EVALUATION OF TUNISIAN REGIONS' EFFICIENCY USING DEA AND TOBIT MODELS

Lamia Mokaddem

Working Paper 862

November 2014

Send correspondence to:
Lamia Mokaddem
University of Tunis El Manar, Tunisia
mkademlamia@yahoo.fr

First published in 2014 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Abstract

The main objective of the Tunisian regional policy in the forthcoming period is to reduce disparities between the regions. Within this scope, regions try to benefit from a set of socioeconomic factors in order to reduce poverty, to increase employment and achieve a standard rate of economic growth. The purpose of this paper is to evaluate the effectiveness of the way each Tunisian delegation utilizes its resources in order to achieve regional development. Data Envelopment Analysis (DEA) is adopted in order to evaluate the efficiency of Tunisian delegations in the year 2010, the year preceding the Tunisian revolution. Efficiency scores are consequently explained using Tobit analysis with a set of relevant explanatory variables playing the role of non-discretionary inputs.

JEL Classification: R11, R15, O18,

Keywords: efficiency, data envelopment analysis, regional disparities, Tunisia

ملخص

الهدف الرئيسي للسياسة الإقليمية التونسية في الفترة المقبلة هو تقليص الفوارق بين المناطق. وضمن هذا النطاق تحاول المناطق الاستفادة من مجموعة من العوامل الاجتماعية والاقتصادية من أجل الحد من الفقر وزيادة فرص العمل وتحقيق معدل قياسي للنمو الاقتصادي. والغرض من هذه الورقه هو تقييم فعالية كل طريقة يستخدمها الوفد التونسي موارده من أجل تحقيق التنمية الإقليمية. واعتمدت هذه الورقة على تحليل مغلف البيانات (DEA) من أجل تقييم كفاءة الوفود التونسية في سنة 2010، وهي السنة التي سبقت الثورة التونسية. ويوضح التحليل بالتالي كفاءة استخدام تحليل Tobit مع مجموعة من المتغيرات التفسيرية ذات الصلة والتي تلعب دور المدخلات غير الاختيارية.

1. Introduction

In post-revolution Tunisia, the priority of promoting balanced regional development has been elevated to rank among the fundamental values of the Tunisian revolution and has become as important as the rights to dignity, liberty, equality and justice.

Social injustice and regional disparities have, in a way, led to social protests that ultimately gave rise to the revolution of 2011. Today, in order to guarantee political stability and economic prosperity for a broader segment of the population, Tunisia is attempting to create a more democratic and accountable political system and through that to create a new development model that can reduce regional disparities and foster social justice. This means that the success or failure of future Tunisian development strategies will not be judged only in light of the criteria prescribed by the market economy, and the 'good governance'. Rather, the success and failure will also be measured in terms of the rate of convergence of living conditions of the lagging interior regions to those of the coastal regions where there are concentration of public investments, services, and economic activities.

Considering the present circumstances, it is important to examine the economic efficiency of the Tunisian regions and the purpose of this paper is to study and explain the Tunisian regional efficiency for 2010, the year preceding the Tunisian revolution.

The study is conducted in two stages. In the first stage, we identify the efficiency of using resources in 252 Tunisian delegations by means of Data Envelopment Analysis (DEA). By applying DEA we obtain efficiency scores for the delegations. Fully efficient regions get a score of one and others get scores of below one. In the second stage, we explain efficiency differences between regions by applying Tobit regression using cross-section data (2010). Explanatory variables include regional characteristics such as population density, distance from national centers, structure of regional economy and the existence of human capital.

The present paper is organized as follows. Section 2 provides an overview of regional development in Tunisia. Section 3 briefly describes the DEA analytical framework. Section 4 presents and discusses the empirical results of the non-parametric efficiency analysis. Section 5 presents results from the econometric model. Section 6 offers some conclusions and political implications.

2. Overview of the of the Tunisian Regional Economic Development

Tunisia is divided into 24 governorates and those are divided into 264 "delegations" or "districts". There are seven main geo-economic regions:

- Greater Tunis (4 governorates: Tunis, Ariana, Manouba and Ben Arous)
- The North-East (3 governorates: Bizerte, Zaghouan and Nabeul)
- The North-West (4 governorates: Jendouba, Beja, Kef and Siliana)
- The Mid-East (4 governorates: Sousse, Monastir, Mahdia and Sfax)
- The Mid-West (3 governorates: Kairouan, Kasserine and Sidi Bouzid)
- The South-East (3 governorates: Gabes, Medenine and Tataouine)
- The South-West (3 governorates: Gafsa, Tozeur and Kebili)

Among these seven regions, the three regions in the North-West, Mid-West and the South happen to be the least developed as they lack adequate economic and social infrastructure and suffer from poor education levels of the population. These deprived regions accommodate 30% of the Tunisian population and less than 8% of total enterprises.

Conversely, the Greater Tunis, the Center, and the North-East are home to 60% of the population in 2008 and are highly urbanized with major cities such as Tunis (9.7% of the population), Sfax (8. 8 %) and Sousse (5.8%). They host almost 90% of total enterprises and attract 95 % of foreign investment in companies.

