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Original Research Article

Foreign direct investment and accumulation of the technological capital in developing countries: interdependence and causality the case of Tunisia

ABSTRACT

In this article, we want to verify the nature of the relationship between the technological capital accumulation and FDI flows attracted by Tunisia over a period of 38 years (1975-2012). Using OLS method, we find that, despite the efforts exerted by Tunisia to attract FDI having the power to enhance the local technological capital, the quality of these investments and the nature of MNC implementation does not significantly affect the quality of Tunisian technological capital except a few sectors where the positive impact of FDI is still marginal.

Key-words: Foreign direct investment, technological capital, endogenous growth, economic convergence.

1. INTRODUCTION

In the late eighties, a new economic approach, not satisfied with the results of neoclassical one, sought to give a more explicit explanation to the technical progress characterized as exogenous by Solow. The founders models of the endogenous growth theories will rehabilitate the economic role of the state with a special emphasis on the positive effects of the private capital stock (Romer, 1989), human capital (Lucas, 1988), innovation technology (Romer, 1990) and the public capital stock (Barro, 1990) on the productivity of the private sector and the long-term growth. Some authors have argued that the accumulation of different capitals promote efficiently the economic growth in the long term. Indeed, growth can last a long time if it is based on a technical, human and public capital which can guarantee certain durability. But authors say that the real problem is the determination of the major factors that affect significantly the accumulation of different capitals.

Respecting the principles of the theory of endogenous growth, Romer (1986, 1990), Lucas (1988), Barro (1991), Barro and Sala-i-Martin (1995) and Grossman and Helpman (1991) say that at side of local private investment, foreign direct investment plays an important role in the long-term growth as an determinant factor of capital accumulation. This theory shows that the convergence and catch-up effect cannot take place if they are not supported by a minimum stock of human and technological capital. Bouklia and Zatla (2000) say that the FDI contributes efficiently in the expecting of the technology transfer to local capital and to improving the quality of the human capital by the learning of workforce, through the process of "learning by doing" or "learning by watching." This idea is confirmed by several other authors such as Van Pottelsberghe de la Pottery (1995), Coe and Helpman (1995), Keller (2001).

In this article, we try to treat the relationship that may exist between the FDI received by Tunisia and the quality of local technological capital. In this sense, we will place the FDI with other economic factors, which have an important influence on the accumulation of technological capital. In the first part, we discuss the theoretical link between FDI, growth and economic convergence. Thereafter, we will present the FDI impact on the technology transfer to different host countries. Finally in the empirical part, we present our model with the obtained results.

2. RELATIONSHIP BETWEEN FDI, CONVERGENCE AND ECONOMIC GROWTH: THEORETICAL STUDY

The endogenous growth theory has identified a set of factors that explain the economic growth of countries (human capital, technological capital, international commerce, economic and political stability,…). Some authors have argued that FDI represents an important channel making an easy movement of these factors between countries (Bende et al 2000;. And OECD, 2002) and they may affect positively the economic growth.

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Practically, the measurement of these effects and the determination of their nature is a difficult task. Several theorists find that the impact of FDI on host economies is largely determined by the quality of the technology offered by MNCs and also by the quality of human capital in these countries. For this reason, Görg and Greenaway (2004), Xu (2000) reported that FDI can increase the economic divergence between countries if the MNCs provide a poor technology and if the host country has a low absorption capacity. On the contrary, Romer (1993) indicates that multinational firms, by providing new knowledge to the developing countries, participate to reduce the technological gap between them and the developed countries, which is considered as an important factor for growth and economic convergence.

Bronstein, De Gregoric and Lee (1998), inspired by the work of Romer (1993), provide a first analysis of the FDI effects on economic growth in the context of an endogenous model. By reducing the cost of introducing of new goods, FDI plays an important role in economic growth; they facilitate the transfer of technology, enhance the skill level of workers and tend to increase exports and improve the competitiveness of developing countries. By working on a sample formed by 69 developing countries, according to the found results, the authors show that GDP increases by 0.8% if the country performs an increase of 1% in the ratio of FDI on GDP. Also, these authors showed that a high level of education in the host country is a necessary condition for a positive impact of the FDI on their economic growth.

