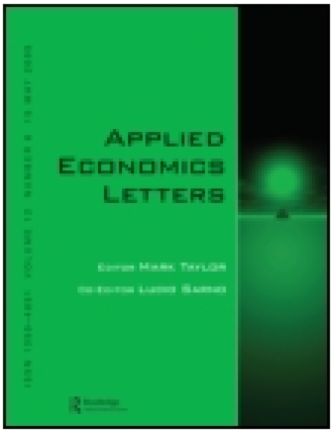

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Software piracy and income inequality

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Software piracy and income inequality

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We investigate the extent to which income inequality influences national piracy rates across a sample of 34 countries. Economic inequality seems to have a negative significant effect on national rates of piracy. Consistent with previous studies, we also find that judicial efficiency affects piracy rates. Additionally, research results show that income and education are not important determinants of piracy rates.

I. Introduction

The increase of piracy is a phenomenon that in recent years has greatly affected markets for information goods[1] such as software applications, sound recordings and movies. Technological advancements have greatly reduced the costs of copying and also increased the availability of technologies to pirate these products. According to the International Planning Research Corporation (IPRC), the estimated world piracy rate for business software applications was 39% in 2002. The IPRC also reports that the worldwide losses from pirated PC business applications rose to $13.07 billion in 2002 from about $11 billion in 2001 (IPRC, 2003).

Much of the formal literature has focused on the determinants of piracy rates across countries. This literature estimates the determinants of piracy rates employing different types of data set (cross-sectional data and panel data) where the national piracy rate is related to some cultural, economic, as well as socioeconomic factors. The quantitative research that focuses on the effect of income inequality on software piracy is surprisingly scarce. To date, only one paper has included economic inequality as an explanatory variable, and tested its significance through OLS regression by using a cross-section of 39 countries (Husted, 2000). Husted (2000) argues that with a more equal income distribution, a relatively large middle class will exist that is more prone to acquire illegal copies and, as a consequence, result in a higher rate of software piracy. He reports that the share of income held by the top 10% has a negative and significant effect on piracy rates. However the author does not control for any other potential determinant of piracy. Another limitation is that the economic inequality data are of dubious quality. Indeed, Husted (2000) does not explicitly mention whether the data are based on expenditure or income.

This paper contributes to the existing quantitative research in two ways. First, we include as additional control the Gini index as a measure of economic inequality. To our knowledge, this is the first cross-country empirical study of piracy using so rich and recent a set of income inequality data, the World Income Inequality Database (WIID, 2000). Second, we also test whether or not the effect of income inequality on piracy is sensitive to the quality of income data. Finally, we also attempt to control for other potential determinants of piracy such as education, income, and the efficiency of the judicial system.

Consistent with past research, we do find a significant effect of inequality on software piracy rates. The magnitude of the estimated effect of income inequality on piracy is similar to that obtained by

[1] One feature of information goods is that they have large fixed costs and small variable costs of reproduction (Varian, 1997).

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Husted (2000). The analysis reveals that the relationship between economic inequality and piracy results is robust regardless of the quality of the data source on income distribution. Our study also corroborated previous empirical research on piracy. We find that higher levels of judicial efficiency are associated with lower software piracy rates.

The rest of the paper is organized as follows. In Section II, we present the data and the empirical model. Section III presents the empirical results and Section IV concludes.

II. The Data and the Model

The dependent variable in this study is the software piracy rate (*PR*). Piracy rate is the difference between software programs installed and software applications legally licensed. Piracy rates range from 0% to 100% (all software installed is pirated). The variable selected has some deficiencies. Piracy rates are only estimates. Another problem with this variable is that it introduces some sort of downward bias in the reported piracy rates as a large part of the software applications are sold without the computer hardware.[2] Despite these limitations, empirical models have largely used the BSA's piracy rates (Husted, 2000; Marron and Steel, 2000; Holm, 2003; Rodríguez, 2003; Shadlen *et al*., 2003; Depken and Simmons, 2004; Van Kranenburg and Hogenbirk, 2005). Annual national software piracy rates are compiled by the International Planning and Research Corporation (IPRC, 2003) for the Business Software Alliance (BSA) and the Software Information Industry Association (SIIA). We have only considered observations from individual countries for which we had piracy rates. Thus, we net out merged observations corresponding to Belgium and Luxembourg.

