Impact of Investments in Public Infrastructures on Economic Performance and Private Investment in Developing Countries: A Case Study for Tunisia

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This article aims to evaluate the impact of different categories of investments in public infrastructures on economic growth and private investment in Tunisia over the period 1975-2014. By using the generalized method of moments, we estimate a simultaneous equations model containing a growth equation and a private investment equation. In the empirical study, we have introduced both economic and social infrastructures. The results demonstrate that in the two cases, the investments in public infrastructures affect positively and strongly the growth and private investment. The experience from Tunisia suggests that it is necessary to adopt economic policies that develop the physical infrastructures and improve the quality of human capital for sustainable economic growth in developing countries.

Keywords: Economic growth, private investment, economic infrastructures, social infrastructures, simultaneous equations model.

JEL Classifications: C32, H54, L9, O1, R42.

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Introduction

The theories of endogenous growth have revalorized the role of the State in the sectors of health (Barro, 1996), education (Lucas, 1988; Romer, 1990) and infrastructure (Barro, 1990; Glomm and Ravikumar, 1997; Turnovsky 1996; Agenor, 2008, 2010). These authors among others note that the different infrastructures have the characteristics of non-exclusion and non-rivalry. Also, they argue that public infrastructures (roads, railways, ports, airports, hydroelectric dams, power stations, telecommunications etc.) are public property which their financing cannot be assured optimally by individual private agents. Therefore, they constitute the principal field of intervention of the State in the economy (Barro, 1991; Easterly and Rebelo, 1993; Easterly and Levine, 1997).

The literature of development economics has emphasized the importance of public infrastructure in economic growth and productivity. Several studies have shown that these types of infrastructure are largely used in all sectors of economy. Calderón and Servén (2003) indicate that, three types of infrastructures (telecommunications, transport and electricity networks) contribute mainly to increase the economic growth in Latin America. Also, they say that the public infrastructures are vital components of an effective production system for the private sector. They allow a better allocation of the limited economic resources and facilitate the penetration of new broader markets of capital and employment.

Several empirical studies treat largely the link between different types of investments in public infrastructure and economic growth. These researches are based on macro-econometric models. The main objective of these researches is to analyze the role of each type of public infrastructure (economic or social) in the economic growth through their particular effect on private investment. In the same order of ideas, the present paper aims to treat the causal relationship between the governmental investments in basic infrastructures, the private sector investments and the economic growth in Tunisia. It is formed by a theoretical study concerning the productive role of public infrastructures and the quality of Tunisian public infrastructures. In the next section, we present the empirical investigation. By using a simultaneous equations model containing a growth equation and a private investment equation, we try to explore the causal relationship between public investment, private investment and economic performance in developing countries. The present work concerns the Tunisia and it is based on an econometric treatment of data in chorological series of 40 years (1975-2014).

1. Literature Review: productivity of different types of infrastructure

Economists distinguish between two types of public infrastructures, economic infrastructures and social infrastructures. The first ones are defined as infrastructures that promote economic activity, such as roads, electricity, telecommunications, irrigation, railways, ports, airports. The second ones are those that have a direct and indirect impact on the welfare of the population by promoting health and education such as, schools, hospitals, libraries…

Concerning the first type, several economists found that the transport infrastructures have the most important impact on economic growth. Marazzo et al. (2010); Chi and Bek (2013) among others argued that the impact of the transport and communication infrastructure is a topic that has attracted considerable attention in the economic literature. Also, they say that the transport infrastructures have the greatest potential to stimulate the economy in the long-run. In addition, Fernald (1999); Yeaple, and Golub, (2007) affirm that there is a strong link between investments in transport infrastructures and economic productivity. They indicate that transport service becomes an important input in the production process

Khanam (1999) studied the effects of road networks on the Canadian manufacturing industry between 1961 and 1994. By estimating a Cobb-Douglas function, the author found an elasticity of productivity of 0.47. Also, by using the data of 29 US industries between 1953 and 1989, Fernald (1999) has shown that the decline in productivity registered in the United States after 1973 (period when there was less investment in infrastructure in the United States) is more important in high intensity vehicle industries. Moreover, he found that these industries benefited disproportionately from investments in road networks. For the case of developing countries, the World Bank (2002) indicates that the deficiency of infrastructures contributes significantly to the low productivity of the factors: the electricity blackouts, the deficiencies of telecommunications systems, the quantitative and qualitative lack of the roads are all obstacles to investment, growth and poverty reduction in these countries.