Actually, the country's *interior* and *coastal regions* did not have the same access to basic services such as water services (99% in Tunis and 54.6% in Sidi Bouzid), sanitation (96%in Tunis, and 26.4% in Mednine), proximity to school and the availability of a health center. These inequalities between the regions cause imbalanced access to social services, education and health.

Internal regions are less served in terms of public services. Sidi Bouzid, Medenine and Gafsa, for example, are the least served governorates in basic healthcare with less than 1.7 general practitioners (public health) per 10,000 inhabitants against the national average of 2.7, and 4.3 for Greater Tunis. The same results can be observed in terms of the number of colleges (secondary education institutions). Illiteracy rate is 30% in these areas compared to 15% in the North-East and the nationwide level of 23%.

2.1 Living standards

Consumption has significantly increased from the year 2000 to 2010. Table 1 shows the annual growth rate of nominal consumption per capita at 6.5%. However, taking into account the inflation registered for the period, we notice that the real consumption per capita has increased only by 2.9% per year during the same period.

Consumption growth was positive in all the regions but it was very low in the Mid-West which has one of the lowest consumption levels (per capita) in Tunisia. The highest growth rates were recorded in the South-East and the South-West, yet consumption levels still remain low in these regions.

The evolution of household consumption revealed clear disparities between the various regions in terms of living standards. The internal regions (particularly in the Mid-West) show the lowest living standards due to the lack of economic opportunities. Greater Tunis, where most of the industrial and service activities are concentrated, knows the *highest level* of expenditure *per capita***.** In this area, household consumption expenditures (TND 3498) are more than twice higher than the Mid-West region (TND 1623). The South-West shows a high growth rate but the consumption level of the region remains low.

The evolution of annual expenditures per capita in the central regions between 2000 and 2010 showed net disparities between the regions. Inland areas showed the lowest standards of living (TND 1623) in addition to a lack of sufficient economic potential. In contrast, in Greater Tunis, consumption level is the highest in the country (TND 3498).

2.2 Poverty

The extreme poverty line is set at 757 dinars per year per person in large cities against 571 dinars per year per person in rural areas (National Institute of Statistics 2012). It should be noted that extreme poverty rate was 4.6% in 2010 against 7.6% in 2005 and 12% in 2000. The poverty rates have declined in all the regions between 2000 and 2010 from 12% to 4.6% nationally, except in the Mid-West and South-West, where the decrease is statistically insignificant. The Mid-West (including Sidi Bouzid and Kasserine) and the South (including Gafsa, Kebili and Medenine) remain the poorest regions. The extreme poverty rate of the Mid-West was six times higher than that of Greater Tunis in 2000 and became thirteen times higher in 2010.

2.3 Unemployment

Unemployment is especially severe in internal regions, which are also the poorest. Since 2004, unemployment rates have exceeded 20% in the region of Kasserine (21%), Gafsa (28%), and Tataouine (24%), compared to the national rate of 13% in 2010. However, Gafsa (47%), Sidi Bouzid (41%), Kebili (43%), and Jendouba (40%) have the highest unemployment rates for graduates, while the national average is 23%.

The Tunisian economy is characterized by high unemployment among young graduates and by skill adaptation in the labor market. It was when this rate reached 14% (for individuals aged 23 to 29 years) that a revolution burst to express the anger and *discontent* of the population over high rates of unemployment. In fact, on Friday, December 17th, Mohamed Bouazizi a young *university graduate who used to sell fruit on the side of the road* in the rural town of Sidi Bouzid, set himself on fire in an act of desperation. Demands for decent jobs and more equity have not yet been satisfied, and youth, who have been the main force behind the revolution, are still in despair.

3. Data Envelopment Analysis (DEA)

In this section, we first present briefly the Data Envelopment Analysis (DEA) method. Then we summarize some regional economic studies that have applied this method.

3.1 The DEA method

This nonparametric method of efficiency evaluation was initiated by Charnes, Cooper and Rhodes (1978) and was extended by Banker, Charnes, Cooper (BCC, 1984) by including variable returns to scale. DEA approach uses linear programming techniques to analyze consumed inputs and produced outputs of the decision making units (DMUs) and builds an efficient production frontier based on best practices. The efficiency of each decision making unit is then measured in relation to this frontier. This relative efficiency is calculated based on the ratio of the weighted sum of all outputs and the weighted sum of all inputs.

Regional applications of DEA consider that there are N regions (DMUs) to be analyzed. Each of them uses m inputs to produce s outputs. Assume $x_{ij} > 0$ is the amount of inputs i used by the region j and $y_{rj} > 0$ is the amount of outputs r produced by region j. In this study, it is assumed that the objective is to maximize the outputs produced by regions using a standard level of inputs; hence, an output-oriented model is considered as more suitable than an input-oriented model.

The output-oriented DEA-CCR (Charnes, Cooper and Rhodes 1978) model can be described as follows:

$$MAX\ \vartheta$$

$$s.t \sum_{j=1}^{N} x_{i,j}\lambda_j \le x_{io} \quad i = 1,2....m$$

$$\sum_{j=1}^{N} y_{r,j} \quad \ge \vartheta y_{ro} \qquad r = 1,2....,s$$

$$\lambda_j \ge 0 \qquad\qquad j \ne o$$

Where, y_{ro}, x_{io}:	The r^{th}output and i^{th} input for a region o under evaluation.
λj , :	The vector of weights (coefficients of linear combination) of the DMUs .
ϑ * :	The decision variable which represents the relative technical efficiency of the region.

