



## THE IMPACT OF TECHNOLOGICAL LEARNING ON FIRM PERFORMANCE: THE SAMPLE OF AN EMPRICIAL RESEARCH



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### ABSTRACT

Technological Learning, as a special area of Organizational Learning is evaluated that a factor effects technology based firm's market performance positively. The aim of this paper is to investigate the relationship between technological learning activities and firm market performance. In this research, although the existence and timing of the relationship between technological learning and firm market performance activities were confirmed, the existence of positive relationship between technological learning activities and firms market performance was not found.

**Keywords:** Technological learning, Technological learning activities, Firm market performance.

### TEKNOLOJİK ÖĞRENMENİN FİRMA PERFORMANSI ÜZERİNE ETKİSİ: DENEYSEL BİR ARAŞTIRMA ÖRNEĞİ

#### ÖZ

Örgütsel Öğrenmenin özel bir sahası olan Teknolojik Öğrenme, teknoloji tabanlı firmaların pazar performanslarını olumlu yönde etkileyen bir faktör olarak değerlendirilmektedir. Bu çalışma, teknoloji tabanlı firmalarda teknolojik öğrenme aktiviteleri ile firma pazar performansı arasındaki ilişkiyi araştıran bir çalışmayı örnek almıştır. İncelenen araştırmada, her ne kadar teknolojik öğrenme aktiviteleri ile firma pazar performansı arasındaki ilişkinin varlığı ve zamanlaması doğrulansa da, teknolojik öğrenme aktiviteleri ile firma pazar performansı arasında pozitif yönlü bir ilişkinin varlığı ispatlanamamıştır.

**Anahtar Kelimeler:** Teknolojik Öğrenme, Teknolojik Öğrenme Aktiviteleri, Firma Pazar Performansı,

#### INTRODUCTION

As the 21st century dawns, business environments and the general societies that provide their context are being transformed by a number of factors including increasing globalization, technological developments, the increasingly rapid diffusion of new technology

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and the knowledge revolution. Uncertainty, dynamism and volatility of the new competitive landscape are altering the fundamental nature of competition as the 21st century begins. The world has changed dramatically with the development of information technology and the increasing importance of knowledge. This transformation is causing firms to reconsider the ability of traditional methods of competition to create value. Perhaps for many companies, the new competitive landscape's uncertainty, dynamism and volatility can be daunting. Various labels and terms are used to identify the 21st century's new competitive era. Among the most prominent and frequently used ones are the new competitive landscape, hypercompetitive environments, the postindustrial society and the new frontier. In the 21st century competitive landscape, virtually all organizations seek to exploit product-market opportunities by using proactive and innovative behaviors. Thus, to survive and prosper in this era, firms must learn how to minimize the negative effects of discontinuities, uncertainty and ambiguity while simultaneously creating dynamic core competencies to exploit the host of environmental opportunities. To generate value, firms must be able to identify, create and continuously manage knowledge (especially technological knowledge). Knowledge may be the most strategically significant resource the firm can possess and on which sustainable competitive advantages can be built. Some scholars believe that competition is becoming more knowledge-based and that the sources of competitive advantage are shifting to intellectual capabilities from physical assets. Thus, being able to develop, maintain or nurture and exploit competitive advantages depends on the firm's ability to create, diffuse and utilize knowledge throughout the company. The increasing competitive importance of knowledge has led to the development of the knowledge-based view of the firm. This evolving perspective, suggesting that the primary rationale for the firm's existence is to create, transfer and apply knowledge, is an extension of the resource-based view of the firm. Some recent works include a greater focus on dynamism and differences in firms as key determinants of competitive advantage. Examples include the development of the "dynamic capabilities" theory, attempts to identify the differences among firms with greatest strategic significance. In this study, firstly we attempt to emphasize that knowledge, types of knowledge, managing of knowledge about development of firms. After we examined technological learning concept and relevant literature at present, we attempted to form multi-dimensional framework to analyse technological learning activities and the effects on firm-market performance. We used a well-known firm as an example which applies subject about technological learning and has some results of it Nevertheless, we attempted to determine how important and necessary transition from traditional competitive model to modern times competitive model for the technological learning at the present in changing competitive conditions, firms at micro plan and country economies at macro plan. Also, in this chapter in the article, we mentioned the results of experimental study that make a connection between technological learning and firm market performance.. As a result, we attempted to determine the necessities of competitive advantages which used in competitive plan according to countries and firms.