The explanatory variables include several socioeconomic variables: income, education, the degree of economic inequality, and a measure of judicial efficiency. The measure of income used in this paper is the GDP per capita, measured in constant dollars, and adjusted via purchasing power parities. Data on GDP per capita are extracted from the World Bank's WDI database (World Bank, 2003). The variable is measured for the year of 1995. Some authors argue that as countries become richer, local producers can devote more resources to innovative activities, and they are more likely to ask national governments to increase the protection of intellectual property rights (Shadlen *et al*., 2003). On the other hand, the higher the income per capita, the more resources the countries have to enforce the national intellectual property laws (Ostergard, 2000). Thus, income is expected to be negatively correlated with piracy rates. Gopal and Sanders (1998, 2000), Marron and Steel (2000), Husted (2000), Holm (2003), Rodríguez (2003), Shadlen *et al*., (2003), Bezmen and Depken (2004) and Depken and Simmons (2004) find a negative association between income and piracy rates. To assess the impact of education on piracy rates, we use as a proxy variable the average years of schooling population over 25 years. These data can be obtained from Barro and Lee dataset (2000). This variable is measured for the year of 1995. Shadlen *et al*. (2003) find that the stock of human capital proxied by the enrolment ratio is negatively and significantly correlated with piracy rates. In contrast, Marron and Steel (2000) and Depken and Simmons (2004) fail to find a significant relationship between a country's education level and piracy rates.

The current study also includes as a further explanatory variable a measure of income inequality. Consistent with past research (Husted, 2000), the degree of economic inequality is measured by the Gini index.[3] This variable is available from the World Income Inequality Database (WIID, 2000) which extends the Deininger and Squire (1996) dataset.[4] The dataset differentiates between 'reliable' and 'less reliable' data. Only Gini coefficients labelled as being of reliable quality and with national coverage are used. Average values were computed for those country–year combinations for which we had multiple observations. If the Gini index is not available for 1995, the observation is taken from the closest year. Finally, rule of law is used as a proxy for the legal system and judicial efficiency but it does not capture the current legal framework regarding piracy activities. According to the economic theory of crime (Becker, 1968), the expected cost of illegal activities should be higher in countries that have more efficient institutions to enforce the law.

[2] Further information on the methodology employed to construct piracy rates can be found in the recent report on global software piracy elaborated by the International Planning Research Corporation (IPRC) for the Business Software Alliance (BSA) and Software Information Industry Association (SIIA) (IPRC, 2003).

[3] The Gini coefficient is the area between the Lorenz curve and the 45 degree equality line. The Gini index ranges from 0 indicating perfect equality to 1 indicating perfect inequality.

[4] The data set is described in detail at http://www.wider.unu.edu/wiid/wiid.htm.

Table 1. Descriptive statistics

Variable	Definition	Source	Mean	Standard deviation	Minimum	Maximum
Piracy	Piracy rate (%)	IPRC (2003)	69.56	17.79	35	98
Income	Real GDP per capita (000s $US)	World Development Indicators (World Bank, 2003)	11.86	11.33	0.38	34.47
Education	Average years of secondary schooling aged over 25	Barro and Lee data (2000)	7.20	2.54	2.38	11.82
Inequality	Gini index	World Income Inequality Database (WIID, 2000)	39.23	10.54	24.2	63.66
Law	Rule of law	Kaufmann *et al.* (2003)	0.73	0.95	−0.81	2.01

A strong judicial system will increase the opportunity cost to engage in illegal activities making piracy less attractive. Thus, efficiency of the judicial system would be negatively correlated with piracy rates. Holm (2003), for a sample of 75 countries, finds evidence supporting the beneficial impact of judicial efficiency on piracy rates. This measure ranges from −2.5 to 2.5, where higher values indicate a higher efficiency of the judicial system. These data can be obtained from Kaufmann *et al.* (2003). The variable is measured for the year of 1996. Descriptive statistics for all variables used in the study are presented in Table 1. Piracy rates within the sample ranged from to 35 to 98. The lowest piracy rate corresponded to Australia and the greatest to Indonesia. In addition, Norway is the country with the lowest degree of economic inequality (24.2) while Brazil had the highest Gini coefficient within the sample (63.66).

