ECONOMICS

ICT INVESTMENTS AND ECONOMIC GROWTH IN EMERGING MARKET ECONOMIES*

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ABSTRACT

This paper examines, the relationship between Capital Input – ICT and Capital Input – Non ICT, Labor Quality and GDP growth in emerging markets by using the panel regression model. The data series have been obtained from "The Conference Board Total Economy Database". These series are annual and include the years between 1996-2017. In order to apply the model on the computer, Stata 14.0 has been used. Based on the F, LM, LR and Score Tests results, the classical model was rejected, and the presence of the unit effect was determined. According to the Hausman's specifications test results, the random effects model was applied. In the random effects model, both heteroscedasticity and autocorrelation were observed. According to the results of the Robust Estimation of the Random effects Model, Capital Input – ICT and Capital Input – Non ICT variables has significant impact on GDP. 1% increase in Capital Input – ICT creates 0.0735% increase in GDP. 1% increase in Capital Input – Non ICT creates 0.5709 % increase in GDP. Labor Input–Quality variable does not indicate statistical significance on GDP.

Key words: ICT investments, Economic Growth, Labor Quality
Gel classification: O30, O40, J24

İKTİSAT

YÜKSELEN PİYASA EKONOMİLERİNDE BİT YATIRIMLARI VE EKONOMİK BÜYÜME

ÖZET

Bu makale kapsamında, Yükselen Piyasalarda, BİT sermaye girdisi, BİT dışı sermaye girdisi, işgücü kalitesi ve GSYİH artışı arasındaki ilişki 2000-2017 yılları arasındaki dönem için panel veri yöntemini kullanarak analiz edilmiştir. Veri seti "The Conference Board Total Economy" veri tabanından alınmıştır. Seriler yıllıktır ve 1996-2017 yılları arasındaki dönemi içermektedir. Modelin analizi için Stata 14.0 kullanılmıştır. Uygulanan F, LM, LR ve Skor Testleri sonuçlarına dayanarak, klasik model reddedilmiş ve birim etkisinin varlığı belirlenmiştir. Hausman'ın spesifikasyon test sonuçlarına göre, rastgele etkiler modeli uygulanmıştır. Tesadüfi etkiler modelinde, hem heteroskedasite hem de otokorelasyon gözlenmiştir. Tesadüfi etkiler modelinin dirençli tahmincileri sonuçlarına göre, BİT sermaye girdisi ve BİT sermaye girdisi değişkenleri GSYİH üzerinde anlamlı bir etkiye sahiptir. BİT Sermaye Girdisinde % 1 artış, GSYİH'da % 0,0735 artış sağlamaktadır. BİT dışı Sermaye Girdisinde % 1 artış ise GSYİH'da % 0,5709 artışa yaratmaktadır. İşgücü kalitesi değişkeni GDP üzerinde istatistiksel olarak anlamlılık göstermemektedir.

Anahtar Kelimeler: BİT Yatırımları, Ekonomik Büyüme, İşgücü Kalitesi

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1. INTRODUCTION

Starting with Schumpeter, the transition process to information society has been analyzed by the growth theorists. Schumpeter explains the economic process in two stages steady state and beyond steady state. With the effect of the technological development that occurs as a result of entrepreneurship activities, the economic system moves from one equilibrium condition to another equilibrium condition. The evolution between the two equilibrium results in a process of "creative destruction (Hilbert, 2012). In Solow-Swan-type economic models, technology that is the only source for total factor productivity is an exogenous factor, and the growth slows down on condition that continuous progress is not enabled in technological developments. In the long term, the economy converges to the steady state. This is the result of the diminishing returns assumption. The growth rate of steady state income per capita depends solely upon the exogenous technological growth rate. In the Neo-classical model, there exists no difference between the technological levels of countries. According to this assumption, it is mentioned that long-term real growth rates of both developed and developing countries will converge to the same steady state (Basilico, 2012).

Endogenous economic growth theory was developed as an answer for the criticism of exogenous model. In endogenous economic growth theories, technology contributes to capital and labor factor by means of efficiency increases created by information dissemination and innovation. According to Romer (1990), technology is neither a traditional nor a public good. Technology has a quality that is not subject to competition. Technological development is the main dynamic of the growth and enables production per labor by encouraging capital accumulation. According to Romer, free external trade leads to technological development by forming a ground for RE&DE activities of firms aiming to achieve market expansion and profit. According to Grossman and Helpman (1991), that the firms create monopolistic powers by benefiting from patent rights and diversify their products to include international markets becomes determinative on the growth dynamics of economies. The speed of new technological production that will enable the economy to enter into a quick growth process depends upon product diversity, the abundancy of resources that the economy has, willingness of the household to postpone today's consumption to future periods as well as the efficiency in RE&DE. Grossman and Helpman (1991) link the relationship between investment rate and economic growth to the technological productions in RE&DE sector (Ateş, 1998).