## **1. THE RELATION BETWEEN TECHNOLOGY AND KNOWLEDGE IN NEW COMPETITIVE LANDSCAPE**

Learning and knowledge are linked closely; knowledge is a critical outcome of learning. If knowledge is a power, learning is a key of this power, too (Koh, 2000; 94). Evidence suggests that knowledge is central to how organizations learn and manage technologies. Beyond this, how managing of knowledge influences the selection and implementation of the firm's strategies. Among many factors that will influence the firm's



performance in the 21st century's Competitive landscape, Globalization, Technological Advances and Knowledge are perhaps the most significant. These three factors have both independent and interactive effects on the shape of the competitive landscape. For example, that in the biotechnology industry, technology and knowledge are highly interrelated. Technology can be defined as “a systematic body of knowledge about how natural and artificial things function and interact”. It follows that technology is a form of knowledge and that technological change can be understood by examining knowledge development. Furthermore, as competition in global markets becomes driven more intensely and frequently by technology, technological knowledge may be even more important for firms with global ambitions (Hitt et al, 2000; 231-233). To describe the potential uniqueness of technological knowledge in the development of competitive advantage and firm value, we first explore the general dimensions of knowledge.

### 1.1.1. Dimensions of Knowledge

There are different types of knowledge. The primary distinction among them is **tacit** knowledge and **explicit** knowledge. Recognized widely by organizational scholars, Polanyi (1958, 1967) originally advanced this important distinction of knowledge types. The dichotomy between tacit and explicit knowledge can be thought of as the difference between experiential (i.e. tacit) knowledge and articulated (i.e. explicit) knowledge (Polanyi, 1958; 120-121). Tacit knowledge is accumulated through learning and experience; often, it is referred to as ‘learning by doing’. Tacitness suggests that individuals know more than they can tell. Tacit knowledge entails commitment and involvement in specific contexts and has a ‘personal’ quality. As Polanyi stated, **“the aim of a skillful performance is achieved by the observance of a set of rules which are not known as such to the person following them”**. Thus, tacit knowledge is difficult to codify, articulate and communicate. A scholarly view of this position is that tacit knowledge may best be defined as **“knowledge that is not yet explained”**. Terms such as; Know-How, Subjective Knowledge, Personal Knowledge and Procedural Knowledge have been used to describe the tacit dimension of knowledge. In contrast to tacit knowledge, explicit knowledge can be formalized, codified and communicated. In fact, explicit knowledge is revealed by its communication while tacit knowledge is revealed through its application. Concepts related to explicit knowledge include; Know-What, Objective Knowledge, Predispositional Knowledge, Declarative Knowledge. The dimensions of knowledge that we have described facilitate understanding of the unique and critical relationship between a particular type of knowledge — technological knowledge — and the firm's ability to create value as it competes in the uncertain, dynamic and volatile competitive landscape (Hitt et al, 2000; 233-234).

### 1.2. Technological Knowledge

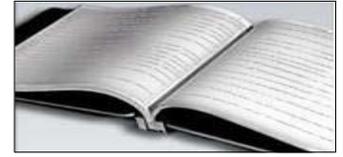
As a systematic body of knowledge, technological knowledge can be defined as **Individual Explicit** (individual skills pertaining to a particular technology that can be codified), **Individual Tacit** (individual skills pertaining to a particular technology that is personal), **Collective Explicit** (standard operating procedures), **Collective Tacit** (an organization's routines and culture regarding technology). Each of these technological knowledge dimensions can be the source of competitive advantage and value creation. However, the dimensions that include a tacit component demonstrate the greatest potential for creating competitive advantages and firm value. From a resource-based perspective, tacit technological knowledge can lead to sustained competitive advantage. Technological



knowledge that is difficult to articulate, codify and explain is also difficult to imitate. Such tacit technological knowledge is idiosyncratic and firm specific in that other firms may find it difficult to understand and use. Furthermore, technological knowledge that is not only tacit but resides in the collective organization can increase the difficulty of imitation by competitors. For example, the success of Southwest Airlines has been attributed partially to its unique culture. This culture represents the knowledge that is embedded in the social practice of the organization and resides in the tacit experiences and enactment of the collective. Spender (1996) argues that, collective knowledge is the most secure and strategically significant kind of organizational knowledge. Thus, collective tacit technological knowledge is an important source of competitive advantage and value creation. As stated previously, knowledge is a critical outcome of individual and collective of organizational learning (Spender, 1996; 45-62).