In another study, Mayer-Foulkes and Nunnenkamp (2005) try to verify if the FDI stimulate the convergence between countries or not. Using disaggregated data to reflect the nature and quality of FDI, the authors want to know if the American FDI received by the developing countries promotes their convergence to the American economy. Authors found that the qualities of the host countries determine the nature of FDI impacts. For example in a country, where the level of per capita income is high enough, FDI affects positively the economic activity. In a second one characterized by a significant delay with regard to the US economy, the impact of FDI is negligible and they have no significant influence.

In addition, the authors have claimed that, for developing countries with a low or middle-income, the American FDI tends to amplify the income gap between the American economy and those of host countries. Choi (2004) found that certain factors can accelerate the convergence of economies including FDI. With a panel data on bilateral FDI flows between 57 countries of origin and 16 receiving countries for the period 1982-1997, the author concluded through the regression results that FDI, geographical proximity and a common language, are majors elements which reduce the economic gap between countries of origin and the host country.

Several researches have insisted on the role of host countries to catch up to the more robust economies by better exploiting the FDI as a good accelerator of the catching-up process. Practically, economists have explained the role of FDI in emphasizing the importance of certain factors which their presence is necessary to say that these investments accelerate significantly the economic growth and generate convergence effects to the more advanced countries. They see that countries with sufficient levels of education and economic development have more chance to obtain a higher growth rates than others. Also, authors indicate that FDI effect is not automatic and they dependent largely on the characteristics of the host country and the nature of FDI in question. Kumar and Pradhan (2005) explain that MNCs are a good generator of positive externalities and a great source of spillovers. However, the weak relationship between the MNCs and local firms in a side and the low absorptive capacity of the latter in another, are two obstacles which prevents FDI to stimulate positively the host economies.

The relationship between FDI and GDP of host countries constitute the subject of several research works. In 1999, the World Bank published a study that showed a positive relationship between the two parties. Indeed, FDI improves economic growth and the countries with high GDP attract more the international investors. Also, Wacziarg (1998) confirmed a complementary relationship between FDI and host economies. He found that, if the volume of FDI increased by 1%, the GDP increased from 0.3 to 0.4 % per capita. Another positive sign is achieved by Lipsey (2000) showing that the flows of foreign investment have a positive impact on host economies and they represent an efficient catalyst of economic growth in developing countries.

On the other part, other researches prove the negative impacts of FDI on the economies of host countries. Singh (1988) did not detect significant effects of FDI on the countries of receptions when he worked on a sample of 73 developing countries. In the same vein, an econometric study in panel data on a sample of 24 countries covering the period from 1971 to 1995 made by Nair-Reichert and Weinhold (2001). Using the causality test of Holtz-Eakin, authors found a low causal relationship between FDI and growth.

Other authors go further by talking about the eventual negative impact of foreign investment on local economies. Shatz and Venables (2000) argued that FDI can increase the global level of investment and it can improve

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productivity in some cases. Also, author indicates that a negative correlation between FDI and economic growth may exist. In particular, the author argues that if the results of FDI appear as an enhancement of capitals in the host country market, it gives a redistribution of labor-intensive industries to capital intensive industries, therefore many workers lose their jobs and then a drop in consumer demand.

3. FDI: MAJOR CHANNELS OF TECHNOLOGICAL DIFFUSION

FDI flows have an important role in the diffusion process of new technologies to developing countries. Several authors argue that FDI is likely to lead to spillovers and dissemination of advanced technologies to the local economy through different channels. These investments can encourage domestic economic activity mainly in two ways: the diffusion of technical progress by training effects and knowledge transfer, including the acquisition of new managerial and organizational techniques. Arrow (1971), Findlay (1978) give researches devoted to studied the diffusion of technology through FDI. They focus on "contagion effect" arising from MNC. They say that technology is like a disease that spreads through human contact. These studies note that technological innovation is copied more effectively in the presence of a "physical" and "continuous" contact between the partner that has the technology and one that will adopt it. In this perspective, FDI plays a very effective means of technology transfer.

