The Stationarity Properties of Software Piracy: Example of the OECD Countries[1]

Selim Yıldırım[2]
S. Fatih Kostakoğlu[3]
Ethem Esen[4]

Abstract

Software piracy refers to the unauthorized copying, distribution and selling of software in copyright. The unlicensed software use and distribution has been important issue for the industry. It leads to tremendous monetary losses in the software sector. According to BSA the commercial value of unlicensed software in 2013 is $13.5 billion in European Union and $17.2 billion in BRIC countries. Moreover, many countries that have high software piracy rate, have shown a predilection towards pirating software in the past. Georgia, Moldova, Zambia and Zimbabwe which has the four highest software piracy rates and all above 90% in BSA's (2014) study have continuously exhibit rates above 90% since 2005. Furthermore, the commercial value persistently climbs since BSA has first began publishing studies on software piracy. This brings forth the question whether software piracy has a characteristic inertia. Due to the size of loss it creates software piracy has many consequences. This study aims to investigate this question for OECD countries. Two different variables related to software, namely the monetary value of software firms' losses and the index of software piracy for thirty OECD countries are investigated using Pesaran's (2007) CIPS (cross-sectionally augmented IPS) and Hadri and Kurozumi's (2012) panel unit root tests. CIPS test indicates that for developing OECD countries software piracy index is stationary and for developing OECD countries monetary value of software firms' losses are trend stationary and for developing OECD countries both variables are stationary. HK test on the other hand indicates that only piracy index for developing countries are stationary. The conflict arises from the opposite null hypothesis of both panel tests; while CIPS test homogenous unit root in the panel HK tests homogenous stationarity. Since none of the panel variables are composed of strongly stationary processes or conversely unit root processes tests do not reach a consensus for the variable in every case. Although results of the test seem to be conflicting two conclusions emerge from this study the index variable, which is the perceived level of software piracy, has remained similar within time for developing counties whereas it has changed greatly for developed OECD countries. Finally, monetary value of software firms' losses has very different dynamic properties even among the countries within the same group so that the two tests cannot agree for a single group or model.

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[1] This study was supported by Scientific Research Projects Coordination Unit of Anadolu University under Project Number 1502E077.
[2] Assoc. Prof. Dr., Department of Economics, FEAS, Anadolu University, selimy@anadolu.edu.tr
[3] Assist. Prof. Dr., Department of Economics and Administrative Science, OEF, Anadolu University, sfkostakoglu@anadolu.edu.tr
[4] Assoc. Prof. Dr., Department of Economics, FEAS, Anadolu University, etheme@anadolu.edu.tr

Introduction

Software companies suffer high value of cost or in other words losses due to software piracy. Also, software piracy is increasingly attracted one of the important ethical problem. It is generally defined illegal capture and use of software (Sims, Cheng and Teegen, 1996: 839). Software piracy does not evaluate only ethical problem but also economic problem which has impact on and close relation with software sector and indirectly macroeconomic indicator. Thus, we discuss related literature under two title: ethical studies and economic studies.

In the literature, there are more software piracy studies as an ethical problem. Swinyard, Rinne and Keng Kau (1990), investigate whether cultural differences and morality affects software piracy or not. They find that cultural- ethical approaches have a substantial effect on the software piracy. Sims, Cheng and Teegen (1996) think that software piracy is an ethical problem. Differently from other studies, they found that gender is one of the significant determiner of software piracy. Other determiners, which are found in this study, are age and working status (student or not). Other studies are; Solomon and O'Brien (1990), Taylor and Shim (1993), Moores and Chang (2006), Gan and Koh (2006), Hinduja (2007), Cronan and Al-Rafee (2008) etc.

Apart from the ethical studies, Lau (2003) takes into account empirical factors to analyze software piracy rather than ethical factors. On the other hand, software piracy creates substantial effect on and show close relation with the economy. Moores (2008) puts forth that software piracy is affected by wealth and cultural factors. Wealth and software piracy show negative relation, cultural factors which are self-centrism and masculinity and software piracy show same relation, too. Cheng, Sims and Teegen (1997) find that software price is determined optimal level for potential buyer will decrease piracy. Taraphagan and Griffith (1998) emphasis that both high national income or household income and legal protections decrease software piracy. Bagchi, Kirs and Cerveny (2006) investigate trend of global software piracy. They find that not only economic factors but also technical, regulatory and social- cultural factors explain variance in piracy data. Other studies are; Givon, Majahan and Muller (1995), Moores (2003), Banerjee, Khalid and Sturm (2005), Goel and Nelson (2009) etc.

