valid for the other capitals of the regions. In short, it is clear that in Burkina Faso, the spatial distribution of investments in road infrastructure is most often directed towards urban areas

2. Specification of empirical models and estimation technique

The linear empirical model of this article is based on the framework defined by Blundell and Bond (2000) applied to the equation(2). We, therefore, seek to estimate the relation following:

$$PIB_{i,t} = \beta_1 K_{p_{i,t}} + \beta_2 T_{r_{i,t}} + \beta_3 R_{b_{i,t}} + \beta_4 R_{T_{i,t}} + \gamma_t + \delta_s + \varepsilon_{i,t} \quad (5)$$

In equation (5), γ_t and δ_s respectively represent the specific temporal and regional effects (individual effects), i the individual dimension, t temporal dimension and $\varepsilon_{i,t}$ is the error term. For Blundell and Bond (2000), when the term autoregressive error is incorporated into the term global error, a dynamic relationship is obtained. Thus, the dynamic model of regional market production is reached as follows:

$$PIB_{i,t} = \beta_1 PIB_{i,t-1} + \beta_2 K_{p_{i,t}} + \beta_3 T_{r_{i,t}} + \beta_4 R_{b_{i,t}} + \beta_5 R_{T_{i,t}} + \gamma_t + \delta_s + \varepsilon_{i,t} \quad (6)$$

The dynamic equations of the productivity of labour and capital are obtained as follows:

$$Procap_{it} = \beta_1 Procap_{i,t-1} + \beta_2 K_{p_{i,t}} + \beta_3 T_{r_{i,t}} + \beta_4 R_{b_{i,t}} + \beta_5 R_{T_{i,t}} + \gamma_t + \delta_s + \varepsilon_{i,t} \quad (7)$$

$$Protrav_{it} = \beta_1 Protrav_{i,t-1} + \beta_2 K_{p_{i,t}} + \beta_3 T_{r_{i,t}} + \beta_4 R_{b_{i,t}} + \beta_5 R_{T_{i,t}} + \gamma_t + \delta_s + \varepsilon_{i,t} \quad (8)$$

Equations (7) and (8) respectively represent the dynamic models of the productivity of productive capital and labour.

It is important to note that these models are applied to a panel of 13 regions over a period from 2006 to 2013, i.e. seven (7) years). Since the number of individuals exceeds that of the period, the autoregressive staggered delay approach (ARDL) of Pesaran et al. (1999) which is the recent econometric approach applied to the panel, will not be applied in this case. Therefore, the parameters of these panel models can be estimated using the no fixed effects and no random effects (OLS) method, the fixed effects method (Within, LSDV) and the effects method random (between). However, since the panel is dynamic, standard econometric methods like OLS, the Within method, the between method do not allow to have efficient estimators since they give non-convergent estimators. The method of Anderson and Hsiao (1981 and 1982) is also ineffective insofar as it is based on the use of instrumental variables

and does not take into account the structure of the error terms and does not exploit all the conditions of the moments.

For these the reasons, Arellano and Bover (1995) and Blundell and Bond (1998) have shown that it is better to use an estimator of the method of moments generalized (GMM) in system. Thus, as Kpodar (2007), we use the estimator to estimate elasticities of commodity production, productivity of capital and work productivity in relation to roads asphalt roads and untarred roads. This method makes it possible to provide solutions to the problems of simultaneity bias and to control the specific effects. In addition, it allows circumventing the problem of endogenousness of variables.

But before, it is first necessary to carry out basic preliminary tests. This is the specification model test, unit root, of over-identification Sargan/Hansen, and the autocorrelation test errors of Arellano and Bond.

3. Empirical results Empirical results and discussions of the results

Before presenting the results of the effects of endowment road network on regional economic development in Burkina Faso, we first present results of the standard tests.

The result of the model specification test gave a fisher statistic of $F(12, 86) = 7.27$ and $P\text{-value} = 0.0000$. At the 5% threshold, this empirical evidence makes it possible to reject the null hypothesis of the absence of individual effects. Then, there is homogeneity of the coefficients of the model and this translates that the data support the panel structure. Before the stationarity test, we conducted the interindividual dependence test of Pesaran (2004) which showed the presence of autocorrelation at the threshold of 1%. This made it possible to carry out the stationarity test of the series using the second-generation test of Pesaran (2007). The Table 4 (attached) shows the results test of stationarity. It appears that the variables traded GDP, productive capital and labour are stationary in level while paved roads and untarred roads are stationary in first differences.

Table 3 below summarizes the results of the three estimates.

Table 3: result of GMM system estimates.