The investments in ICT and digital content play a key role for endogenous growth theorists in terms of facilitating the compliance with learning, changing market and social condition (Mansell, 2014). The growth differences between the countries that have made ICT investments and those that have been late to do it for different reasons have become more obvious in recent years. In some countries, it is also possible that the efficiency effect of ICT investments displays relatively poor performance in some conditions (Pilat, 2004). CSLS (2005), compared ICT investment level determinants specifically in terms of Canada and United States of

America. According to the data obtained from the analysis, industry structure and firm size are among the factors that affect the ICT investment level. Few numbers of workers in the ICT sectors, the dominance of small and medium-size enterprises on the industry rather than big ones play a determinant role on the ICT investment levels. On the other hand, low labor cost decreases the appeal of expensive ICT investments and moves the direction of public encouragement from the ICT investments towards labor-intensive sectors that will increase employment. On micro level, it is possible to encounter some obstacles such as the incompliance of the education level of the managerial staff and their qualifications to manage ICT companies. Exchange rate is the other significant factor that affects the ICT investment level. Devaluation of the local currency against American dollar increases the cost of technology transfer and decreases the amount of ICT investments.

This study analyzes the relationship between ICT investments and GDP for the period of 1996-2017. In the second part of the study, the emerging market economies including Morocco, South Africa, China (Official), India, Indonesia, Philippines, Singapore, South Korea, Taiwan, Thailand, Czech Republic, Hungary, Poland, Romania, Russian Federation, Turkey, Brazil, Chile, Colombia, Mexico, Greece and Portugal have been examined with regard to GDP growth, labor input quality, capital input ICT and capital input non-ICT data. In the third part of the study, a relevant literature review has been presented. In the fourth part, the panel data analysis regarding the correlation among the variables has been provided. In the fifth part, the results of the study have been presented.

2. ICT DEVELOPMENT PROCESS IN EMERGING MARKETS

As one of African economies, Morocco grew by 4.23% on average during 1996-2017 while South Africa grew by 2.76% on average during the same period. Morocco, having the biggest phosphate deposit, sustains its economy through agriculture, manufacturing, fishing and tourism sector income as well as currencies brought by the Moroccans working abroad. As Morocco economy's dependence upon agriculture and phosphate sector has decreased in the last ten years, the share of manufacturing and service sector has increased in GDP. Depending upon the performance of agriculture sector, GDP varies each year (DEİK, 2018). The slow development observed in the economic growth of South Africa Republic is closely related to the economic performance. With the effect of 2008 global financial crisis, the GDP of South Africa displayed a sharp decrease. Although the growth turned into positive digits as of 2010, it did not manage to obtain the performance before crisis. Other factors that slow down the growth are fluctuations in commodity prices and electric cut-outs that affect the industrial production negatively (ECO , 2017).

While the labor quality index value increased by 0.1% on average during 1996-2017 in Morocco, it was 0.5% in South Africa. It is seen that South Africa's rate of labor quality increase is five fold higher than that of Morocco. According to the CBTED Methodological Notes, Labor Quality Index is formed based on the weighted

summation of labor groups with different skill levels. For developing economies, the labor quality index that is formed with the weighted summation of labor percentage at low, medium and high skill levels varies between 1 and 2.8. The countries whose labor quality index is 1 have low labor quality while those whose labor quality is 2.8 have high labor quality. In this respect, it is seen that the labor of both countries is of low quality. However, Morocco's active population's average quality that is measured with educational attainment is relatively lower compared to that of similar countries. While the national illiteracy is 57.7% in female, it is 44% in males (Agenor & Aynaoui, 2003). As a matter of fact, according to The Global Competitiveness Index (2017-2018) Morocco obviously falls behind other North African and Middle East countries with regard to the categories of higher education and training, innovation and technological readiness. Technological changes require higher labor quality and the development of the current labor quality. In order to evaluate the opportunities provided by ICT, a very strong skill base is required. For this reason, ICT sector needs a talented labor. According to Manpower 2016/17 talent shortage survey, 30% of employers in South Africa have been experiencing a serious talent problem since the recession. This situation is the result of economy's structural transformation, quick population increase and low schooling rate. The education and talent levels of the labor in South Africa are lower than those of other countries. While 20% of the employed population has high quality, 31% of them are graduates of secondary school and 50% of them have not been registered. Diseases such as HIV/AIDS have negative effects on skill development. These diseases decrease proficiency and increase labor cost (Laubscher, 2018).