To demonstrate the role of economic infrastructures in the development of economic activity, Yeaple, and Golub (2007) present their study for 12 developed and developing countries. They estimated the effects of three types of infrastructure (roads, telecommunications, and electricity) on total factor productivity in 10 industrial sectors between 1979 and 1997. They found that

among the three types of infrastructure, roads have the greatest effect on productivity in different industries. Indeed, an increase in road networks is associated with a significant increase in total factor productivity of 9 among 10 industries. While the telecommunication networks and electricity are associated with a significant increase in only two industries.

Also, investments in telecommunications have been recognized for their role in the economic development process. Roller and Waverman (2001) found that the relationship between the telecommunications' infrastructures and economic growth is no linear for 21 OECD countries between 1970 and 1990. They demonstrate that if the use of technology increases by 10% the economic growth increases by 1.5%. Chakraborty and Nandi (2011) studied the effect of telecommunication infrastructure in 93 developing countries between 1985 and 2007. They found that the effect of such infrastructures on economic growth depends on the country's development level. The authors identified three groups of countries: less-developed, emerging and more-developed. Chakraborty and Nandi (2011) found that the impact of the investments in telecommunication infrastructures is more important in the less-developed and emerging countries. For the countries of Latin America (Guatemala, Honduras, Nicaragua), Escribano and Guasch (2005) indicate that the access to the Internet increases the productivity of workers from 11% to 15%.

Gollin and Rogerson (2010); Balisacan and Pernia (2002) indicate that the agriculture infrastructures have a major role in the economic development. In developing countries the agricultural sector is very important for economic growth and poverty reduction. In this sense, these authors among others say that the improvement of productivity in the agricultural sector is an essential element for the development of rural areas. However, to improve agricultural productivity it is necessary to develop first and foremost agricultural infrastructure, such as, rural roads, irrigation system, etc. In order to demonstrate the importance of agriculture infrastructures, several studies have examined the effects of the improvement of land quality through the irrigation on poverty reduction. Balisacan and Pernia (2002) showed that in Indonesia an increase by 1% in the total irrigated area increases the average income of the poor people between 0.23 and 0.31%. This result was confirmed by Bhattarai and Narayanamoorthy (2003), in fact, authors estimate that in fourteen states in India an increase by 1% in the total irrigated agricultural land decrease poverty by 0, 37%. Moreover, Bhattarai and Narayanamoorthy (2003) find that in rural region a 1% increase in irrigated area increases the average monthly consumption by 0.21%.

Khandker and koolwal. (2011) show that, the construction of rural roads in various villages of Bangladesh allows the increase of the schooling of boys and girls by 20% and 14% respectively. In addition, Mu and van de Walle (2007) showed that the extension of rural roads networks in Vietnam increases the opportunity to have a job by 11% for the unskilled workers. In a study about China Fan, Zhang Li. and X. Zhang (2002) examine the effects of different spending of the Chinese Government on growth and poverty. They found that among the various projects, the rural roads have the greatest impact on poverty reduction; indeed, for every 10,000 Yuan invested in rural roads there will be 3.2 people out of poverty.

Another type of infrastructures has an important role in the economic development, there are the social ones. Barro (1991) indicates that these infrastructures such as education, health, water sanitation are very important components in the process of economic growth. Straub et al., (2008) argued that public spending in social infrastructure can improve the health, the worker qualification, the literacy rate, all of which can significantly improve the productivity and economic growth in a given country. According to Hall and Jones (1999), the difference in production per capita at the international level is due, among other factors, to the level of social infrastructure in each country. De and Ghosh (2004) confirm this result by demonstrating that the social infrastructures contribute effectively to the widening of regional disparities. Furthermore, De and Ghosh (2004) find that social infrastructure is needed for a better use of other types of infrastructure. From his side, Wagstaff (2002) estimates that between 1965 and 1990, the annual economic growth in the countries of East Asia increases by 1.7% if the public services in health and in education increases by 1%. Sahoo and Dash (2010) conclude that the social infrastructures play an important role to maintain a high rate of economic growth in India. Also, the authors show that between 1970 and 2006, the infrastructure output elasticity varies between 0.14 and 0.24.