In developing countries, imitation of practical functional of FMN allows local firms to improve the performance of their production systems and increase their efficiencies. Also, the spread of new technologies in the national industrial base is faster by re-engineering channel. For local firms, copying a product involves less cost than its design and development by domestic efforts.

In the case of reengineering, the transfer process of technology may be achieved in an efficient and cost effective manner if it was started by the simple operations of assembly or by the process technologies with lower value added. In a following step and if we have succeeded the previous one, the receiver becomes able to progress to more complex functions such as manufacturing and design of products (Kumar 996). In the period 1950-1970, the technology development process in the Japanese and Korean business perfectly demonstrates the importance of reengineering.

The contribution of FDI in promoting growth by facilitating technology transfer was the subject of several research works. Using endogenous growth models Grossman and Helman (1991),) and Barro and Sala-i-Martin (1995) argue that FDI promote worker qualifications, increase exports and enhance local competitiveness. For them, FDI plays a central role in the development process, unlike traditional theories where technological innovation was left to oblivion.

In the same vein, Borensztein et al. (1998) obtained the same results. They suggest that the technology transfer is a channel through which growth can be significantly accelerated. Blomström and Kokko (1996) argue that "technology transfer between multinationals and their subsidiaries do not take place only through the machinery, equipment, patents and expatriate of managers and technicians, but also through the training of local employees of subsidiaries. This training affects all levels of employment, from simple workers to the technicians and senior managers.

4. EFFECTS OF FDI ON TECHNOLOGICAL CAPITAL ACCUMULATION: ECONOMETRIC STUDY

In the next section, we will use data of 38 years (1975-2012). The objective is to study the relationships that can take place between the technological capital in Tunisia presented by the global number of patent demands and the flows of foreign direct investment that entered in Tunisia during the study period. So we ask if there are relationships of short and long-term between the two variables (FDI and technological capital) and subsequently the effects of this relationship on the global economy of Tunisia. Our equation is written as follows:

$$\ln(KT_t) = \beta + \alpha_1 \ln(GDPC_t) + \alpha_2 \ln(FDI_t) + \alpha_3 \ln(INV_t) + \alpha_4 \ln(IMP_t) + \alpha_5 \ln(TRSP_t) + \alpha_6 \ln(OPEN_t) + \varepsilon_t$$

With

KT_t: dependent variable,

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X_t: vector of explanatory variables,
εt: classical error term.
In this work, we will use economic variables that have been widely introduced in the previous researches. In the following table, we present these variables and their calculation methods.

Table1. Endogenous and exogenous variables

	Introducing variables
KT	Technological capital: total number of patent demand
GDPC	Gross domestic product per capita
FDI	Foreign direct investment in current dollars
INV	Domestic Investment: gross fixed capital formation
IMP	Import of capital goods other than agriculture
TRSP	Transport services : % of commercial service exports
OUV	Economic openness : X+M/.GDP

4.1 Econometric Analysis

4.1.1 Study of stationary and cointegration of series

4.1.1.1 Stationary study of series

Stationary refers to infinitely persistent nature of the series of randomness on. To avoid the risk of spurious regressions, the researchers want to verify this property as a part of their estimates on the temporal data. There are several varieties of stationary test that can be used simultaneously. We will use two different stationary tests: Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP) and the results are presented in Table2.