## **2. TECHNOLOGICAL LEARNING CONCEPT**

Technological learning is a part of organizational learning. Technological learning can be described as technological development and process that firms covered and clear sources stock, creating undeveloped abilities, to renew and improve. This learning combines both managerial and technic learning processes. Managing technological abilities create increasing economic profits. Dodgson (1991) defines technological learning as “the ways firms build and supplement their knowledge-bases about technologies, products and processes, and develop and improve the use of the broad skills of their workforces” (Dodgson, 1991; 140-148). Firms operating in technological fields often operate in complex, dynamic and risky competitive conditions. Mohrman and Von Glinow (1990) stated that, the technological environment could simultaneously create new opportunities for entry, bankrupt existing companies, and render obsolete entire product lines and manufacturing and design processes overnight. As such, technological learning is important to build technological knowledge, particularly in a dynamic, discontinuous and complex competitive landscape. Recent evidence shows that technological learning contributes to the success of new ventures competing in global markets and highlights the importance of this particular type of learning. Thus, technological learning, especially when applied through meta learning processes, helps the firm to develop its technological knowledge stock and use that stock to create value (Mohrman and Von Glinow, 1990; 261-280). Also we can describe technological learning as a development of new technological knowledge which assumed creative solving type of problem by all organization. Because of the dynamic competitive landscape, advantage accrues to firms that are particularly adept at technological learning. Contextual factors that are either internal (e.g. firm size, structure, managerial ability) or external (e.g. industry) to the organization may enhance or impede the firm’s ability to engage in effective technological learning processes. Technological learning facilitates the firm’s efforts to take appropriate levels of risks, proact, innovate, develop, maintain and use dynamic core competencies, build sustained competitive advantages, and create value (Hitt et al, 2000; 233-234). Technological learning can be mentioned as a practice which makes organizational learning more private and focused. New knowledge, in other words technical knowledge shapes not only product design but also organization basic routines and practices (Kazanjan, Drazin, Glaynn, 2002; 273-274). If we consider from different point of view, the world has changed dramatically with the development of information technology and the increasing importance of knowledge. Consequently, technological learning also needs to be revamped. The concept of technological learning in developing countries, which inherently focuses on technologies and



learning, needs to be redefined in today's hypercompetitive environment (D'Aveni, 1994; 98-103). Technological learning is no longer about learning technologies solely. Instead, it should involve learning both technologies and nano-technologies, such as effective management techniques. More often than not, the latter is more important than technology itself. Further, technological learning should involve multiple sources, multiple subjects, and multiple methods. As such, a more integrative model of technological learning may be more appropriate for the needs of today's developing countries. Many scholars suggest that firms must adopt integrated learning to survive and grow in today's turbulent environment. Lei et al. (1996) introduce the term "meta-learning" which consists of information transfer and retrieval, experiment, and dynamic routines. They claim that meta-learning is necessary to develop and sustain effective dynamic core competence. Firms need to enhance the breath, depth, and speed of technological learning in order to effectively manage technological knowledge. Integrated technological learning requires firms to conduct acquisition, assimilation, and improvement simultaneously. The overemphasis on the role of stages of acquisition and assimilation in traditional model prevent firms in developing countries from strategic learning. This can account for the well-known problem of "trap of technology import" in developing countries, that is, firms keep importing technologies from developed countries, but never build up their own technological capabilities (Chen and Qu, 2002; 2).

### **3. AN EXAMPLE OF TECHNOLOGICAL LEARNING**

Many studies have focused on the processes of successful technological learning in the industrialization of developing countries. It is believed that, in general, newly industrialized countries initially learn technologies from developed countries, and then build their own technological capabilities step by step. The stages of technological learning are necessary for developing countries that want to build up their own technological capabilities. Korea is an excellent example of successful technological learning. In fact, no nation has tried harder and come so far as quickly. This country has gone from handicrafts to heavy industry and from poverty to prosperity, and has been transformed from a subsistent agrarian economy into a newly industrialized one during the past four decades. Some scholars in Korea argue that the technological trajectory in developing countries is comprised of acquisition, assimilation, and improvement (from imitation to innovation), which is in the reverse order of that in developed countries. China considers Korea as a paragon in technological learning. Therefore, many scholars in China believe that Korea's model of technological learning is also applicable to China. Arguably, however, no one solution can effectively deal with all problems (Chen and Qu, 2002; 1). Technological learning in some firms in China does not follow the traditional staged model. These firms have opted for a more integrated technological learning that involves acquirement, assimilation, and improvement simultaneously. There are three common characteristics among these firms. First, technological learning in these firms is often fast and successful. Second, most of them are high-technology-based. Third, these firms generally keep close relationship with universities or research institutes and have their own technological capabilities in certain fields at the initiation stage. The ZDZK Automation Ltd Co. is a good example of new technological learning. It has many typical properties that can be explained by the staged model (Chen and Qu, 2002; 3).