In addition, the role of social infrastructure in growth is extensively studied by economists. They tried to determine the impact of this factor on the sustainable growth in long-run. Some authors treat the issue through the channel of human capital and the effect of its accumulation. Romer (1990), De Gregorio and Lee (2003) include the level of human capital in their regression in order to bring up its contribution in growth. By a panel data model, Andreosso-O'Callaghan (2002) worked on a set of 10 Asian countries over the years 1980, 1990 and 1997. The author finds that human capital, expressed by literacy rate, plays an essential role in the production, and therefore in the growth of these countries. In the same vein and by the same technique, Aghion

and Cohen (2004) work on a larger sample and over a longer period (N = 110, T = 40). By approximating human capital by the number of years of education of the workforce, they also found that the accumulation of this factor affects positively the economic growth.

Arriving at this point, we find that the contribution of the basic infrastructure in economic growth is largely confirmed. Convinced of the importance of the role of public investment, Tunisia considers an increase in its investments in order to accelerate economic development. In the next section, we will present the quality of Tunisian public infrastructures. We will talk about three types of infrastructures that will be introduced into our econometric modeling. We will have two economic infrastructures (transport and telecommunications) and one social infrastructure (higher education).

2. Public infrastructures in Tunisia

The National Institute of Statistics (INS, 2015) indicate that in Tunisia, which has covers an area of 163 610 km^2; the road network has reached at the end of 2014 about 19083 km including 6495 km of regional roads and 4745 km of national roads. Also, Tunisia has an express road network of 356.3 km in exploitation and 420.2 km currently under construction. In addition, Tunisia has a rural road network of 51 000 km among which 16 000 km are paved and 19 000 km are groomed. Also, Tunisia has a rail transportation of passengers and freight which occupies a great importance in the economic activity and a major role in the reduction of pollution. Its importance is manifested through the big projects of modernization, electrification of high-density lines and the achievement of the project of rapid rail network in Tunis; the capital of the country. The total length of the railway network has reached 2200 km at the end of 2014.

In terms of air transport, eight airports are currently operational in Tunisia (an airport was realized in the framework of partnership between the public and private sector). These airports ensure an effective distribution of air traffic on the entire territory. Also, they allow the good connection of Tunisia with its international environment. Indeed, for Tunisia an efficient air transport can support mainly the tourism activity and contribute to strengthening the economic openness. Concerning the maritime transport; the role is crucial to support the economic activities by facilitating the international commercial exchanges and strengthening the fishing sector. The achievements in this sector are 8 commercial ports and 41 fishing ports in which 7 for deep fishing.

According to the ministry of Communication Technologies and the Digital Economy (2015), in Tunisia, the sector of Information Technology and Communication has experienced a remarkable development in terms of access to telecommunications networks and the quality level of offered services. This is illustrated by the evolution of the following indicators:

- Strengthening the connexion capacity to the Internet international network to accompany the dynamic that has the country in this field. Indeed, this capacity has reached 90 Gbit /s in 2014 against 11.25 Gbit /s in 2008.
- Evolution of the number of Internet subscribers to reach 1,129,000 subscribers in 2014 against 413,900 subscribers in 2009.
- Increased number of Internet subscribers via mobile networks (3G) going from 62,800 subscribers in 2010 to 861,000 subscribers in 2014.

The same ministry indicates that the Tunisian telecommunications sector has undergone significant changes during the period 1994-2014. The number of subscribers to the fixed and mobile telephone networks reached 13.7 million in 2014 against 0.5 million in 1994. Thus, the telephone density is 125.4 lines for 100 inhabitants in 2014 against only 5.3 in 1994. It is expected that the rate of change in subscriber numbers will accelerate to more than 14.8 million subscribers at the end of 2016 giving a telephone density of 133.9 lines for 100 inhabitants. This important development is mainly explained by the continued efforts to modernize the infrastructure through the extension and upgrading of switching systems, improving service quality and diversification of the supply options and the extension and increase the capacity of the mobile network system.

