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Software Piracy and Productivity: Evidence from Developing Countries

Yazılım Korsanlığı ve Verimlilik: Gelişmekte Olan Ülkelerden Kanıt

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Abstract

In this paper, we attempt to investigate the effect of usage of pirated software on productivity by utilizing three distinct indicators of productivity for developing countries and an unbalanced panel data set containing the years between 2003 and 2017. Our hypothesis claims that increase in the use of pirated software enhance the productivity level in developing countries. Firstly, we implemented univariate analyses and the results of univariate analyses implied that the usage of pirated software and productivity are positively and significantly related in all of three models. Secondly, three control variables (i.e., education, investment, and openness) were employed in our three productivity models in order to check if the findings of univariate analyses remain valid and robust. After inclusion of the three control variables, the statistically significant positive association between the use of pirated software and productivity were observed in all models. Regarding to control variables, they take expected signs whenever they are statistically significant. Based on the estimated coefficients of PROD1 models, a 1% positive change in usage of pirated software leads to a rise in a growth in productivity by 0.1023% and 0.0623% in univariate and multivariate models, respectively while a 1% positive change in usage of pirated software leads to a rise in a growth in productivity by 0.1072% and 0.0684% in univariate and multivariate models of PROD2, respectively. Besides a 1% positive change in usage of pirated software induce to an increase in productivity level by 0.0881 and by 0.0601, respectively in PROD3 models. Secondly, three control variables, namely education, investment, and openness, were included in our three productivity models to test if the finding of univariate analyses keeps its validity. EDUC, INVEST, and OPEN variables are taken the anticipated positive influences and they are statistically significant at least at the level of 5%. More specifically, in estimation results for PROD1 model, one percent increase in EDUC, INVEST, and OPEN variables cause to a jump in productivity by 0.2309%, 0.1198%, and 0.7359%, respectively. Openness of an economy has the most explanatory power among all independent variables. In addition to PROD1 model, in estimation results for PROD2 model, one percent increase in EDUC, INVEST, and OPEN variables cause to a jump in productivity by 0.2482%, 0.0893%, and 0.7211%, respectively. Besides a 1% positive change in EDUC, INVEST, and OPEN variables induce to an increase in productivity level by 0.3345%, 0.0341%, and 0.2238%, respectively in PROD3 models.