#### **3.1. The Technological Learning at ZDZK**

As we mentioned before, the technological learning at ZDZK does not follow the traditional staged model. Based on information technology, this new technological learning



has multiple objects, sources, subjects, and methods. ZDZK succeeded in learning technologies and nano-technologies simultaneously. As a tech-based company, ZDZK learned technologies from many sources when the company developed its first DCS called JX-100. They developed the software for the upper part by imitating the control interface and operational methods of “qXL” DCS, which came from Japan. They also imitated the structure of control station and the “ONSPEC” software, which came from the USA, to develop the lower part. As ZDZK had strong links with the CSERCIA and the CSKLICT, they capitalized on this association and made use of the technologies that these research institutes were developing. At the same time, ZDZK learned nano-technologies actively. One manager said that because they lacked experience in management, they often appropriated effective managerial methods from other firms and imitated them when needed. Moreover, to improve the quality of its products, ZDZK began to implement the ISO9001. Unlike some firms that always learned matured technologies, ZDZK made a balance in learning matured and emerging technologies. The company had utilized many matured technologies from foreign firms during the development of DCS. In 1996, ZDZK imported the software called “Hiecon” from Adersa Co. in France. They transplanted “Hiecon” into the systemic supervision software of the “JX-300X” DCS and developed an improved control software—AdvanTrol–Hiecon. The company assimilated the technology of “Smart 1151” transport, which is produced by Rosemount Co., and developed an intelligent transport called “SMART1151” in 1997. With the completion of its manufacturing factory, ZDZK adopted a lot of advanced equipment to improve its production. At the same time, ZDZK learned many emerging technologies from China’s research institutes. For example, during the development of “JX100” DCS, the company utilized the technologies of redundancy and groupware from the Industrial Control Institute of Zhejiang University (Chen and Qu, 2002; 5).

**Table 1. The First Degree of New Technological Learning** (Chen and Qu, 2002; 5)

INDEX		MEASUREMENT
<b>Inside of Firms</b>		
1	Capabilities of personnel	Education, work experiences, etc
2	Structure of R&D	Extent of appropriate pyramidal personnel structure
3	Accumulation of R&D documents	Amount of R&D document per documents year
4	Usage of R&D documents	Ratio of R&D documents used to total documents
5	R&D tools	Extent of advance in R&D tools
6	Knowledge sharing in R&D	Extent of formal and informal knowledge sharing Department
7	Knowledge sharing among departments	Extent of formal and informal knowledge sharing among R&D, production, and marketing departments
8	Top management support	Learning CEO’s attitude and effect to support technological learning
9	Incentive systems	Extent to which incentive systems are suitable for technological learning



10	Training programs	Training plans or informal training
11	Knowledge management	Extent of formal knowledge management
12	IT usage in KM	Extent of IT penetration in knowledge management
<b>Outside of Firms</b>		
13	Cooperation with leading firms	Extent of joint venture, technological cooperation and exchange with domestic and international leading firms
14	Cooperation with universities	Extent of cooperation with universities and R&D institutes research institutes
15	Cooperation with users	Extent of cooperation with users
16	Cooperation with suppliers	Extent of cooperation with suppliers
17	Benchmarking	Extent of using benchmarking or best practice
18	Human resource	Extent of consistence between human resource planning and learning strategy
19	Usage of IT in cooperation	Extent of IT penetration in outside cooperation
20	Technology monitoring	Extent of formal technology monitoring

ZDZK had many sources for technological learning, including the foreign leading firms, universities, research institutes, users, and suppliers. Although foreign leading firms and universities were its main sources of learning, ZDZK did not want to miss the chance to learn from other sources. As the company belonged to Zhejiang University, it could easily learn technologies from this university. ZDZK often combined emerging technologies from the university and matured technologies from foreign firms to develop new products. ZDZK also emphasized its openness to the innovative ideas from actual users. For example, during the development of its series of DCS, suggestions from users played an important role. Some managers believed that it was this attention to the demand of users that drove the improvement of products. Also the company kept a close relationship with providers (Chen and Qu, 2002; 5).

#### **4. EMPIRICAL TESTING OF TECHNOLOGICAL LEARNING THEORY: RESEARCH METHODOLOGY**

In this paper, it is attempted to explain conceptualizing and identifying instances of higher technological learning, as well as its nature, content, process, context and impact. In this chapter, Carayannis and Jeff Alexander are engaged in a multi-industry, longitudinal, empirical study to investigate the relationship between technological learning activities and firm market performance. Based on the previous analysis of learning activities and their relationship to competitive advantage, the following broad research questions are addressed :

1. In what instances and through which aspects do learning activities contribute to or detract from firm market performance?
2. What is the scale of the impact of technological learning activities on firm market performance, and how does that impact vary under different firm, industry and market conditions?



3. What is the time lag between learning activities and their impact on firm market performance?
4. How does the scope of learning activities affect the resulting impact on firm market performance?
5. How does the level of investment in learning activities affect the impact of those activities on firm market performance?

These research questions can be further narrowed into hypotheses appropriate for empirical testing through the study of actual firm technological learning activities:

**H1:** The scale of technological learning activities is correlated with firm market performance (test of relationship).

