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Regional inequality of public investment in infrastructure in Tunisia

ABDESSALEM GOUIDER
Assistant Professor
Al-Imam Muhammad Ibn Saud Islamic University, KSA
Member of the Research Unit URECA, Sfax University, Tunisia
RIDHA NOUIRA
Assistant Professor
Monastir University, Tunisia
Member of the Research Unit UREP, Sfax University, Tunisia

Abstract:

The objective of this paper is to measure the extent of inequalities of public investment in infrastructure in the 24 governorates which make up the Tunisian territory. The method of Principal Component Analysis on regional data allowed us to note a problem of favoritism of the State for the Greater-Tunis areas and the Central-East areas. Then, a Gini index for each variable is calculated to measure the extent of infrastructure inequalities. Using convergence tests, it is shown that the unequal endowments in infrastructure are relatively low and falling.

Key words: Regional Inequality, Investment in Infrastructure, Convergence

JEL Classification-*D63, H54, O18*

INTRODUCTION:

Sustained economic growth permits the creation of decent jobs and the improvement of the standard of living of all citizens. However, economic growth in Tunisia has not benefited all regions equitably, in spite of efforts made over the last decades.

The benefits of economic growth failed to affect the interior regions of the country and create better opportunities in the disadvantaged areas (Banque mondiale, 2014). This problem reflects a duality between the inland regions and those of the coastline of the country, thereby causing persistent regional imbalance and proving the failure of the development strategies adopted by the Tunisian government. The centralized economic growth masks significant regional disparities in terms of investment, employment, and especially in term of level of life (poverty, health, access to safe drinking water, education).This has resulted in a sense of dissatisfaction among a large part of the population and has accounted for the events of December 2010, events which have led to the fall of the regime of Ben Ali.

To reduce regional inequalities, the government must invest permanently in the economic infrastructure in the most disadvantaged regions. Public investment in the infrastructure plays a crucial role in the functioning of the economy. It is an important catalyst of economic growth and employment. It generates positive externalities for the private sector and contributes to improve the welfare and the productivity of the companies (Pereira et Andraz, 2013). In addition, it allows to reduce the price of domestic goods and to increase demand.

The geographical distribution of private investment depends on the nature and location of the infrastructure. Indeed, the access to infrastructure such as roads, airports, maritime ports, electricity, telecommunications, water, sanitation and health services especially in the rural areas may encourage investors and strengthen production capacity in the long term. In contrast, a less developed infrastructure or of a poor quality is an handicap for investment and therefore to economic growth and reduction of inequality. In General, a quality infrastructure can generate economies of agglomeration. For (Martin and Rogers, 1995), transport costs are a decreasing function of the level of regional public infrastructure. In this context, Bougheas et al. (2003) show that an increase in the investment in infrastructure of 1% could reduce transport costs of 0.14%. They also concluded that poor infrastructure accounts for 40% of transport costs for coastal economies and 60% for landlocked economies. The need to improve the quality of infrastructure services is a necessary condition for the success of businesses.

The need to improve the quality of infrastructure services constitutes a necessary condition for the success of the companies. Infrastructure investment stimulates economic activities, allows the reduction of transaction costs, improves the competitiveness and creates employment opportunities for the poor (Sahoo et al., 2010). Moreover, the development of the infrastructures allows the realization of productivity gains as it facilitates external trade. This is considered one of the main determinants of FDI inflows (Sahoo, 2006). According to the Keynesian theory, investment in infrastructure can stimulate the aggregate demand by making it possible to the individuals to access new markets. Thus, the expenditure of infrastructure supports the growth and reduces poverty.

In this paper, we seek to measure the extent of inequalities in public investment in infrastructure in the 24 governorates which make up the Tunisian territory. At the outset, it is appropriate to recall the main orientations of regional development policies adopted by Tunisia since independence. Then, we will apply the method of Principal Component Analysis (PCA) on regional data in order to visualize the decomposition of the Tunisian territory into regions with unequal infrastructure allocation. Finally, to measure the extent of the inequality of investment in infrastructure, we will proceed in two stages. First, we calculate the Gini index for each variable. Then, a synthetic index of infrastructure will be calculated in order to visualize the territorial aspect of these inequalities. Second, we will use the tests of convergence in order to verify if these inequities are persistent or seem to be diminishing over time.

1. REGIONAL DEVELOPMENT POLICIES IN TUNISIA THROUGH HISTORY

Since independence, Tunisia's regional development policy has not been able to reduce regional disparities or even curb their worsening. Historically, these disparities seem to be serious and persistent.

Four phases have generally marked the Tunisian regional development policy (Ghazouani, 2010). The first phase dates from the 1960s and was intended to reduce disparities inherited from the colonial period. This phase was characterized by the creation of industrial poles in the interior regions in order to develop the natural resources in these regions. These include the textile industry in the country's center (at Ksar Hlal), the heavy industry in the North (refinery at Bizerte), the food industry in the Northwest (sugar industry in Beja), the processing industry in the Central West (the cellulose in Kasserine).

The second phase covered the period 1972-1986 which was characterized by the adoption of an economic policy of liberal orientation. The attempt of the State to reduce regional disparities was based on the establishment of certain programs such as the Rural Development Programs (RDP), the Integrated Rural Development Programs (IRDP), the Integrated Rural Development Fund (FODERI) ...

The third phase runs from 1986, date of the implementation of the Structural Adjustment Program until 2004. This phase is marked by the application of certain measures which aimed at the opening up of the Tunisian economy and its integration within the global economy. During this phase, a new concept of regional development policy has been established. This policy was based on the mobilization of regional capacity and strengthening the role of the private sector. Furthermore, this policy was to improve the institutional framework through the strengthening of the decentralization process.

