Topics in Economic Analysis & Policy

Volume 3, *Issue* 1 2003 *Article* 5

Can economic theory explain piracy behavior?

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Abstract

This paper investigates if economic theory can explain variations in piracy behavior between individuals and between countries. It is demonstrated that economic theory explains a notable part of the individual variation in a survey study. Individuals with a low net valuation of an original when a copy is available are more prone to engage in piracy than individuals with a higher valuation. Individuals with a low cost of obtaining and handling copies are also more engaged in piracy. The country-wise variation can also be explained by economic variables; GNI/capita and judicial efficiency explain a substantial part of this variation.

KEYWORDS: piracy, intellectual property, contingent valuation, digital economy

1. INTRODUCTION

The Commission of the European Communities estimates that piracy and counterfeiting accounts for between 5% and 7% of world trade in value terms.[1] This amounts to more than $200 billion per year. At the same time the Commission admits, "Counterfeiting and Piracy in the Single Market are a phenomenon the nature and characteristics of which are little understood…" (p.8, Commission of the European Communities, 1998). Both the lack of knowledge concerning piracy and its economic magnitude motivate more research.

This paper focuses on piracy of digital intellectual property. This type of piracy combines low reproduction costs with low distribution costs of the pirated edition (e.g., through the Web), which appears to be something new in the economy.[2] Several important economic questions related to piracy have received attention in the economic literature. One question concerns the effect of copying on the value of intellectual property. This issue was partly addressed by Liebowitz (1985), who found that property right owners in some cases could appropriate the full extra value from copying. However, the issue reappeared in the so-called Napster file sharing case and is not entirely settled (see Klein et al., 2002, and Boldrin and Levine 2002). Another related issue concerns the welfare effects of copying. There are two main welfare effects that work in opposite directions (see, e.g., Romer, 2002). On the one hand intellectual property laws automatically make the owner a monopolist with the usual deadweight loss as a result. On the other hand, to the extent that copying reduces the value of intellectual property, under provision of creative work will result (see, e.g., Novas and Walkman, 1984, Johnson, 1985, and Hui and Png, 2002).[3]

One issue that has received virtually no attention at all in the literature concerns the variation in piracy behavior between individuals and between countries. Whereas some individuals' collections of software programs, music CDs, and computer games mostly consist of illegal copies, others' only consist of originals. Can these differences be explained by economic variables relating to the individuals' preferences and costs or is digital piracy behavior a phenomenon governed by entirely new mechanisms? Similar questions can be raised regarding the variation in piracy rates between countries. In 1999 the piracy rate for PC business software applications varied between 25% (USA) and 98% (Vietnam) according to IPRC's Global Software Piracy Report. Can these differences be explained by economic variables? Answers to these questions may help in understanding and predicting piracy behavior.

There are a few empirical studies on digital piracy behavior (primarily outside the economics literature) that are practically oriented against a certain problem often identified by the industry or that have a descriptive orientation. For instance, Swinyard (1990) observes that Asians have a more casual attitude towards software piracy than individuals from Western countries. Solomon and O'Brien (1991) observe that females and old subjects pirate less than other subjects do. Gopal and Sanders (1997) aim at testing the efficiency of preventive and deterrent controls on software piracy. Marron and Steel (2000) conducted a descriptive study that

[1] See Commission of the European Communities (1998).

[2] These two costs are considered to be critical by Shapiro and Varian (1999) for the design of a rights management strategy. The same authors emphasize that not only pirates but also intellectual property owners can take advantage of low reproduction and distribution costs.

[3] More indirect mechanisms and effects of piracy have also been analyzed. For instance, Conner and Rumelt (1991) and Takeyama (1994) have recognized that copying can cause positive externalities and increase demand for the firm that sells the original. Copying also makes social sharing of information goods easy, which may increase the willingness to pay for these goods (see Bakos et al., 1999). On the other hand, expectations of a future illegal market for copies may also create expectations of future price cuts on the original, which can cause immediate reductions in demand and profit for the seller of the original (see Takeyama, 1997).

is closely related to this paper's second objective (i.e., to explain piracy rates between countries). Here piracy rates in different countries are interpreted as proxies for intellectual property right protection policies. A number of stylized facts are established. One is that high-income countries have a lower degree of piracy compared to low-income countries. Another is that institutions and culture matter for piracy rates.

One danger of generating results without restrictions from of a theory is that coincidental relationships between variables are generated sooner or later. Another danger is that vested interest instead of scientific motives may determine the research agenda if the intellectual property rights industry becomes too dominating in formulating the questions. It is therefore believed that the area benefits from independent studies that are founded on micro economic theory of piracy that restricts the set of predictions that are tested against the data. Consequently, we will analyze data from a survey study that was designed with an eye on Besen and Kirby's (1989) model (henceforth denoted by BK) for the demand on copies. Admittedly, this is a very simple model of piracy behavior, but we think it may be useful in the initial stages in this research area. Questions about subjects' valuations of originals over pirated editions were posed together with questions aimed at eliciting the subjects' engagement in piracy behavior. In addition to this other questions were posed that either could be motivated from the model or from earlier research. Our findings are that some predictions of the BK model are verified when tested against the data. More specifically, the difference between the subjects' valuations of the original and the copy is significantly negatively associated to piracy behavior. Furthermore, low costs for subjects to acquire and handle copies in terms of having computer skills also appear to increase the inclination for piracy.