**H2:** The level and direction of correlation between technological learning activities and market performance vary with the time horizon implicit in calculating the level of firm market performance (test of time effects)

**H3:** Investment in technological learning activities is positively correlated with the level of firm market performance (test of sensitivity) (Chen and Qu, 2002; 6).

#### 4.1. Sample Selection

In the study done by Carayannis and Alexander, technological learning activities of 24 firms across six industries were analyzed. These six industries fall into two general technological “clusters”. **Cluster 1** consists of firms in pharmaceutical, chemical, and biotechnology industries. **Cluster 2** is composed of firms in the semiconductor, computer, and computer peripherals and networking industries. The firms in the sample were selected in two ways: For more established industries chemical and semiconductor we chose the leading firms as identified by the 1999 Fortune 500 listing of the largest US firms in each industry by sales. For more entrepreneurial industries, such as biotechnology; firms identified as industry leaders by securities analyst reports. In this article, market performance and indicators of technological learning for these 24 firms across a time period of approximately 12 years, from 1986 to 1997 is examined (Chen and Qu, 2002; 6-7).

#### 4.2. Data Collection

As outlined in the model in fig. 6, Carayannis and Alexander measured the relationship between specific indicators of inputs to technological learning and outputs representing market performance. After that they investigated how that relationship had been affected by the mediating aspects such as content and context. The data set for inputs to technological learning drew on two types of indicators described above: quantitative and qualitative indicators. For quantitative indicators of technological learning activities, this study utilized two generally-accepted measures of the scale of technological capability in R&D, namely research and development spending and patenting rates. The patenting rate was generated by counting the number of new patents awarded each year to each firm by the US Patent and Trademark Office (PTO), using the PTO’s own database of awards. To normalize these statistics to firm size, R&D spending and new patent awards as a ratio of total firm assets for each year measured, producing two quantitative indicators: R&D spending (RDS) and patent productivity (PAT) (Chen and Qu, 2002; 7).



**Table 2. The Sample Used For Learning Activities Indicators (Chen and Qu, 2002; 7-8)**

R&D Indicators	Research
	Development
	Patent
Cooperative R&D Indicators	Integrate
	Joint-Venture
	Licencing
Technology Management Indicators	Acquisition
	Innovation
	Quality

#### 4.3. Preliminary Results

To determine the strength of the relationship between each of the learning indicators in this study and performance, a series of multivariate linear regressions are conducted as:

1. A regression of RDS against ROA.
2. A regression of PAT against ROA.
3. A regression of LRN against ROA.
4. A regression of RDS and PAT against ROA.
5. A regression of RDS, PAT and LRN against ROA.

In each case, a dummy variable to identify the membership of each firm in each of the six industries can be found. Also, as the theoretical framework included the implicit assumption that any change in performance would follow changes in learning activities by some period of time, they conducted the regressions by inserting a time lag between the observed learning indicators and the observed firm performance. Table 7 summarizes the results for regression 5 for lag periods of 1, 2, 3 and 4 years. Based on these results, it is possible to say that there is no strong evidence of a linear relationship between firm performance and any of the learning indicators (with the possible exception of spending AGH at a lag of 4 years). It is also interesting to note that the coefficients generated by these regressions would indicate that both patenting and the qualitative learning index are negatively related to performance.

**Table 3. Results of Full Regression (Chen and Qu, 2002; 8-9)**

Time Lag	Adjusted R <sup>2</sup>	Variables Used	Beta	Sig. T
<b>1 Year</b>	0.192	RDS	0,048	0,565
		PAT	-0,1	0,156
		LRN	-0,01	0,849
<b>2 Years</b>	0.189	RDS	0,095	0,284
		PAT	-0,1	0,196
		LRN	-0,02	0,821
<b>3 Years</b>	0.218	RDS	0,133	0,158
		PAT	-0,11	0,19
		LRN	-0,07	0,401
<b>4 Years</b>	0.199	RDS	0,268	0,009
		PAT	-0,12	0,171
		LRN	-0,06	0,484



More extensive examination of the data generated the following insights which guided further analytical investigations:

1. Attempting to fit a curve to the scatter plots for each of the learning indicators and performance showed that the relationship between these variables is not linear. In most cases, the best-fitting curve between each indicator and performance at various time lags was a cubic equation. The curve fit analysis showed an interesting pattern. For LRN and RDS, performance initially improves as the value of each indicator increases, and performance later declines. Performance once again improves as the indicator values reach their maximum. For PAT, the inverse pattern is observed, with performance declining initially as patenting increases. Performance later improves, and then declines again.