Morocco's growth of capital services provided by ICT Assets was 19.06% on average for the period of 1996-2017 while South Africa's was 23.99%. The growth of capital services provided by non-ICT Assets, on the other hand, is 4.5% and 3.2% in Morocco and South Africa respectively. As a new development that triggers the growth of ICT–supported services, the firms in high-income countries tend to outsource their office and information technology functions so that they can benefit from advance skills and decrease the labor cost of service providers. More than three/fourth of call centers that provide service to French-speaking markets are located in Morocco and Tunisia. In Morocco, in consequence of the applied program, ICT capital services increased quickly between the period 1996 and 2000. It is observed, however, that it decreased after 2000. When compared to Morocco's other nine potential offshore places with regard to offshore ICT service competition, this structure does not have any advantage in criteria except for the rental cost. According to Network Readiness Index, Morocco has more advantage with regard to categories such as availability and reliability of basic infrastructure, telecommunications costs, pool of skills and IT competences, labor costs of IT workers, presence of IT & BPO suppliers, regulatory environment and country risk (Cattaneo, Diop, & Walkenhorst, 2007).

When ICT sector is analyzed within the scope of Asian countries, it can be said that East Asia and South Asia countries display a successful performance in terms of benefiting from the advantages of ICT. During 1990's, China grew by four fold

more than the world average of ICT sector. During 1975-1980, the share of ICT investment decreased to 0.6%. During the first five years of 1980's, it increased again to 1.1%. At the end of 1980's, China started to make more investments in ICT and these investments reached 1.62% of the total investments. During 1990 to 1995, however, the share of ICT sector increased to level 6.6%, and it remained at level 5% at the end of 1990. After 2000, more than 5% of all investments belonged to ICT investments. India was the other country that benefited most from the developments in ICT sector. Today, India is investing in ICT infrastructure and techno-parks in order to attract direct foreign capital investments that will trigger economic growth (Almas & Wanshan, 2006). According to E-government Practice at the Information Solutions Group (ESG) note, re-allocation of the profits obtained from ICT investments in South Korean Incentive Fund for Knowledge Acquisition (1996), creation of a system that allows for ICT-based investments and developing new financing methods for the sector encouraged private sector investments that used public resources as initial capital. The Korean Government selected ICT sector as the engine of the growth. Significant efforts were made; believing that forming a broadband infrastructure early was the most important step to transit to a knowledge-based economy. One of the factors behind Korean's success in ICT sector is government incentive. During the process of planning and applying national projects, the Korean government used such various policy tools as main plans, legal regulations, fund and organizations in an effective way. The distinguishing feature of this intervention is that the government played a complementary role as the supporter of ICT development rather than competing with the private sector.

3. LITERATURE REVIEW

Colecchia & Schreyer (2002), put forth the positive effect of ICT investments on economic growth for 1990's in terms of a group of selected countries. According to the obtained data, the positive effect of ICT on the economic growth increased in the second half of 1990's. The countries benefiting most from this increase included the USA, Australia, Finland and Canada. This study also shows that rather than the existence of big industries that produce ICT, dissemination effect of information plays a key role during the emergence of ICT growth effect. Similarly, Jorgenson (2001), shows that ICT investment contributed to economic growth. In the study, it was stated that the increase in IT investments in the US resulting from the remarkable fall in prices of IT equipment were the main reason for the increase in economic growth.

Erdil, Türkcan, & Yetkiner (2009), showed that ICT investment had positive and significant effect on the growth rates of less-developed and developing countries. In the study, it was seen that the value of a unit increase in ICT usage that was represented with the number of fixed line and mobile phone subscriber per 100 persons and the number of internet user per 100 caused about 0.1% increase in GDP

growth. In the model, the indirect effect of ICT was represented with the advanced technology export indicator.

Roller & Waverman (2001), analyzed the effect of telecommunication infrastructure investments on GDP in terms of 12 OECD countries for the period of 20 years and indicated that there existed a positive correlation from telecommunication infrastructure investments towards GDP.