The fourth phase began in 2004. Regional development policy had main axis: the strengthening the decentralization process, the improving the competitiveness of regions, the strengthening of the complementarily between regions.

The various regional development policies adopted since independence have failed to realize the expected objectives. On the contrary, regional disparities seem to have worsened and the duality of the Tunisian economy between coastal and inland regions has increased. This regional imbalance is of a socio-economic nature. It relates to education, employment, poverty, transport infrastructure...

Regarding education, the lowest illiteracy rate is recorded in the District of Tunis (11.6% in 2012), followed by the Northeast Region (17.9% in 2012) whereas the highest rate is recorded in the North-West (29.5% in 2012) and Central West (28.9% in 2012).The governorate of Jendouba is characterized by the highest rate of illiteracy, 32.4% in 2012 while the governorate of Tunis recorded the lowest rate, 11.6% in the same year. Nationally, the illiteracy rate is 18.1% in 2012[1]. In term of employment, the highest unemployment rate is registered in the Southeast Region, 26.1%, followed by the South West region with a rate of 25.3% in 2012. The lowest rates of unemployment are recorded in the North-East and East Central regions with 12% and 12.4% in 2012. for the same year, the national unemployment rate is 17.4%.In terms of governorates, the lowest unemployment rates were recorded in Monastir (Central East region) and Zaghouan (Northeast region) with respective rates of 5.7% and 8.9% in 2012 while the highest rates concern the governorates of Tataouine (South East region) and Sidi Bouzid (Center-west region) with respective rates of 51.7% and 29.4% in 2012[2]. Regarding

[1]Data from the national survey on population and employment (2012)
[2]Data from the national survey on population and employment (2012)

unemployment among graduates, Southwest and South East regions recorded the highest rate with respectively 47.4% and 42.5% in 2012. The lowest rate was registered in the District of Tunis that is 16.2%. The governorate of Tataouine is the most affected by unemployment of graduates with 56%, more than the double of the national unemployment rate for graduates (26.1% in 2012). The lowest rate is recorded in the governorate of Ariana that is 10.5% in 2012[3].

In term of transport infrastructure the governorates of Greater Tunis are better off in term of density of paved roads with a density of 70.8 km / 100 km² for Tunis, 46,6km / 100 km² for Ariana, 41.2 km / 100 km² for Manouba and 38.7 km / 100 km² for Ben Arous. Governorates that have the lowest density of paved roads are Kebili with only 3 km/100km², Tozeur (4.8 km / 100km²), Tataouine (6 km / 100 km²), Gafsa (7 km / 100 km²), Kasserine (7.1 km / 100 km²), Sidi Bouzid (8 km / 100 km²).

For the health services, disparities persist particularly in terms of the availability and quality of services provided. For example, nationally, medical density per hundred thousand inhabitants is of 123 doctors in 2010. It is spread very unevenly in the national territory. Indeed, the highest density of medical concerns the Northeast and the Central East regions that is 368 doctors in the governorate of Tunis, 192 doctors in the governorate of Sousse and 175 doctors in the governorate of Sfax. The lowest density of medical concerns mainly the regions of Central West, Northwest and Southeast. The governorates of Kasserine, Sidi Bouzid and Jendouba have the lowest density of medical doctors with respectively 45 doctors, 46 doctors and 51 doctors per 100,000 inhabitants in 2010[4].

With regard to poverty, regional disparities still persist. In 2010, the poverty rate varies between 8 and 9% for the region of East-Central and greater Tunis, while it is between

[3]Data from the national survey on population and employment (2012)
[4]Ministry of Public Health (2011)

26% and 32% respectively in the Northwest and the West Central regions (World Bank, 2014).

2. TYPOLOGY OF REGIONS ACCORDING TO THE INFRASTRUCTURE ENDOWMENTS

The objective of the following work is to visualize the division of the Tunisian territory in different regions with unequal endowments of infrastructure. In other words, it is to classify the 24 governorates in homogeneous groups in term of investment in infrastructure and to study their economic and social characteristics. To carry out this work, we applied the Principal Component Analysis (PCA) on the data for nine regional infrastructure indicators, published by the National Institute of Statistics in 2012[5]. These regional indicators of infrastructure are: Rate of drinking water service, Household connection rate in drinking water, Connection Rate to sewerage system, Electricity Connection rate, Rate of fixed telephone network connection, Distribution of subscribers to ADSL, Postal cover, Occupancy rate of classrooms in the second basic education cycle and in secondary education as education infrastructure indicator[6] and the number of hospital beds as the health infrastructure indicator.

Principal Component Analysis (PCA) is a method for the analysis of multivariate data. It aims to "explore" a set of observations collected in the form of a data table, showing for each statistical unit, the observed values of a number of quantitative variables. It is based on the calculation of averages, variances and correlation coefficients. The purpose of

[5] The database used lacks a variable representing the transport infrastructure per governorate. This variable is not available for the 24 governorates

[6]This variable is used by the National Statistics Institute (2005) to approximate education infrastructure. It is calculated by dividing the number of students to the number of classrooms. More this rate is low, more the education infrastructure is better.

the PCA is to obtain a representation of individuals in a lower dimensional space.

Principal Component Analysis conducted using the XLSTATA software permits the creation of the following factorial axis:

Table 1 : Eigenvalues

	F1	F2	F3	F4	F5	F6	F7	F8	F9
Eigenvalues	4.197	2.233	0.832	0.734	0.495	0.280	0.162	0.041	0.022
Variability (%)	46.636	24.817	9.251	8.156	5.503	3.118	1.800	0.463	0.252
Cumulative (%)	46.636	71.453	80.705	88.862	94.365	97.484	99.284	99.747	100.00

The interpretation will focus on the factorial plan (F1, F2). Indeed, we note that the first two principal components account for 71.45% of the total variance. For each selected axis, we are interested to variables and individuals most involved in its formation. The most interesting points are usually those who are close enough to one of axis, and far enough away from the origin. These points are well correlated with this axis and are the points that contribute most to its explanation.