Keywords: *Software Piracy, Productivity, Developing Countries, Panel Study.*

Öz

Bu çalışma korsan yazılım kullanımının verimlilik üzerindeki etkisini sorgulamayı amaçlamaktadır. Bu kapsamda 2003-2017 dönemini kapsayan dengesiz panel veri seti ile gelişmekte olan ülkeler için verimliliğin üç farklı göstergesi modellere dahil edilmiştir. Çalışmanın hipotezi; korsan yazılım kullanımındaki artışın gelişmekte olan ekonomilerde verimlilik düzeyini arttıracağını iddia etmektedir. İlk olarak, tek değişkenli analizler uygulanmış ve üç ayrı modellerdeki analiz sonuçlarına göre korsan yazılım kullanımı ve verimlilik arasında istatistiksel olarak anlamlı bir pozitif yönlü ilişki olduğu görülmüştür. İkinci olarak, tek değişkenli analizlerimizin bulgularının geçerliliği ve sağlamlılığını kontrol etmek için ayrıca eğitim, yatırım ve açıklık gibi üç kontrol değişkeni çalışmadaki üç ayrı verimlilik modelimize dahil edilmiştir. Üç kontrol değişkeninin modellere dahil edilmesi sonrasında elde edilen sonuçlara göre; tüm modellerde korsan yazılım kullanımı ile verimlilik arasında yine istatistiksel olarak anlamlı bir pozitif yönlü ilişki gözlemlenmiştir. Ek olarak, modellere dahil edilen ve istatistiksel olarak anlamlı sonuç veren tüm kontrol değişkenlerinin de literatür de beklenen işaretleri aldığı görülmüştür. PROD1 modellerinin tahmin edilen katsayıları düşünüldüğünde, korsan yazılım kullanımındaki %1 pozitif değişimin tek değişkenli ve çok değişkenli modellerde sırasıyla %0.1023 ve %0.0623 kadar verimlilik büyümesine yol açmıştır. PROD2 modellerinin tek değişkenli ve çok değişkenli model sonuçlarına bakıldığında ise, korsan yazılım kullanımındaki %1 artış verimlilik üzerinde sırasıyla %0.1072 ve %0.0684 kadar verimliliğe etkide bulunmaktadır. Diğer taraftan; PROD3 modellerinin tek değişkenli ve çok değişkenli model sonuçlarına bakıldığında ise, korsan yazılım kullanımındaki %1 artış verimlilik üzerinde sırasıyla %0.0881 ve %0.0601 kadar verimliliğe etkide bulunduğu görülmüştür. İkinci olarak; modellere eğitim, yatırım ve açıklık kontrol değişkenleri de dahil edilmiş olup verimlilik üzerinde beklenen pozitif sonuçlar istatistiksel olarak en azından %5 anlamlılık düzeyinde anlamlı sonuçlar vermiştir. Daha spesifik olarak, PROD1 modelleri için EDUC, INVEST ve OPEN değişkenlerindeki %1'lik bir artışın verimlilik üzerinde sırasıyla %0.2309, %0.1198 ve %0.7359 kadar pozitif bir etkide bulunduğu görülmektedir. Tüm kontrol değişkenleri içinden OPEN değişkenin en çok açıklayıcı değişken olduğu görülmektedir. PROD2 için tahmin sonuçlarına bakıldığında EDUC, INVEST ve OPEN değişkenlerindeki %1 artışın verimlilik üzerinde sırasıyla %0.2482, 0.0893 ve %0.7211 düzeyinde bir etkiye sahip olduğu sonucuna ulaşılmıştır. Ayrıca PROD3 modelleri düşünüldüğünde, EDUC, INVEST ve OPEN değişkenlerindeki %1'lik bir artışın verimlilik üzerinde sırasıyla %0.3345, %0.0341 ve %0.2238 kadar bir artışa yol açtığı sonucuna ulaşılmıştır.

Anahtar Kelimeler: *Yazılım Korsanlığı, Verimlilik, Gelişmekte Olan Ülkeler, Panel Çalışma.*

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Introduction

The acceleration of productivity is often linked with the rise of the economic growth (Arazmuradov et al., 2014: 116). In this sense, productivity is an essential issue that deserve examinations. It may provide advantages to the economic growth for countries. Examining the empirical results of the nexus between productivity and economic growth in the light of previous contributions is also important because it indicates economic contributions of the productivity to economy (Wu, 2000; Baier et al., 2006).

Thus, the determinants of productivity are an important area in the economic literature about global and domestic technological developments. Okşak & Koyuncu (2021) suggested that a way to enhance productivity was to explain FDI inflows while Okşak (2018) found significantly the long run positive connection between globalization and productivity. Their findings show also unidirectional causal relation from globalization to productivity for the period 1970-2014 for Turkey. The paper of Koyuncu & Unver (2018) also explained the short and long-run influence of globalization on labor productivity in a example of 34 OECD countries for the period of 2002-2012. They found that increases in globalization level led to statistically significant rises in the labor productivity in both short and long-run. However, Özen (2021) examined the relationship between productivity, globalization, and rents in a panel dataset of developing economies over the period 1991-2017. The paper confirmed some of the estimated empirical results. For example, the findings indicated that a larger rent levels, as an institutional variable, is associated with lower productivity level. The findings also asserted that there is a unidirectional causality from rents and globalization to productivity. In addition, there was also the impacts of subsidies given to companies on productivity level in a country. Koyuncu & Okşak (2017) demonstrated that subsidies have a significant and positive impact on the productivity, and thus subsidies policies will affirmatively affect level of value-added using panel data covering the period from 1972 to 2013 in 151 countries.

Consequently, technological development may become important factor for productivity through FDI, globalization, and subsidies because they may lead to technology transfers, especially with software products that decrease costs of firms and entrepreneurs. Thus, internet systems associated with software products will undoubtedly be a substantial indicator for technological development. In this context, it is anticipated that the factors determining the decrease of software piracy rate are also important. For example, Martinez-Sanchez & Romeu (2018) investigated the changes in software piracy rates among countries using panel data covering the period 2006-2013 in 111 countries. Their findings confirmed that lower software piracy is more visible in economies with higher development level. Moreover, they also found that higher availability of internet access leads to a lower software piracy. Robertson et al. (2008) tried to investigate the determinants of pirated software in 20 Latin America countries. The findings showed that economic growth, foreign direct investment, internet usage, and development assistance may play important roles in software piracy.

