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Size of Cities and Transport Costs in African Countries of the CFA Franc Zone

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Abstract: The results presented here want to make a contribution in the field of transport. Our purpose is to shed light on the evolution of public transport costs as the size of the city increases. We also try to highlight the role of certain factors that are characteristic of the supply: level of service, vehicle capacity, spatial extension, frequencies, etc. In this article, we show, from a sample of 25 African cities, that it is doubtful that economies will emerge in the operation of urban public transport when the size of cities grows. The growth in operating expenses, more than proportional to the size of the cities, can be explained by both a growth in the unit cost (at the place-kilometer-offered) and the offer to the inhabitant. Large cities (in terms of population) escape the drift of unit charges, but not per capita charges because of a particularly strong supply. The comparison between large cities and small towns suggests that the capacity of the buses in circulation can be a decisive factor in the improvement of productivity. Capacity growth, however, appears to be occurring in very large cities, such as Abidjan or Bamako, whose counterpart may well be @ the lengthening of travel times and distances. These results then raise the question of a divergence between the performance of urban services and the economic efficiency of spaces.

Keywords: Transport Costs, Size of Cities, Africain Countries, CFA Franc Zone

1. Introduction

Since the 1960s, numerous theoretical and empirical works have enriched our knowledge of the costs and benefits attributable to the size of cities. In terms of costs, the problem that dominates is the study of cost trends of urban services, in particular to determine an optimal size of city. As an extension of WEBER's work, ISARD [9]), studies agglomeration economies and describes a bell curve, particularly for transport and education. A phase of economies of size follows a phase of diseconomies. Another approach, RICHARDSON [13], consists in proposing simple analytical forms for various production functions. BAIROCH [2] gives estimates of the optimal size of cities: about 300,000 according to his calculations, while the optimal sizes appearing in his bibliographic review are more dispersed. Finally, it is possible to use the economic calculation to simulate the consequences in terms of the cost-benefit balance of business locations, LESOURNE [11].

In addition, work on the productivity of urban areas, developed in particular by KAUSKAS [10] and EGAL [5], seems to establish higher productivity in large cities. More recently, PRUD'HOMME and ROUSSEAU [12] have measured overproductivity of large cities relative to the rest of the territory and corrected for structural effects of employment. Finally, FUJITA [7] and ABDEL-RAHMAN, AND FUJITA [1] emphasizes the importance of variety economies when the size of the city grows.

A certain disparity thus appears between trends in the productivity of urban services and those of urban areas. The need to take into account the externalities, of which the city is fruitful, is also powerful from all the works mentioned. FAUDRY [6] stresses the need to extend the problem of urbanization costs to social costs. For EGAL [5] and BARRETT [3] the interurban labor market equilibrium is achieved by the costs of transport, pollution and other nuisances, which compensate for the dispersion of wage rates by urban areas. Lastly, HENDERSON [8] emphasize the importance of externalities, while proposes a tax in the Pigouvian logic to reduce the divergence between the social cost and the private cost of localization in a city.

These results invite to go beyond the objective of optimal size of the city and to direct the investigations on the analysis of the urban concentration. It is in particular to seek to identify the logic in which externalities are implemented. Insofar as these relate to interactions between different agents, and thus also between different sectors of urban functioning, analyzes should focus on sectoral studies. Overall results lose much of their relevance and can lead to the production of false ideas. As the above examples suggest, this is especially true for studies of urban productivity, for which expansion to externalities may reveal hidden factors of production.

There are already some results in the transport sector, particularly in urban public transport. Current observation suggests that they are highly dependent on the size of cities, without a prior analysis showing how their productivity is changing. It is often argued that travel length and congestion act as an external source of lost productivity. Conversely, big cities make it possible to develop more productive mass transport. In 1999, a study restricted to surface modes, relates variables of transport supply, attendance and urban characteristics to the size of cities (SSATP, [14). BAIROCH [2] highlights two thresholds of optimal productivity, the first being around 200 000 inhabitants (appearance of a network), the second between 400-600,000 inhabitants (appearance of an underground network). Lastly, TOUNKARA [15] and BONNAFOUS (4) conducted analyzes on medium-sized cities, while also emphasizing temporal elasticities.