Concerning the educational sector, in Tunisia, the investments in education are expressed by the big investments in the infrastructure of basic education, higher education and scientific research. This sector knew a significant development mainly through the continuous increase in the number of classrooms in basic and secondary education. For the 2013-2014 school year, the total number of classrooms reached 65,500 against 42,780 for 1994-1995 school year, so an increase by 53%. Concerning the scientific research, the number of research units reached 174 units in 2014 against only two units in 1998 and particularly the number of research laboratories has increased from 16 in 1998 to 241 in 2014. Furthermore, the number of universities has evolved in different regions and reached 198 institutions for the 2013-2014 academic year against 83 institutions for the 1994-1995 academic year. Similarly, the

upgrading program of the professional training sector has increased the number of training centers from 136 establishments in 1994 to 213 in 2014.

Although the importance of various public infrastructures is verified theoretically for several countries, few studies have focused on evaluating the effects of the composition of public spending on economic performance in Tunisia. The Tunisian government has implemented a long-run growth strategy based on the development of human capital and productive infrastructures. In the infrastructure sector, the sectoral strategy is based on the rehabilitation of existing infrastructure and on the building of new ones. In the next few years, the budget of the ministries in charge of infrastructure should develop. This work aims to answer the main question of our study: How different types of public investments in infrastructure affect growth and private investment in Tunisia?

3. Analytical framework

In this assay, we consider two types of infrastructures, economic infrastructure (transport and telecommunications) and social infrastructure (higher education). The choice is determined by: first, the growing role of transport in the national economy and private investment, then the importance of the third sector in the Tunisian economy. Finally, a country like Tunisia, where natural resources are limited, human capital has a greater role to play in the economic growth process in the long-run.

3.1 The econometric modeling

In this section, we present the technique used to evaluate the impact of different components of investment in public infrastructure on growth and private investment. The econometric model is based on the idea that public investment in infrastructure affects economic growth mainly through the private investment channel. Indeed, it is recognized that increasing the stock of public capital reduces production costs and improves labor productivity and capital efficiency (Agenor, 2005). To evaluate the impact of public infrastructure spending on economic performance, we should take into account their exact impact on private investment. In fact, we define a growth equation inspired by the increased model of Solow as specified by Mankiw, Romer and Weil (1992). In such models, human capital is treated as an additional factor of production to physical capital, population, and technology as shown in equation (1) below:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} A(t) L(t)^{1-\alpha-\beta} \quad (1)$$

Eq (1) states that the production level (Y) may be significantly affected by the physical capital (K), human capital (H), technology (A) and labor (L). If we replace human capital by public capital, we get the production function defined in equation (2) below;

$$Y(t) = K_t^P (t)^{\alpha} K_t^G (t)^{\beta} A(t) L^{1-\alpha-\beta} \quad (2)$$

In Eq (2); we have made a distinction between the private capital (K_t^P) and public capital (K_t^G). The accumulation functions of private capital and public capital are given by equations (3) and (4):

$$k_p(t) = (S^P) y(t) - (n + g + \delta) k_p(t) \quad (3)$$
$$k_G(t) = (S^G) y(t) - (n + g + \delta) k_G(t) \quad (4)$$

y= Y/AL, k_P = K_P/AL, k_G = K_G /AL represent respectively; production, physical capital and human capital per effective working unit. Also, n and g are the population and technology growth rates. We assumed that private capital and public capital depreciate at the same rate δ. S^P and S^G are the production parts invested in private capital and public capital. The combination of the production function and the accumulation equations gives the equation (5) defined by:

$$Ln\left(\frac{Y_t}{L_t}\right) = \ln(A_0) + g_t + \frac{\alpha}{1-\alpha}\ln(S_t^P) + \frac{\beta}{1-\alpha}\ln(S_t^G) - \frac{\alpha}{1-\alpha}\ln(n_t + g + \delta) \quad (5)$$

Equation 5 shows that GDP per capita in each period depends on the technology, private investment, public investment and population growth. The equation to estimate may appear as follows:

$$LGDP_t = \alpha_0 + \alpha_1 LINVP_t + \alpha_2 LINVG_t + \alpha_3 Ln_t + \varepsilon_t \quad (6)$$

The "L" placed before each variable is its logarithm. GDP is the GDP per capita, $INVP_t$ is the gross fixed capital formation of the private sector as a percentage of GDP, $INVG_t$ is the gross fixed capital formation of the public sector as a percentage of GDP, and n_t the growth rate of the active population.