In the recent years, it seems that Intellectual Property Rights (IPRs) is highly correlated with software products for developing and low-income countries in the empirical literature (Hamister & Braunscheidel, 2013; Asongu, 2021). There has been the importance of this relation because the IPRs protection in the software products may play an important role in raising economic growth by promoting the returns to innovation, and thus the incentives to make innovation (Andres & Goel, 2012: 285). For instance, Bezmen & Depken (2004) investigated how software piracy rate influences economic development. The paper found that lower levels of software piracy rates, as reflected in stronger enforcement of IPRs, correspond with higher degrees of economic development. Otherwise, some papers have focused a negative relationship between stringent IPRs regimes in software products and knowledge economy. For example, Asongu (2014) aimed to make a contribute to empirical literature on knowledge economy by explaining the role of software piracy in Africa. In this paper, it was asserted that scientific and technical publications are crucial indicators for the economic growth and development because they provide more knowledge spillovers in the economic environment. The results indicated that less IPRs protection in the scientific-related software leads to higher economic growth and development through dissemination of knowledge. In other words, higher software piracy rate leads to a higher knowledge level through scientific and technical publications, which could generate an increase in the economic growth and development. Andres et al. (2015) also reported that enforcements of IPRs protection in the software industry is not a sufficient condition for more productive knowledge economy. In addition, the paper of Fernandez et al. (2018) examined the direct influence of pirated software on economic growth in 95 countries over the 2000 - 2014 period. The results indicated a negative effect of pirated software on economic growth with non-linear relationship.

A rise in usage of pirated software may reduce poverty level through two channels in a country. First, software piracy allows users of pirated software to save the amount of software price. Second, the usage of pirated software that help to enhance productivity and size of the business operations can cause reductions in the degree of poverty. In this since, the results of the study of Unver & Koyuncu (2022) are consistent with this argument. They examined the impact of pirated software on poverty level by applying to the unbalanced panel data of developing and Latin America countries during the period 2003-2017. The researchers concluded that the coefficients of usage of pirated software are negative and statistically significant for six different poverty variables. The original paper was examined by Asongu (2014), who also

estimated the relationship between software piracy, inequality, and poverty in Africa. According to the paper's main result, software piracy has an important role for the poverty because its effect on income distribution is statistically significant and positive. In this sense, it is also sensible to conclude that software piracy has affected human development. In addition, Asongu & Andres (2017) showed the effect of software piracy on the inclusive human development (IHD) index in 11 African countries over the period 2000-2010. IHD index consists of three specific components, including income, literacy, and life expectancy. Their results assumed that there is a positive and statistically significant connection between software piracy and IHD. They also found evidence that the contribution of literacy rate has a key role in the positive relation between software piracy and IHD.

As claimed by Oulton (2002: 364), information and communication technologies (ICTs) consist of the sum of four different types: computers, software, telecommunication equipment, and chips. Put it differently, it can be explained that ICTs are directly connected to the development of networks in the form of the internet through investments in software. Thus, it is considered that ICTs are a source of usage of software products. In this regard, ICTs are related to software piracy through the increase of usage of software products. For instance, Yang et al. (2009) found, for 59 countries over the period 2000-2005, that higher level of ICTs is related to lower software piracy. However, there are many papers investigated the relationship between ICTs and productivity in the literature (Dahl et al., 2011; Cardona et al., 2013; Spiezia, 2013; Abramova & Grishchenko, 2020).

The aim of this paper is to contribute to existing software piracy literature by analyzing the influence of pirated software on productivity level in developing countries for the period 2003-2017. It also employs three distinct indicators for productivity level in models and uses an unbalanced panel data set. It is discussed that software piracy may be associated with productivity level in different aspects. For instance, software usage may be anticipated to enhance productivity level through decreasing costs in recording transactions and tracking stocks of goods, and thus an increase in software piracy could lead to a growth in economic activities by using software products without copyright. Therefore, our hypothesis is that greater usage rates of pirated software may have created larger productivity level in developing countries. In addition, we will use three control variables for the robustness checks of the findings in the analyses. Thus, the controls involve education, investment, and openness variables. Education variable, which reflects the human capital in the business world, is anticipated to have a positive impact on the productivity level. The estimated coefficient of investment variable, which reflects a source of technological advances in a country, is anticipated to be positive for productivity level. Finally, the estimated coefficient on globalization or openness variables is anticipated to have a positive effect on the productivity level.