On the other hand, Beil, Ford, & Jackson (2005), examined the relation between the investments of telecommunication firms and GDP in America for the years of 1947-1996 by means of Granger-Sims causality tests. The analysis results showed that the investments made by telecommunication firms resulted from economic activity. This result indicates that the policies of telecommunication firms to encourage the USA economy by quickening their investments will not be successful.

Niebel (2018), analyzed the relationship between ICT capital and GDP growth in 59 countries for the period of 1995-2010 by using various panel data regressions. The results obtained from the developing, emerging and developed country sub-groups confirm the positive correlation between the variables.

Dedrick, Kraemer, & Shih (2013), analyzed the relationship between IT investments and efficiency for 45 countries for the period of 1994-2007. The results of the study showed that the developing countries with high income obtained significant efficiency returns from IT investments as they increased their IT capital stocks and gained experience in IT usage. They also found out that human resources, openness to foreign investments, quality and cost of telecommunication infrastructure had an effect on country factors.

Piatkowski (2003), analyzed the effect of ICT investment on output increase for the period of 1995-2000, and it was seen that the ICT investments contributed to 8.9% GDP increase.

Karlsson & Liljevern (2017), examined the correlation between ICT investment and GDP for 101 countries for the period of 1995-2015 with panel data analysis. The countries were categorized as high, high medium, low medium and low income. The results indicated that the ICT investments made contributions to the growth only in the richest three countries.

4. Data Set and Method

The countries that have been examined in this study include Morocco, South Africa, China, India, Indonesia, Philippines, Singapore, South Korea, Taiwan, Thailand, Czech Republic, Hungary, Poland, Romania, Russia, Turkey, Brazil, Chili, Columbia, Mexico, Greece and Portugal. In the analysis, the relationship between GDP and Labor Input – Quality, Capital Input – ICT, Capital Input - Non ICT have

been investigated. The series are annual and include the years between 1996-2017. In order to apply the model on the computer, Stata 14.0 has been used. The data series have been obtained from " (Total Economy Database - The Conference Board)".

The Total Economy Database (TED) is a database providing annual data such as GDP, Population, Employment, Total Hours Worked, Per Capita Income and Labor Productivity for 123 countries covering the period 1950-2019. Since the late 1990s, TED has started to produce data jointly with the Conference Board. In 2010, The Conference Board Total Economy Database (CBTED) was extended with a module on growth resources. The extended module contains time series data on the contributions of factor inputs (Labor Quantity and Quality, Non-ICT and ICT Capital Services and Total Factor Productivity) to GDP growth covering 1990-2017. Therefore, CBTED can be used in comparative analysis across countries.

5. Empirical Findings

While examining a model formed with panel time series, it is firstly needed to become suspicious of the existence of unit effect. If the required importance is not given to the unit effect process, the method of Pooled OLS is used. The prediction of Pooled OLS that is made by ignoring the existence of unit effect creates a result that is really far away from the reality. For this reason, the classic model is first tested and the unit effect is controlled with some tests. As is mentioned, in order to test the existence of unit effect, some tests are made with the aim of testing the classic model in terms of fixed or random effects. These tests and their results are shown in the tables below:

Table 1. F Test Results

	Statistics Value	**Probability Value**
F (21, 459)	2.72	0.0001*

*%5 denotes that the main hypothesis is rejected at 5% significance level.

According to the results mentioned above, the classic model was tested over fixed effects, and the existence of unit effect was verified. When the existence of unit effect is researched through random effects, the following results are obtained:

Table 2. LM Test Results

	Statistics Value	**Probability Value**
Chi(1) X^2	20.51	0.0000 *

* denotes that the main hypothesis is rejected at 5% significance level.

According to the results mentioned above, the classic model was tested over random effects, and the existence of unit effect was proven. Another test that tests the classic model against random effects is Likelihood Ratio (LR) test, and its results are shown in Table 3.

Table 3. LR (Likelihood Ratio) Test Results

	Statistics Value	**Probability Value**
Chi(1) X^2	12.35	0.0000 *

* denotes that the main hypothesis is rejected at 5% significance level.

According to the results mentioned above, the classic model was tested against random effects in terms of the indicators shown in Table 3, and the existence of unit effect was proven. Finally, the unit effect in the classic model was examined again by using another test called Score test, which tests the unit effect in classic model. The results are shown in Table 4.

Table 4. Score Test Results

	Statistics Value	**Probability Value**
Chi(1) X^2	32.04	0.0000 *

* denotes that the main hypothesis is rejected at 5% significance level.