Table 2. Stationary test (ADF, PP)

	ADF		PP	
	In level	***First difference***	***In level***	***First fiffrence***
GDPC	-2.18	-3,003***	-1,18	-3,11**
KT	-2,08	-3,26**	-1,24	-3,62***
FDI	-2,32	-4,64***	-1,49	-4,57***
TRSP	-2,76	-6,29***	-2,56*	-6,32***
INV	1,61	-4,11**	-2,04	-3,54***
OPEN	-1,65	-4,72***	-1,59	-4,33***
IMP	-1,9	-6,29***	-1,94	-6,43***

*Starionary at 10% ** Starionary at 5% ***Starionary at 1%

According to the results of the unit root test (ADF & PP), we can say that all variables are non-stationary in levels. But in a first differentiation, the variables (KT, GDPC, FDI, TRSP, INV, IMP and OPEN) become stationary in first difference and thus integrated of order 1.

4.1.1.1 Cointegration Test

In the previous section, we showed that the variables are integrated in the same order. So we can say that, KT, GDPC, FDI, TRSP, OPEN, INV, IMP are integrated in order 1 and the cointegration study will allow us to test the existence of equilibrium relations at long-term linking the rate of capital technology with other variables. The cointegration test according to Johannsen method takes two tests: the trace test and the eigenvalue test.

In a first step, we try to check the cointegration relationship between the variables with the trace test. Always by the application of this test, the null hypothesis assumes the absence of the cointegration relations. This assumption is valid if the calculated value is less than the critical one. So in the present case, with $r \leq 2$ we accept H0 because we have a critical trace value equal to 69,818 and the calculated trace value equal to 55,734. Therefore, we can say that there is at least one relationship between the variables of the model.

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In another step, the cointegration test is performed under the test of the maximum eigenvalue. Also, the values found say that the null hypothesis is rejected if r = 0 and r = 1 with critical values lower than the calculated values. But, with r = 2, we can accept H0 and say that there is no cointegration relationships between the variables of the model. Finally, the cointegration test is validated and it is confirmed by both used tests (trace test and eigenvalue test) by comparing different critical and calculated values either by a probability compared to the 5% threshold.

Table 3: relations of cointegration between variables: from trace test

	r=0	r ≤1	r≤2	r≤3	r≤4	r≤5	r≤6
eigenvalue	0.8031	0.803	0.610	0.380	0.265	0.168	0.007
Statistics trace	170.209	102.901	55.7342	28.3922	14.5236	5.5715	0.2162
critical Value	125.615	95.753	69.818	47.856	29.797	15.494	3.841
probability	0.000*	0.0147*	0.3887**	0.7964**	0.8100**	0.7455**	0.6419**

H0: no cointegration relationship. *** null hypothesis accepted at 0.05*

4.1.2. Causality test

Regarding to the dependence of technological capital to the other variables, we find that it is weakly influenced by the volume of FDI arriving in Tunisia. For this reason, we think that multinational firms established on Tunisian territory are not major carriers of new technologies and new production processes. Also, we find that the level of GDPC affects directly the increase of the global number of patent demand, subsequently we can say that a high level of GDP per capita reflect a good global GDP that stimulates positively the accumulation of technological capital. In the opposite direction, relationships are of the same nature.

Table 4. Granger causality test

Pairwise Granger Causality Tests
Sample : 1975 2012
Lags : 2

Null Hypothesis :	Obs	F-Statistic	Prob.
FDI does not Granger Cause GDPC	33	6.05205	0.0194**
GDPC does not Granger Cause FDI		4.00146	0.0303**
KT does not Granger Cause GDPC	33	4.47014	0.0245**
GDPC does not Granger Cause KT		3.09843	0.0360**
KT does not Granger Cause FDI	33	4.24544	0.0289**
FDI does not Granger Cause KT		3.30995	0.0313**

H0: no causality relationships. ** rejected null hypothesis.

Also, the test output gives us a clear idea about the relationship between technological capital and opening rate of the Tunisian economy in its international and regional environment. A significant relationship occurred in both directions. In addition, the achieved F-statistics and probabilities say that the level of domestic investment affect the technological capital with a significant manner which is not noted for imports. All these relationships and their senses are well studied in the next section.