Under the assumption of constant returns to scale (CRS), there are no economies (or diseconomies) of scale present. The size of the delegation is not considered to be relevant in assessing its efficiency. So small delegations (in terms of population), can produce outputs with the same ratios of input to output, as can larger delegations. However, this assumption may be inappropriate for regional development and policy implications on efficiency amongst the Tunisian delegations, because economies of scale may exist.

Therefore in this study we consider the Variable Returns to Scale (VRS) Data Envelopment Analysis (DEA) model and we use the following output-oriented BCC formulation of the DEA method by Banker, Charnes and Cooper (1984):

$$e_0 = Max\,\vartheta_0$$

$$Subject \sum_{j=1}^{n} \lambda_j x_{ij} \le x_{ij0} \qquad \text{i} = 1,...\text{m}$$

$$\vartheta_0 y_{rj0} - \sum_{j=n}^{j=1} \lambda_j y_{r,j} \le 0 \qquad \text{r} = 1,....\text{s}$$

$$\sum_{i=1}^{n} \lambda_j = 1$$

$$\lambda_j \ge 0 \qquad \forall \text{j}$$

Where ϑ_0 is the scalar expansion factor for DMU j_0 currently assessed, y_{rj} is the amount of the r^{th} output to unit j , x_{ij} is the amount of the i^{th} input to unit j , λ_j are the weights of unit j.

3.2 Regional studies applying the DEA method: A brief overview

Several regional applications of DEA have emerged along the years. Charnes et al. (1989) applied this method to evaluate the economic performance of 28 Chinese cities in 1983 and 1984. Tong (1996/1997) used DEA to investigate the changes in production efficiency in 29 Chinese provinces. Bernard and Cantner (1997) applied the empirical DEA to selected regions of the French economy from 1978 to 1989. In a recent study, Maudos et al. (2000) analyzed the relationship between efficiency and production structure in Spain from 1964 to 1993. Susiluoto and Loikkanen (2001) studied inter-regional and inter-temporal differences in efficiency (or productivity) in Finnish regions during the period 1988-1999. Susiluoto (2003) examined efficiency rates for the 83 Finnish and 81 Swedish regions during the period 1988-1999. Axel et al. (2010) identified and examined efficiency in 439 German regions. They show that the regions' efficiency is driven by an arguably spatial and a non-spatial structural factor. Nah and Jeong (2010) measured the efficiency of the Korean and Chinese large cities and then explored the implications on the two countries' efficiency in these cities. Rabar (2013) evaluated regional efficiency of Croatian counties over three years (2005-2007) using VRS data envelopment analysis model. The study identifies efficient counties as benchmark members and inefficient counties are analyzed in detail to determine the sources of inefficiency. Finally, Dzemydaitė and Galinienė (2013) applied DEA analysis to evaluate the efficiency of Lithuanian regions. The results identified four efficient regions (Vilnius, Klaipėda, Utena and Marijampolė) and five inefficient regions (Alytus, Tauragė, Kaunas, Šiauliai, Panevėžys). The study helped to formulate the benchmarks for regional development.

4. Data and Models in The DEA Estimation of Regional Efficiency Scores

4.1 Data

In our analysis we assess the relative efficiency of individual Tunisian delegations for 2010, within each of the above-mentioned twenty four governorates defined according to the Tunisian nomenclature of territorial units having already considered the desegregation level. The data was obtained from the National Institute of Statistics (2012).

To use the DEA approach in order to obtain efficiency measures, we need data on the delegation's inputs and outputs. The selection of inputs and outputs is based on the available information and indicators. In Table 2, we present the main variables taken into consideration in calculating the DEA.

The first goal indicator to be maximized is the per capita income growth. However, no local income measures used by local governments were available. To overcome this problem, we

selected human capital indicators registered in delegation accounts for the year 2010 as a measure for the delegation's economic growth; a better measurement tool would be that of productivity growth. Since we do not observe outputs, it is hard to measure productivity (Glaeser et al. 1992). For Glaeser and Saiz (2003) education share is a particularly powerful predictor of income growth. The authors find that cities with higher skills are growing because they are becoming more economically productive (compared to cities where there are less skills). They say their analysis implies that "city growth can be promoted with strategies that increase the level of local human capital." They assert that economic revitalization efforts should concentrate on "basic services, amenities, and quality public schools that will lure the most skilled," and on boosting the education level of loc00al residents. Here, the share of students with a *bachelor degree (HUM)* is used as a *measure of quality of education and as an indicator of* per capita income growth. The second goal indicator to be maximized is living standards (CONS) measured by consumption per capita. The third goal indicator to be maximized is the share of people who live in families with purchasing power parity (PPP) equal to $1 per day. The DEA variable to be maximized, POV, is thus defined as 100% minus extreme poverty rates. The fourth goal indicator to be maximized is the employability rate (EMP); hence, a DEA variable to be maximized, EMP, is defined as 100% minus TU; that is, the unemployment rate.