Following the empirical specification employed by Husted (2000), Marron and Steel (2000), Holm (2003), Van Kranenburg and Hogenbirk (2005), Bezmen and Depken (2004), Depken and Simmons (2004), the reduced form to be estimated is:

$$Piracy = \alpha_0 + \alpha_1\, Income + \alpha_2\, Education + \alpha_3\, Law + \alpha_4\, Inequality + \varepsilon \qquad (1)$$

where *Piracy* is the natural log of the piracy rate, *Income* is the GDP per capita, expressed in constant terms, and adjusted via purchasing power parities, *Education* is the average years of secondary schooling aged above 25 years, *Law* is a measure of judicial efficiency, and *Inequality* is the degree of economic inequality. The α are unknown parameters to be estimated and ε is the usual error term. The final data set is restricted by the availability of income inequality data. There are also missing values for other explanatory variables, in particular, for the education variable. The final sample covers 34 countries for 1995.

Table 2. The effect of income inequality on piracy

Explanatory variables	Coefficient
Income	−0.006 (1.16)
Inequality	−0.007** (2.54)
Education	−0.016 (1.17)
Law	−0.173** (2.44)
N	34
Adj. R^2	0.6969
Shapiro-Wilk (*p-value*)	0.94 (0.05)
RESET (*p-value*)	0.37 (0.77)

Notes: The dependent variable is the log of piracy rate. Robust standard errors. Absolute *t*-statistics in parentheses. Estimations were carried out using STATA v.8. All models include a constant term.** indicates significant at the 5% level.

III. Results

Table 2 displays the results obtained when estimating Equation 1 by ordinary least squares (OLS).[5] In addition, we have also tested for the presence of outliers and influential observations. Outliers are often a serious concern with cross-country data (Kennedy, 2001). Diagnostic tools such as Studentized residuals, and Cook's distance were employed to test for the presence of outliers. Applying these methods and employing as cut-off the absolute value of two (Belsley *et al.*, 1980), the United States was identified as an outlier and

[5] The following countries are included in the analysis presented in Table 2: Australia, Brazil, Canada, Chile, China, Colombia, Denmark, Dominican Republic, Finland, France, Honduras, Hong Kong, Hungary, India, Indonesia, Israel, Italy, Mauritius, Mexico, Netherlands, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Singapore, South Africa, Spain, Sweden, Thailand, Turkey, United Kingdom and Zimbabwe.

therefore removed from the analysis. The Ramsey test (Ramsey, 1969) suggests that there is no problem with model misspecification (see Table 2). The Shapiro–Wilk test (Shapiro and Wilk, 1965) indicates that there is no problem of non-normality of residuals.

Together with the constant term, the set of explanatory variables explains about 70% of the variation in reported national piracy rates. The Gini coefficient exhibits a statistically significant, negative effect on piracy rates. Nations with more equal income distribution have higher piracy rates, after controlling for the other potential determinants of piracy. The estimated coefficient on income inequality (0.007) is similar with that obtained in previous cross-sectional studies (Husted, 2000). With respect to the other control variables, only the law variable seems to impact on piracy rates. The coefficient on rule of law is negative and statistically significant. This finding suggests that the efficiency of the legal system might act a deterrent factor of piracy behaviour, hence supporting previous findings (Holm, 2003). Although, education is not statistically significant, the sign of the estimated coefficient is negative. This result is consistent with previous findings (Marron and Steel, 2000; Depken and Simmons, 2004). The income has a negative and insignificant effect on piracy rates. This is in accordance with previous studies that emphasize a negative relationship between income and piracy rates (e.g. Gopal and Sanders, 1998; Marron and Steel, 2000; Holm, 2003; Rodríguez, 2003; Shadlen *et al.*, 2003).

IV. Conclusions

In this paper, we empirically investigate the relationship between income inequality and software piracy rates using a rich and recent dataset on income distribution. This study shows that income inequality appears to have a negative and significant effect on piracy rates, and hence supporting Husted's result (2000). The regression results also reveal that the efficiency of the judicial system is an important factor when explaining cross-national variations in piracy rates. No significant association was found between income, education and piracy rates. Overall, the results are in line with previous empirical research. Obviously, the present study is subject to some caveats. First, important factors such as measures of software protection, cultural, and measures of individualism and power distance have been neglected. Second, the sample may be expanded to include more time periods. Third, the use of panel data instead of cross-sectional data would allow us to control for unobserved heterogeneity across countries, which reduces the likelihood of omitted variable bias. Finally, in order to derive solid conclusions, future research should pay attention to the use of income inequality data measured on a consistent basis.

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