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ICT, Organizational Innovations, Human Capital and Performance of Tunisian Firms of Eeha Sector

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ABSTRACT

ICT (information and communication technologies), organizational innovations and human capital are, these last three decades, the key determinants of the firms' performance in advanced economies. But what about their diffusion level and effects in developing countries and particularly in the southern Mediterranean economies? Our paper fills a gap by questioning the level of diffusion of ICT, organizational innovations and human capital and their performance effects on a sample of Tunisian firms from electric, electronics and household appliances (EEHA) sector. It is the most dynamic sector in Tunisian economy and the most subjected to the pressure of the international competition and contractors.

Our finding shows that the firms invest more intensively in organizational innovations and human capital than in ICT. However, only the ICT have an important and significant effect on the firms' performance. That is explained, partially, by the fact that these investments are carried out under the pressure of the international contractors and respond to their waiting and not in a framework of a strategic project making it possible the creation of competitive advantages for the studied firms. As the partners of Tunisia operate mainly in Northern Mediterranean, the risk of unequal sharing of the fruits of these investments in favor of the Northern countries is real and very important.

JEL classification: *O5, O3, L2, J24*

Keywords: *Mediterranean countries, ICT, organizational innovation, human capital, flexible production model, firms' performance.*

1. INTRODUCTION

There is an ample and growing evidence that we live since the nineties a new growth regime based on information and knowledge. The concept of knowledge economy reflects the fact that the competitiveness of firms, regions and countries are currently dependent on their ability to create access and use knowledge. ICT constitute so the key-infrastructure of this new economy, such as railways and roads of the industrial economy, make it possible the creation, accumulation, management and sharing of knowledge [1].

In a neo-Schumpeterian perspective, these technologies constitute the basis of a new technological paradigm[1] [2, 3]. So the knowledge economy based on ICT is not simply and only about investment in physical infrastructure (computer and telecommunication), but also involves very high levels of skills and new management and work organization methods [1, 5].

The complementary of these technological and organizational innovations demand financial and human resources that influence the speed and the intensity of their diffusion and their impact on the international level and particularly on developing countries. The aim of this paper is to explore the relative importance of the diffusion and effects of ICT, organizational innovations and human capital in Tunisian electrical, electronics and appliances (EEA) sector. This is justified by the importance of this sector in the Tunisian economy as a leading exporter of manufactured goods with the textile sector and therefore more subjected to competition and pressures of international buyers. This study has also completed work done on other Tunisian sectors [6].

The structure of the paper is as follows. In section 2 a theoretical and empirical background on the relationship between ICT, organizational change, human capital and firms' performance is outlined. Section 3 presents the sources of the data used in this work. In section 4 we present a descriptive analysis of technological, organizational and cognitive characteristics of the studied firms before deriving and presenting in section 5 some estimates of their effects on firms' performance. A concluding section summarizes the empirical results and briefly reflects the policy and strategic implications and further research directions.

2. THEORETICAL AND EMPIRICAL BACKGROUND

The huge investment in ICT, organizational innovations and human capital are the major change that occurs in work environments in developed countries during recent decades. These changes respond mainly to the dysfunction of the Ford production model and to ensure to firms their performance in a highly competitive environment [7]. Indeed, during the golden age (1940s - 1960s), the demand was booming and the Fordist model has been the ideal-type model for the mass production of standard products and achievement of economies of scale. The main object for firms was to

[1]Technological paradigm is defined *« as a 'model' and a 'pattern' of solution of selected technological problems, based on selected principles derived from natural sciences and on selected material technologies»,* Dosi (1982) in [4, p. 60].

develop their production apparatus and increase their productivity in order to maximize their performance based on financial indicators such as benefit, profitability and sales [8].

However, since the 1980s, the relevance of these financial criteria has been questioned due to the diversion of the excellent financial results of many firms due to imperceptible decline in quality or customer satisfaction and the entry of new competitors in their markets [8]. As a result, firms are increasingly using the concept of global performance which takes into account other societal and economic indicators such as quality and variety of products, innovative capability, customer satisfaction, response time, respect for the ecological environment and human and consumer rights, creating employment and skills development ... [9, 10].The relationship between the global performance and ICT, organizational innovations and human capital was then the subject of several investigations both theoretical and empirical.