By following the same principle of equation (6), we obtain an investment equation (Eq 7). Several studies have used econometric models to identify the

main determinants of private investment and business location (eg Gao, 2003). Also, they try to provide empirical validation to the various competing theoretical models. Inspired by these works, we define a function of private investment in Tunisia, where the dependent variable, private investment, depends on the real GDP, the public investment, the external debt, the inflation in Tunisia and the degree of economic openness. Equation (7) is as follows:

$$LINVP_t = \beta_0 + \beta_1 LGDP_{t-1} + \beta_2 LINVG_t + \beta_3 LDET_t + \beta_4 LOPEN_t + \beta_5 LINF_t + \varepsilon_t \quad (7)$$

In this equation (Eq 7), we have; DET represents external debt as a percentage of national income, OPEN represents the degree of trade openness of Tunisia abroad measured by the ratio of exports plus imports to GDP of Tunisia and INF is the rate of inflation in Tunisia. Based on the equations (6) and (7), we define a simultaneous equation system (system 8) in which the GDP and private investment are endogenous variables:

$$LGDP_t = \alpha_0 + \alpha_1 LINVP_t + \alpha_2 LINVG_t + \alpha_3 Ln_t + \varepsilon_t$$

$$LINVP_t = \beta_0 + \beta_1 LGDP_{t-1} + \beta_2 LINVG_t + \beta_3 LDET_t + \beta_4 LOPEN_t + \beta_5 LINF_t + \varepsilon_t \quad (8)$$

3.2 Data source and estimation technique

3.2.1 Data source

To study the impact of different categories of investment in public infrastructure on growth and private investment, we realized successive estimations by replacing by turns the variable INVG in the system (8) by (i) investments in roads as a proxy of transport infrastructure in the first model. (ii) Secondly, we introduce the investment in new information and communication technologies (ICT) as a proxy of the telecommunications infrastructure. (iii) Finally, higher education investment is used to present the social infrastructures.

The data used in the econometric investigation come from two main sources. The data on GDP, private investment, population growth, foreign debt, economic openness and inflation were taken from the database of the World Bank (World Development Indicator 2015). Concerning the data relative to investments in the transport networks, the higher education and the telecommunication infrastructure they have been collected from various

ministries in charge over the period 1975-2014: Ministry of Transport, Ministry of Communication Technologies and the Digital economy and Ministry of Higher Education and Scientific Research. The public investments provided for these period represent the amount effectively consumed by these ministries.

3.2.2 Estimation technique

Since the data are specified in time series, it is necessary to test their stationarity. The results of stationarity tests are contained in Table 1 below.

Unit root tests

Table 1

	In level		In first difference	
	ADF	**PP**	**ADF**	**PP**
LGDP	-2.456*	-2.258	-1.748***	-1.716***
LINVG	-1.085	-1.179	-6.707*	-6.442*
LINVGTr1	-1.548	-1.554	-4.847*	-4.582*
LINVGTc2	-2.245	-2.548	-4.789*	-4.458*
LINVGTHe3	-1.425	-1.426	-6.425*	-6.412*
LINVP	-1.256	-1.569	-4.256*	-4.349*
Ln	-1.548	-2.514	-5.159*	-5.125*
LDEBT	-2.254	-1.865	-4.892*	-4.558*
LOPEN	-1.478	-1.958	-6.472*	-6.256*
LINF	1.000	1.015	-5.489*	-5.451*

(*), (**), (***) significant at 1%, 5% and 10%.
(1), (2), (3) variables relative to transport, telecommunications and higher education infrastructures respectively

The augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP) indicate that all variables are non-stationary and integrated of order 1. The estimation has been made with variables in first difference. Although this technique can evacuate the long-run relationship between the variables, it allows us to avoid spurious regressions.