The first component analysis (F1) explains 46.6% of the total variance. It is mainly explained by the variables: Household connection rate in drinking water, Electricity Connection rate, Rate of fixed telephone network connection, Rate of drinking water service and Distribution of subscribers to ADSL. These variables explain almost 74% of the information contained in this axis.

The second component analysis (F2) explains 24.8 % of the total variance. This axis is mainly correlated with the indicators “Connection Rate to the sewerage system", "Postal cover" and “Occupancy rate of classrooms". These variables account for 60% of the information contained in this axis.

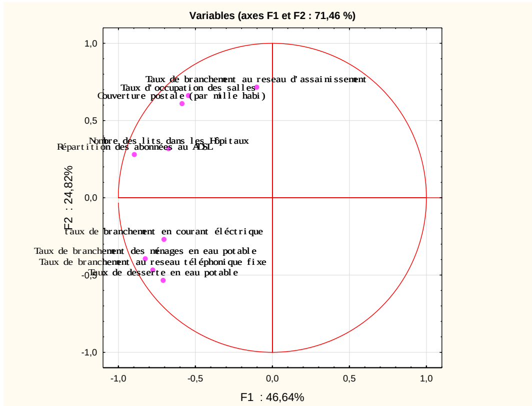


Figure 1 : Projected variables on the factorial plan (F1 and F2)

It should be noted that the constitution of homogeneous groups (governorates) will be using the individuals and the variables that contribute most to the axis: if a variable has a strong positive contribution to the axis, individuals with high positive contribution to the axis are characterized by a high value of the variable.The screening of individuals on the factorial plan (F1, F2) has allowed us to retain three groups.

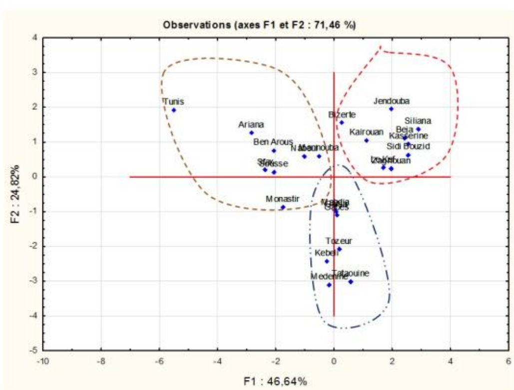


Figure 2: Projection of the Regions on the factorial plan (F1 and F2)

The first group includes the governorates of Tunis, Ariana, Ben Arous (Greater Tunis), Sousse, Sfax and Monastir (Central-East). In these regions are concentrated the largest share of the national economic activity as well as of the population (nearly 40% of the total of the Tunisian population). Compared to other regions of the country, it is most favored and has a developed infrastructure. So this region is characterized by a better quality of life compared to the other regions of the country. Indeed, according to the World Bank (2014), the Greater-Tunis region and the Central-East region record the lowest poverty rate, a rate which varies between 8 and 9%.

The second group includes the governorates located in North-West and Central-West of the country. These are the governorates of Zaghouan, Beja, Jendouba, Kasserine, Siliana, Le Kef, Kairouan and SidiBouzid. In these regions is concentrated almost 25% of the Tunisian population. These regions have the lowest rate in term of Household connection in drinking water, Connection Rate to sewerage system, Electricity Connection, Fixed telephone network connection, Distribution of subscribers to ADSL, Postal cover and the number of hospital beds. These regions are under-developed in term of infrastructure which reflect the poor quality of life. Thus, these governorates are the most disadvantaged and suffer from the highest rates of poverty. According to the World Bank (2014), the poverty rate is 26 to 32% respectively in the North-West and Mid-West regions.

The third group is constituted by the governorates of Bizerte, Nabeul (North-East Region), Mahdia (Central-East Region), Mannouba (Greater-Tunis), Gabès, Médenine, Tataouine (South-East Region), Kebeli, Gafsa and Tozeur (South-West Region).These governorates bring together nearly 35% of the total Tunisian population. They are equipped with a less developed infrastructure compared to the first group especially in terms of Household connection rate in drinking water, Fixed telephone network connection and Electricity Connection. In term of living standards, these regions are less disadvantaged and poverty rates are lower than those recorded in the second group.

According to PCA results, there was a public infrastructure investment inequality between the 24 governorates. This inequality shows a favoritism of the state for the governorates of Greater-Tunis and Central- East regions. However, the North-West and Central-West regions remain the most disadvantaged in terms of public infrastructure investment.

3. MEASURE OF THE SCALE OF THE REGIONAL DISPARITY OF PUBLIC INVESTMENT IN INFRASTRUCTURE

The regional disparities in infrastructure remained a major concern of the Tunisian economic policy. The disparities of infrastructure reflect inequality of public investment in infrastructure between the various governorates. To measure the disparities, several indicators are used in literature (Gini Index, Theil Index, …). Gini Index appears the most popular.

Gini Index varies between 0 and 1. It is equal to 0 in a situation of complete equality (where all the governorates have the same level of infrastructure) . In other extreme, it's equal to 1 in the situation of maximal inequality. This case concerns a situation when all of the investment in infrastructure is monopolized by some governorates.

The Gini coefficient is calculated as follows:

$$G = \left(\frac{2}{N^2\bar{X}}\right)\sum_{i=1}^{N}\left(\left(i - \frac{N+1}{2}\right)X_i\right) \;; \qquad \bar{X} = \frac{1}{N}\sum_{i=1}^{N} X_i$$

N is the total number of governorates, i is the order of governorate according to the value of the X_i variable.