2.1 ICT and firm performance

In a knowledge based economy, firm performance depends on its ability to create, access and use knowledge, field that can be supported by ICT. These technologies play as catalysts and accelerators of knowledge codification, information treatment, transmission and storage and make it possible the access to knowledge systems, e-learning, the observation of any phenomenon in real-time, and monitoring of all flows [5, 11]. These technical and economic opportunities offered by ICT enable firms to reduce costs and increase productivity, innovate and improve their products and services quality, satisfy and retain customers, increase their market share, saving energy and natural resources, create new jobs, etc.. [5, 12]. There are four categories of impact of ICT [13]; productivity enhancement in traditional industries; restructuring of economic activities within industries; the creation of efficient markets; and the creation of new combinations, giving rise to new products and industries.

Empirical studies in developed countries, presented by the OECD report [14], show positive relationship between ICT and firm performance in terms of labor productivity, innovation, demand for skilled labor and turnover growth. Many Canadian studies [10, 15] find strong evidence of a link between the use of ICT technologies and labor productivity of plants. Another stydy [16] also show that the plants that intensively use ICT are more likely to increase their productivity and their chance to introduce innovations in products and process. Using plan-level data for U.S. some works [17] find a positive and significant impact of computer networks and computer investment on labour productivity from this theoretical and empirical survey, we can then forward the following hypothesis:

Hypothesis 1: Investment in ICT improves firm performance.

2.2 Organizational innovations and firm performance

Development and diffusion of new organizational practices, since the mid-1980, throughout the industrial economies argue the emergence of new organizational paradigm: transition from a Ford production organization to a Japanese production organization, also known as the flexible production system [18, 19]. The idea of its new organizational model is to organize the production process from a customer's perspective (demand-based flow manufacturing). It focuses on waste elimination, cost reduction, employee empowerment and varieties increase. Its main organizational practices are: teamwork, job rotation, employee involvement in work, flatter hierarchies, sharing of information and decision-making power, total quality management, inventory reduction, etc. [7].

There are several theoretical and empirical works studying the relationship between these innovative organizational practices and firm performance. In the economic literature, the link between firm performance and organization is found in studies of the determinants of organizational change. In a first approach, the demand instability and increasing demand of differentiated products, resulting of intensifying competition, rising education levels and women employment, involve greater production flexibility. Firms must be changed to respond consistently to the customers' preferences and adapt their products supply to the unstable demand [20, 21, 22]

In a second approach, organizational change is viewed as a result of production factors change. Indeed, the rise of skilled labor supply (consequence of rising of the general education level) accelerates the speed of innovation and reduces, therefore, the life cycles of products and production processes. In this case, the flexible firm will naturally be more efficient than mechanical organization [23]. The versatility of employees will be more advantageous in terms of productivity and innovation then specialization especially in the case of complementary tasks [24]. Moreover, technological advances, particularly in ICT, stimulate the organizational change [25, 26].

Finally, organizational change is seen as a consequence of the transformation of employees-employers relationship to resolve problems of absenteeism, turnover, manufacturing defects and other forms of workers' resistance sources of Ford model dysfunction [7].

In the management literature, Experts suggest that new organizational practices allow a firm to improve their performance. For example, the practices of knowledge management such as management skills, up-skilling of employee and knowledge codification, sharing and storage increase the flexibility, adaptability and organizational performance [27, 28]. Production and efficiency Practices such as Business re-engineering, decentralization, outsourcing, just-in-time,

allow a firm to reduce its costs, enhance flexibility, speed delivery, productivity, innovative capabilities and achieve economies of scale, [16]. Human resource management practices producing a skilled and motivated workforce constitute a strategic tool for firm to reduce its costs production and develop new products [29, 30]. Among these practices, there are: performance-based pay, job rotation, employee involvement, skills training and communication procedures. Product/Service Quality-related Practices such as Total Quality Management (TQM), improving coordination with customers/suppliers and improving customer satisfaction are widely recognized in management as a critical competitive strategy [31,32,].