With respect to the inputs of the transformation relationship, a whole set of economic and social factors can act as resources that influence the previously identified goals. First, infrastructure—physical resources like roads and electricity infrastructures—is recognized as a key variable. It leads to a decrease in poverty and to a rise in living standards in addition to the creation of employment by acting as an incentive to investment. For the second resource component, the number of teachers and the number of secondary school buildings are used as inputs in order to detect the provision of education for every delegation. Furthermore, hospital beds per 1,000 citizens (NHO) and the number of doctors per 1,000 citizens (NDO) are used to detect the health care provision. Finally, to account for private capital formation the number of enterprises (ENTER) is used.

The software Data DEAP 2.1 version is used to measure DEA's efficiency. After calculating the DEA, we ranked the delegation according to the efficiency score. To conduct DEA, an output-oriented measure is used to quantify the necessary outputs' expansion keeping the inputs at a constant level.

4.2 DEA results

In this section, the estimates of technical efficiency for the 252 delegations in Tunisia are presented.

The individual and complete DEA results for every delegation in each of the twenty four governorates are presented in Appendix.

From table 3 we notice that efficiency scores of Tunisian delegations range from 0.28 to 1. There are 29 efficient delegations in the year 2010. The DEA results also show (see Appendix) 118 delegations with efficiency scores ranging between 0.7 and 0.9. This category of regions operates at an acceptable level of efficiency but needs improvements on the utilization of economic sources.

Greater Tunis, -East and Mid-East seem to be the most efficient regions concerning the utilization of resources. These regions host the highest share of efficient delegations. The high efficiency of these regions emanates from the favorable conditions such as the existence of effective infrastructures and good local governance.

It is possible to note by comparing the average of efficiency scores observed within regions, that the North-West, the Mid–West and the South-West regions have the lowest efficiency

scores (an average of 0.73). Consequently, it can be roughly stated that deprived regions produce 27% less output than the efficient areas for the same amount of inputs. The low efficiency scores of these deprived regions reflect the rather fragile situation in these regions that comes along with low living standards, poor level of education and high poverty.

5. Explaining Delegations' Efficiency

5.1 Tobit regression model

Tobit model (Tobin 1958) is known as a truncated or censored regression model. In this second part of the study, Tobit analysis is used in order to explain the efficiency differences among delegations for the year 2010. The censored DEA efficiency score lies between 0 and 1 with the highest being 1.

Tobit model can be defined as:

$$\vartheta_i^* = X_i \beta + \mu_I \quad (1)$$

$$\vartheta_i = \vartheta_i^*, \text{ if } \vartheta_i^* > 0$$

$$\vartheta_i = 0 \text{ , otherwise.}$$

X_i is a vector of explanatory variables, i refers to region and β is a vector of parameters to be estimated. ϑ_i^* is a latent variable which can be viewed as a threshold beyond which the explanatory variables must affect in order for ϑ_i to "jump" from 0 (here being inefficient) to some positive value (being efficient in various degrees).

For the explanatory variables in the Tobit regression model, we use the following. **Population density** of the region (AGGL) is aimed to catch agglomeration effects. It is calculated as the (log) ratio between regional population and size (square kilometers).

The state of knowledge or education level is measured by the percentage of people graduating from university (HT). This measure is associated with "talents" or the creative class. As a measure of **concentration** of private sector economic activity, we use regional Herfindahl index measure (SPEC). It is calculated in terms of the city's number of firms per sector in a city. It could take values between zero and one. High values of the Herfindahl index indicate more pronounced specialization. According to the Marshall's *view*, specialized regions would have skilled workers and a greater innovative performance. Domestic economic accessibility of the regions (DISTANCE) is measured inversely by **distance** variable. It is the distance in kilometers between each delegation from the district capital. Economic geography supports that proximity is essential in order to access spillovers, whether pecuniary or non-pecuniary, originating from the interaction between people, firms and institutions, through vertical and horizontal linkage.

Thus we apply Tobit regression model defined as:

$$\vartheta_i = \alpha_0 + \alpha_1 . AGGL_i + \alpha_2 . H_i + \alpha_3 . DISTANCE_i + \alpha_4 . SPEC_i + \varepsilon_i \quad (2)$$

5.2 Results from Tobit regression model

Table 4 includes results from the Tobit regression of DEA coefficients for the above mentioned set of explanatory variables (see equation 1). We excluded the delegations for which data was not available for at least one sub-indicator. Delegations excluded for this reason were the following: Douz north and Douz south.

Table 4 shows that the population density (AGGL) coefficient is positive and significant in models (1.a) and (1.b) but when we introduce the indicator of distance (DISTANCE) in model (1.c) we fail to notice a robust positive effect of this level of population density on efficiency.

The positive coefficient for population density indicates the presence of agglomeration economies. This suggests that densely populated cities often providing a larger home market, rich physical and institutional infrastructure in addition to a large number of financial, legal and social services may be advantageous for efficiency of resources and investment. According to Krugman (1991b), manufacturing firms tend to locate in regions with larger market demand to realize scale economies and minimize transaction costs.

We find that tertiary education seems to be important. This result suggests that higher education institutions have an important role to play in regional development. They achieve this through a number of mechanisms such as providing high-level skills in the workforce so that they attract high-technology industries generating high income in the region. Secondly, higher education institutions contributing to the development of a knowledge-based economy improve access and use of technology and improve the competitive advantage of the region. Finally, these institutions promoting entrepreneurship can be used to provide employment.