The results presented here want to make a contribution in the field of transport. Our purpose is to shed light on the evolution of public transport costs as the size of the city increases. We will also try to highlight the role of certain factors that are characteristic of the supply: level of service, vehicle capacity, spatial extension, frequencies, etc. We are led to distinguish a notion of "size effect" which designates the dependence of a variable describing the public transport system in relation to the size of the cities. This size effect will be studied in cross section and not in time series.

The evolution of the variables of the transport system can not easily be related to the phenomenon of urban growth.

2. Method and Field of Analysis

2.1. The Notion of Economy of Size

With regard to urban public transport, two influences on the unit cost of production can be expected from the increase in the size of the city.

1) On the one hand, a cost variation resulting from a qualitative transformation of production, especially the supply is diversifying (appearance of new modes of transport). The phenomenon is close to the concept of economies of scale, which reflects productivity gains associated with the expansion of the field of activity, the simultaneous production of several goods being more profitable than separate. However, in terms of our field of study these large economies are highly dependent on the size of the city, whereas in the first sense they are not related to the size of the production unit. In particular, they can stem from the sole decision of diversification.
2) On the other hand, economies of scale in the traditional sense. As the size of the city increases, expanding the scale of production on each of the supply segments is likely to affect productivity.

The notion of economies of size is therefore composite. It reflects changes in the unit cost that result from both qualitative and quantitative changes in supply.

2.2. Distinction Operating Costs-Investment Expenses

Particularly in terms of urban public transport, it is difficult to estimate the part of the unit cost of production that is sustainable factors. Historical dimensions (depreciation of sustainable factors), spatial (large cities concentrate more long-term investments), but also institutional (in the sense of allocation procedures) are introduced and difficult to access using empirical resources.

1) In practice, the consumption of sustainable factors are imputed to a production by the filter of a depreciation accounting technique. With regard to urban public transport, these raw accounting data are often missing or uncertain, in particular because of the organizational structures of the service (links between network concessionaires and the organizing authorities).
2) In addition, the nature of the equipment may explain residual use values while accounting depreciation has been carried out. Old investments, including in areas other than transport, may appear as a real natural resource (the case of million-dollar cities in terms of population).
3) Finally, the production of fixed equipment is based on a particular economic logic resulting from strong discontinuities and a presumption of increasing marginal yields. The decision to settle is often tutelary, partly arbitrary, just as cost coverage is, at least in part, socialized. These elements dominate the conditions of use of sustainable factors by current supply and may explain a certain variance in unit investment costs that is not necessarily economic logic.

The costs in sustainable factors thus indicate a strong specificity, which suggests that the problem of economies of size can only validly and practically be developed within the limits of current operating expenses.

The exploitation data that we will use in this article are extracted from the database called "Urban Transport Policy in Sub-Saharan Africa" exploited by the Transport Department of the World Bank with the help of annual surveys of managers.

2.3. An Operative Definition of the City and the Determination of a Sample

The urban phenomenon has uncertain contours by nature. Many spatial delimitations of the city are possible, from the commune to the region. Our object of study leads to favor a specific perimeter in the field of transport: the Urban

Transport Perimeter (UTP). This spatial framework is more relevant because we can admit that UTP membership is a sign of a greater degree of integration of the population into its public transit system, both in terms of its use and its funding. or the sizing of the offer. However, to ensure a certain homogeneity of the comparative transport systems, both on the demand and supply sides, we have excluded from the study the urban units for which the UTP and the agglomeration in the sense of statistical institutes diverge too much. Finally, because of the extreme variety of situations that makes it difficult to seek dependency on urban size, we have selected the two largest cities (in terms of population) of the member states of the CFA franc zone (excluding the Equatorial Guinea where we have retained only the capital for lack of data for the second city). Some of these cities have a public transit system and others have an informal public transit system (see appendix).

2.4. Econometric Technique

In order to observe the influence of city size on the urban transport operating variables, econometric relations were tested. The strong correlation between variables (size with density, length of displacements, etc.) makes uncertain the coefficients obtained from multiple regressions. The best relations were obtained with logarithmic regressions of the form:

$$\text{Log}(X) = e.\text{Log}(H) + b$$

also be $X = k.\ H^e$

where X is an indicator describing the transport system, H, the number of inhabitants of the city, e, the elasticity of the transport indicator at the size of the city, b and k, constants.