2. The original analysis was based on an extrinsic grouping of companies, trying to control for the influence of the firms' industry membership on the relationship between learning and performance. More useful results were gained by using an intrinsic grouping approach, i.e. clustering the firms based on their performance and then testing for the relationship between learning and performance. To develop this intrinsic grouping, firstly the firms were ranked based on a combination of two criteria: the level of returns on assets, and the stability of returns on assets. Following the methodology established in Carayannis and Maldifassi (1991), the average and standard deviation of ROA for each firm over the 12 year period of the study were calculated. This provided a means to rank the firms based first on how well they minimize the variability in their performance, and second on the absolute scale of performance. Stability of performance is particularly important to research on learning, as learning should enable firms to adjust more rapidly to changes in their environment and maintain consistent performance over time. Then the median average and median standard deviation of ROA for all firms were calculated in the study over the period. These statistics were used for grouping the firms into four cohorts or "quadrants" based on their relative performance scores (Table 8). This ranking reflects a higher value assigned to firms with consistent performance records versus those with a high level of performance (Chen and Qu, 2002; 8-9).

**Table 4. Ranking Scheme for Firm Performance**

Standard Deviation of ROA	Average ROA	Rank
Below Median	Above Median	1
Below Median	Below Median	2
Above Median	Above Median	3
Above Median	Below Median	4

Using this ranking, a series of partial correlations were performed to determine if any relationship existed between the learning indicators and performance. The results of this analysis were more promising than the linear regressions described above. In several cases, the learning indicators showed a significant degree of correlation with performance at various time lags (see Table 4). As this table shows, the PAT indicator is significantly correlated with ROA in the negative direction at a 3year lag, with a 95% level of significance. RDS is significantly correlated with ROA in the positive direction at a 4-year lag, with a 99% level of significance. LRN is significantly correlated with ROA in all lag periods. To begin investigating the relationship between higher order learning activities and performance, a similar set of correlation analyses between ROA and a new set of indicators showing the year-to-year percentage change in the indicators PAT, RDS and LRN were conducted. These new



indicators were labeled as DPAT, DRDS, and DLRN, respectively. The results, which are shown in Table 10, are less conclusive. DPAT is significantly correlated in the negative direction with ROA with a 1-year lag at the 95% level. DRDS is significantly correlated in the negative direction with ROA with a 1-and 4-year lag at the 90% level. DLRN is not significantly correlated with ROA at any time lag (Chen and Qu, 2002; 9-10).

**Table 5. Results of First Order Partial Correlation**

	ROA	PAT	RDS	LRN	Lag
<b>ROA</b>	1.000	-0,0885	-0,0036	-0,1609	
	0	237	237	237	1 Year
		<i>P=0,173</i>	<i>P=0,955</i>	<i>P=0,013**</i>	
<b>ROA</b>	1.000	-0,0902	0,0742	-0,1903	
	0	213	213	213	2 Years
		<i>P=0,188</i>	<i>P=0,279</i>	<i>P=0,005***</i>	
<b>ROA</b>	1.000	-0,01553	0,0737	-0,1229	
	0	189	189	189	3 Years
		<i>P=0,032**</i>	<i>P=0,311</i>	<i>P=0,090*</i>	
<b>ROA</b>	1.000	-0,0814	0,2371	-0,2934	
	0	165	165	165	4 Years
		<i>P=0,296</i>	<i>P=0,002***</i>	<i>P=0,000***</i>	

**Table 6. Results of Higher Order Partial Correlations (Chen and Qu, 2002; 9-10)**

	ROA	DPAT	DRDS	DLRN	Lag
<b>ROA</b>	1.000	-0,1585	-0,1116	0,0248	
	0	237	237	237	
		<i>P=0,014**</i>	<i>P=0,085*</i>	<i>P=0,0703</i>	1 Year
<b>ROA</b>	1.000	-0,0842	0,0533	0,001	
	0	213	213	213	
		<i>P=0,219</i>	<i>P=0,437</i>	<i>P=0,989</i>	2 Years
<b>ROA</b>	1.000	-0,0906	-0,0459	-0,111	
	0	189	189	189	
		<i>P=0,212</i>	<i>P=0,528</i>	<i>P=0,879</i>	3 Years
<b>ROA</b>	1.000	-0,0215	-0,1483	0,0274	
	0	165	165	165	
		<i>P=0,783</i>	<i>P=0,056*</i>	<i>P=0,726</i>	4 Years
<b>"Significant at *90%, **95%.***99%</b>					

#### 4.4. Findings

Through this research, the following aspects of technological learning and market performance have been tested:



1. The existence of a relationship between technological learning and market performance;
2. The timing of the relationship between technological learning and market performance;
3. The direction of the relationship between technological learning and market performance.