The main concern in this study is whether software piracy is persistent in OECD countries. In order to answer this question two-unit root tests are implemented on a panel of thirty OECD countries within the period 1994-2011. The panel has annual frequency and includes two variables: first variable is an index that depicts the rate of software piracy in a country and the second variable is the commercial value of pirated software. These two variables are tested for unit root using CIPS (cross-sectionally augmented IPS) test proposed by Pesaran (2007) and Hadri and Kurozumi's (2012) test (HK henceforth). The CIPS test examines the unit root against alternative that some individual time series in the panel lacks unit root while HK test examines stationarity of all panel against the alternative of nonstationary of some individual time series in the panel. The terms "stationarity" and "unit root" are not unlike two sides of a coin. While stationarity loosely indicate the temporal joint distribution does not change over time, unit root indicates in information observed so far into series carries over to the next observation. For our purpose, stationarity indicates lack of persistency and existence unit root means software piracy is persistent.

Additionally, both CIPS test and HK test are second generation panel unit root tests. Here second generation term indicates that these panel unit root tests take into account that interdependency or the relation between individual time series. Thus the consequences of the connectedness (at an age where one can reach internet anytime and anywhere, and pirate software) that is reflected in the panel is also taken into account the study.

Under the next title software piracy is discussed more in detail through various studies on the topic; followed by the further deliberation of the methodology employed in this study, and under the title "Data and Empirical Findings" the results of the CIPS and HK tests are reported. Finally, in conclusion the implications of the empirical findings are discussed and topics about further study is proposed.

Methodology

CIPS and HK tests employed in this study to investigate the inert pertinaciousness of the software piracy are second generation panel unit root tests. As stated previously unit root tests are one of the most used methods to test persistency or reversely transiency of phenomenon captured in a time series. The aforementioned CIPS and HK unit root tests especially selected for this study because they are suitable to test more than a single series at a time and also can take cross sectional dependency into account. The second generation term in essence implies this final statement; CIPS and HK tests are developed to deal with the cross sectional dependency among the individual series composing the panel. Both tests are improvements upon first generation tests; CIPS is developed form the IPS test is introduced by Im et al. (2003) and HK test is developed form the panel unit root test by Hadri (2000) which in turn is panel version of the well-known KPSS test developed by Kwaitkowski et al.(1992). Provided the initial values given, IPS test models the series as first order autoregressive process

$$y_{it} = (1-\phi_i)\mu_i + \phi_i y_{i,t-1} + u_{it}, \quad i = 1,\ldots,N, t = 1,\ldots,T \tag{1}$$

which can also be expressed as

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \varepsilon_{it}, \tag{2}$$

where $\alpha_i = (1-\phi_i)\mu_i$, $\beta_i = -(1-\phi_i)$ and $\Delta y_{it} = y_{it} - y_{i,t-1}$. Hence the null hypothesis of unit root is written as

$$H_0 : \beta_i = 0 \text{ for all } i$$

against the alternatives,

$$H_1 : \beta_i < 0, i = 1,2,\ldots,N_1; \quad \beta_i = 0, i = N_1 + 1, N_2 + 1,\ldots,N$$

which indicates that homogenous unit root is tested against the alternative that at least one series does not have unit root. The IPS test utilizes the individual Dickey-Fuller (DF henceforth) statistics mentioned in the study by Dickey and Fuller (1979) to calculate the IPS statistic, which is also called $\tilde{t}-bar$ statistic. The DK statistic is based on t-statistic and calculated as follows:

$$\tilde{t}_{iT} = \frac{\Delta \boldsymbol{y}_i' \boldsymbol{M}_\tau \boldsymbol{y}_{i,-1}}{\tilde{\sigma}_{iT}\left(\boldsymbol{y}_{i,-1}' \boldsymbol{M}_\tau \boldsymbol{y}_{i,-1}\right)^{1/2}} \ ,$$

where $\Delta \boldsymbol{y} = (\Delta y_{i1}, \Delta y_{i2}, ... \Delta y_{iT})'$, $\boldsymbol{y}_{i,-1} = (y_{i0}, y_{i1}, ... y_{i,T-1})'$, $\boldsymbol{M}_\tau = \boldsymbol{I}_T - \tau_T(\tau_T'\tau_T)^{-1}\tau_T'$ in which $\boldsymbol{I}_T$ is the identity matrix and $\tau_T = (1,1,...,1)'$, moreover

$$\tilde{\sigma}_{iT}^2 = \frac{\Delta \boldsymbol{y}_i' \boldsymbol{M}_\tau \Delta \boldsymbol{y}_i}{T-1} \ .$$