The passage through logarithms thus makes it possible to have relations highlighting, in terms of elasticity, the dependence of the indicator X on the size of the city. Moreover, it is known that the hypothesis of homoscedasticity applied to the logarithm of a variable leads to the assumption that the residuals are approximately proportional to the value of the exogenous variable H. This hypothesis seems more satisfactory than the assumption corresponding to linear regressions. which would lead to the assumption that the standard deviation of the It is indeed intuitively satisfying to consider that the events - supposedly random - that account for the variables ignored by the analysis have effects proportional to the size of the cities.

The value of the elasticity, e, can testify to a size effect by means of two tests:

1) if the magnitude is "extensive", such as the amount of the operating expenses or the number of available place-kilometers, a size effect will be observed if e is significantly different from one (the hypothesis H0: e = 1 can be rejected with a low risk of error of the first kind);
2) if the magnitude is "intensive", as is the case of a ratio such as the unit cost or the frequency, it is a significantly different elasticity of zero which will highlight a size effect (the hypothesis H0: e = 0 can be rejected with a low risk of error of the first kind).

2.5. An Analytical Model

Two determining variables guide the analyzes:

1. operating expenses (CH) which make it possible to identify productivity developments;
2. the supply measured in Kilometers-Offered Places (KOP) which can help to illuminate productivity developments.

Around the operating expenses, it is possible to give a first analysis framework by comparing the three following elasticities (with D the number of displacements):

$$CH = k_1.\ H^{eCH} \quad (1)$$

$$KOP = k_2.\ H^{eKOP} \quad (2)$$

$$D = k_3.H^{eD} \quad (3)$$

The comparison of (1) and (2) makes it possible to analyze the evolution of the loads at the PKO with the size of the city. We will talk about productivity efficiency. The comparison of (1) and (3) reflects the evolution of the loads to the realized displacement, which we will designate by a social productivity. Because of the non-storage property of transport production, it is important to know whether potential productivity gains in efficiency benefit society, or if they are definitely dissipated and lost. Finally, starting from the only regression (1), we will define an efficiency productivity (evolution of operating costs to the inhabitant). If the notion of efficiency is applied to the production function, efficiency is a more global objective of the city. In a way, the population variable contains the city's choice of public transportation, the equation (3) of which is the cost counterpart.

Secondly, from the KOP variable, the study of the size elasticities of the descriptive parameters of the supply makes it possible, within the limits of the available data, to identify the factors that could affect productivity.

We can first decompose the production according to the equation KOP = CA * KR, where CA denotes the average capacity of the moving sets and KR, the number of kilometers they perform (Kilometers-vehicles). He then comes the following two relations:

$$CA = k_4.\ H^{e\ CA} \quad (4)$$

$$KR = k_5.\ H^{e\ KR} \quad (5)$$

the elasticities being additive, $e_{PKO} = e_{CA} + e_{KR}$

It is then possible to break down the growth of mileage achieved by public transport vehicles according to a spatial extension represented by the length of lines (denoted L) and an intensive parameter: the increase in the number of vehicles circulating per unit of time and per unit length of the network. This last parameter is analogous to a frequency, we will call it generalized frequency (denoted F). He comes then:

$$L = k_6.H^eL \quad (6)$$

$$F = k_7.H^{eF} \quad (7)$$

with $e_{KR} = e_L + e_F$

Finally, it is possible to relate the spatial extension of the network to the increase in the city's surface area.

(L= L/S.S) to construct a kind of spatial accessibility indicator. However, the L / S ratio only imperfectly reflects the evolution of the spatial coverage by the transport network, because of the concentration of lines. We therefore did not pursue the investigations.

2.6. A Particular Treatment for Major Cities

The urban hierarchy of African cities in the study is characterized by a strong pre-eminence of port cities. Establishing the regressions with the big port cities would lead to a strong orientation of the dependencies, because of the variance brought by the difference in size between the big cities and others, that even taking into account the effect of scale of logarithms.

In addition, it is commonly accepted that the characteristic of big cities goes hand in hand with a singular collective transport system. It is therefore interesting to look for a size effect on a sample of smaller cities, by establishing a set of econometric relationships that form a sort of model of small cities. In a second step, it is possible to observe - with the help of classical linear model prediction techniques - whether large cities fit into the model of small cities.