In the empirical level, some studies showed, on French data, a negative relationship between the degree of decentralization of decision-making and communication structure and firm productivity [33]. A limited impact of flexible practices on labour productivity is also found on U.S data, [34]. In contrast, exploiting the same U S data, it emphasize that productivity growth is related less to its organizational practices, then to their diffusion level among the different services and workers categories [35]. The high costs of these practices or the lack of time and skills may also delay or impede the benefits of organizational innovations [36, 37]. Changes in work organization such as just-in-time, teamwork, decentralization of decision-making can improve the innovative capabilities of the firm [38]. There is also a positive link between the adoption of knowledge management practices and firm innovative capabilities [39, 40]. Similarly, studying a sample of Russian companies, some studies show a positive relationship between organizational change and firm performance [41]. We therefore suggest a second hypothesis:

Hypothesis 2: adoption of innovative organizational practices allows firms to improve their global performance.

2.3 Human Capital and firm performance

Human capital concept introduced in the sixties [42, 43] and it means all the knowledge, skills, expertise and other capabilities in possession of an individual to productive aim. It involves that investment in education and training allows person to increase his labor productivity and innovative capabilities. In the knowledge and innovation based economy, human capital is the key determinant of sustainable competitive advantage of firms [27, 44, 45, 46, 47]. The ability of current firms to increase their performance "depends on the capabilities (tacit) of individuals to solve problems, monitor and improve process, find new technological solutions and design new products, integrate different fields of knowledge, build relationships with customers and interpret market trends [...]. This threshold of human capital is a structural variable whose value differs not only between industries but also between the different segments of the same industry" [44, p. 92].

In the empirical literature, several studies on the United States show the existence of a positive relationship between labor productivity and education of staff on the firm [48, 49] and the training investment [48, 50, 51]. Using Canadian data, some works [16] found insignificant link between knowledge workers and business performance, however other [10] find a positive link between education and computer training and labor productivity. We can then formulate the following hypothesis:

Hypothesis 3: Investment in human capital allows firms to improve their global performance

2.4 ICT, human capital and organizational innovations: complementarities effects

Several theoretical and empirical studies have highlighted that ICT, organizational innovations and human capital are complementary factors. The greatest contribution of ICT on business performance appear to be realized when ICT investment is combined with new organizational practices and high level of human capital. Thus, the knowledge codification, fast and cheap information transmission and increased control made be possible by ICTs, enable the outsourcing, information sharing, just-in-time production, total quality management, decentralization and lower hierarchical levels, etc. [18, 44, 52, 53].

Furthermore, having a highly skilled workforce is essential to benefit of ICT opportunities. The cumulative increase of the codified knowledge base provides huge opportunities for the exchange of knowledge and learning but their implementation still requires more skills and competences [11, 44]. Furthermore, the appropriation of codified knowledge is a complex process; the abundance of information does not make it more available because individual must be able to sort, classify, interpret, adopt and channel it to act pragmatically as necessary [54].

In empirical literature, many studies have highlighted the existence of complementarities between ICT, organizational innovations and human capital, [10, 14, 16, 18, 55, 56, 57, 58, 59, 60, 61]. They show that ICT can have the greatest effects on business performance if ICT investment are combined with a great delegation of decision-making, higher skills, higher general culture, moderns working methods (particularly teamwork and quality circles) and human resource management, etc.. Consequently, we propose the last two assumptions:

Hypothesis 4: The intensive use of ICT will be more beneficial for firms that invest heavily in organizational innovations

Hypothesis 5: The intensive use of ICT will be more beneficial for firms that invest heavily in human capital

3. SOURCE OF DATA

The data used in the study were taken, by questionnaire, from 40 Tunisian firms from electric, electronics and household appliances (EEHA) sector, nearly 30% of the total population firms with entirely Tunisian capital (without foreign capital participation).

The choice of firms was essentially based on data provided by the Industrial Promotion Agency (IPA) with respect to their general distribution in terms of size and target market. Thus, 62.5% of respondents employ less than one hundred employees and 70% of them are exporters (Appendix 1).

The questionnaire was composed of three parts, and refers to several works [15, 16, 62, 63]. It is used to collect data on ICT adoption, organizational innovation intensity and human capital investment and the firm performance level in 2004.

To ensure data quality, the research instrument was pre-tested with five firms before use in its normal course. Following some minor modifications, we used the final questionnaire to conduct lengthy personal interviews in firms that agreed to participate in the study. The respondent set for each firm included a top manager, and person responsible for manufacturing operations or computer service who provided data on technologies used, organizational capabilities and business performance. It's the advantage of the directly contact with interviewers that allows ensuring their identity, reducing errors risk, saving time and especially decreasing the no-answer risk and removing any ambiguities.