Therefore, looking from perspectives given above, this study makes some useful contributions to software piracy literature. First contribution of the existing study is to explore the positive effect of software piracy on productivity level. According to our knowledge, the study of Ding & Liu (2009) is one of the rare papers that explore the relationship between software piracy and productivity. They also conducted an annual data of 11 Asian countries and 4 non-Asian industrialized countries over the period 1994 – 2002. Their main results are that productivity growth tend to raise with increasing software piracy in the 4 non-Asian industrialized countries due to technical progress while productivity growth is negatively influenced by software piracy among Asian developing countries due to reduction in efficiency. On the other hand, our paper explores a positive and statistically significant relation between software piracy and productivity in developing countries. Thus, we conclude that the rise in software piracy level has caused a contributing driver to the acceleration in productivity level in developing countries. Second contribution of this study is to use three distinct indicators of productivity level to exhibit the robustness of estimates in our models. The results indicate that the estimated coefficients on the software piracy appear to be robust because our results appear that there have been positive and statistically significant connections between software piracy and productivity in all of three models. The final contribution is to compare two distinct approaches to panel data analyses, being one-way univariate and multivariate in fixed effect and random effect models.

The next section of the paper presents empirical framework, and Section 3 reports and discusses estimation results. In Section 4, the study concludes and supplies concluding opinions.

1. Empirical Framework

This paper aims to explore the effect of usage of pirated software on productivity by utilizing three different proxies of productivity for developing countries and an unbalanced panel data set covering the years between 2003 and 2017. In 21stcentury, the usage of software has become an inevitable component for the business world in recording transactions and tracking stocks of goods. Because of this, the use of software may improve productivity of firms or businesses. Therefore, our hypothesis asserts that increases in the use of pirated software enhance the productivity level in developing countries.

The following one-way univariate and multivariate fixed effect models (FEM) are constructed and estimated:

$PROD1_{it}=\beta_{0i}+\beta_1 PIRACY+u_{it}$ *(1.A)*

$PROD2_{it}=\beta_{0i}+\beta_1 PIRACY+u_{it}$ *(1.B)*

$PROD3_{it}=\beta_{0i}+\beta_1 PIRACY+u_{it}$ *(1.C)*

$PROD1_{it}=\beta_{0i}+\beta_1 PIRACY+\beta_2 EDUC+\beta_3 INVEST+\beta_4 OPEN+u_{it}$ *(2.A)*

$PROD2_{it}=\beta_{0i}+\beta_1 PIRACY+\beta_2 EDUC+\beta_3 INVEST+\beta_4 OPEN+u_{it}$ *(2.B)*

$PROD3_{it}=\beta_{0i}+\beta_1 PIRACY+\beta_2 EDUC+\beta_3 INVEST+\beta_4 OPEN+u_{it}$ *(2.C)*

The following one-way univariate and multivariate random effect models (REM) are also constructed and estimated:

$PROD1_{it}= \beta_0+ \beta_1 PIRACY+ \varepsilon_i+u_{it}$ *(3.A)*

$PROD2_{it}= \beta_0+ \beta_1 PIRACY+ \varepsilon_i+u_{it}$ *(3.B)*

$PROD3_{it}= \beta_0+ \beta_1 PIRACY+ \varepsilon_i+u_{it}$ *(3.C)*

$PROD1_{it}=\beta_0+ \beta_1 PIRACY+\beta_2 EDUC+\beta_3 INVEST+\beta_4 OPEN + \varepsilon_i+u_{it}$ *(4.A)*

$PROD2_{it}= \beta_0+ \beta_1 PIRACY+\beta_2 EDUC+\beta_3 INVEST+\beta_4 OPEN + \varepsilon_i+u_{it}$ *(4.B)*

$PROD3_{it}= \beta_0+ \beta_1 PIRACY+\beta_2 EDUC+\beta_3 INVEST+\beta_4 OPEN + \varepsilon_i+u_{it}$ *(4.C)*

where *it* subscript represents the *i-th* country's observation value at time *t* for the relevant variable. β_{0i} stands for country specific factors not taken into account explicitly in the regression model, which can vary across countries but not within a particular country or across time. ε_i is a time invariant stochastic term, which represents the country specific factors not regarded explicitly in the regression model. u_{it} is error term of the regression model.