We should measure the Gini Index for the nine indicators used to determine the degree of the disparity of infrastructure. The results of this application are summarized in following table:

Table 2: Calculation of the Gini index for all indicators (2004-2012)

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Rate of drinking water service	0,106	0,104	0,102	0,101	0,099	0, 098	0, 097	0, 098	0, 098
Electricity Connection rate	0,005	0,026	0,023	0,021	0,019	0,019	0,017	0,018	0,017
Occupancy rate of classrooms	0,027	0,026	0,022	0,031	0,027	0,039	0,041	0,042	0,042
Rate of fixed telephone	0,193	0,19	0,194	0,2	0,212	0,212	0,221	0,223	0,226
Postal cover	0,213	0,215	0,217	0,217	0,219	0,217	0,211	0,237	0,216
Distribution of subscribers to ADSL	0,614	0,634	0,613	0,6	0,551	0,512	0,495	0,472	0,464
Number of hospital beds	0,388	0,384	0,385	0,384	0,367	0,374	0,368	0,368	0,366
Household connection rate in drinking water	0,031	0,028	0,024	0,02	0,017	0,017	0,016	0,016	0,016
Connection Rate to the sewerage system	0,137	0,124	0,117	0,113	0,11	0,105	0,103	0,101	0, 059

Source: calculation of the authors

The Gini Index shows a relatively high disparity for the variable "Distribution of subscribers to ADSL", as well as for the variable "Number of Hospital beds" and a low disparity for variables "Electricity Connection rate" and " Rate of drinking water service". Indeed, the Gini coefficient are closer to zero for variables "Household connection rate in drinking water", " Electricity Connection rate", "Occupancy rate of classrooms", "Rate of drinking water service" and "Connection rate to the sewerage system". This implies that these infrastructure indicators are equally distributed on the Tunisian territory.

For the indicators "Rate of connection in fixed telephone" and "Postal cover", the Gini index varies between 0,19 and 0,22. For these two variables, the disparity is aggravating. Indeed, the highest Gini coefficient is registered at the end period of the study: it is 0,237 in 2011 for "Postal cover" and 0,226 in 2012 for "Rate of connection in the fixed telephone network".

The disparities of infrastructure concern mainly the "Distribution of subscribers to ADSL" for which the coefficient of Gini remain worrisome (0,614 in 2004) even if it decreased in time (0,464 in 2012). Also, health services are unequally distributed between the various governorates. During the period 2004-2012, the Gini coefficient for the infrastructure health was near to 0,37.

Given that the evaluation of the infrastructure level in regions cannot be limited to the observation, separately, of several indicators but it requires the construction of a synthetic index which groups these various infrastructure measures, we will calculate a synthetic infrastructure index. This synthetic indicator permits to make the comparison of the infrastructure level in the various governorates. This comparison permits to judge the efficiency of the Tunisian regional policy. We calculate the synthetic infrastructure indicator using a factorial components technique to combine various measures of infrastructure. Once the synthetic infrastructure index is calculated for all governorate, we measured its degree of disparity using the Gini index. The results of this application as well as the scores of this synthetic index are summarized in the below table:

Table 3: Synthetic of infrastructure by region and Gini Index

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Tunis	92.76	91.20	90.99	90.25	87.30	90.03	91.90	92.62	89.65
Ariana	86.06	86.39	86.35	83.61	84.29	88.02	86.88	87.91	88.38
Ben Arous	78.63	80.49	76.99	77.31	79.07	81.91	81.06	84.24	81.81
Mannouba	73.02	73.18	73.62	68.40	69.50	69.30	67.13	70.12	67.75
Nabeul	59.82	60.41	62.28	58.61	60.06	62.26	63.08	66.00	62.64
Zaghouan	37.41	41.55	42.42	44.12	46.53	45.13	43.73	45.79	42.28
Bizerte	56.58	55.62	55.99	52.01	53.75	57.18	59.63	49.01	59.22
Beja	42.95	41.70	42.27	39.71	45.41	43.60	41.59	44.52	42.51
Jendouba	42.08	40.28	42.50	38.11	40.00	41.42	41.64	44.31	42.41
Le Kef	44.84	39.78	44.83	38.43	41.50	46.59	43.77	45.79	42.53
Siliana	34.50	34.33	37.80	39.30	35.14	33.85	34.68	38.41	36.27
Sousse	70.65	69.02	71.16	68.38	69.74	73.20	71.65	75.15	72.01
Monastir	59.16	58.14	61.07	59.73	61.66	63.32	62.17	67.16	63.18
Mahdia	44.94	44.23	43.45	45.21	47.69	46.01	50.28	50.45	47.27
Sfax	59.94	59.65	62.20	64.25	64.82	61.78	61.42	64.57	62.26
Kairouan	49.22	48.49	49.68	46.82	49.45	48.68	50.63	52.20	48.44
Kasserine	37.64	34.38	39.31	32.60	38.19	36.63	37.40	39.58	37.36
Sidi Bouzid	34.73	29.52	29.95	28.94	33.71	30.00	30.94	32.21	31.04
Gabes	50.00	50.13	51.92	50.44	52.11	51.39	53.15	54.36	50.89
Medenine	36.03	34.46	35.96	37.09	38.32	35.20	38.63	38.66	34.22
Tataouine	35.25	36.16	39.27	38.95	41.30	39.79	39.94	41.81	37.94
Gafsa	49.52	48.13	47.02	49.90	49.83	47.09	50.84	51.74	47.70
Tozeur	49.32	48.36	50.00	49.50	50.50	50.49	50.48	54.55	49.03
Kebeli	41.87	43.03	46.77	46.74	47.48	43.67	47.35	49.78	44.77
Gini Index	**0,162**	**0,17**	**0,157**	**0,161**	**0,148**	**0,163**	**0,157**	**0,152**	**0,162**