Similar to other studies (Loikkanen and Susiluoto 2006; Loikkanen et al. 2011; and Afonso and Fernandes 2008), our results show a significant negative impact of distance on the efficiency of delegations. Being spatially further, the economic and political capital seems to be disadvantageous to local governments; since they may experience a greater migration of highly skilled workers in addition to a limitation in investment. On the contrary, governorates that are close to Tunis may have the ability to exercise direct influence on national economic politics to their advantage.

Finally, we find positive and statistically insignificant estimates for the coefficient of the specialization variable. Our results suggest that externalities of Marshall Type do not affect the efficiency of the regions. An increase in regional specialization towards a particular industry does not increase regional innovativeness.

6. Conclusions and Policy Implications

In this paper efficiency differences between 252 Tunisian delegations in 2010 were examined by using Data Envelopment Analysis (DEA) and Tobit analysis.

Regional efficiency scores were first estimated with a DEA model, ranging from a basic four outputs–six inputs case. Outputs included regional quality of education, living standards, population above poverty line, and employability rate. Inputs included the number of secondary school buildings, the number of teachers, the number of doctors per 1,000 citizens, the number of hospital beds per 1,000 citizens, access to safe water (% of population), paved roads (% of total roads), and to electricity (% of population), and the number of enterprises.

According to the DEA estimates regional differences in efficiency proved to be considerable. In 2010 only 29 delegations were located on the analytical production frontier, 108 delegations had an acceptable level of efficiency and 115 were inefficient. The most efficient delegations were found in Great Tunis, the North-East and the Mid-East regions, while the most inefficient delegations were located predominantly in the North-West, Mid-West and the South.

In the second part of the study, Tobit analysis was used in order to explain the (in)efficiency differences among delegations. For the year 2010, empirical results show that delegations with high population densities were significantly more efficient. Efficiency decreases with distance, which is a result confirmed by several other studies. Additionally, the existence of a significant percentage of high-school graduates strengthens efficiency.

These results confirm the lack of an efficient regional policy in Tunisia. More precisely, the lack of public services, and the lack of adequate social and economic infrastructures has led to grave economic consequences for the inefficient internal regions. Therefore, social justice is

not achieved. The distribution pattern of public and private investments seems to favor the coastal regions.

In Tunisia, the challenge in the realization of regional development objectives is not mainly due to a lack of public resources, but rather to a lack of good local governance that empowers local authorities, promotes community participation and favors transparency. Local governance creates greater autonomy for local governments and improves the efficiency of public services once local governments are democratically elected. This will facilitate the conception and implementation of development strategies that are more adapted to the local population's needs.

Beyond this policy that should be common to all regions, efficiency problems of the internal regions (North-West, Mid-West and the South) also require specific measures such as:

- Providing funding to inefficient rather than efficient regions: public investment, especially basic investment, should be equitably distributed among regions with objective criteria taking into account the level of poverty, the unemployment rate and the available utilities and infrastructure in the governorates.
- Developing infrastructure to promote industrialization, to sustain agriculture and to facilitate trade and communication between the governorates and the neighboring countries.
- Modernizing the economic structure and encouraging the diversification of industries.
- Expanding and improving business opportunities and the business climate to attract and maintain skilled labor and private investments in the internal regions.
- Coordinating industrial policies among governorates via a center of industrial policy coordination.
- Reviewing the different mechanisms related to social policy (housing, education, training and basic health).

This study not only helps in evaluating efficient DMUs, but it also identify the inefficient DMUs in order to conduct appropriate strategies that will help to overcome regional developmental constraints.

References

Afonso, *A,*. Fernandes (2008), "Assessing and explaining the relative efficiency of local The Journal of Socio-Economics 37, 1946–1979.

Axel, S., S. Léopold, and R. Jan. 2010. Decomposing regional efficiency. Working Paper Series in Economics no.10, Karlsruhe Institute of Technology (KIT), Department of Economics and Business Engineering.

Banker, R. D., A. Charnes and W. W. Cooper, 1984, "Models for the Estimation of Technical and Scale Inefficiencies in Data Envelopment Analysis", Management Science, 30, 1078-1092.

Bernard, J. and U. Cantner. 1999. French regional performance and variety. A non-parametric frontier approach.in PYBadillo and J.C Paradis (ed), La Méthode DEA –Analyse des performances, Paris Hermes sciences de publication, pp255-73.

Charnes, A., W. Cooper, and S. Li. 1989. Using data envelopment analysis to evaluate efficiency in the economic performance of Chinese cities. *Socio-Economic Planning Sciences* 23(6):325–44.

Charnes, A., W. W. Cooper, and E. Rhodes. 1978. Measuring the efficiency of decision making units. *European Journal of Operational Research* 2, 429–44.

Dzemydaitė, G., and B. Galinienė. 2013. Evaluation of regional efficiency disparities by efficient frontier analysis. ISSN 1392-1258. *Ekonomica* 92(4), 21-36.

Glaeser, E. L., H. D. Kallal, J. A. Scheinkman, and A. Shleifer. 1992. Growth in cities. Scholarly Articles 3451309, Harvard University, Department of Economics.