The dependent variable of the study is productivity. We employed three distinct indicators of productivity to see if the findings of the study remain valid regardless of which indicator is used. The proxies for productivity are output per employed person (PROD1), output per hour worked (PROD2) and GDP per person employed (PROD3), respectively. If the findings of the study remain unchanged across three models, this will hint that the findings are valid and robust regardless of which indicator of productivity is used. Table 1 displays the list of variables used in the models.

Table 1. Descriptions of Variables

Variable	Definition	Data Source
PROD1	Output per employed person	The Conference Board Total Economy Database
PROD2	Output per hour worked	The Conference Board Total Economy Database
PROD3	GDP per person employed	WDI
PIRACY	Commercial value of unlicensed software (in million US dollars)	The IDC Global Software Piracy Study
EDUC	School enrollment, secondary (% gross)	WDI
INVEST	Gross capital formation (as a percentage of GDP)	WDI
OPEN	KOF overall globalization index	KOF Index

The following section examines the independent variables with their expected signs. Software piracy variable in the models is performed by commercial value of unlicensed software in million US dollars (i.e., PIRACY). As mentioned above, it is reasonable to discover that software piracy may support to increase productivity level in a country by decreasing costs for the business world in recording transactions and tracking stocks of goods. Thus, we expect the coefficients of PIRACY variable in models to be positive for three productivity variables.

In addition to PIRACY variable, control variables were gathered in the light of former papers existing in the literature and in the light of the hypotheses. Logarithmic forms of dependent and independent variables were used in all analyses. In this sense, the controls include secondary school enrollment as a percent of total population (i.e., EDUC), gross capital formation as a percentage of GDP (i.e., INVEST), and KOF overall globalization index (i.e., OPEN).

EDUC variable is a proxy for human capital of a country. We collected its dataset from WDI. The papers of Aghion et al. (2009) and Benhima (2012) found empirical evidence that secondary school enrollment as a proxy of education was a positively significant factor in determining the productivity growth. Hence, we expect EDUC variable to have a positive effect on the productivity variables since an increase in the human capital through education leads to higher values of the productivity growth.

INVEST variable implies fixed capital investments of a country. Data source is available from WDI. When accumulation of capital stock increase, technological advances may rise through new inventions. Then, capital formation contributes productivity growth through technological advances (Wolff, 1991: 566). Hence, it can be explained that investments play a key role in productivity growth. For example, this finding was be confirmed employing a panel dataset of 111 countries including the period 1985-2010 as in the study of Koyuncu et al. (2016). They revealed that gross capital formation enhances labor productivity. This result is also statistically significant. Thus, the coefficient on INVEST variable is anticipated to be positive impact on productivity variables.

OPEN variable refers to KOF overall globalization index or a measure of economic openness. The dataset is obtained from Zurich Technology Institute. It is assumed that globalization do positively affect economies' production methods. Countries with the higher level of openness have the higher level of productivity. For example, Koyuncu & Unver (2018) have shown that the effect of globalization on productivity level is statistically significant and positive on a balanced panel of 34 OECD countries spanning 2002-2012. Thus, in this paper, we expect the estimated coefficients of OPEN variable to be positive for productivity variables.

In Table 2 below, we displayed descriptive statistics for the original series.

Table 2. Descriptive Statistics

	PIRACY	PROD1	PROD2	PROD3	EDUC	INVEST	OPEN
Mean	361.2648	42961.78	22.49988	40715.70	79.84991	24.14870	63.61833
Median	98.00000	26940.58	12.76411	33581.40	85.44908	23.05069	63.84295
Maximum	7779.000	185479.7	83.21198	159730.3	128.9296	46.87646	83.34835
Minimum	3.000000	2178.735	1.231646	6869.762	22.41254	7.999999	41.09774
Std. Dev.	881.2600	37655.38	21.27441	31470.51	21.39870	6.429819	7.568148
Skewness	5.797380	1.248137	1.174810	1.565397	-0.796045	0.799005	-0.171073
Kurtosis	42.23347	4.107295	3.262132	5.330763	2.960234	3.795522	2.893120
Jarque-Bera	27127.95	120.8734	90.59537	246.9230	41.10975	51.64772	2.082572
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.353000
Sum	140532.0	16712131	8752.454	15838406	31061.61	9393.843	24747.53
Sum Sq. Dev.	3.01E+08	5.50E+11	175609.0	3.84E+11	177666.9	16040.92	22223.42