The estimation of the system (8) by OLS method poses the problem of endogeneity of variables. Indeed, one of the conditions of the OLS estimation is that all explanatory variables are exogenous, that is to say they are not correlated with the error term. If this condition is violated, the OLS estimators become biased and are not converging. To solve this problem, it is recommended to use the method of instrumental variables by finding a variable that is highly correlated with the endogenous variable, but that is not correlated to the error term. Only the labor force was seen as a purely exogenous variable. External debt as a percentage of national income has been used as an instrument of public investment for other variables; the lagged values were

used as instruments in accordance with the method proposed by Arellano and Bond (1991). For using the method of instrumental variables the number of instruments must be at least equal to the number of endogenous variables in each equation (Johnston and Dinardo, 1997). The exogenous variables in the strict sense can be used as instruments for them-selves.

For the present study, we found that the generalized method of moments (GMM) provides robust estimators since it requires no information on the exact distribution of errors. This method is robust even when heteroscedasticity and autocorrelation are of unknown form. The most estimators are considered as a special case of the generalized method of moments. Therefore, this method appears to be the most appropriate to the use of instrumental variables, and it is chosen for the next estimations.

3.3 Results and Recommendations

To treat the different impacts of the public investments on the growth and private investment, we start by the results of the growth equation then by those of the investment equation.

3.3.1 Results of growth equation

For the growth equation, table 2 contains the results of three models (M1, M2 and M3). According to R square, our models are statistically significant with considered explanatory power.

According the results, we found that private investment has a significant impact and affects positively the economic growth. Model 1 demonstrates that the economic growth in Tunisia increases by 0.045% if the private investments increase by 1%. In model 2, where we consider the public investment in telecommunications, we found that the economic growth enhances by 0.039% if the private investment increases by 1%. In the last case, we have a significant and positive effect of private investment in economic growth if we take into account the public investment in higher education as indicator of the investment in the social infrastructures. A magnitude of 0.022 implies that the income increases by 0.022% if the private investment increases by 1%. That is to say, if we replace the INVG in our model by investment in infrastructure of higher education the effect of private investment remains always positive and significant at 5% level.

Estimation of the growth equation

Table2

Explanatory variables	Growth equation dependent variable D(LGDP)		
	M1	**M2**	**M3**
Constant	0.0599 (0.008*)	0.0712 (0.005*)	0.0698 (0.006*)
D(LINVP)	0.045 (0.005*)	0.039 (0.025**)	0.022 (0.023**)
D(LN)	1.462 (0.566***)	2.001 (0.433***)	2.556 (0.256***)
D(LINVG)	0.018 (0.009*)	0.02 (0.007*)	0.011 (0.016**)
R^2	0.745	0.805	0.785
R^2 ajusted	0.635	0.726	0.648
SCR	0.100	0.102	0.98
Durbin -Watson	1.965	1.923	1.961

(*), (**), (***) significant at 1%, 5% and 10%.

Regarding the starting subject, we find that the public investment in transport infrastructure affects directly the growth of the GDP per capita in Tunisia. The significance is at 1%, which means when Tunisia increased the investment in transport infrastructure by 1%, the GDP per capita increased by 0.018%. This result is found very significant and confirms those of Sahoo and Dash (2010); Sahoo et al (2012); Yeaple, and Golub (2007) for the developing countries. Also, it is in accordance with the findings of Meersman and Van de Voorde (2013) who argue the bi-directional relationship between freight transport and economic growth for a set of European countries. Indeed, the impact of transports on economic growth in Tunisia is very important and they are key factors to promoting economic activity. In recent years, Tunisia has worked to obtain infrastructures at international standards. Several economists consider the developed infrastructures among the most important elements to support the private investment in the regions, strengthening the competitiveness of enterprises and the integration of the national territory. So, transport influences more and more the spatial analysis and the urban and regional planning which allows the determination of economic characteristics of Tunisia. These results confirm those of Stilwell and Birkin, (2008); Wilson and Fotheringham, (2008) whose demonstrate the positive role of transport in the territorial management furthermore in the economic growth.