Results of the research provided following insights about these aspects. First, as predicted by our theory, there is evidence that technological learning activities are related to firm performance, although that relationship cannot be proven to be particularly strong. Still, the results support our hypothesis H1. In particular, the significance of the correlation only becomes apparent when the analysis controls for the performance characteristics of the firms. This suggests that high-performing firms may be more adept at leveraging the advantages gained from technological learning and applying those advantages to influence their performance. If this is true, it appears that the strength of the relationship between technological learning and firm performance exhibits positive returns to scale; that is, firms which perform better learn better, and in turn are positioned to improve their performance even more. It is also important to include variability as a component of measuring performance, since technological learning should help a firm to maintain more consistent performance by enabling the firm to adapt more quickly to rapid changes in its market environment. Second, there is also apparently some lag between the time that technological learning activities are conducted and their impact on market performance, based on the results that a significant level of correlation is found only if a specific time lag is inserted between the observations of technological learning and performance. This confirms our hypothesis H2. Furthermore, the lag is dependent upon the type of technological learning activity, and patenting activity is correlated with performance along a time horizon which differs from that for research and development spending. Third, we do not find conclusive evidence that technological learning is positively correlated with firm market performance. Thus, our hypothesis H3 is not supported by the research results. In fact, the linear regressions and partial correlations suggest that the relationship is negative in many cases. However, upon closer examination, the relationship appears to be nonlinear, complicating the task of determining the direction of the relationship. In particular, the curve shapes for LRN and RDS suggest that learning activities may initially improve performance, but that there is some limit to a firm's absorptive capacity for learning. Larger increments of technological learning begin to depress performance, until a new critical point is reached and performance again improves. This suggests the presence of an optimal learning absorption bandwidth for each firm, where learning activities should not exceed the absorptive capacity of the firm but also must be sufficient to sustain improved performance (Chen and Qu, 2002; 10-11).

#### **4.5. Future Research Directions**

Based on the findings, we plan to expand the scope of data collection to cover additional industrial clusters. The findings regarding quantitative data on the content, process, context and impact of technological learning provided some evidence that the market performance of the firms studied is positively impacted with a certain time lag from the occurrence of technological learning activities. This finding still needs greater statistical validation, and the implications of trends in decreasing firm market performance must still be explored as a result of initial resource investments to promote technological learning, as well



as resource investments in technological learning beyond certain levels. Moreover, we will further refine the methodology for collecting and analyzing qualitative data on the content, process, context and impact of technological learning. Our findings to date indicate that we must find better ways for identifying valid qualitative data and derive consistent indicators of learning patterns from those data. In a strategic sense, a firm must have a sufficiently long-term perspective on these investments in technological learning to continue these investments even if market performance is decreasing in the short term. At the same time, the firm must be flexible enough to sense when investments in technological learning may have reached a level of diminishing returns. This would provide greater insight into understanding the demands of flexibility required for the management of technological learning resources. Our research appears to indicate that the effectiveness of technological learning activities in influencing firm market performance varies across industries. As Linton and Walsh (1999) discuss, however, different learning styles may also be needed to acquire different technological competences within the same set of firms. Therefore, variation in the relationship between technological learning activities and market performance may be related not only to industry characteristics, but to characteristics of the technologies underlying each industry as well. One stream of future research would investigate whether industry factors or technological factors have greater significance for the selection of technological learning activities by a given firm at a given point in time (Linton and Walsh, 1999; 101). One other aspect that warrants further examination is the distinction between strategic, tactical and operational technological learning, and their relative effects on market performance. Refining the indicators of technological learning activities could help to distinguish between these levels of technological learning. Existing literature from the organizational learning, strategic management, and technology management fields suggests that the relationship between technological learning and firm market performance is substantial but very complex and contingency-dependent. A more detailed analysis of learning activities shows that technological learning has numerous aspects which are interlinked in a nonlinear manner, each of which affects the final influence of learning activities on firm market performance. Furthermore, the relationship between learning and performance can change with the context adopted to analyze the relationship. The empirical study undertaken to date shows that quantitative indicators of technological learning have limited ability to predict firm performance. The addition of qualitative variables adds somewhat to the strength of the relationship identified between technological learning and market performance. While full case studies would provide the greatest detail linking technological learning to firm performance, the limited generalizability of case studies makes a hybrid quantitative and qualitative approach more useful in the exploration of technological learning. The key issue for this research is not simply to extrapolate future performance from past performance. Instead, the key issue is to discover the underlying drivers of past performance and examine predictable patterns in learning activities versus performance. This would enable analysts to forecast more reliably future performance. Even if the causality cannot be established between technological learning and market performance, proving correlation will assist in this forecasting effort by directing analysts' attention to specific critical indicators linked to future performance. An important caveat is that this method for examining the influence of learning on firm market performance should not cluster firms by industry, but instead by their performance characteristics. Therefore, better forecasting could result from studying technological learning in cross sections of firms from different industries with similar records of performance.