Source: calculation of the authors

The analysis of the regional scores of this synthetic index during the period 2004-2012, shows the existence of a regional disparity in infrastructure between the 24 governorates. Governorates presenting the weakest regional scores being the most affected by this infrastructure disparity. So, the governorates of Mednine, Tataouine, Sidi Bouzid, Siliana and Kasserine are the least endowed in infrastructure. These governorates did not record notable improvements in their infrastructure endowments cover the period (2004-2012). Any regional development policy must be concentrated on the increasing of the investments in infrastructure in these governorates. The Gini index applied to the synthetic infrastructure index is practically stable and varies between 15 and 17 %. This implies the existence of a persistent disparity between the 24 governorates of Tunisia, but this disparity is not of high magnitude.

The observation of the evolution of the Gini index disparity (see graph in annexe 2 page 24), shows that, generally, the biggest values of this index are registered at the beginning of the period (2004-2005). These coefficients decrease in time and reach their weakest values at the end of the period (2011-2012). So, the gap of the infrastructure inequality decreases over time which imply an eventually convergence of the infrastructure levels between regions.

3.1. Convergence tests: The disparities in infrastructure investment are persistent?

The degree of the disparities in infrastructure investment in the 24 governorates being determined, it is interest to verify if these disparities are persistent or on the contrary they reduced in time. To answer this interrogation, we use the convergence analysis. Convergence exist when the difference between the series or their dispersion is reduced in time. The convergence measures, here, the reduction of infrastructure disparities within a group of regions. So, there is a convergence when the regional infrastructure indicators get closer. According to the pioneers' works of Baumol (1986), several empirical studies were undertaken on the models of convergence. The various proposed tests are cross sections tests, panels tests, chronological series or cointegration analysis.

Among convergence approach we can cite the ß-convergence method. It is relative to the instantaneous cut data that tries to study the behavior on returning to the average of the variable. However, this method is subject to several critics mainly those of (Bernard and Durlauf, 1991) concerning the fact that the ß - convergence test doesn't take into account the non-stationary of series.

In this work, we will just apply the most usual convergence test: the panel unit root tests and the panel cointegration test. These approaches will be used to answer the following question: is there a phenomenon of convergence of the infrastructure indicators for the 24 governorates?

The first convergence approach uses panel unit root test. This method try to test the stability of the series, otherwise, we test the hypothesis that gap in the average is stationary, or still if the series tend to return to their average. The advantage of the unit root test is to use a statistics of test appropriate to the not stationary character of the series. (Beine, Docquier and Hecq, 1998) and (Lopez and Papell, 2012) tested the stationarity of y_{it}^{dif}, such as:

$$y_{it}^{dif} = y_{it} - \frac{\sum_{i=1}^{N} y_{it}}{N}$$

In this work, we will use this approach with near difference that we test the stationarity of $y_{it}^{dif} = y_{it} - \frac{\sum_{j\neq i}^{N} y_{jt}}{N}$. We have a convergence if the difference is stationary. The literature of the panel stationarity test is rather recent but it is also very rich. These tests form two generations. The first generation is based on the hypothesis of cross-sectional independence. Among these tests we cite the test of (Levin-Lin, 2002), (Im-Pesaran and Shin, 2003) and of (Maddala-Wu, 1999).

The second generation of the panel stationarity test releases the hypothesis of cross-sectional independence. They take into account the dependence between individuals. This second generation of tests includes the test of Bai and Ng (2004), Moon and Perron (2004), Chang (2002), Pesaran (2007). According to these tests, the cross-sectional dependence is due to the existence of the common components for all individuals of the panel.

To examine whether individuals are interdependent, we use a test suggested by Pesaran (2004). This test is based on the average of the correlations between the residuals from a regression on each individual separately. Consider the variable y_i relative to individual i. The variable is regressed on its first lag and the residuals are collected to compute ρ_{ij} which is the correlation coefficient between the residuals from individual i and j regressions. The statistic is:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \rho_{ij}$$

This statistic is shown to have a N (0, 1) distribution under the null hypothesis of independence, where N is the number of individuals and T is the number of years.

The results of the test applied to all infrastructure index are presented in Table 4. For all variables, the tests reject the null hypothesis of independence of individuals.

Table 4: Tests of the Independence of the Variables across Individuals

Infrastructure indicator	**Calculated Statistics**
Rate of drinking water service	3.27***
Electricity Connection rate	3.18***
Occupancy rate of classrooms	4.05***

Rate of fixed telephone	6.12***
Postal cover	15.506***
Distribution of subscribers to ADSL	3.41***
Number of hospital beds	7.13***
Household connection rate in drinking water	3.14***
Connection Rate to the sewerage system	4.26***
Infrastructure indicator	8.01***
Critical value at 1%	2.8

(***) significant at 1%

To examine stationarity, we should use a test that incorporates the interdependence of individuals. The Pesaran (2007) test is the most adequate because it targets a situation where N (the number of individuals) is higher than T (the number of years). In addition, the test allows analyzing non-stationarity within a heterogeneous panel framework, i.e. a panel in which each country is allowed to evolve according to its own dynamics. The test builds on the well-known augmented Dickey-Fuller regressions. Practically, consider y_{it} relative to individual *i* at time *t*.

The regression is : $\Delta y_{it} = \alpha_i + \rho_i y_{it-1} + \gamma_i \bar{y}_{t-1} + \delta_i \Delta \bar{y}_t + v_{it}$

Where $\bar{y}_t$ is the average of yit over all individuals at time t.