These methodological considerations strongly guide the presentation of results and analyzes:

1) firstly, we will attempt to characterize a size effect on small towns using data for the year 2000. The consistency of this size effect will have to be tested by inter-temporal comparisons;
2) the data relating to the big cities will then be confronted with the size effect observed on the small towns;

3. A Model of Size Effect on Average Cities

3.1. Results from 2017 Data

The various regressions obtained on the sample considered enable us to draw up Table 1.

Table 1. *Size effect on medium cities.*

Relationship	Indicator	e, estimated élasticity	*Estimated standard deviation*
[1]	Loads	1,27*	0,06
[2]	PKO	1,13*	0,06
[3]	Travel	1,15*	0,08
[1']	Charges / PKO	0,16+	0,07
[1"]	Charges / travel	0,08	0,05
[4]	capacities	0,04	0,05
[5]	Km-vehicles	1,08	0,06
[6]	Length	0,84*	0,09
[7]	Frequency	0,24+	0,08

Source: Author

* indicates a significantly different elasticity of 1 at the 5% threshold

\+ indicates a significantly different elasticity of 0 at the threshold of 5%.

The productivity

Transport supply and demand grow more than proportionally to city size, with statistically indistinguishable elasticities and very close values (relations [2] and [3]). The parallelism between the increase in supply and demand is somewhat surprising. One could legitimately assume that the average length of travel increases with the size of the city. All things being equal, more PKO would be needed to meet this demand. It must therefore be assumed that any increase in distances traveled is offset by an increase in the "filling" of vehicles. We are not able to verify this hypothesis.

Depending on the size of the city, we observe that the loads progress faster than the production (relations [1] and [2]). A drift of unit loads at the PKO can be evidenced with a significantly different elasticity of zero (relation [1']). It is therefore possible to say that there are no major economies in the operation of public transport, and even that a downward trend in productivity efficiency can be observed.

On the other hand, it is not possible to isolate a statistically significant size effect on social productivity (relation [1"]).

The descriptive factors of the supply

First, a relatively counterintuitive finding is required. It is not possible to highlight a significant growth in vehicle capacity with the increase in the size of cities (relation [4]). This result is however dependent on our measuring instrument (the elasticity of 0.04 is of the same order of magnitude as the "noise" with a standard deviation of 0.05).

If, despite everything, there is a size effect, it is low: the elasticity corresponds to a growth of less than 10% of the online capacities for a tenfold increase of the population. Productivity gains can probably be expected, but they appear to be insufficient, other factors of counter-productivity are at work, as evidenced by the growth of unit cost at the PKO with the size of the city.

With an elasticity of 1.08 (relation [5]), the growth of vehicle-kilometers is slightly stronger than that of the population, but the assumption of elasticity equal to one can only be rejected with a risk about 10%. The size effect is therefore not, here again, clearly highlighted.

However, this lack of a size effect in terms of capacity can correspond to a significant evolution of the transport supply in terms of spatial extension and frequencies. Relationships [6] and [7] make it possible to judge.

1) The length of the network grows less than the population. The elasticity (0.84) is significantly different from one (with a risk of less than 4%). For a tenfold increase in the population, the length of the network would be multiplied by a factor of less than seven.
2) A significant increase in the generalized frequency can also be observed. Elasticity (0.24) is significantly different from zero (risk less than 1.5 per thousand). A tenfold increase in the size of the city would correspond to a growth of about 75% of the generalized frequency.

3.2. Inter-Temporal Validation of the Size Effect

Comparing the results obtained for 2017 to other years follows a methodological imperative. Obtained in cross-section and thus reflections of a totally singular situation, the results can be considered as purely circumstantial. Firstly, the inter-temporal comparison aims to test the consistency of the size effect defined as a significant break with the hypothesis of independence. It is in a second time that the question arises of the stability in time of the numerical value of the elasticities. The analyzes will be conducted in relation to the population data (Table 2). The year 2012 was chosen because of its relative proximity to 2017. The sample of cities remains of course the same.