4.2. Results and discussion

To make the relationship between variable in percentage terms, we use the model in its log-linearized form and all variables are in first difference. Also, this form gives a minimization of fluctuations in the series. The log-linear form of the model is as follows:

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$$\ln(KT_t) = \beta + \alpha_1 \ln(GDPC_t) + \alpha_2 \ln(FDI_t) + \alpha_3 \ln(INV_t) + \alpha_4 \ln(IMP_t) + \alpha_5 \ln(TRSP_t) + \alpha_6 \ln(OPEN_t) + \varepsilon_t$$

With:
KT_t: dependent variable,
X_t: vector of explanatory variables,
ε_t: classical error term.

In a first step, we estimate the model by the method of ordinary least squares (OLS). Following the value of the determination coefficient and the value of the Fisher test, the model appears significant with a large explanatory power. So, it contains good informations about the relationship between variables.

Table 5. Estimation of technology capital regression

Dependente variable: **technological capital (ln(KT))**				
variables	**coefficient**	**Std.error**	**t-statistic**	**prob**
C	-10.74417	3.857879	-2.784993	0.0090
D(LOG(GDPC))	0.769848	0.255561	3.012383	0.0051*
D(LOG(IMP))	0.004522	0.023873	0.189423	0.8510
D(LOG(FDI))	0.057052	0.116084	0.491473	0.6266
D(LOG(OPEN))	2.553302	0.325327	7.84842	0.0000*
D(LOG(INV))	0.410394	0.174605	2.350409	0.0253**
D(LOG(TRSP))	0.156545	0.264378	0.592127	0.5581
R-squared	**0.850000**	**Durbin-Watson stat**		**1.724807**
F-statistic	**9.136**	**Prob(F-statistic)**		**0.000000**

* Significant at 1% ** significant at 5% *** significant at 10%

According to a t-statistic equal to 7.848 and a p-value equal to zero, we notice that the relationship between the technological capital accumulation and economic openness of Tunisia is significant. In the theoretical research, we find that countries with a higher effort of research and development than others have an invention power more profitable. Since the eighties, the economic openness of Tunisia on FDI has been heavily involved in the strengthening of the international cooperation efforts in research and development. Thereafter, the rhythm of invention of new techniques and working procedures becomes faster giving a greater technological capital. Tunisia as all the countries involved in collaborative R & D can benefit from the complementarities of expertise and can prevent recurrences of their results. Another advantage of cooperation in R & D is the internalization of "spillovers" that patents do not mean necessary a perfect protection against imitation.

Secondly, the values of t-statistics and p-value (0.189 and 0.851) say that it is not possible to have a significant impact of the goods and services importation to the technological capital in Tunisia. Although, some authors have emphasized the role of imports as a knowledge dissemination channel that are at the same level of the imported products which can incorporate new technology. In the present case, the results prevent us to support the same ideas. Also, these authors say that for Tunisia, like all developing countries unable to produce technology, imports of goods and services can help them to accumulate the technologies if they provide the necessary conditions for an effective absorption. The found results confirm the work of Coe and Helpman (1995); Coe, Helpman and Hoffmaister (1997); Keller, (1999). The same result is attributed to transport services offered to the international investors. They do not have an important influence on technological capital accumulation and the relative dependence degree appears low.

Concerning the domestic investment, its impact on the research and development activity is checked with the Student test values and the probability of acceptance of this hypothesis (t-statistic = 2.350; prob = 0.0253). Practically, when the volume of investment increases the need for new techniques and strategies becomes more important to the functioning of firms. In addition to economic openness to the international market, competition is becoming more severe and domestic investors are obliged to maintain a close enough competitiveness of those foreigners. This result in domestic investment reflects the case of global growth. The t-statistics and p-value equal to 3.012 and 0.0051 respectively show that the accumulation of knowledge and technology is influenced significantly by the rate of growth.