After the calculating of the DF statistics for each cross section unit their average is taken to calculate IPS statistic:

$$\tilde{t}-bar_{NT} = \frac{1}{N}\sum_{i=1}^{N} \tilde{t}_{iT}$$

which is also referred to as $\tilde{t}-bar$ statistic. Although useful and popular the IPS test assumes that the individual time series in the panel were cross-sectionally independently distributed. Pesaran (2007) introduces the CIPS test that is robust to cross-sectional dependency of the individual series in the panel. In order to accomplish this CIPS incorporates a single-factor structure to the framework in equation (1)

$$u_{it} = \gamma_i f_t + \varepsilon_{it}$$

where f_t is the unobserved common effect and ε_{it} is the individual-specific error term. Therefore, the process can be rewritten as below, instead of equation (2);

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \gamma_i f_t + \varepsilon_{it}, \qquad (3)$$

where $\alpha_i = (1-\phi_i)\mu_i$, $\beta_i = -(1-\phi_i)$ and $\Delta y_{it} = y_{it} - y_{i,t-1}$. The relevant unit root null hypothesis and the alternative hypothesis remain the same however cross-sectionally augmented DF (CADF) tests have to be calculated and used instead of the standard DF statistics. The CADF statistic is calculated as follows:

$$t_i(N,T) = \frac{\Delta \boldsymbol{y}_i' \bar{\boldsymbol{M}}_w \boldsymbol{y}_{i,-1}}{\hat{\sigma}_i\left(\boldsymbol{y}_{i,-1}' \bar{\boldsymbol{M}}_t \boldsymbol{y}_{i,-1}\right)^{1/2}}$$

where $\Delta \boldsymbol{y} = (\Delta y_{i1}, \Delta y_{i2}, ... \Delta y_{iT})'$, $\boldsymbol{y}_{i,-1} = (y_{i0}, y_{i1}, ... y_{i,T-1})'$, $\bar{\boldsymbol{M}}_w = \boldsymbol{I}_T - \bar{W}(\bar{W}'\bar{W})^{-1}\bar{W}'$ in which $\bar{W} = (\tau, \Delta\bar{\boldsymbol{y}}, \bar{\boldsymbol{y}}_{-1})$ and $\tau = (1,1,...,1)'$, $\Delta\bar{\boldsymbol{y}} = (\Delta\bar{y}_1, \Delta\bar{y}_2, ..., \Delta\bar{y}_T)'$, $\bar{\boldsymbol{y}}_{-1} = (\bar{y}_0, \bar{y}_1, ..., \bar{y}_{T-1})'$; moreover

$$\hat{\sigma}_i^2 = \frac{\Delta \boldsymbol{y}_i' \boldsymbol{M}_{i,t} \Delta \boldsymbol{y}_i}{T-4}$$

and $\boldsymbol{M}_{i,t} = \boldsymbol{I}_T - \boldsymbol{G}_i(\boldsymbol{G}_i'\boldsymbol{G}_i)^{-1}\boldsymbol{G}_i'$ in which $\boldsymbol{I}_T$ is the identity matrix and $\boldsymbol{G}_i = (\bar{W}, y_{i,-1})$. After the calculation of CADF statistic the existence of unit root in the panel is tested using CIPS statistic; which is the average of the individual CADF statistics:

$$\text{CIPS}(N,T) = t - bar = \frac{1}{N}\sum_{i=1}^{N} t_i(N,T).$$

The relevant critical values for IPS and CIPS statistics are found in papers by Im et al. (2003) and Pesaran (2007) respectively. On the other hand, the second panel unit root test, the HK test, asymptotically converges to standard normal distribution. Moreover, HK test considers moving average type models;