4. FIRMS CHARACTERISTICS: A DESCRIPTIVE ANALYSIS

In this section we will examine the state and characteristics of the information and communication technologies diffusion, organizational innovation intensity and the human capital level within the studied firms.

4.1 Technologies characteristics: state of ICT diffusion

ICT considered in this work are not limited to the last wave of communication and collaborative work financial resources to invest in ICT technologies [64]. However, upgrading program, launched by the State since 1990s to modernize firms and stimulate ICT diffusion, is in favors of the competitive and large firms that seem able to wining the international competition. Our study shows already that SMEs (less than 100 tools, but they involve any hardware incorporating software or computers as robots and flexible manufacturing systems. It seems very important to highlight the diffusion level of these technologies characterizing any flexible production model and determining the level of spread and appropriation of the most advanced technologies [15]. Thus, we selected twenty three technologies, defined in a Canadian manufacturing sector study [15] , divided into three groups: software, hardware and network communication tools (Table 1).

Table (1) provides the proportion of firms adopting different technologies. It shows that nearly three quarters of companies are equipped with at least one software, a communication tool or technology hardware. For software technologies, companies are more likely to use knowledge based software, computer aided design and engineering (CAO/CAE), Manufacturing Resource Planning (MRPII), computer-aided Manufacturing (CAM). Concerning communication tools, the local network, inter-enterprises networks and CAD files exchange are relatively the main adopted technologies. Other communication tools such as wide computer networks and remote digital control are poorly distributed. Finally, the hardware technologies used by most firms are programmable control devices, automated storage and robots equipped with sensors.

In general, the diffusion of ICT is not yet wide and each technology is adopted in the best cases only by two fifths of companies excepting the local network which is adopted by the majority of studied companies. This can be explained by the importance in the sample of small and medium enterprises (SMEs) which are less likely to use ICT as it is shown by the variance analysis (appendix 2) and that for at least two reasons. Firstly, these entities are generally devoid of human and

employees) have not received subsidies to finance their ICT investment Secondly, the small number of firms' staff requires less coordination and, therefore less ICTs technologies. We find also a positive relationship between ICTs use and target market firm. Exporting firms are

more likely to use ICT (Appendix 2).This can be explained by the instability of foreign demand and the growing demands of international buyers in terms of product quality, delivery time and production costs which involve exporters to invest in flexible technologies.

Considering these different characteristics of the ICT diffusion process, nearly three-quarters of companies in our sample indicate that they are satisfied with their equipment, despite the reduced number of technologies used by the majority of them. Unsatisfied companies have mainly a small or medium size that cannot afford to introduce advanced technologies and that are not exporters. As the three groups technologies are complements [15] these firms do not fully benefit from their adoption of ICT.

The part of ICT investment in 2004 compared to firms' turnover is relatively important. It represents more than 5% for the quarter of businesses and it exceeds the 1% for almost three quarter of them (Table 2). This means that much of the technologies viewed above are still new and imposed by the intensification of local and foreign competition following the successful integration of several emerging countries in the labor international division. The proportion of ICT investment compared to total equipment investment did not exceed 50% for the majority of studied companies and is even below 25% for half of them.

Table 1 : Shares of ICT- users firms

Technologies groups	Used technology	Share of users firms (%)
Software	**Use of at least one software**	75
	Computer-aided Design and engineering (CAD / CAE)	40
	CAD applied to manufacturing machines control (CAD/CAM)	32
	Modeling or simulation Technologies	23
	Manufacturing Resource Planning (MRPII)	40
	Computer-aided Manufacturing (CAM)	35
	Acquisition and control data systems (ACDS)	18
	Using inspection data for production control	20
	Software knowledge base	43
Communication tools	**Use of at least one communication tool**	73
	CAD files Exchange	38
	Local area networks (LAN)	73
	Wide computer networks	13
	Inter-enterprises networks	40
	Remote digital control of plant process	7.5 E-02
Material	**Use of at least one material technology**	68
	Flexible manufacturing systems (FMS)	18
	Programmable control devices	40
	Robots equipped with sensors	28
	Robots devoid of sensors	12
	Rapid prototyping systems	13
	Identification of components for automatic machining	10
	Automated storage	30
	Artificial Vision systems used for inspection or testing	20
	Other automated sensor systems used for inspection or testing	25
	Control Computer on plant activities	22