2. Estimation Results

Table 3 below exhibits the panel unit root test results for Levin, Lin & Chu (LLC) panel unit root test where the null hypothesis supposes common unit root process and PP-Fisher chi-square (PPF) panel unit root test where the null hypothesis supposes individual unit root process. The findings show that our variables are integrated order zero and hence our models do not have spurious regression problem.

Table 3. Panel Unit Root Test Results

	Method	Statistic	Prob.
PIRACY	Levin, Lin & Chu	-5.63741	0.0000
	PP - Fisher Chi-square	165.687	0.0025
PROD1	Levin, Lin & Chu	-6.05914	0.0000
	PP - Fisher Chi-square	262.616	0.0000
PROD2	Levin, Lin & Chu	-7.17611	0.0000
	PP - Fisher Chi-square	200.997	0.0000
PROD3	Levin, Lin & Chu	-4.11644	0.0000
	PP - Fisher Chi-square	165.094	0.0008
EDUC	Levin, Lin & Chu	-8.73023	0.0000
	PP - Fisher Chi-square	114.679	0.1196
INEST	Levin, Lin & Chu	-5.63862	0.0000
	PP - Fisher Chi-square	184.422	0.0000
OPEN	Levin, Lin & Chu	-19.4591	0.0000
	PP - Fisher Chi-square	518.628	0.0000

Table 4, 5, and 6 below exhibit univariate and multivariate estimation results for PROD1, PROD2, and PROD3 models, respectively. The Hausman test statistics for deciding between FEM and REM models are utilized significant at the level of 1%.

As shown from Table 4, based on Hausman test results assessed at 1% significance level, FEM model was selected for univariate analysis and REM model for multivariate analysis. Given the F-test findings, both models are statistically significant. We have positive statistically significant coefficient for PIRACY variable in univariate and multivariate estimation results. In other words, 1% jump in the usage of pirated software causes a growth in productivity by 0.1023% and 0.0623% in univariate and multivariate models, respectively. EDUC, INVEST, and OPEN variables are taken the anticipated positive influences and they are statistically significant at least at the level of 5%. More specifically, one percent increase in EDUC, INVEST, and OPEN variables cause to a jump in productivity by 0.2309%, 0.1198%, and 0.7359%, respectively. Openness of an economy has the most explanatory power among all independent variables.

Table 4. Estimation Results for PROD1 Model

	Univariate Results		Multivariate Results	
	Coefficient	Prob.	Coefficient	Prob.
Constant	9.8958	0.0000	5.5782	0.0000
PIRACY	0.1023	0.0000	0.0623	0.0000
EDUC			0.2309	0.0011
INVEST			0.1198	0.0283
OPEN			0.7359	0.0005
R-squared	0.9787		0.2938	
F-statistic	478.0568		44.0905	
Prob(F-stat.)	0.0000		0.0000	
Obs.	618		429	
Country	54		48	
Hausman Stat.	7.7381		5.8368	
Prob(Hausman)	0.0054		0.2117	
Selected Model	FEM		REM	

As can be deduced from Table 5, FEM model was selected for univariate analysis and REM model for multivariate analysis. F-test statistics show that both univariate and multivariate models are statistically significant. We obtained positive statistically significant coefficient estimation for PIRACY variable in univariate and multivariate models. 1% rise in the

usage of pirated software induces to an increase in productivity by 0.1072% and 0.0684% in univariate and multivariate models, respectively. EDUC and OPEN are statistically significant and take the expected positive signs. Put it differently, one percent increase in EDUC and OPEN variables induce an increase in productivity by 0.2482% and 0.7211%, respectively. Again, openness of an economy possesses the most explanatory power among all independent variables.