Table 2. *Inter-temporal validation of the effect size.*

Relation	Indicateur	2000	2005	2012	2017
[1]	Loads	1,45* (0,11)	1,35* (0,08)	1,23* (0,06)	1,27* (0,06)
[2]	KOP	1,34* (0,10)	1,28* (0,12)	1,12* (0,07)	1,13* (0,06)
[3]	Travel	(-)	(-)	1,12 (0,08)	1,15* (0,08)
[1']	Loads/KOP	0,12+ 0,05	0,07 (0,08)	0,11+ (0,04)	0,16* (0,07)
[4]	Capacity	0,05 (0,07)	0,11 (0,08)	0,07+ (0,02)	0,04 (0,05)
[5]	Km-Véhicles	1,29*	1,17*	1,05	1,08

* indicates a significantly different elasticity of 1 at the 5% threshold
+ indicates a significantly different elasticity of 0 at the 5% threshold
(-) indicates the absence of data
Numbers in parentheses are estimates of standard deviations of estimated elasticities.

The productivity

For both operating expenses and production, the size effect observed in 2017 can be highlighted in 2012, 2005 and 2000. Elasticities remain significantly different from one. The drift of the operating expenses is confirmed in 2000 and 2012. For the year 2005 the rejection would be done with a risk of 16%, thus higher than the conventional threshold of 5%. Overall, however, the assumption of unit cost growth and a decline in efficiency productivity appears relatively consistent.

The numerical values of the elasticities vary over time. Production elasticities and operating costs decreased from 2000 to 2012, from 1.45 to 1.23 for expenses and from 1.34 to 1.12 for production.

On our sample nine transport networks multiplied by more than three their production between 2000 and 2007. Seven of them belong to the smallest cities. As a result, the differences between small and large cities are attenuated.

Overall, we will retain from these analyzes that the size effects on the charges, output, and charges at KOP, defined as the negation of the independence assumption, are stable. However, temporal singularities explain variable elasticity values.

The descriptive factors of the supply

Regarding capabilities, working on the 2017 data, we could not reject the nullity of elasticity hypothesis. This situation can be found in 2000 and 2005, but the 2012 data would show that the development of networks is accompanied by gains in capacity. This does not greatly affect our conclusion. At most it must be nuanced. We will say that there is probably a slight increase in the capacity of vehicles in circulation with the size of the cities, but that this weak dependence is of the same order of magnitude as the factors ignored by the analysis supposedly correctly represented by "noise". random.

The elasticity of frequency to city size is significantly different from zero for the four years taken into consideration. The highest numerical value of elasticity in 2000 may reflect a larger gap between the production of small and large transport systems. This gap was subsequently reduced by an increase in the frequencies of small networks, some of which increased their production considerably between 2000 and 2012, as we have already mentioned.

The size effect on the length of the networks is also confirmed. The elasticity of the length can be declared lower than one at the threshold of 5% for the years 2017, 2012 and 2000. The rejection of the assumption of equality is less easy in 2005 (risk of about 13%). However, it seems that globally the size effect is relatively consistent, even constant, despite once again the year 2005 can be considered as an exception. It is impossible for us to assess whether this singularity of the year 2005 is due to anything other than random fluctuations.

In total, a size effect, confirmed by an analysis of its stability over time, can be detected in the operating conditions of public transport of small cities. The main features are:

1. The public transport offer is growing more than proportionally to the size of the cities. The stability over time of this higher per capita production in large cities suggests that it could be a constraint of urban operation. This growth in the level of service would explain part of the decline in so-called efficiency productivity (operating expenses per inhabitant).
2. It may be that public transport is used more in large cities (in terms of annual movements per inhabitant), but this result could not be subjected to an inter-temporal test.
3. Operating expenses grow more than the size of the city.

While this loss in productivity efficiency is partly explained by the improvement in supply, another part is a growth in the unit cost at the PKO. There is therefore no significant savings in the operation of public transport in the sense of productivity efficiency (cost to the PKO).
4. No trend has been established with regard to so-called social productivity (displacement operating cost).
5. The massification of transport flows - which goes hand in hand with the increase in the size of networks - results in an increase of frequencies more than capacities. This increase in frequencies allows for greater production, despite an extension of the length of the networks lower than the growth of the population of the cities. The increase in the size of cities therefore leads to a spatial and temporal massification of supply.
6. The massification through the generalized frequency, rather than by the potential sources of productivity, does not manage to generate overall productivity gains, on the contrary an increase in the production costs of the PKO is observed.