Table 2 : ICT investissement

Variables		Share of firms (%)
ICT investment compared to turnover	< 0.5%	10
	[0.5; 1[	20
	[1; 5]	45
	> 5 %	25
ICT investment compared to total investment in equipment	< 25%	57.5
	[25 ; 50 [	25
	[50 ; 75]	7.5
	> 75%	10

4.2 Organizational and human characteristics

To determine the innovative organizational practices adopted by the sample firms, we used the OECD definition [16, 63]. It includes three broad streams: production and efficiency practices (PEP),

human resource management (HRM), product/service quality-related practices.[2] Different practices corresponding to each stream and their proportions of adoption are shown in table (3). Overall, it emphasizes a widespread of organizational innovations in the studies enterprises. Variance

analysis shows that exporters and large firms are more

Table 3 : share of firms adopting organizational innovations

Organizationel innovations	Share of adoption (%)
Production and Efficiency Practices (PEP)	
Business re-engineering	42
Downsizing	57
Flexible work arrangement	82
Outsourcing	45
Greater integration among different functional areas	55
Decrease in the degree of centralization	45
Human Resources Management (HRM) Practices	
Individual incentive systems	45
Productivity/quality gain sharing and other group incentives	50
Profit sharing plan	13
Merit pay and skilled-based pay	78
Employee suggestion programs	38
Flexible job design	75
Greater reliance on job rotation and multi-skilling	67
Information sharing with employees	80
Quality circles, problem solving teams	48
Joint labor management committees	53
Self-directed work groups	70
Increase employee involvement/participation	60
Formal job-related training	72
Classroom training	32
Participating in training subsidies program syndical	48
Participating in other training program	45
Enhancing labor-management cooperation	30
Product/Service Quality – related Practices (PQP)	
Improving product quality	75
Improving coordination with customers/suppliers	97
Total quality management	100

able to introduce new organizational practices (Appendix 2). The correlation table (appendix 3) also shows a positive relationship between intensity of ICT use and organizational innovations adoption. It seems, following other studies [6], that the dynamics of organizational and technological change in Tunisian firms result from their insertion into the international outsourcing dynamics and trade openness following the signing, by State, of Free Trade agreements in the 1990s.

[2] For more detailed definition of these organizational practices see [16].

Studied firms have also a high human capital level due to the specificity of studied sector that demands a high skilled workforce. Thus, the average share of graduate workers is over 1 / 3. The strong correlation between the share of computer users and graduate workers (appendix 2) shows that the purchase of computers is accompanied by skilled workers recruitment.

The combined investments in ICT, organizational innovations and skilled workforce show the desire of the studied firms to get closer to the flexible production model. These investments are made mainly under pressure of buyers and international contractors and not as part of a strategic project. Examine the effects of these investments on firms' performance is so interesting.

5. DETERMINANTS OF FIRMS PERFORMANCE: AN ECONOMETRIC ANALYSIS

After studying the technological, organizational and human features of our sample firms, we will verify the validity of hypothesis made in the literature review. For this, we will, initially, present the econometric model and define the utilized variables then we will discuss the results of different estimates.

5.1 Models and key variables

To verify the first three hypotheses presented previously we use a probit model to estimate the influence of ICT, organizational innovations and human capital on the firm performance. The latter is measured by six dummy variables relating to the global performance concept as defined above: labor productivity, profit, turnover, product innovation, process innovation and total number of employees. In our model, we also control for firm size and target market fixed effects. Indeed, many studies show the existence of a positive relationship between these two variables and firm performance [15, 16]. The model is presented by equation (1):

$$Y_i^* = C + \alpha_1 ICT_i + \alpha_2 OI_i + \alpha_3 HK_i + \beta_1 SIZE_i + \beta_2 EXP + \varepsilon_i \quad (1)$$