Explanatory variables	Variables explained		
	Market GDP	Productivity of productive capital	Labor productivity
GDP delayed	0.208 *** (0.0658)	-	-
Productive capital	0.0432 *** (0.00347)	-1.685 *** (0.297)	-0.0316 ** (0.0116)
Job	-0.0572 (0.0441)	0.313 *** (0.0313)	-0.322 *** (0.00762)
Asphalt road	0.229 ** (0.0903)	0.0302 *** (0.00879)	0.0574 *** (0.00651)
Untarred road	0.0102 *** (0.00253)	0.00971 (0.0118)	0.0179 * (0.00895)
Capital productivity	-	0.294 *** (0.0568)	-
Labor productivity	-	-	0.0599 *** (0.0158)
Number of observations	91	91	91
Number of regions	13	13	13
Arellano - AR bond (1)	1.61 (0.107)	-1.73 (0.083)	1.61 (0.107)
Arellano - AR bond (2)	-0.61 (0.541)	-0.68 (0.496)	-0, 61 (0.541)
Sargan test	10.52 (0.062)	3.44 (0.064)	10.52 (0.064)

Note: All variables are in logs. Sargan's test is associated with the null presence of instrument hypothesis; the AR (1) and AR (2) tests are associated with the hypothesis of absence of autocorrelation of order 1 and 2 ; The values in parentheses are the P-values ; * ** significant at 1% ; ** significant at 5% ; * significant at 10 %.

Source: authors' estimates.

The table shows the results of the three estimates. It should be noted that in the discussion of these results, we will limit ourselves to the variables of interest, namely the paved roads and the earth roads of the regions.

Effect of network road regional on the market production

The results of the regression GMM system of market production show positive influence regional roads (asphalt and soil) on GDP merchant area in Burkina Faso. When considering all the regions, it becomes clear that the regional road network positively affects their market output. However, the asphalt roads are a key instrument in the promotion of the market production. In fact, the elasticity of marketable production compared to asphalt roads

is 0, 23 against 0, 01 for the earth roads. These elasticities reflect an increase of 1% of the linear road paved and unpaved roads improve market output regions respectively 0.23% and 0.01% all things equal elsewhere. In view of this result, it is possible to conclude that road capital stimulates the economic development of regions in Burkina Faso. This result is similar to those of Kopp (2007) and Aschauer (1989a and 1989b) for whom the road capital through its direct and indirect effects admits positive influence on regional development and hence on output macroeconomic of nations. For these authors, this positive impact of roads necessarily goes through their contribution to improving the productivity of private factors.

Effect of the regional road network on the productivity of productive capital and labour

Paved roads at the 1% positively and significantly affect the productivity of productive capital and labour. An increase in the linear of this category of roads by 1% increases all things equal, moreover, the productivity of productive capital by 0.03% and that of labour by 0.06%. Regarding the untarred roads, yet they affect positively productivity 10% threshold in the labour and admit no significant effects on the productivity of productive capital. Two reasons could explain this result. First, there would a minimum level of regional road network endowment from which, the untarred roads admit a positive impact on agricultural productivity, of productive capital. This result indicates that regions in Burkina Faso have probably not yet reached this minimum level. Secondly, this result is explained by the fact that the existing untarred roads are in general and in many cases of poor quality and therefore have a low practicability in any season. According to Sigue (2018), in Burkina Faso, with the exception of paved roads, which are generally in good condition, the other types of roads, namely modern roads, ordinary roads, rural roads of type A and B are generally of poor quality. In addition, the untarred roads can only be used one season in two. In the rainy season, for example, certain regions remain isolated. This situation clearly reflects the weakness or even the absence of maintenance work on these roads which, moreover, are the most frequent compared to paved roads which represent only 23.79% of the classified road network of the country in 2015 (MID and MT, 2011).

In any case, the road network is an important factor in stimulating the economic growth of regions in Burkina Faso. This is not surprising since the roads, when they are in good condition; allow effective interaction between the sphere of production, marketing and consumption.

4. Conclusion

The aim of this article is to assess the effects of the diversity of the road network allocation on regional economic development in Burkina Faso. To this end, we estimated three models. These are dynamic panels of regional market production, the productivity of productive capital and labour productivity.

The results of these estimates showed that the regional road network positively affects regional production in Burkina Faso. This impact is explained by its positive contribution to the productivity of the private factors of market production. Indeed, the productivity of labour and capital are significantly elastic to regional endowments in the road network.

Moreover, it is established that the paved roads improve more the productivity of productive capital and labour and hence of commodity production than untarred roads. Thus, the more the regions are endowed with roads in general and asphalt roads in particular, the higher market production they record.

In the light of these results, the implication of economic policy which emerges is that any provision allowing to have roads in good condition makes it possible to ensure a regional interconnection and thus to increase the market production of the regions thanks in particular to the positive effects on the productivity of private factors.

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Annex

Table 4 : Pesaran stationarity test (2007)

Variables	CPIS *	Differentiation Level	Decision
GDP _r	-1.997	0	Stationary at 5%
K _p	-3.160	0	Stationary at 1%
Tr	-2.099	0	Stationary at 5%
R _b	-2.697	1	Stationary at 5%
R _t	-2.697	1	Stationary at 5%