Pesaran CIPS statistique is based on the average of the t-student coefficient t_i of the coefficient ρ_i

The statistic: $\mathrm{CIPS}(N,T) = \frac{1}{N}\sum_{i=1}^{N} t_i(N,T)$ is used to test stationarity but it does not have a standard distribution. We follow Pesaran (2007) and simulate the critical values using the Monte Carlo approach. If the computed statistic (CIPS) is above the critical value, one cannot reject the null hypothesis of stationarity.

Table 5 : Test of the Stationarity of the infrastructure indicators

Infrastructure indicators	**Calculated Statistics: CIPS**
Rate of drinking water service	-3.06***
Electricity Connection rate	-1.68
Occupancy rate of classrooms	-1.12
Rate of fixed telephone	-2.41***
Postal cover	-0.92
Distribution of subscribers to ADSL	-1.13
Number of hospital beds	-3.15***
Household connection rate in drinking water	-1.67
Connection Rate to the sewerage system	-1.39
Infrastructure indicator	-1.98
Critical value at 1%	-2.20

(***) significant at 1%

Table 5 presents the results. The tests reveal that there is a convergence for the following variables: Rate of drinking water service, Rate of fixed telephone and Number of hospital beds.

The second approach analyses the convergence as a long-term process. The convergence between two macroeconomic variables involves that their difference is stable. So, two no-stationary series do not converge if they are cointegrated. The convergence tests are founded on the cointegration concept. The cointegration relationship is a relation of long-term equilibrium: equilibrium in the sense where the shocks cannot have a temporary effect on the equilibrium relation. The coïntégration is a necessary but not sufficient condition to permit the convergence. The convergence imposes, furthermore, constraints on the long-term parameters.

In this work, and with the aim of testing the convergence of the infrastructure indicators between 24 governorates of Tunisia, we will test the existence of a cointegration relation between y_{it} and y_{it}^* where y_{it} is one of the variables used as indicators of infrastructure for the region i and $y_{it}^* = \frac{\sum_{j \neq i}^{N} y_{jt}}{N}$ is the average of this variable for the other regions. A necessary condition of the convergence between all regions is the existence of a relation of cointegration between y_{it} and y^*_{it}.

Before testing the coitegration relation between y_{it} and y^*_{it}, we tested the stationarity of variables by the Pesaran (2007) panel unit root test. The results of this test show that, generally, we have a non-stationarity for all infrastructure indicators (annex 3 page 24).

Now, we should use a co-integration test that takes account of the interdependence between individuals. This is possible using Westerlund (2007) test. It is based on an Error Correction Model and proposes two statistics. These are the panel statistic and the group mean statistic. The relevance of this distinction lies in the formulation of the alternative hypothesis. For both statistics the null hypothesis is no-cointegration for the panel as a whole. For the panel statistics, the alternative hypothesis is cointegration for the panel as a whole. For the group mean statistics, the alternative hypothesis is cointegration for at least some countries. The panel and the group mean statistics are respectively:

$$P_\tau = \frac{\hat{\alpha}}{SE(\hat{\alpha})}$$

and

$$G_\tau = \frac{1}{N}\sum_{i=1}^{N}\frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)}$$

where a, a_i and SE are respectively is the Kernel estimators of the common error correction parameter, country's i error correction parameter and their standard errors. The statistics, once normalized and standardized by the appropriate moments, converges to a standard normal distribution. Table 6 reports the results of Westerlund test.

Table 6 : Test of co-integration

Infrastructure indicators	Statistics			
	G_τ		Ga	
	Calculated value	P-value	Calculated value	P-value
Rate of drinking water service	-8.32***	0.00	-6.34***	0.00
Electricity Connection rate	1.26	0.32	0.897	0.41
Occupancy rate of classrooms	0.327	0.57	0.168	0.6
Rate of fixed telephone	-5.38***	0.001	-5.12***	0.001
Postal cover	0.619	0.74	0.195	0.58
Distribution of subscribers to ADSL	0.841	0.43	0.234	0.51
Number of hospital beds	-7.39***	0.00	-6.37***	0.00
Household connection rate in drinking water	-6.84***	0.00	-5.27***	0.001
Connection Rate to the sewerage system	0.798	0.62	0.297	0.69
Infrastructure indicator	0.697	0.61	0.237	0.51

(***) significant at 1%

The null hypothesis of no-cointegration is rejected for "Rate of drinking water service", "Rate of fixed telephone" , "Number of hospital beds" and "Household connection rate in drinking water"

The existence of this long-term relation is necessary, but not sufficient condition, to assure the convergence. The convergence imposes, furthermore, constraints on the parameters of long-term, α and β in the following equation: $y_t = \alpha + \beta y_t^* + \varepsilon_t$. Bernard and Durlauf (1991, 1995), using temporal series, imposes that β is equal to one. Thus, so that there is a convergence, we have to test if the long-term coefficient is equal to 1. Some methods are available to get efficient estimate of the parameters. Among them, DOLS was developed by Kao and Chiang (2000) and consists of adding to the co-integration equation lags of the explanatory variables in order to "clean" the error term from any autocorrelation and heteroskedasticity. The DOLS estimator has better properties than alternative estimators (see Kao and Chiang, 2000) because it allows, to some extent, taking into account the cross-country dependence while allowing for heterogeneity of the panel in the short term. Table 7 presents the DOLS results.

Table 7 : Results DOLS estimator

infrastructure Indicators	coefficient	P-value of the test $\beta = 1$
Rate of drinking water service	-0.832	0.32
Rate of fixed telephone	-0.879	0.39
Number of hospital beds	-1.14	0.46
Household connection rate in drinking water	-9.37	0.001

The results of this table show that we have a convergence between 24 governorates of Tunisia for the following indicators of infrastructure: Rate of drinking water service, Rate of fixed telephone and Number of hospital beds. These results are in accordance with the results that we found using the panel unit root test.