In the second column of table 2, the obtained result is related to the model in which we have introduced the investment in telecommunication infrastructures. A magnitude of 0.02 implies that a 1% increase in the public investment in the telecommunication tends to increase the economic growth in Tunisia by 0.02%. At this point, we find that our result in accordance with those of Chakraborty and Nandi (2011); Roller and Waverman (2001); Shiu and Lam (2008); Savage et al., (2006) who found a positive impact of investments in telecommunications on economic growth in various countries. In a next step, we examine the effect of social infrastructure on the growth of GDP per capita, we have used the investments in the higher education. We found that each increase in investment in this sector by 1% gives an increase by 0.011% of the GDP per capita, so our result is significant at 1%. The importance of these educational infrastructures, social infrastructure more generally, is said to its role in the improvement of the quality of Tunisian human capital.

3.3.2 The estimation results of the private investment equation

The estimation results of the investment equation are in table 3. Concerning the significance of the models, we find that for the three cases the R-squared value denotes that the models are statistically significant with a good explanatory power. First, we have the impact of growth on private investment. According the results, a positive relationship is found between the two variables and a significant effect at 1% level is detected. Indeed, we can say that each 1% increase in GDP per capita in Tunisia generates an increase by 0.3% in private investment.

Estimation of investment equation

Table3

Explanatory variables	Private investment equation dependent variable D(LINVP)		
	M1	**M2**	**M3**
Constant	-0.058 (0.017*)	-0.051 (0.014*)	-0.049 (0.011*)
D(LINVG)	0.021 (0.008*)	0.018 (0.015**)	0.023 (0.007*)
D(LGDP-1)	0.311 (0.0095*)	0.285 (0.012*)	0.301 (0.0092*)
D(LDEBT)	-0.011 (0.040**)	0.015 (0.038**)	0.022 (0.026**)
D(LOPEN)	0.021 (0.035**)	0.036 (0.029**)	0.042 (0.018**)
D(LINF)	-0.015 (0.029**)	0.018 (0.020**)	0.028 (0.019**)

Explanatory variables	Private investment equation dependent variable D(LINVP)		
	M1	M2	M3
R^2	0.702	0.745	0.694
R^2 ajusted	0.622	0.656	0.536
SCR	0.922	0.935	0.102
Durbin -Watson	1.845	1.924	1.881

(*), (**), (***) significant at 1%, 5% and 10%.

Concerning the economic openness, the impact is statistically significant as an explanatory element of the development of the Tunisian private investment. According to the results in table 3, if the degree of economic openness increases by 1%, private investment may increase by 0.02%, hence the significance at the 5% level. This result validates the findings of several studies that have shown the important role of trade and economic openness to encourage domestic private investment and also the foreign investments. In their work, Barga and Mendoça (2004) argued that, for a sample of 38 developing countries, the economic openness represents a key factor to develop the territorial attractiveness for the foreign direct investment (FDI).

In Table 3, we analyzed also the relationship between inflation and private investment. A significant relationship at the 5% is detected with a coefficient of 0.015. This value shows that if the inflation rate in Tunisia increases by 1%, the private investment decreases by 0.015%. This is the negative effect of inflation on private investment. The same negative effect is confirmed for foreign direct investment by Serven and Solimano (1993) who indicated that the high rate of inflation discourages private investment. Also, a negative and significant impact is found for the external debt that has a significant impact at the 5% level.

The findings mentioned previously are obtained in the case of the first model. In other words, the model where we considered that public investment in system (8) is presented by public investment in transport infrastructure. According to results from table 3, the same conclusions can be found in two remaining cases, where we have replaced the INVG by investments in telecommunications and in social infrastructure respectively.

Concerning the relationship between transport infrastructure and private investment in Tunisia, we can say that a very direct effect is found. A magnitude of 0.021 indicates that if the investments in transport infrastructure are augmented by 1%, the private investment may increase by 0.021%. This significant and positive relationship is essentially caused by the role of transport in the development of industrial zones and also by its importance for the proper functioning of private enterprises. These results are in accordance with

several empirical researches indicating that transport infrastructures have a significant impact on productivity and structure of costs in private companies (Aschauer, 1989; Nadiri and Mamuneas, 1994; Morrison and Schwartz, 1996; Haughwout, 2001). Also, they confirm those of Erenberg (1993) who speaks about the influence of transport infrastructures on the work of private firms. He also believes that if the State does not provide these types of infrastructure, the national private sector and multinational companies operate less efficiently.