$$y_{it} = z_t'\delta_i + f_t\gamma_i + \varepsilon_{it} \tag{4}$$

where $z_t = z_t^m = 1$ presents the model with only constant and trending model is depicted by $z_t = z_t^t = [1, t]'$ and $\varepsilon_{it} = \phi_{i1}\varepsilon_{it-1} + ... + \phi_{ip}\varepsilon_{it-p} + \nu_{it}$ for $i = 1,..., N$ and $t = 1,...,T$. In equation (4), $z_t'\delta_i$ is the individual effect while f_t is the unobserved common factor and ε_{it} is the individual-specific error term. The null hypothesis of HK test is stationarity

$$H_0 : \phi_i(1) \neq 0 \text{ for all } i$$

against the alternative hypothesis that some individual time series are nonstationary

$$H_0 : \phi_i(1) = 0 \text{ for some } i$$

where $\phi_i(L) = 1 - \phi_{i1}L - \phi_{i2}L^2 - ... - \phi_{ip}L^p$. The test statistic is constructed as follows:

$$Z_A = \frac{\sqrt{N}\left(\overline{ST} - \xi\right)}{\zeta}$$

where $\xi = 1/6, \zeta = \sqrt{1/45}$ when $z_t = z_t^m = 1$ and $\xi = 1/15, \zeta = \sqrt{11/6300}$ when $z_t = z_t^t = [1, t]'$ furthermore

$$\overline{ST} = \frac{1}{N}\sum_{i=1}^{N} ST_i.$$

The ST_i is defined as below

$$ST_i = \frac{1}{\hat{\sigma}_i^2 T^2}\sum_{t=1}^{T}\left(S_{it}^w\right)^2$$

where $S_{it}^w = \sum_{s=1}^{t}\hat{\varepsilon}_{is}$ and $\hat{\sigma}_i^2$ is the estimator for the long run variance estimator. The test statistic depends on how the long-run variance is estimated. HK test uses two separate methods to obtain the long-run variance; first method depends on the method proposed by Sul et al. (2005) then the test statistic is called Z_A^{SPC} and the second method is based on lag augmentation method proposed by Choi (1993) and Toda

Yamamoto (1995) in which case the HK test statistic is named Z_A^{LA}. Since for both type of test statistic converges standard normal distribution asymptotically it is easy to provide p-values for them.

Data and Empirical Findings

This study investigates the persistence of piracy on a panel of thirty OECD countries betwixt the period 1994-2011 employing two variables. First variable is an index that shows the level of software piracy in a country and the second is the monetary losses due to piracy of commercial software. The data for this study is collected from annual Business Software Alliance (BSA) publications named “Piracy Study”. Furthermore, the monetary loss is transformed to real losses using CPI (base=2005) obtained from World Development Indicators (WDI) and then natural logarithm of this transformation is taken.

Both the CIPS and the HK test is implemented on the full panel of thirty OECD countries as well as two sub-panels namely developed OECD and developing OECD countries. The list of the OECD countries in the panel is Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

The sub-panel of developed OECD countries includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. Finally, Czech Republic, Hungary, Mexico, Poland, Slovakia, Slovenia and Turkey are the developing OECD countries.

The countries in any of the date sets are listed in an alphabetical order. This is especially important because not only the CIPS test statistics but also the individual CADF statistics are reported in table 1. In other words, the individual CADF test statistics in table 1 are given in the order the countries listed above (in an alphabetical order). Table 1 as mentioned before displays the results of CIPS test results as well as the individual CADF statistics composing the CIPS test for the full set of thirty OECD countries, the twenty-three developed OECD countries and finally for seven developing OECD countries. Due to the long list of individual CADF test statistics the table 1 is separate in to three parts table 1a, table 1b and table 1c. In table 1a results of full panel are displayed, table 1b exhibits the empirical results for the developed OECD countries and table 1c details the results of the test on developing OECD countries.