Taking into account results of the Gini index and convergences tests we can group the infrastructure indicators in three categories:

- Indicators which the distribution is almost egalitarian between the 24 governorates. It is about the " Rate of drinking water service ", " Household connection rate in drinking water ", " Electricity Connection rate " and " Occupancy rate of classrooms ".
- Indicators whose distribution is unequal, but it is abatin g. It is about the " Number of beds in hospitals ".
- Indicators which inequality are relatively high and which are aggravating in time. It is in particular about the "Postal cover" and about the "Distribution of subscribers to ADSL".

For the last two categories, the public efforts should be multiplied to realize the regional equilibrium in terms of infrastructure endowment.

CONCLUSION

The objective of this paper was to measure the degree of the regional disparities in Tunisia in terms of disparities of infrastructures endowment for 24 governorates which make up the Tunisian territory and to verify if these disparities are persistent. Indeed, the infrastructure investment stimulates the economic activities, reduces transaction costs, improves the competitiveness and creates opportunities of employment for the poor people. The challenge for Tunisia is to converge the standard of living on the whole territory (World Bank, on 2014). Indeed, the economic policies adopted since the independence missed the territorial dimension and the measures made in this direction failed. So, the regional disparities in Tunisia remained a major concern of the economic policy, their reduction need more a local mobilization of the resources rather than a redistribution of income.

We often fall the persistent regional imbalance which characterizes the Tunisian economy to the disparities of infrastructure investment in the various governorates. The results of this study show that many improvements were realized in infrastructures relative to the distribution of the drinking water and the education. In this domain, the distribution of the infrastructure is almost equal for all Tunisian territory. Nevertheless, persistent disparities still exist for the "Postal cover" the communication means ("Distribution of subscribers to ADSL" and "Rate of fixed telephone" and "Number of hospital beds". Besides, any regional development policy will have to take into account.

The State must practice some positive discrimination measures in the governorates which have the poor infrastructure endowment (Jendouba, Siliana, Sidi Bouzid Medenine and Tataouine) in order to encourage investment in these regions. Of course, the quality of the results is dependent on the database used in this paper. The absence of the regional data concerning the infrastructure transport, for example, can affect the quality of obtained results.

REFERENCES

BAI J. and NG S. (2004), "A PANIC attack on unit roots and cointegration", *Econometrica*, 72, pp. 1127-1177

Banque mondiale (2014),"La révolution inachevée : créer des opportunités, des emplois de qualité, et de la croissance pour tous les tunisiens", Rapport N° 86179-TN, mai 2014.

BARRO R., et SALA-I-MARTIN X., (1996), « La croissance économique », Mc Graw Hill, Ediscience

BAUMOL W.J. (1986), "Productivity growth, convergence and welfare what the long-run data show", *The American Economic Review*, 76, 1072- 1085.

BEINE M., F. DOCQUIER et A. HECQ (1998), « Convergence des groupes en Europe: une analyse sur données régionales », Ministère de la Région Wallonne, Service des Etudes et de la Statistique, discussion paper n° 9801.

BERNARD A.B. et S.N. DURLAUF (1991), « Convergence of international output movements », NBER Working Paper n° 3717.

BERNARD A.B. et S.N. DURLAUF, (1995) « Convergence of international output movements », *Journal of Applied Econometrics*, 10, 97-108.

BOUGHEAS S., DEMETRIADES P., MORGENROTH E. (2003), "International aspects of public infrastructure investment", *Canadian Journal of Economics*, Canadian Economics Association, vol. 36(4), pages 884-910, November.

CHANG Y. (2002), "Nonlinear IV unit root tests in panels with cross-sectional dependency", *Journal of Econometrics*, 110, pp. 261-292.

DANA G. and MICHAEL M. (2014), Infrastructure Investment and Economic Growth: Surveying New Post-Crisis Evidence

GHAZOUANI K. (2010),"Les incitations à l'investissement pour le développement régional en Tunisie : une évaluation", *Région et Développement*, n° 31-2010.

HADRI, K. (2000), Testing for Unit Roots in Heterogeneous *Panel Data, Econometrics Journal*, 3, 148-161

Institut National de la Statistique (2012), Enquête national sur la population et l'emploi (2012), www.ins.nat.tn

IM K.S., PESARAN M.H. et SHIN Y. (2003), "Testing for unit roots in heterogeneous panels", *Journal of Econometrics*, 115, pp. 53-74.

LEVIN A., LIN C.F. et CHU J. (2002), "Unit root tests in panel data : Asymptotic and unite sample properties", *Journal of Econometrics*, 108, pp. 1-24.

LOPEZ, C., PAPELL, D,.H. (2012), "Convergence of Euro area inflation rates," *Journal of International Money and Finance*, Elsevier, vol. 31(6), pp 1440-1458.

MADDALA G. et Wu S. (1999), "A comparative study of unit root tests and a new simple test", *Oxford Bulletin of Economics and Statistics*, 61, pp. 631-652.

MARTIN, P., ROGERS, C.A., (1995), Optimal stabilization policy, in the presence of learning by doing, *Discussion Paper* No. 1129. CEPR, London.

MC.COSKEY S. et KAO C. (1998), " A residual-based test of the null of cointegration in panel Data », *Econometric Reviews*, 17, pp. 57-84.

Ministère de la santé publique, Direction des Etudes et de la Planification (2011), *Carte sanitaire (2010).*

MOON, H.R. and PERRON, B. (2004), "Testing for a Unit Root in Panels with Dynamic Factors", *Journal of Econometrics*, 122, 81-126.