- Yi * is the unobserved performance measure for firm i. The observed counterpart yi to the unobserved firm performance measure is the change in the productivity, profit, turnover, product innovations, process innovations, and total number of employees. We then have six models to estimate relative to the six performance indicators. The variable yi takes a value of one if the firm reports an increase in productivity, profit, turnover and total workforce, introducing products innovations and process innovations, otherwise is equal to zero.

$$y_i = 1, \text{ si } y_i^* > 0,$$
$$\text{and}$$
$$y_i = 0, \text{ si } y_i^* \leq 0$$

- ICT: measures the level of information and communication technology use measured by the following three variables:

* INVT: measures the share of ICT investment compared to total investment in equipment during 2004,

* LT: measures the share of workers using computers compared to the total workforce, the survey day,

* TECH: measures the number of technologies (belonging to three groups: software, hardware and communication) used by the firm, the survey day.

The share of ICT investment represent only the investment in 2004, while the share of users and the number of technologies captures the outcomes of all ICT investments, past and present. These last two measures are, therefore, more exhaustive than the first.

- OI: measures the intensity of organizational innovations, introduced by firms in 2002-2004 period, by the three variables described above:

* PEP: the number of new production and efficiency practices,

* HRM: the number of new human resources management practices,

* PQP: the number of new product/service quality practices

- HK: measures the human capital by the share of graduate workers compared to the total workforce of the firm.

- SIZE: the firm size measured by a binary variable taking a value of one if the size is relatively large (total number of employees over 100), otherwise it is equal to zero.

- EXP: the target market measured by a binary variable taking a value of one if the firm is exporting, otherwise it is equal to zero.

-C: constant.

- ε_i: the error term.

To test the two complementarities hypotheses we re-estimate [16] the same Probit equation (1). Thus, to test the complementarities between ICT and organizational innovation, we divide our sample of firms into four groups: High-ICT use and high organizational innovations (OI) level, High-CT and low-OI; low-ICT and High-OI; Low-ICT and Low-OI. We introduce dummy variables (D) denoting different groups in the initial model. The strong correlation between the number of used technologies and organizational practices, mentioned above, suggests that these two variables can have a complementary effect on the firm performance. Therefore, on the ICT side, we define High-ICT as those firms that have above-median number of used technologies. Low-ICT firms are defined as those firms that have below-median number of used technologies. On the organizational innovation side, we define High-OI firms those firms that have above-median measure of organizational practices, otherwise they are considered as low-OI firms. The same method will be followed to examine the complementarity hypothesis between ICT and human capital (HK).

5.2 Importance of the ICT contribution to the firm performance: the results of econometric analysis

The results of the binomial probit estimates made, using Eviews, on firm performance indicators are presented in Table (4). These results show that the relationship between ICT and firm performance is different across technologies measures. On the one hand, we find that the share of computer users has negative and significant effects on the likelihood that firms introduce innovations in products and in process and increase their number of total employees. These negative effects can be explained by the lack of complementary investments in organizational change and human capital, underdevelopment of networks linking these computers and the required time for workers to learn and to use the new tools, rules and work procedures. On the other hand, we observe that the share of ICT investment compared to total investment in equipment and especially the number of used technologies have positive and significant impacts on most performance indicators. Thus, firms that have invested heavily in ICT and use a large number of ICT are more likely to increase their productivity, turnover, profit, number of total employees and to introduce innovations in products and in process. At this level, our first hypothesis is verified.

The effects of organizational innovations on firm performance also depend on the organizational practices group introduced by the firms. Indeed, our analysis shows that the production and efficiency practices (PEP) and the product/service quality practices (PQP) are not related to the different firm performance measures. In contrast, the management of human resources (MHR) practices has positives and significant effects on labor productivity and the introduction of process innovations. It appears that the practices being adopted by firms such as problem solving teams, skilled- based pay, information sharing and employee involvement have positive effects on these two performance indicators.

Our results also find positive and significant effects of the human capital (measured be the share of skilled workers) on the likelihood that firm introduces innovations on products and process. However, human capital has insignificant effects on labor productivity, turnover, profit and total number of employees.

These little effects of organizational change and human capital limited to labor productivity and innovation reflect several facts. First, these two performance measures allow satisfying the international buyers and contractors who continue today to intensify

the competition between plants across the globe forcing them to reduce their delivery time, improve their product quality and reduce dramatically their prices [65]. Second, several organizational practices (training, total quality management, etc.) and the recruitment of skilled workers are subsidized by the State. The risk of limited appropriation of their innovations is so important since the firms do not support their costs. Third, the benefits of these investments may require more time so that workers appropriate the new organizational practices and technologies. Finally, the limited effects of organizational innovations and human capital on business performance can be justified, as we will see later, by the low adoption of ICT.