Glaeser, E. L., and A. Saiz. 2003. "The rise of the skilled city". NBER Working Papers 10191.

Krugman (1991),"Increasing returns and Economic geographical", Journal of political Economy, vol 99,n°51,483-499.

Loikkanen, H. A. 2002. An evaluation of economic efficiency of Finnish regions by DEA and Tobit models. 42st Congress of the European Regional Science Association, Dortmund, Germany, 27–31 August.

Loikkanen, H.A. and Susiluoto, I. (2006): Cost Efficiency of Finnish Municipalities in Basic Service Provision 1994 – 2002. Helsinki Center of Economic Research Discussion Paper No. 9.6

Loikkanen, H.A., Susiluoto, I. and Funk, M. (2011): The Role of City Managers and External Variables in Explaining Efficiency Differences of Finnish Municipalities. Helsinki Center of Economic Research Discussion Paper No. 312

Maudos, J., J. Pastor, and L. Serrano. 2000. Efficiency and productive specialization: An application to the Spanish regions. *Regional Studies* 34(9):829–42.

Nah, H. S., and H. Y. Jeong. 2010. The comparative study on efficiency of the large-sized cities in Korea and China. *The journal of the Korean economy* 11(1):31–53

National Institute of Statistics. 2012. *Measuring poverty, inequalities and polarization in Tunisia 2000-2010.* Tunisia: National Institute of Statistics.

Polyzos, S. S. Niavis, and T. Pnevmatikos. 2012. Longitudinal evaluation of Greek regional policies using Window Data Envelopment Analysis. *Polyzos-Niavis-Pnevmatikos,* T Pnevmatikos - MIBES Transactions, *305-317*

Rabar, D. 2013. Assessment of regional efficiency in Croatia using Data Envelopment Analysis. *Croatian Operational Research Review (CRORR)* Vol. 4, 76-88

Susiluoto, I., and H. Loikkanen. 2001 a. The economic efficiency of Finnish regions 1988-1999: An application of the DEA Method. Paper presented at the 41st Congress of the European Regional Science Association, Zagreb, Croatia, 29 August- 1 September, 2001

Susiluoto, I., 2003. Effects of ICT on regional economic efficiency. Helsinki City Urban Facts Office: web publications 2003, 16

Tobin, J. (1958), "Estimation of Relationships for Limited Dependent Variables," Econometrica, 26, 24-36.

Tong, C. (1996): Industrial Production Efficiency and its Spatial Disparity among the TVEs of China: A DEA Analysis. Singapore Economic Review, Vol. 41, No. 1, 85-101.

Tong, C. (1997): China's Spatial Disparity within the Context of Industrial Production Efficiency: A Macro Study By the Data Envelopment Analysis (DEA) System.Asian Economic Journal, Vol. 11, No. 21, 207-217.

Table 1: Aggregate Consumption Per Capita by Region

	Consumption (current prices)		Average annual growth rate (2000-2010)	Consumption aggregate (constant prices 2005)		Average annual growth rate (2000-2010)
	2000	2010	%	2000	2010	%
Capital	1738	3228	6.4	2331	2624	2.8
North-East	1147	2113	6.3	1547	1718	2.7
North-West	979	1613	5.1	1292	1311	1.5
Mid-East	1483	2693	6.1	1902	2189	2.5
Mid-West	841	1491	5.9	1034	1212	2.3
South- East	978	2198	8.4	1574	1787	4.7
South- West	928	1853	7.2	1338	1507	3.5
Tunis	1252	2360	6.5	1696	1919	2.9

Source: National Institute of Statistics (2012)

Table 2: Variables Used to Construct the DEA Model

Inputs (minimize resource use or conditions)	
Education	School buildings measured by the number of secondary school buildings Number of teachers (TEACH)
Health	Number of doctors per 1,000 citizens (NDO), Number of hospital beds per 1,000 citizens (NHO),
Sanitation	Access to safe water (% of population), (WATER)
Road infrastructure	Roads, paved (% of total roads) (ROAD)
Electricity infrastructures	Rate of access to electricity (% of population) (ELEC)
Private capital formation inputs	Number of enterprises (FIRM)
Outputs (maximize output or goal)	
Growth or quality of education	Students with a *bachelor degree* , (HUM)
Living standards	Consumption per capita, (CONS)
Population above poverty line	100% minus extreme poverty rate (POV)
Employability rate	100% minus unemployment rate (EMP).