## 5. CONCLUSION

Economics attempts to explain the issue that unlimited necessities are served by insufficient sources. Changing and becoming varieties of consumer's needs and contrarily sources' being difficult to find causes to reach competitiveness so serious and cruel. The uncertainty, dynamism and volatility of the new competitive landscape are altering the fundamental nature of competition as the 21st century begins. In this exciting competitive era, science and technology learning plays a vital role in a firm's competitive success. Thus, the world has changed dramatically with the development of information technology and the increasing importance of knowledge. As an evaluation, firstly we will explain effects of technological learning in micro plan and then we are going to discuss the role of micro plan in country economies. The basic reference point is present firms' having large sharings in free market economies and in the highlight of capitalist system. Therefore, big or small, different kinds of organisations in country have some characters thanks to technological learning and so these characters have very important effects in the country economy. Some scholars believe that competition is becoming more knowledge-based and that the sources of competitive advantage are shifting to intellectual capabilities from physical assets. Thus, being able to develop, maintain or nurture and exploit competitive advantages depends on the firm's ability to create, diffuse and utilize knowledge throughout the company. As Polanyi stated, the aim of a skillful performance is achieved by the observance of a set of rules which are not known as such to the person following them. Thus, tacit knowledge is difficult to codify, articulate and communicate. Importantly, the tacit dimension does not suggest that knowledge cannot be codified. In fact, the important point is accepting learning culture in many of the organisations in the country. Occuring organisational learning with technological learning cause competitive advantage in organisations in the sector. The first example related to this subject is ZDZK firm. The firm, thanks to technological learning, has become a market leader with its products in a short period. It is also possible to see such firms in Kore. For example; CANDU's unprevented success in electronic sector has been regarded as a result of applying technological learning in an effective way. It's not possible to say that there is a definite relation with technological learning activities and firm-market performance. From practising example in countries, technological learning result of getting organisations abilities, we have to accept productivity of employees. It is real that majority of creating value added activities in economies necessary condition for economic development. In fact, without any changes in any productive factors, increasing in productive is characterized as a productivity. For this reason, technological learning activities create competitive advantage. Sustainable development in macro economic dimensions have an important part. The basic condition to sustain economic development, the minimization in sustainable cost in productivity. In this point, cost minimization can be achieved by creating activities, productivity and rasyonalisation in productivity factors. Final product and service producing, firstly raw material, productivity factors and the most important labour cost minimization can create competitive advantage. Previous research suggests that technological knowledge may be the foundation for economic growth. For example, Sanchez and Ross (1990) state that technological change involving the development of superior technologically advanced products is the main reason for the growth of output per worker in the United States and other industrialized countries. This supports Schmookler's arguments that technological knowledge is the principal source of long-run economic growth. Through technological learning, firms create and/or acquire technological knowledge from both internal and external sources. Furthermore, by using integrating mechanisms to manage technological knowledge



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and to link it with strategy, the firm can develop an ability to proactively use technological knowledge to innovate. These efforts can produce core competencies and ultimately sustained competitive advantage. It is still early to say that there is technological learning taking place in Turkey in a general sense. Following questions help us see the big picture of the situation in Turkey. Is Turkey a technologicalaly developping country? Do we produce or do we buy technological knowledge? How do we manage it? The proportion of Tubitak's budget allocated to R&D activities, which is approximately % 0,6 (Tubitak Official web site), shows us the lack of collaboration between universities and industry. And it is still developed countries that are producing technological knowledge. In general, newly industrialized countries initially learn technologies from developed countries, and then build their own technological capabilities step by step. The stages of technological learning are necessary for developing countries which want to build up their own technological capabilities. We tried to explain how technological learning activities affect organization basics in micro plan and countries in macro plan with the help of examples given above. The examples showed us that the goal of gaining technological learning and then accepting it as a culture in Turkey can be firstly achieved by investigating in R&D sufficiently. Secondly, building up cooperation between universities, which are founded to produce science and industries are practice fields for this science. Besides they are considered to help the development of technological learning. Technological research is also important with many kinds of research centers. We have an idea that many economy authorities in unproductiveness as a set in front of economy in financial developing and improvement can transfer into productivity in technological learning. In this sense, technological learning can be useful for understanding technological learning general in our country and taking place in future's world . The Korea example supports our thesis. Korea is an excellent example of successful technological learning. In fact, no nation has tried harder and come so far as quickly. This country has gone from handicrafts to heavy industry and from poverty to prosperity, and has been transformed from a subsistent agrarian economy into a newly industrialized one during the past four decades. Creating competitive advantage will be possible with whether your rivals doing or not. Technological learning will be constituted in todays technology in increasing proportion creating competitive advantage. As a matter of fact that unimitated knowledge and competitive advantage will continue until discovering from rivals.



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