Table 1a. CIPS test on Software piracy index and losses form Software piracy in OECD countries

index				losses			
NO det. Trend		det. Trend		NO det. Trend		det. Trend	
Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat
3	-1.2911	3	-0.3275	2	-5.5342	2	-5.8454
3	-1.2935	3	-0.3641	2	-6.5947	2	-6.5442
3	-1.2469	3	-0.2954	2	-5.7713	2	-5.87
3	-1.2886	3	-0.6145	2	-5.1526	2	-5.4306
3	-1.1867	3	-0.5886	2	-4.9597	2	-5.6094
3	-1.2135	3	-0.3029	2	-3.2908	2	-3.1081
2	-3.765	2	-3.7242	2	-4.6748	2	-4.7158
2	-3.9043	2	-4.0057	2	-4.2757	2	-5.0155
2	-3.3069	2	-3.4257	2	-4.7549	2	-5.4528
2	-2.9383	2	-3.968	2	-3.3136	2	-5.0977
2	-2.0035	2	-3.0305	2	-2.8035	2	-5.2709
2	-1.9167	2	-2.8269	2	-2.569	2	-4.4995
4	-1.637	4	-0.7794	2	-3.7891	3	-1.1944
4	-3.582	4	-3.0565	2	-4.457	2	-4.8242
2	-3.9631	2	-3.7575	2	-3.6441	2	-3.8285
2	-2.557	2	-2.4704	2	-3.1125	2	-3.1989
2	-2.092	2	-1.9769	2	-3.6383	2	-4.0199
2	-1.9846	2	-1.8161	2	-3.9697	3	-1.0466
3	-2.2063	3	-1.1653	3	-2.6585	3	-1.9349
3	-1.4016	3	-0.7231	3	-3.4029	3	-2.2296
3	-1.2995	3	-0.6925	2	-5.0831	2	-5.051
3	-1.5322	3	-0.8743	3	-2.0785	3	-3.0416
3	-1.8475	3	-1.3064	3	-2.2762	3	-3.3772
3	-1.6132	3	-1.0686	3	-2.8514	3	-2.8537
2	-3.0523	2	-3.3992	2	-3.58	2	-3.3572
2	-2.6005	2	-2.7061	2	-4.1845	2	-3.9793
2	-2.2047	2	-2.2667	2	-3.9637	2	-3.8488
4	-1.4114	4	-1.0859	2	-3.7301	2	-3.5358
4	-1.3657	4	-1.098	2	-3.5325	2	-3.33
4	-1.2889	4	-1.0753	2	-3.4205	2	-3.2265
CIPS-stat=-2.0998		CIPS-stat=-1.8264		CIPS-stat=-3.9023		CIPS-stat=-4.0113	

Table 1a continued.
The critical values for the CADF and CIPS test are obtained from Pesaran (2007)

Critical Values for CADF-stat			
N=30			
1%	T=15	-4.68	No Trend (p.275)
	T=20	-4.35	
5%	T=15	-3.55	
	T=20	-3.43	
10%	T=15	-3.07	
	T=20	-3.01	
1%	T=15	-5.50	Trend (p.276)
	T=20	-4.97	
5%	T=15	-4.18	
	T=20	-4.01	
10%	T=15	-3.65	
	T=20	-3.56	

Critical Values for CIPS-stat			
N=30			
1%	T=15	-2.34	No Trend (p.280)
	T=20	-2.32	
5%	T=15	-2.17	
	T=20	-2.15	
10%	T=15	-2.07	
	T=20	-2.07	
1%	T=15	-2.89	Trend (p.281)
	T=20	-2.83	
5%	T=15	-2.70	
	T=20	-2.67	
10%	T=15	-2.60	
	T=20	-2.58	

There are thirty OECD countries in the panel each representing a time series of eighteen observations length. Consequently, when obtaining the critical values form Pesaran's (2007) study to interpret the results in table 1a we choose N=30. On the other hand, Pesaran's (2007) study provides critical values for a pane with time dimension of fifteen and twenty observations but not for panels with eighteen observations long time dimension. The critical values in Pesaran's (2007) study with the closest time dimension to the panel employed in this study is for twenty observations, therefore the results of the CADF and CIPS stats are interpreted using critical values with T=20. However, values for T=15 is also listed so that the reader may compare the interpretation of results betwixt the two critical values.