MOUDOUD E. (1985), "L'impossible régionalisation « jacobine» et le dilemme des disparités régionales en Tunisie", *La Revue Canadienne des Sciences Régionales,* VIII:3, pp. 413-438.

PEREIRA A.M. and ANDRAZ J.M. (2013), "On the economic effects of public infrastructure investment: A survey of the international evidence", College of William and Mary Department of Economics, Working Paper Number 108.

PESARAN M. H. (2004), "General Diagnostic Tests for Cross Section Dependence in Panels", Cambridge Working Papers in Economics, No 435, University of Cambridge, and Cesifo Working Paper Series No. 1229

PESARAN, M. H. (2007), "A Simple Panel Unit Root Test in the Presence of Cross Section Dependence", *Journal of Applied Econometrics,* 22, pp. 265-312.

QUAH D. (1993), « Galton's fallacy and tests of the convergence hypothesis », CEPR Discussion Paper, n° 820.

SAHOO P., DASH R.K., and NATARAJ G., (2010), "Infrastructure Development and Economic Growth in China", The Institute of Developing Economies (IDE), Discussion Paper N°.261.

SAHOO P. (2006),"FDI in South Asia: trends, policy, impact and determinants", Asian Development Bank Institute, Discussion Paper N°.56, Tokyo

WESTERLUND, J. (2007), "Testing for Error Correction in Panel Data", *Oxford Bulletin of Economics and Statistics*, 696, pp. 709-748.

ANNEXES:

Appendix 1: calculation of the synthetic infrastructure indicator:

The synthetic infrastructure indicator integrates nine variables related to the infrastructure level such as : Rate of drinking water service, Household connection rate in drinking water, Connection Rate to the sewerage system, Electricity Connection rate, Rate of fixed telephone network connection, Distribution of subscribers to ADSL, Postal cover, Occupancy rate of classrooms in the second basic education cycle and in secondary education and the number of hospital beds. The calculation of this indicator is made in two steps: (a) the normalization and (b) weighting variables.

a- The normalization: the normalization of variables is necessary to limit the scale effect. For all variables used in the calculation of the synthetic indicator, we calculate a normalized index. For the j^{nth} governorate, the normalized index takes the following form:

$$Z_j = \frac{X_j - Min(X)}{Max(X) - Min(X)}$$

With X_j is the value of the variable (X) for the governorate j, Min (X) and Max (X) are respectively the smallest and the biggest value of the variable (X) for all the regions.

b- Weighting variables : In the present work, we calculate the synthetic indicator using the weighting stemming from the factorial analysis[7].

[7] This method is based on the relative contribution of every factor to the explanation of the global variance. For more detail see Nicoletti G, Scarpetta S. (2003)

The following table recapitulates the weightings allocated to all variables used in the calculation of the infrastructure indicator.

The weighting coefficients of variable

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Rate of drinking water service	0,08	0,09	0,08	0,09	0,08	0,09	0,08	0,09	0,08
Household connection rate in drinking water	0,08	0,09	0,09	0,09	0,09	0,08	0,08	0,09	0,09
Connection Rate to the sewerage system	0,22	0,23	0,24	0,21	0,22	0,23	0,21	0,23	0,23
Electricity Connection rate	0,04	0,03	0,05	0,05	0,06	0,06	0,07	0,06	0,05
Rate of fixed telephone	0,09	0,08	0,08	0,09	0,09	0,09	0,1	0,09	0,09
Distribution of subscribers to ADSL	0,06	0,07	0,04	0,05	0,04	0,04	0,03	0,04	0,03
Postal cover	0,28	0,29	0,26	0,25	0,25	0,28	0,26	0,26	0,28
Occupancy rate of classrooms	0,09	0,07	0,09	0,1	0,11	0,08	0,1	0,09	0,1
Number of hospital beds	0,06	0,05	0,07	0,07	0,06	0,05	0,07	0,05	0,05

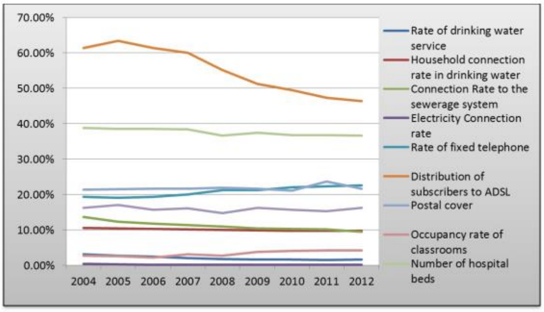
Source: calculation of the authors

The synthetic infrastructure indicator can be calculated by the following formula:

$$IF_j = \sum_{i=1}^{8} \lambda_i Z_{ij}$$

Such as IF_j is the synthetic infrastructure indicator, λ_i is the weighting of X in the synthetic indicator, Z_{ij} is normalized variable.

Appendix 2: Evolution of the Gini index (2004-2012)



Appendix 3: Results Pesaran stationarity test:

Infrastructure indicators	**Calculated Statistics: CIPS**	
	y_{it}	y_{it}^{*}
Rate of drinking water service	-2.05	-2.2***
Electricity Connection rate	-1.37	-1.52
Occupancy rate of classrooms	-1.24	-1.37
Rate of fixed telephone	-1.76	-1.54
Postal cover	-0.86	-0.79
Distribution of subscribers to ADSL	-1.32	-1.24
Number of hospital beds	-2.15	-2.08
Household connection rate in drinking water	-1.53	-1.69
Connection Rate to the sewerage system	-1.31	-1.11
Infrastructure indicator	-1.73	-1.62
Critical value at 1%	-2.20	

(***) significant at 1%