According to the results of Score test, which tests the classic model against random effects, the existence of unit effect was verified. According to F, LM, LR and Score Test Results, it is seen that the model subject to the analysis is not a classic model, and the existence of unit effect is identified within the model. In this model, where the classic model is rejected, Hausman (1978), test was used in order to determine the direction of unit effect (fixed or random effect).

Hausman (1978)'s specification test, which was prepared with the aim of determining specification errors, can be used in many areas. On the other hand, it is preferred by estimators in panel data model to make a choice (fixed or random effect) (Tatoğlu, 2012). In table 5 above, Hausman Test Results are shown:

Table 5. Hausman Test Results

	Statistics Value	**Probability Value**
Chi(3) X^2	3.37	0.3384 **

* denotes that the main hypothesis cannot be rejected at 5% significance level.

According to the results of Table 5, it is seen that H0 hypothesis is not rejected for the model and the estimation of random effects is valid. Therefore, the analysis is continued with random effects estimation.

In econometric models, it is required to test main assumptions while making a regression analysis. The same issue is observed in panel data econometrics. For this reason, in the model where random effects estimation is valid according to Hausman's specification test results, it is tested whether the activity is valid by examining heteroscedasticity, auto-corrrelation and correlation between units. Firstly, the existence of heteroscedasticity was surveyed and the results are shown in Table 6.

Table 6. Levene, Brown, Forsythe Test Results

	Statistics Value	**Probability Value**
$W_{0\ df(21,462)}$	2.3527	0.0007 *
$W_{50\ df(21,462)}$	1.9039	0.0094 *
$W_{10\ df(21,462)}$	2.0845	0.0034 *

* denotes that the main hypothesis is rejected at 5% significance level.

H0 hypothesis shows the inexistence of heteroscedasticity. According to the results of Table 6, main hypothesis is rejected, and heteroscedasticity is observed in the random effects model. For the other assumption mentioning that there exists no correlation between error terms, autocorrelation test is made. The results of autocorrelation test is shown in Table 7 below:

Table 7. Bhargava, Franzini and Narendranatla DW - LBI Test Results

	Statistics Value	**Probabality Value**
Bhargava et al. (DW)	1.52	0.0000 *
Baltagi-Wu (LBI)	1.58	0.0000 *

* denotes that the main hypothesis is rejected at 5% significance level.

According to the hypotheses mentioned above, the main hypothesis claims that there exists no autocorrelation. Bhargava et al. Durbin-Watson test and Baltagi-Wu's locally best invariant test indicates that autocorrelation is significant when the value is lower than 2, though critical values are not mentioned in the literature. According to the results given in Table 7, both Bhargava et al. DW value (1.52) and BW-LBI value (1.58) remain below 2, which claims the existence of autocorrelation in the random effects model.

According to these results, in the random effects model, both heteroscedasticity and autocorrelation is observed. Consequently, robust estimation of the random effects model is used in the application, and the results are shown in Table 8.

Table 8. Random Effects Robust Estimation Test Results

Variables	Coefficient	Statistics Value	Probability Value
Labor Input – Quality	0.0870	0.36	0.717
Capital Input – ICT	0.0735	3.16	0.002 *
Capital Input – Non ICT	0.5709	5.23	0.000 *

* denotes statistical significance at 5% significance level.

According to the results in Table 8, Capital Input – ICT and Capital Input – Non ICT variables has significant impact on GDP. 1% increase in Capital Input – ICT creates 0.0735% increase in GDP. 1% increase in Capital Input – Non ICT creates 0.5709% increase in GDP. Labor Input–Quality variable does not indicate statistical significance on GDP.

6.Conclusion

The aim of this study is to investigate how the increase in ICT and non-ICT Capital Inputs and Labor Quality will affect economic growth. The research, which was carried out using a panel data set of 22 countries, covers the years between 1996-2017. According to the findings of the study, the impact of ICT and non-ICT Capital Inputs on economic growth is significant. The Labor Input–Quality variable does not indicate statistical significance on GDP in the model.

These results are consistent with the relevant literature. 1% increase in Capital Input – ICT creates 0.0735% increase in GDP, 1% increase in Capital Input – Non ICT Input creates 0.5709 % increase in GDP. These results suggest that Non-ICT Capital Input have a relatively higher impact on economic growth. These results indicate that emerging market economies focus on non-ICT investments in order to gain comparative advantages in international markets. One reason tending to the non ICT investment of the emerging markets is the lack of qualified labor force to be hired in advanced technological sectors. This constraint makes the existing skilled labor relatively expensive by raising the wages and leads to loss of cost advantages in the relevant markets.

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