Table 3: DEA Efficiency Results

Region	N. of DMUs	N. of Efficient DMUs (delegation)	Average efficiency scores	Minimum efficiency scores
Tunis	21	5	0.85	0.534 (Djebel Djelloud)
Ariana	6	1	0.78	0.631 (El Mnihla)
Ben Arous	12	0	0.8	0.603 (Mohamedia)
Manouba	8	1	0.75	0.562 (Tebourba)
Efficiency score of the Tunis District region: 0.8				
Nabeul	16	5	0.86	0,292 (Grombalia)
Zaghouan	6	0	0.65	0.451 (En-Nadhour)
Bizerte	14	1	0.77	156 (Menzel Bourguiba)
Efficiency score of the North-East region: 0.8				
Béja	9	0	0.71	0.325(Goubellat)
Jendouba	12	1	0.68	0.525 (Fernana)
Le Kef	8	0	0.57	0.108 (Kalâat Khasbah)
Siliana	11	2	0.77	0.526 (Gaâfour)
Efficiency score of the North-West region: 0.68				
Sousse	16	3	0.85	0.28 (M'saken)
Monastir	12	1	0.92	0.5 (Sahline)
Mahdia	11	3	0.88	0.72 (Bou Merdès)
Sfax	16	2	0.8	0.4 (Ghraiba)
Efficiency score of the Mid-East :0.85				
Kairouan	11	1	0.83	0.69 (EL Ouslatia)
Kasserine	9	1	0.69	0.41 (Kasserine Sud)
Sidi Bouzid	12	0	0.73	0.69 (Jilma)
Efficiency score of the Mid-West:0.75				
Gabes	6	0	0.71	0.5 (El Hamma)
Mednine	8	2	0.85	0.236 (Ben Guerdane)
TaTaouine	15	0	0.76	0.72 (Remada)
Efficiency score of the South-East: 0.79				
Tozeur	5	0	0.75	0.67 (Degach)
Kebili	6	0	0.77	0.726 (Kebili Sud)
Efficiency score of the South-West: 0.77				

Table 4: Parameter Estimates of Tobit Model Explaining the Efficiency of Delegations for 2010

	(1.a)	(1.b)	(1.c)	(1.d)	(1.e)
AGGL	.023	0.012	.00052		
	(3.98)	(1.63)	(0.05)		
HT		0.057	.0062	.0063	.007
		(2.0)	(2.16)	(2.68)	(2.85)
DISTANCE			-.0003	-.0003	-.0003
			(-1.95)	(-2.55)	(-2.25)
SPEC					.130
					(1.02)
Constant	0.66	.68	.78	.78	.74
	(20.3)	(20.35)	(13.15)	(28.8)	(17.4)
Log likelihood =	45.7	47.7	49.6	49.6	50.13
LR chi2(1) =	15.37	19.42	23.2	23.2	24.4
Prob > chi2 =	0.0001	0.0001	0.0000	0.000	0.0000
Number of observations	250	250	250	250	250

Notes: Values between parentheses are estimated t-student

Appendix: DEA Results

Table A1: DEA Results for Delegations of Greater Tunis

Tunis	**0.85**	**Ben Arous**	**0.8**
Carthage	0.841	Ben Arous	0.761
La Medina	0.882	La Nouvelle Medina	0.708
Bab El Bhar	0.926	El Mourouj	0.765
Bab Souika	0.977	Hammam Lif	0.898
El Omrane	0.994	Hammam Chôtt	0.78
El Omrane Supérieur	0.817	Bou Mhel El Bassatine	0.947
Ettahrir	1	Ezzahra	0.863
El Menzah	1	Radès	0.855
Cité El Khadhra	1	Megrine	0.814
Le Bardo	0.783	Mohamedia	0.603
Sijoumi	0.755	Fouchana	0.689
Ezzouhour	0.641	Mornag	0.91
El Hrairia	0.716	**Manouba**	**0.75**
Sidi Hassine	0.716	Mannouba	0.794
El Ouardia	0.844	Douar Hicher	0.622
El Kabaria	0.835	Oued Ellil	0.73
Sidi El Béchir	0.772	Mornaguia	0.813
Djebel Djelloud	0.534	Borj Amri	0.952
La Goulette	0.872	Djedeida	0.735
Le Kram	0.775	Tebourba	0.562
La Marsa	0.775	El Battane	0.779
Ariana	**0.78**		
L'Ariana Ville	1		
Soukra	0.831		
Raoued	0.923		
Kalaât El Andalous	0.685		
Sidi Thabet	0.685		
Cité Ettadhamen	0,661		
El Mnihla	0.661		
Efficiency score of the Greater Tunis: 0.8			

Table 2: Results for Delegations of North-East Region

Nabeul	**0.86**	**Bizerte**	**0.77**
Nabeul	0.949	Bizerte Nord	0.854
Dar Châabane El Fehri	0.977	Zarzouna	0.771
Beni khiar	1	Bizerte Sud	1
Korba	0.899	Sedjnane	0.65
Menzel Temime	0.869	Djoumine	0.7
El Mida	1	Mateur	0.947
Kelibia	0.931	Ghezala	0.78
Hammam El Guezaz	1	Menzel Bourguiba	0.484
El Haouaria	0.878	Tinja	0.629
Takelsa	0.766	Utique	0.918
Soliman	0.782	Ghar El Meleh	0.9
Menzel Bouzelfa	0.852	Menzel Djemil	0.837
Beni Khalled	0.853	El Alia	0.918
Grombalia	0.294	Ras Djebel	0.695
Bou Argoub	0.9		
Hammamet	0.858		
Zaghouan	**0.65**		
Zaghouan	0.677		
Ez-Zeriba	0.861		
Bir Mchergua	0.592		
El Fahs	0.6		
En-Nadhour	0.451		
Saouaf	0.717		
Efficiency score of the North-East : 0.8			