Table 5. Estimation Results for PROD2 Model

	Univariate Results		Multivariate Results	
	Coefficient	Prob.	Coefficient	Prob.
Constant	2.3298	0.0000	-1.9827	0.0286
PIRACY	0.1072	0.0000	0.0684	0.0000
EDUC			0.2482	0.0006
INVEST			0.0893	0.1156
OPEN			0.7211	0.0021
R-squared	0.9804		0.2841	
F-statistic	488.0424		39.0955	
Prob(F-stat.)	0.0000		0.0000	
Obs.	582		399	
Country	54		48	
Hausman Stat.	9.5650		7.1302	
Prob (Hausman)	0.0020		0.1292	
Selected Model	FEM		REM	

As indicated by the estimation results in Table 6, REM model was selected for univariate analysis and FEM model for multivariate analysis. Highly significant F-test statistic values point out that both univariate and multivariate models are statistically significant. Positive statistically significant coefficient estimation for PIRACY variable was obtained for univariate and multivariate models. 1% increase in the usage of pirated software induces a growth in productivity by 0.0881% and 0.0601% in univariate and multivariate models, respectively. Only EDUC variable is statistically significant and has the expected positive sign. One percent increase in EDUC variable induces to a growth in productivity level by 0.3345%.

Table 6. Estimation Results for PROD3 Model

	Univariate Results		Multivariate Results	
	Coefficient	Prob.	Coefficient	Prob.
Constant	9.9474	0.0000	7.5992	0.0000
PIRACY	0.0881	0.0000	0.0601	0.0000
EDUC			0.3345	0.0000
INVEST			0.0341	0.2890
OPEN			0.2238	0.1192
R-squared	0.1729		0.9884	
F-statistic	133.7670		632.4472	
Prob(F-stat.)	0.0000		0.0000	
Obs.	642		464	
Country	56		52	
Hausman Stat.	0.0012		42.4531	
Prob (Hausman)	0.9729		0.0000	
Selected Model	REM		FEM	

Conclusion

This paper has a try to analyze the influence of usage of pirated software on productivity by utilizing three distinct indicators of productivity for a sample of developing countries with an unbalanced panel data set for the period of 2003-2017. In 21st century, the usage of software has become an indispensable component for the business world in recording transactions and tracking stocks of goods. Therefore, the use of software may enhance efficiency and productivity of firms. For that reason, we constructed a hypothesis claiming that the use of pirated software contributes to the productivity level in developing countries.

We checked the stationarity status of our series by conducting two different panel unit root tests. The findings of panel unit root tests disclosed that all variables in our models are stationary at levels and thus our models do not contain potential spurious regression problem.

Firstly, we implemented univariate analyses to see the individual influence of software piracy on productivity level and the findings of univariate analyses found that the usage of pirated software and productivity are positively and significantly associated in all of three models. Based on the estimated coefficients of PROD1 models, a 1% positive change in usage of pirated software leads to a rise in a growth in productivity by 0.1023% and 0.0623% in univariate and multivariate models, respectively while a 1% positive change in usage of pirated software leads to a rise in a growth in productivity by 0.1072% and 0.0684% in univariate and multivariate models of PROD2, respectively. Besides a 1% positive change in usage of pirated software induce to an increase in productivity level by 0.0881 and by 0.0601, respectively in PROD3 models. Secondly, three control variables, namely education, investment, and openness, were included in our three productivity models to test if the finding of univariate analyses keeps its validity. EDUC, INVEST, and OPEN variables are taken the anticipated positive influences and they are statistically significant at least at the level of 5%. More specifically, in estimation results for PROD1 model, one percent increase in EDUC, INVEST, and OPEN variables cause to a jump in productivity by 0.2309%, 0.1198%, and 0.7359%, respectively. Openness of an economy has the most explanatory power among all independent variables. In addition to PROD1 model, in estimation results for PROD2 model, one percent increase in EDUC, INVEST, and OPEN variables cause to a jump in productivity by 0.2482%, 0.0893%, and 0.7211%, respectively. Besides a 1% positive change in EDUC, INVEST, and OPEN variables induce to an increase in productivity level by 0.3345%, 0.0341%, and 0.2238%, respectively in PROD3 models. After addition of the three control variables, we identified statistically significant positive connection between the pirated software and productivity level for developing economies. In regard to control variables, they get expected signs whenever they are statistically significant.

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