4. The Comparison Large Cities-Small Cities

4.1. The Results of the Comparison

The investigations were carried out for a perimeter of transport of port cities (generally millionaire cities in terms of inhabitant) They consist in checking that the value observed for these big cities enters a forecast interval calculated from the regressions obtained on the small town. This interval is constructed in accordance with conventional assumptions about the distribution laws relating to the residual error and the parameters of these regressions (Table 3).

Table 3. *Comparison of Big Cities - Small Towns (2017).*

Relationship	Indicator	Elasticity size Small towns	Are big cities an extension of small town trends (at the 5% threshold)
[1]	Charges	1,27*	Oui
[2]	PKO	1,13*	Non
[3]	Déplacements	$0,16^{+}$	Non
[1’]	Charges/PKO	0,04	Non
[4]	Capacité	1,08	Oui
[5]	Km-Véhicules	0,84	Oui
[7]	Longueur	0,24	Oui
[8]	Fréquence	$0,24^{+}$	Oui

Source: Author
* indicates a significantly different elasticity of 1 at the 5% threshold
+ indicates a significantly different elasticity of 0 at the 5% threshold.

4.2. The Productivity

The transport supply of the big cities deviates significantly from the prolongation of the regression obtained on the small town (relation [2]). This means that between small and large cities, supply increases more than population growth should have produced. Moreover, the operating expenses are compatible with the value of the elasticity size obtained on the small town (relation [1]). We can thus admit that the growth of operating costs, more than proportional to the size of the city with an elasticity close to 1.27, continues until the big city (efficiency decrease efficiency).

Given the substantial increase in supply, the unit charges at PKO out of the trends of small towns (relation [1']). In clear terms, we can validly postulate efficiency productivity gains in large cities, relative to smaller cities.

Table 4 illustrates these first results.

Table 4. *Evolution of unit operating costs (in CFA francs 2017).*

Town	Numbers of cities	Cost to KOP	Cost per capita per year	Elasticity size (at the threshold of 5% Cost to PKO Cost to the inhabitant	
Small cities*	13	0,16	44300	On the whole small town:	
Big cities	12	0,18	55800	e different from 0	
Big cities	1	0,12	141200	Deviates from the small town trend	In the small town trend

* Below 1.000.000 inhabitants
+ 1 million inhabitants.

It is not possible to study the evolution of social productivity between big cities and other cities. In general, the displacement data are largely imperfect. On the one hand, we do not have an elasticity size on the small town sufficiently consistent. On the other hand, it is difficult to appreciate the displacements on the perimeter of the large cities which we retained.

The descriptive factors of the supply

Supply decomposition variables (vehicle kilometers, generalized frequency, network length) conform to the elasticity laws obtained in small towns, with the notable exception of vehicle capacity (relationship [4]). Atypical growth in the supply of large cities is thus essentially attributable to massification by vehicle capacity. Table 5 gives a synthetic view of the evolution of supply and its decomposition.

1. the per capita supply, standing out from the size effect on the small town, is multiplied by 4,
2. using capacities multiplied by nearly 5, according to a trend that does not conform to the size effect characterized in the small town,
3. and a generalized frequency and length of lines per capita (both conform to the size effect), respectively multiplied by 1.86 and 0.43.

Table 5. *Summary of supply decomposition variables (in 2017).*

Indicator	Cities	Average Value
Supply / inhabitant (in PKO)	- Small cities	2836
	- Big Cities	11 712
Capacity	- Small cities	103
Annual network frequency	- Big Cities	481
	Small Cities	31 422
	Big cities	58 500
Length of lines per inhabitant (in meters)		0,98
		0,42

In the first place, analyzes have shown that the mass transit system of the big cities exhibits singularities that urban size can not explain, with reference to a calibrated size effect model for small towns. A strong per capita supply, mainly developed through vehicle capacity, is the essential feature of this break in the size effect. This appears to result in a lower PKO cost.

The study of the agglomeration of large cities thus supports the hypothesis that the economies of size, in terms of production efficiency, are highly dependent on massification by capacity. This explanation of productivity, however, is valid only within the limits of our investigative apparatus (see our analytical model of supply).

Also, if we admit that the increase in the size of the cities requires that we increase the per capita supply, the growth of the urban size does not however make it possible to produce the additional service with the help of a less expensive process. Urban sizes are not sufficient to ensure that transport flows can be largely massive and that it is possible to develop, on a scale generating productivity gains, means of transport with high capacity. This could be the main explanation for the major diseconomies observed in small towns.