Table A3: DEA Results for Delegations of North-West Region

Béja	**0.71**	**Kef**	**0.57**
Béja Nord	0.727	Kef Ouest	0.61
Béja Sud	0.695	Kef Est	0.647
Amdoun	0.838	Nebeur	0.43
Nefza	0.819	Sakiet Sidi Youssef	0.52
Teboursouk	0.782	Tajerouine	0.55
Tibar	0.697	Kalâat Snan	0.773
Testour	0.702	Kalâat Khasbah	0.108
Goubellat	0.325	Djerissa	0.368
Medjez El Bab	0.798	El Ksour	0.854
Jendouba	**0.68**	Dahmani	0.903
Jendouba	0.757	Es-Sers	0.558
Jendouba Nord	0.757	**Siliana**	**0.77**
Bou Salem	0.532	Siliana Nord	0.69
Tabarka	0.904	Siliana Sud	0.755
Ain Draham	0.575	Bou Arada	0.554
Fernana	0.527	Gaâfour	0.526
Ghardimaou	0.568	El Krib	0.957
Oued Meliz	0.568	Bourouis	1
Balta - Bou Aouane	1	Makthar	0.922
		Er-Rouhia	0.609
		Kesra	0.841
		Bargou	0.814
		El Aroussa	0.817
Efficiency score of the North-West region: 0.68			

Table A4: DEA Results for Delegations of Mid-East Region

SOUSSE	**0.85**	**Mahdia**	**0.88**
Sousse Medina	0.855	Mahdia	0.951
Sousse Riadh	0.765	Bou Merdès	0.72
Sousse Jawhara	0.88	Ouled Chamekh	0.817
Sousse Sidi Abdelhamid	0.798	Chorbane	0.911
Hammam Sousse	0.956	Hebira	1
Akouda	0.997	Essouassi	0.805
Kalaâ Kebira	0.939	El Djem	0.808
Sidi Bou Ali	0.774	Chebba	0.926
Hergla	1	Melloulech	1
Enfidha	0.597	Sidi Alouane	0.896
Bouficha	1	Ksour Essef	0.896
Kondar	1	**Sfax**	**0.80**
Sidi El Héni	0.901	Sfax Ville	0.94
M'saken	0.28	Sfax Ouest	0.905
Kalaâ Seghira	0.98	Sakiet Ezzit	0.94
Monastir	**0.92**	Sakiet Eddaïer	0.905
Monastir	0.939	Sfax Sud	1
Ouerdanine	0.921	Tina	0.838
Sahline	0.501	Agareb	0.838
Zermadine	0.864	Djebeniana	0.714
Beni Hassen	0.869	El Amra	0.623
Jammel	0.984	El Hencha	0.6
Bembla	0.941	Menzel Chaker	0.806
Bekalta	0.929	Ghraiba	0.407
Teboulba	1	Bir ali Ben Kelifa	0.806
Ksar Helal	0.955	Skhira	0.806
Ksibet El Mediouni	0.877	Mahres	0.749
Sayada-Lamta Bou-Hjar	0.959	Kerkenah	1
Efficiency score of the Mid-East: 0.85			

Table A5: DEA Results for Delegations of Mid-West Region

Kairouan	**0.83**	**Kasserine**	**0.69**	**Sidi Bouzid**	**0.73**
Kairouan du Nord	0.831	Kasserine Nord	0.632	Sidi Bouzid Ouest	0.835
Kairouan Sud	0.88	Kasserine Sud	0.41	Sidi Bouzid Est	0.844
Sbikha	0.744	Ezzouhour	0.686	Jilma	0.694
EL Ouslatia	0.694	Sbeitla	0.954	Menzel Bouzaïenne	0.718
Haffouz	0.898	Sbiba	1	Meknassy	0.684
El Alâa	0.834	Thala	0.57		
Nasrallah	0.708	Hidra	0.685		
Echrarda	1	Foussana	0.62		
Bouhajla	0.884	Feriana	0.591		
		Majel Bel Abbès	0.772		
Efficiency score of the Mid-West: 0.75					

Table A6: DEA Results for Delegations of South-East Region

Gabes	**0.69**	**TaTaouine**	**0.76**
Gabes Medina	0.742	Tataouine	0.752
Gabes Sud	0.758	Bir Lahmar	0.88
El Metouia	0.759	Ghomrassen	0.692
El Hamma	0.518	Remada	0.729
Nouvelle Matmata	0.755		
Mareth	0.763	**Gafsa**	**0.59**
Medenine	**0.85**	Gafsa Nord	1
Medenine Nord	0.805	Sidi Aïch	0.96
Medenine Sud	0.805	El Ksar	0.527
Beni Khedech	0.794	Oum El Araies	0.374
Ben Guerdane	0.737	Redeyef	0.479
Djerba Houmet Souk	0.96	Metlaoui	0.533
Djerba Midoun	0.96	Mdhila	0.323
Djerba Ajim	0.876	EL Guetar	0.593
Zarzis	0.91	Belkhir	0.668
		Sned	0.486
Efficiency score of the South-East: 0.79			

Table A7: DEA Results for Delegations of South-West Region

Tozeur	**0.75**
Tozeur	0.765
Degach	0.677
Tameghza	0.765
Nefta	0.82
Kebili	**0.78**
Kebili Sud	0.726
Kebeli Nord	0.88
Souk El Ahed	0.774
Douz Nord	0.806
Douz Sud	0.723
Efficiency score of the South-West: 0.77	