The individual CADF statistics of the software piracy index shows that at 95% confidence interval Finland, France, Italy and Japan are stationary. If the confidence interval is lowered to 90% Germany and Spain are also added to the list since these two series also reject the null hypothesis of unit root. When possibility of trending behavior is taken into account only Finland, France and Japan continue to be (trend) stationary and only at 90% confidence interval. Moreover, Greece also emerges as trend stationary. For France the trending behavior is not obvious as is in the other countries series; therefore, it is safe to say Finland, Greece and Japan are trend stationary while France is stationary (without any need for transformation). The individual CADF statistics of monetary losses due to piracy of commercial software indicate that at 99% confidence level Australia, Austria, Belgium and Canada are stationary. When the confidence interval is dropped to 95% only New Zealand and Portugal remain non-stationary. When the possible trending behavior in the loss series of the thirty OECD counties is regarded, Australia, Austria, Belgium, Canada, Czech Republic, France, Germany, Greece, Hungary and Poland is trend stationary at 99% confidence level. At 95% confidence level Finland, Ireland, Italy and Mexico are added to the list of trend stationary countries. Finally, at 90% confidence level Japan, Sweden and Switzerland emerge as trend stationary.

The CIPS statistic, as mentioned before, tests the null hypothesis of homogenous unit root against the alternative that at least one series does not have unit root; thus is a panel summary of the individual CADF tests. The findings of this statistics demonstrate that piracy index for the thirty OECD countries show that the null hypothesis cannot be rejected at 5% significance level for both the no trend and trend models. On the other hand, losses variable strongly rejects the null hypothesis of homogenous unit root, indicating many series composing the panel is actually stationary.

Table 1b and table 1c delivers the CADF and CIPS statistics for two subgroups of OECD countries: developed and developing. Developed OECD countries consist of twenty-three and developed OECD countries consist of seven countries. Since the cross-sectional dimension of the critical values presented in Pesaran's (2007) study closest number to the actual dimension is selected; namely N=20 for developed and N=10 for developing OECD countries. Additionally, time dimension is taken to be T=20 again.

Table 1b. CIPS test on Software piracy index and losses form Software piracy in developed OECD countries

Developed OECD							
index				losses			
NO det. Trend		det. Trend		NO det. Trend		det. Trend	
Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat
2	-3.4267	2	-3.4834	3	-1.536	3	-2.4312
2	-2.6418	2	-3.034	3	-1.9891	3	-5.5426
2	-3.1561	2	-3.2229	3	-1.4358	3	-2.7236
2	-2.8345	2	-2.688	4	-2.1331	4	-1.5886
2	-2.5062	2	-2.3803	4	-2.2508	4	-2.3666
2	-2.3504	2	-2.3132	4	-2.6664	4	-2.2667
2	-3.3223	2	-3.0618	3	-1.1523	3	-2.7433
2	-2.6871	2	-4.1895	3	-2.1793	3	-4.0047
2	-5.2037	2	-5.116	3	-1.8781	3	-1.885
2	-4.6045	2	-4.3716	3	-2.5954	3	-2.4564
2	-4.1787	2	-3.9951	3	-3.4003	3	-3.6469
2	-3.0388	2	-2.8857	3	-1.3943	3	-4.1332
2	-2.6577	2	-2.5826	3	-1.1999	3	-1.3406
2	-2.6287	2	-2.4652	2	-3.1204	2	-3.0515
3	-3.0991	3	-2.8391	2	-3.3092	2	-3.8497
3	-2.4119	3	-2.4343	2	-3.687	2	-3.7693
2	-4.3844	2	-3.8838	3	-2.4843	3	-2.5034
2	-3.1205	2	-2.6017	3	-1.4559	3	-2.9304
2	-2.3744	2	-2.3079	3	-2.0028	2	-3.8786
2	-3.4416	2	-3.5009	2	-2.4802	2	-2.3794
2	-3.3253	2	-3.112	2	-1.8883	2	-2.0142
2	-3.758	2	-3.9669	2	-3.3834	2	-3.3057
3	-2.8714	3	-6.4935	2	-3.2591	2	-3.1383
CIPS-stat=-3.2184		CIPS-stat=-3.3448		CIPS-stat=-2.2992		CIPS-stat=-2.9543	

Table 1b continued.
The critical values for the CADF and CIPS test are obtained from Pesaran (2007)

Critical Values for CADF-stat			
N=20			
1%	T=15	-4.62	No Trend (p.275)
	T=20	-4.32	
5%	T=15	-3.54	
	T=20	-3.42	
10%	T=15	-3.06	
	T=20	-3.01	
1%	T=15	-5.40	Trend (p.276)
	T=20	-4.96	
5%	T=15	-4.14	
	T=20	-4.00	
10%	T=15	-3.62	
	T=20	-3.55	