5. Conclusions

Our work shows that doubts can be expressed about the existence of economies linked to the size of the city in the field of urban public transport. It is important to repeat the main results.

First of all, small towns.

1) the assumption of a productivity loss of efficiency (operating cost at the KOP), of small magnitude but statistically significant, when the size of the city increases, is strongly validated.
2) Associated with the growth of the per capita supply, this results in a significant increase in the operating cost per inhabitant. The passage from a notion of efficiency to that of efficiency does not allow any more to isolate economies of size, on the contrary.
3) In general, there is no information to establish trends in the cost of travel. The few data available to us suggest that the most plausible hypothesis is that of a growth in at the same pace as supply, as the size of the city grows. So with regard to social productivity, defined as the cost of operating the displacement, this would again result in a lack of significant savings.

It can be shown that large cities are avoiding the drift of unit loads at the PKO spotted when the size of the city grows. However, this result only partially calls into question the judgment that there are no major economies in urban public transport.

1. These better productive performances probably have the counterpart of high capital expenditure incurred over many decades, but it is impossible to measure their influence.
2. The operating costs at the inhabitant conform to the size effect on the average cities. There is therefore no productivity gain in efficiency.
3. The greater efficiency of transport in large cities is an urban size that is more exceptional than common rule. Potential economies of size, in the sense of the efficiency of the factors of production, would thus appear beyond a threshold singularly out of the ordinary.
4. But above all, the analyzes show that the gains or losses of efficiency of public transport seem strongly dependent on the variable capacity of the vehicles in circulation.

The considerable capacity of the transport system of large cities can only be justified in the case of a gigantic metropolis. The significant increase in user transport time is then the counterpart. This highlights the importance of externality phenomena in the analysis of urban concentration.

Also, the question arises as to whether the greater efficiency of transport in large cities persists when investment expenditure is introduced, but more importantly, one can validly admit that it can not withstand the balance sheet perspective. socio-economic is open. This is an important question of the impact of urban concentration on public transport.

Two remarks can however be made to emphasize the limits and extensions of our investigations:

1. the introduction of sustainable factor expenditure in the search for economies of size remains problematic. Given the results on the farm, can we not expect at best constant returns to size?
2. international comparisons would be very profitable, especially to identify an effect specific to the organization of African public transport systems. To our knowledge, however, statistical data, particularly with respect to cost variables, are lacking.

We know that the costs of urban concentration are weighed against its benefits. However, the analysis we conducted shows the interest of sectoral approaches. To the extent that productivity losses go hand in hand with a growth of supply to the inhabitant, which itself appears to be an urban necessity - the exceptional growth of the supply of large cities confirms this last point - is it then not legitimate to rethink the current regulation of urban travel? Here too, there is a question that comes down to an analysis in terms of externality.

Appendix: Sample of Cities

Table 6. *Sample of citiess.*

Cities by size UTP (Urban Transport Perimeter)	***Population 2017***
Cotonou	Cotonou 2 401 067 habitants
Ouagadougou	Ouagadougou 2 868 034 habitants
Yaoundé	Yaoundé 3 500 000 hab
Bangui	Bangui 1 145 280 habitants
Brazzaville	Brazzaville 1 838 348 habitants
Abidjan	Abidjan: 5 707 404
Libreville	Libreville 803.940
Bamako	Bamako 4 347 997 habitants
Dakar	Dakar 3 630 324 habitants
Ndjamena	Ndjamena 1 243 994
Lomé	Lomé 2 133 579 habitants
Bissau	Bissau 587 909
Malabo	Malabo 476 564 habitants
Niamey	Niamey 774,235
Porto Novo	Porto Novo 264 320
Bobo-Dioulasso	Bobo-Dioulasso 806 939 habitants
Douala	Douala 2 768 436 hab
Bambari	Bambari 93 863
Pointe Noire	Pointe Noire 715 334
Bouaké	Bouaké 694 841
Franceville	Franceville 178,156
Bafata	Bafata 22,521
Ségou	Ségou 469 219
Agadez	Agadez 321 639
Kaolack	Kaolack 1 155 748
Abéché	Abéché 100.000
Lama-Kara	Lama-Kara 109 287

Source: politique de transports urbains en Afrique subsaharienne (Banque Mondiale, 2017).

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