For control variables, our study shows that the firm size has negative and significant effects on most performance measures. Small and medium size firms are more likely to improve their performance than large firms. This can be explained by the fact that the EEHA (electric electronic and household appliance) sector is currently characterized by the emergence of competitive and specialized producers, "small mass producers", that realize very large economies of scope reducing the economies of scale advantage of large firms. Finally, the target market has different effects, but not statistically significant. This can be explained by the fact that studied firms are insensitive to market compared to other factors taken into account in the estimated models.

The estimate of the complementarities hypothesis, (table 4), shows that firms using ICT intensively and adopting a high level of organizational practices related to the production and efficiency (PEP), human resources management (HRM) or product quality (PQP) are more likely to improve their performance among our sample of firms. The likelihood that these companies introduce innovations in products and process and increase their total number of workforce is higher than firms that have low level of ICT use and do not make organizational change.

The joint investments in ICT and human capital have positive and significant effects on most performance measures of studied firms (table 4). Firms that combine a large number of ICT and high share of skilled workers are more likely than others to increase their productivity and benefit, and to introduce innovations in products and in process. In addition, we emphasize that the effects of organizational change and human capital will be clear when they are combined by intensive ICT use, even if they fail to affect the six performance measures used in this study. This fully justifies our explanations, above, about the limited impact of organizational change and human capital on firms' performance.

6.CONCLUSION

The aim of this paper is to highlight the fact and the state of diffusion and appropriation of ICT, organizational innovations and human capital in the Tunisian EEHA sector. Although, our

Table 4: Results of Probit models regressions

Variables	Labour Productivity	Profit	Turnover	Product Innovations	Process Innovations	Total number of employees
Probit model estimates : hypothesis 1, 2 and 3						
LT	-0.0280	-0.0004	-0.0142	**-0.0659****	**-0.1192****	**-0.0527****
INVT	**2.0751****	**1.0370***	**0.4516***	0.4610	0.2549	**0.6601****
TECH	**0.6336***	**0.3840****	**0.2353****	**0.2224****	**0.2795***	0.0399
PEP	**-1.0397***	-0.2801	-0.2374	-0.0968	0.0220	-0.0864
GRH	**0.5036***	0.1077	-0.1230	-0.0042	**0.1683***	0.0384
PQP	1.0750	-0.1913	0.1913	1.1835	-0.2106	0.3134
HK	0.0182	-0.0124	-0.0036	**0.0496***	**0.1215***	0.0327
SIZE	**-5.2125***	-	**-2.0593****	**-2.2486****	-0.1402	0.3531
EXP	-0.3400	-0.3722	1.3832	1.0364	1.8582	0.6371
McFadden R^2	60	44	36	42	53	26
Marginal effects estimates probit models, hypothesis 4 :						
Model 1						
High –ICT, high-PEP	0.4013	**1.5258***	0.9193	**2.8976*****	**1.4262***	**1.3644****
High –ICT, low-PEP	0.4606	1.1754	1.0333	**1.9882****	0.6229	0.3604
Low – ICT high-PEP	-0.3393	-0.3486	-1.0035	0.5661	-0.6602	-0.3527
Model 2						
High–ICT, high-GRH	1.2444	1.2841	0.7089	**2.6234****	**2.1299****	**1.9200****
High –ICT, low-GRH	0.8615	1.0327	0.8194	**2.1134****	0.8694	1.2306
Low–ICT, high-GRH	1.0059	-0.6712	-1.3658	0.4570	0.4636	**1.6146***
Model 3						
High –ICT, high-PQP	1.0353	0.5602	1.1667	**2.5972*****	**1.3640***	**0.9429***
High –ICT, low-PQP	0.5646	-0.0258	0.3325	9.0386	0.8874	0.5236
Low –ICT, high-PQP	0.6639	-1.0539	-0.6352	1.1158	0.2290	0.4948
Marginal effects estimates probit models, hypothesis 5						
High –ICT, high-KH	**3.0349****	**1.8316***	**1.8270****	**2.7297****	**2.1817***	1.3466
High –ICT, low- KH	2.1861	1.6176	**2.4248****	**2.3139****	0.5847	0.5797
Low –ICT, high- KH	0.7033	-0.5867	0.8528	**1.5744***	0.6925	0.1995