Critical Values for CIPS-stat			
N=20			
1%	T=15	-2.45	No Trend (p.280)
	T=20	-2.40	
5%	T=15	-2.22	
	T=20	-2.21	
10%	T=15	-2.11	
	T=20	-2.10	
1%	T=15	-3.00	Trend (p.281)
	T=20	-2.92	
5%	T=15	-2.77	
	T=20	-2.73	
10%	T=15	-2.65	
	T=20	-2.63	

Although calculated separately the individual CADF statistics in table 1a and table1b are almost the same for the countries include in both tables. The small change occurs due the difference in cross-sectional augmentation part. The results for piracy index is as follows: In the model with no trend at 99% confidence interval Greece, Ireland and Norway emerges as stationary; when the confidence level is lowered to 95% Australia, Norway, Sweden and United Kingdom also appears in the list of stationary countries; furthermore, Greece and United States is trend stationary at 1% significance level and additionally Germany and Ireland is trend stationary at 5% significance level. The real value of losses resulting from software piracy indicate that only New Zealand is stationary at 5% significance level; moreover, Austria is trend stationary at 1% significance level, at 5% Germany and Italy is added and finally 10% Israel, Netherlands, New Zealand and Spain is added to the list of trend stationary countries. The CIPS statistics results show that for developed OECD countries, the null of hypothesis of homogenous unit root is rejected for piracy index in both trended and not trended model at 99% confidence interval; however, results are more complicated for losses due to software piracy. CIPS statistics of the no trend model cannot reject the null hypothesis of homogenous unit root at 1% significance level, however the null hypothesis is rejected at 5% significance level; additionally, trend model rejects the null hypothesis even for 1% significance level indicating panel to be strongly trend stationary.

Table 1c. CIPS test on Software piracy index and losses form Software piracy in developing OECD countries

Developing OECD							
index				losses			
NO det. Trend		det. Trend		NO det. Trend		det. Trend	
Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat	Lags	CADF-stat
2	-3.3058	2	-3.5333	2	-4.4645	2	-4.2286
2	-5.302	2	-4.912	4	-1.4167	4	-1.6597
2	-2.6768	2	-2.5839	3	-2.1844	3	-6.3909
2	-4.2397	2	-4.0174	2	-3.919	2	-3.9562
2	-3.3758	2	-3.2628	2	-3.911	2	-3.6335
2	-3.9612	2	-5.2365	2	-2.9129	2	-3.6058
4	-0.8874	4	-2.3009	2	-2.9847	2	-3.0319
CIPS-stat=-3.3927		CIPS-stat=-3.6924		CIPS-stat=-3.1133		CIPS-stat=-3.7866	

Table 1c continued.
The critical values for the CADF and CIPS test are obtained from Pesaran (2007)

Critical Values for CADF-stat			
N=10			
1%	T=15	-4.65	No Trend (p.275)
	T=20	-4.35	
5%	T=15	-3.53	
	T=20	-3.43	
10%	T=15	-3.06	
	T=20	-3.00	
1%	T=15	-5.44	Trend (p.276)
	T=20	-4.97	
5%	T=15	-4.17	
	T=20	-3.99	
10%	T=15	-3.64	
	T=20	-3.55	

Critical Values for CIPS-stat			
N=10			
1%	T=15	-2.66	No Trend (p.280)
	T=20	-2.60	
5%	T=15	-2.37	
	T=20	-2.34	
10%	T=15	-2.22	
	T=20	-2.21	
1%	T=15	-3.24	Trend (p.281)
	T=20	-3.15	
5%	T=15	-2.93	
	T=20	-2.88	
10%	T=15	-2.76	
	T=20	-2.74	

Table 1c presents the results of CADF and CIPS tests for the loss and index variables for only the developing OECD countries. CADF statistics for index show that only Mexico is stationary at 1% significance level, Slovakia and Turkey become stationary at 5% significance level and finally Hungary and Slovakia are added to the stationary country list at 10% significance level. Trend model on the other hand shows that Turkey is trend stationary at 1% significance level, Mexico and Slovakia are added to the list of trend stationary countries at 5% significance level, and no new addition occurs at 10%. For the monetary value of losses for the developing OECD countries we can say that Hungary is stationary at 1% significance level, Slovakia and Slovenia are added to the list of stationary countries at 5% significance level, and no new addition occurs at 10%. Finally, losses series for Poland is trend stationary at 1%, Hungary is trend stationary at 5% and Slovakia, Slovenia and Turkey is trend stationary at 10% significance levels. The CIPS statistic indicate that index variable as well as losses variable is stationary at 99% confidence interval.