Several theoretical studies argue that the FDI attracted by host countries affect the knowledge accumulation and can be excellent catalysts for technological growth. To start from our results in Table 5, we can say that the

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insignificant effect of FDI on the accumulation of technological capital in Tunisia is confirmed by a t-statistic equal to 0.4914 and an associated p-value equal to 0.6266. Several empirical studies have attempted to explain the relationship between FDI and technology diffusion to host countries. These studies do not all agree on the idea that new technologies are spreading abroad essentially through the subsidiaries of multinational firms (Blomstrom 1986; Miyamoto 2003).

In the international environment in which firms' competitiveness depends largely on their ability to innovate and on the performance of their department of research and development, the control of knowledge and technology has become an essential factor in economic and social development in host countries. In this regard, Tunisia has worked to increase its absorptive power of new technology provided by the MNC. Also, it seeks to consolidate the investment in research and development through the enhancement and adaptation of the education and training system in order to have the skills capable to meeting the challenges posed by these changes and to consolidate the initiative, the creativity, the innovation and subsequently the promotion of economic growth and employment.

Since the eighties, Tunisia has adopted a policy of improving of the FDI attractiveness. One of the major goals was to acquire new technologies which Tunisia is unable to produce. In this regard, Tunisia has created organizations whose the main function is to promote domestic investment as the Industry Promotion Agency (API) in 1973 and the National Institute of Standardization and Industrial Property (INNORPI) in 1982. In addition, Tunisia has emphasized the role of supporting actors to innovation such as research laboratories, incubators, technopoles and a multitude of public and private financing structures.

In Tunisia, as in several developing countries, a significant effort was made to strengthen the capacity to absorb new knowledge from the MNC. But a quick comparison, between the expenditure of MNCs in the parent companies and subsidiaries, indicates that the expenses of foreign firms in R & D in their implantation sites are very low compared to the expenses of the parent companies. These results would suggest that foreign industrial groups take a little part in the development of the technological potential of the host countries. Moreover in Tunisia, despite the importance of volume of FDI they are found concentrated in sectors with low technological value-added (47% of the priority technology investment is monopolized by the Textile Clothing sector and Cook)

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Several studies claim that when implanted abroad, MNCs tend to retain control of their technologies and the work on research and development is conducted in the parent companies. In addition, to choose a new site of implantation, they prefer countries where the industrial fabric is very dense and less able to assimilate the technologies. So, technology transfer induced by FDI is not significant. In parallel and in the creation program of technology centers, research centers will be consolidated and diversified to continuously develop new growth sectors and exploit new opportunities. In its perpetual quest for development, Tunisia will intensify its efforts in attractiveness in an environment where competitors are numerous and make real achievements in attracting FDI.

5. CONCLUSION

Borensztein et al. (1998); Baldwin (1992) find that FDI represent an interesting channel that effectively ensures the accumulation of capital. They also show that FDI can stimulate growth through their contribution in increasing the stock of knowledge in the host country. Indeed, FDI actively participate in the creation of dynamic benefits leading to technology transfer, promotion of innovation and increased technological Tunisian capital.

But the found results in our work, confirmed several other works indicated that technological capital in Tunisia is not significantly affected by FDI. Indeed, the MNC location strategies in Tunisia are in the vertical nature in their majority. So a reduced contact with local companies prevents the transfer of production technology to Tunisian industry. Also, the MNCs keep the research activities in their parent companies to vie imitation and contagion effects.

Theoretically, the technology transfer is considered by many researchers as the strong positive effect of FDI. In our case, this impact appears negligible and it can not affect the technological capital significantly. Cooperation in research and development between the MNC and Tunisian firms is very low and it suffers from several problems which are essentially caused by the implementation strategies of MNCs and also from the vertical nature of FDI inflows in Tunisia.

Recently, the awareness of the importance of MNCs in production technology pushes Tunisia like other developing countries to follow effective strategies to improve cooperation in research and development. a good

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professional relationship between foreign and domestic firms aims to create technology that Tunisia is unable to produce it. This strategic direction generates a small positive change noticed by the changing numbers of patent demands by Tunisian who is still very low if it is compared with other competing countries.

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