Note: *** means significant at 1%, ** significant at 5%, * significant at 10%. t-statistics are adjusted for heteroscedasticity using the Huber-White method. Add that for methodological reasons and form (high number of estimates) we did not present the effects of other variables included in the models related to hypothesis 4.

study is exploratory and limited to a small number of firms, it allows drawing important conclusions on the technological and organizational changes in this sector. Thus, we found that the different technologies and organizational innovations, characteristics of the flexible production model began to spread in the EEHA sector. We also found that firms invest more intensively in organizational change, driven mainly by the international buyers and contractors, than in ICTs. The low diffusion of these technologies is mainly explained by their high cost and small size of our sample firms and in Tunisia in general. The diffusion of these tow assets appears also accompanied by recruitment of large numbers of skilled workers. Our results are consistent

with conclusions emphasized by a study on other Tunisian manufacturing sectors [6].

However, our study shows limited effects of organizational innovations and human capital on firms' performance in contrast to ICT effect that is more important. The impact of organizational innovation and human capital, even with intensive use of ICT, are still in embryonic age and essentially respond to the international buyers waiting and not to the needs of the Tunisian entrepreneurs (turnover and benefit enhancement) and society (job creation). It seems that appropriation of such investments by the EEHA sector, heavily dependent on northern Mediterranean contractors, submitted to other logic than the complementarity theory that we must be discover. Thus, the global production network (GPN) may turn out to be a vehicle of cumulative growth where the strongest participants (multinational firms) will raise their power and market shares over time, while the weakest participants will shrink [66]. The risk is in fact important and real if we think the great power gained in last decades by multinational firms (MNFs), which are the major actors in promotion and diffusion of ICT-based global production and distribution networks.

Then to benefit from their adoption of the key determinants of production flexible model (ICT, organizational innovations and human capital), southern Mediterranean firms and particularly those connected on the GPN must shift their strategy from a position of producing standards components subjected to strong price competition to a products development strategy, carrying their own mark.
This implies a considerable public support in the creation of comparative advantages (education systems, national and international infrastructure, etc...) and the development of competitive territories particularly in those markets where the extraordinary power gained by MNFs determines an oligopolistic structure and an unbalanced relation of power within firms' networks [67]. The concepts such as industrial district, innovative milieu, cluster, learning region and other regional models are so rich and can be mobilized to build an ideal-type model of "appropriating territory" able to appropriate the flexible production model in the southern Mediterranean sector connected to the GPN.

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Appendix 1: Sample presentation

Appendix 2: Relationship between ICT, organizational innovations, human capital, size and target market of the firm

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

Variables	**Number**	**Share (%)**
Size		
large firms	15	37.5
Small and medium firms	25	62.5
Total	40	100
Target market		
Exporters firms	28	70
No exporters firms	12	30
Total	40	100

	PEP	HRM	HK	WT
PEP	1			
HRM	0.628***	1		
PQT	0.302*	0.266*	1	
HK	0.06	0.087	-0.160	1
WT	0.161	0.059	-0.144	0.553***
INVT	0.199	0.149	0.130	-0.172
TEC	0.474***	0.298*	0.385**	-0.183

Appendix 3: Correlation between ICT, organizational innovations and human capital

Variables	Size	Target market
	Φ^1	
ICT use		
Software	0.328**	0.378**
Communication	0.477***	0.574***
Hardware	0.427***	0.361**
	F^2	
Use intensity		
PC users	1.574	0.015
ICT investment	2.988***	0.158
Total number of used technologies (software, communication, hardware)	38.134***	12.357**
Organisationnel innovations		
PEP	8.126***	9.257***
HRM	4.74**	7.087**
PQP	9.5***	3.507*
Human Capital (graduated workers)	6.039*	2.576

*** significant at 1%, ** significant at 5%, * significant at 10%

[1] $\Phi = \sqrt{\chi 2/n}$; [2] F = = sum of intergroup square / sum of intra-group square