Table 1a, 1b and 1c presents the results of the CIPS test where the null hypothesis is unit root, on the other hand table 2 present the empirical results of HK test for the same panels of countries. HK test has the hull hypothesis of homogenous stationarity against the alternative hypothesis that some individual time series are nonstationary. Table 2 presents the p-values for the statistics, consequently it is easier to interpret the test statistics. The p-value shows the significance level at which the null hypothesis of the test may be rejected. In table 2, with the exception on index variable of the developing OECD countries all p-values are less than 0.05, which indicates for all these panel variables the null of homogenous stationarity is rejected at 5% significance level. According to HK test only piracy index for developing OECD countries is stationary.

Table 2. HK test on Software piracy index and losses form Software piracy

OECD	index				losses			
	NO det. Trend		det. Trend		NO det. Trend		det. Trend	
	stat	p-value	stat	p-value	stat	p-value	stat	p-value
ZA_spac	5.082	0.0000	16.858	0.0000	10.8109	0.0000	32.976	0.0000
ZA_la	12.1628	0.0000	57.6795	0.0000	11.0492	0.0000	37.2161	0.0000

Developed OECD	index				losses			
	NO det. Trend		det. Trend		NO det. Trend		det. Trend	
	stat	p-value	stat	p-value	stat	p-value	stat	p-value
ZA_spac	3.6218	0.0001	22.0621	0.0000	6.8426	0.0000	45.0761	0.0000
ZA_la	4.0629	0.0000	32.4191	0.0000	6.5100	0.0000	61.1164	0.0000

Developing OECD	index				losses			
	NO det. Trend		det. Trend		NO det. Trend		det. Trend	
	stat	p-value	stat	p-value	stat	p-value	stat	p-value
ZA_spac	1.6900	0.0455	22.9021	0.0000	2.1519	0.0157	33.8497	0.0000
ZA_la	0.5547	0.2895	68.0819	0.0000	4.3261	0.0000	56.0721	0.0000

Conclusion

In this study dynamics of two variable related to software piracy are investigated, which are the monetary value of losses due to software piracy and the index of software piracy, for thirty OECD countries. While the “losses” variable shows the real monetary damage incurred by software firms due to the software piracy in a given country the “index” shows the perceived level of piracy in a country. Both these variables have significant impact on software industry because whether perceived or real the piracy level affects a software company’s policies within a given country. The main consequence of the polices is not the direct monetary gain, which is enormous even for economies as large as United States, but the cutting-edge technology produced within the sector which spreads to other sectors and propagates development and economic growth.

Software piracy while causing to monetary losses for to software producing firm; may have seen harmless to the user or the economy since the pirated software is not unreplaceably lost the original user or the firm. However, the drop in sales of the firm my lead firm to stop innovating and may lead to drop in technological development, and slowing down economic growth. Thus the dynamics of software piracy gains significance in this regard and brings forth the question whether software piracy has a characteristic inertia. This question is investigated using Pesaran's (2007) CIPS unit root test and Hadri and Kurozumi's (2012) HK panel stationarity test. CIPS test indicates that for developing OECD countries software piracy index is stationary and for developing OECD countries monetary value of software firms' losses are trend stationary and for developing OECD countries both variables are stationary. HK test on the other hand indicates that only piracy index for developing countries are stationary. The conflict arises from the opposite null hypothesis of both panel tests; while CIPS test homogenous unit root in the panel HK tests homogenous stationarity. Since none of the panel variables are composed of strongly stationary processes or conversely unit root processes. Although results of the test seem to be conflicting two conclusions emerge from this study the index variable, which is the perceived level of software piracy, has remained similar within time for developing counties whereas it has changed greatly for developed OECD countries. Finally, monetary value of software firms' losses has very different dynamic properties even among the countries within the same group so that the two tests cannot agree for a single group or model.

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