The role of investment in telecommunications infrastructure is found significant with a positive effect on the Tunisian private investment. A 1% increase in public investments in the information and communication technologies (ICT) tends to increase the private investment by 0.018%. For developing countries, ICTs represent a new lever of economic growth with very important effects. In Tunisia, ICT is one among the sectors with the fastest development rate. In addition, ICTs become indispensable elements for the effectiveness of private companies and to increase their competitive powers. These findings appear in the same order with those of Allab et al. (2000) who explain that the management of stocks and stores are mainly affected by the increased use of ICTs. Indeed, new techniques such as Radio frequency Identification Data (RFID) or Global Positioning System (GPS) can increase the service quality, relevance of information, traceability of products and also improve productivity. In this area, Tunisia works to build developed logistics zones which allow the better exploitation of these technologies in the ports and airports. In addition, there are the same results arrived at by Chakraborty and Nandi (2011) for the case of developed and developing countries and Escribano and Guasch (2005) for the countries of Latin America.

Finally, social infrastructures, represented by the higher education, have a positive and statistically significant effect on private investment. For the Tunisian case, a 1% increase in social infrastructure investment provides an increase by 0.023% in private investment. This important relationship is caused essentially by the importance of a good human capital to ensure the firm's survival in an increasingly competitive environment. Also, the creation of social infrastructure at good quality encourages the foreign investment. This result is consistent with the study of Romer (1986, 1990); Lucas (1988); Borensztein et al. (1998). The authors among others well emphasized the importance of education, health and professional training to attract investors. Moreover, they confirm the positive effect of the quality of human capital to increase the territorial attractiveness to investors which promotes the private investment and eventually all the economic activity.

Conclusion and policy implications

The role of basic infrastructure in economic growth is increasingly important, both for economic policy and development economy. Recently, the perception of the role of public spending as a growth factor has been changed remarkably in recent years. Indeed, the improvement of public infrastructures becomes a major factor for improving productive performance and private investment efficiency. Some of the economists focus on physical infrastructure (electricity, transport, communications, etc.) and some others focus on social infrastructure, notably through education and health, which improve the productivity of workers and develop their adaptation to modern techniques and technologies.

The present paper tries to evaluate the impact of different categories of public investment on economic growth and private investment. We estimated a simultaneous equation model by the generalized method of moments. The study concerns the Tunisian case over the period 1975-2014. The external debt has been used as an instrument of public investment and the lagged values as instruments of other variables. The results show that for the growth equation, the public investments in transport infrastructure and higher education have significant effects at 1% on the growth of GDP per capita. However, the impact of public investment in telecommunications is positive and statistically significant at 5%. For the private investment equation, the public investment in transport and in higher education promotes significantly the private investment. Their impacts are positive and significant at the 1%. Finally, the impact of investment in telecommunications is positive at 5%. Arriving at this stage, we can say that the role of State is very important for the realization of investments in public infrastructures that directly support private investment; furthermore the global economic growth.

In less-developed countries, the infrastructure deficit is a real problem that prevents them from taking off economically. More generally, studies on the productive characteristic of infrastructures should make it possible to better assess the transmission channels of their role, as well as better quantify their impact on growth. The specific role of the various types of infrastructure is also of interest for economic policy, since the determination of the most profitable investments takes great place in the context of fiscal consolidations. According the obtained results, we found that the impact of pubic investment on the economic growth as well as on the development of private investment is positive. Also, we can say that the public investment in education, transport and telecommunication represent a strong lever of development in Tunisia.

Furthermore, these infrastructures have a particular impact on the development of the Tunisian territorial attractiveness to the multinational companies. In the same vein, we can consider the transport, logistics and education among the major determinant of the foreign direct investments which can improve strongly the competitiveness of Tunisia. For these reasons and others, we found Tunisia today, as well as the developing countries, obliged to invest more and more in transport and logistics to encourage the entry of the multinational companies. Also, the improvement of the quality of local labor force affects significantly the entry of foreign investors which provide additional sources of private investments in the host countries. Moreover, the FDI can participate significantly in the accumulation of capitals (human, public and technological) regarded as strong factors of endogenous growth for the long period.

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