The reasoning behind the model in BK is also used when deriving economic predictions regarding the variation between countries' piracy rates. According to theory the aggregate income and judicial efficiency of a country should both be negatively associated to income. A simple statistical study of these variables confirms that this is indeed the case. Without claiming that the last word has been said on these issues, our results indicate that economic theory appears to be an important source of knowledge in understanding piracy behavior.

The outline of the study is as follows. In section 2 the theory of piracy behavior is shortly introduced. In section 3 predictions from the theory are motivated and tested against survey data. In section 4 piracy behavior from an international and aggregated perspective is presented. Section 5 contains concluding remarks.

2. PIRACY IN A MICRO PERSPECTIVE

In this section we will use BK to analyze the basic theoretical determinants of piracy behavior.[4] According to this model the demand for copies depends on the relative values individuals place on originals and copies respectively and the prices of originals and copies.

Consider a given intellectual property (e.g., a software program) of which each consumer is interested to possess at most one original or copy.[5] Let $V_o(x)$ denote the value placed by consumer x on an original and let the value placed by x on a copy be denoted by $V_c(x)$, where $V_o(x) > V_c(x)$. The "price" or cost of obtaining copies for consumer x is denoted by r_x and is assumed to include both material production costs and all non-material costs such as search costs,

[4] BK present different specifications of their model. In this paper Case 1 is used since this specification appears to be most appropriate for digital goods.

[5] The issue of "space shifting" (see, e.g., Klein et al. 2002) is not considered in this model.

expected fines if caught, psychological cost of breaking the law, etc.[6] If P_o denotes the price of an original (where $P_o > r_x$) at the legal market, the consumer will buy an original if and only if:[7]

$$V_o(x) - V_c(x) \geq P_o - r_x . \qquad (1)$$

3. EMPIRICAL TEST OF MICRO DATA

This section contains a presentation of the theoretical predictions, the variables to be studied and the results from the survey study.

3.1. Data Description and Theoretical Predictions

From a survey study on piracy behavior among undergraduates, 289 subjects out of 336 subjects were selected.[8] One group of 106 subjects from Lund Technological Institute specializing in computer engineering and one group of 183 subjects taking a course in Economics at the School of Economics and Management at Lund University were recruited. To maximize turn out rates the cost of participation in the study was minimized. Subjects were approached at the end of a lecture (after agreements with lecturers) and given a questionnaire that took 5-10 minutes to fill out. Since some questions concerned illegal activities, anonymity was assured. Although, participation was voluntary very few students chose not to participate.

To determine the intensity of individual copying behavior, subjects were asked to estimate the proportion of their collections of i) music discs, ii) computer games, and iii) software that were illegal copies. To explain this behavior with economic theory, subjects were asked to answer questions regarding their valuation of an original when a copy was available, their ethical concerns regarding illegal copying, and their incomes. To control for demographic factors, subjects were also asked about their age and gender.[9]

Below we will explain in more detail how each variable was measured and what predictions economic theory makes if based on BK.

Individual piracy behavior

The intensity of a subject's piracy behavior is denoted by *PI* and measured by a normalized index based on the share of copies in the subjects' collection of music, computer games and software programs.[10]

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[6] We deliberately deviate here somewhat from BK who assume that *r* is the same for all consumers. This is a special case of the model presented here. There are many reasons for making this generalization when individual piracy behavior is analyzed. One is that there are only hidden illegal markets for copies, which makes it more difficult for the law of one price to be effective.

[7] We assume here that $V_o(x) - P_o \geq 0$.

[8] The survey was conducted during the fall semester 1999-2000. The reason for not including all subjects is that we wanted to test the impact of computer skills as indicated by their educational program. To make the distinction between students with special training in computers and others sharper we excluded a small group of technology students that did not specialize in computer engineering.

[9] As noted before, Solomon and O'Brien (1991) have shown that both gender and age can have an explanatory power in piracy behavior.

[10] The questions and the construction of the index are given in the Appendix.

Relative valuation of an original

According to BK, one important predictor of whether an individual buys an original or a copy depends on how much more the individual values the original to a copy (i.e., $V_o(x) - V_c(x)$). The prediction is that the lower relative valuation of the original, the higher probability that the individual demands a copy.

In order to elicit the difference between the individuals' valuations of an original and a copy each subject answered a willingness to pay question for an original when a copy was available by a friend.[11] By framing the scenario so that a copy is available from a friend, r_x can be assumed to be negligible. This variable is denoted by NWTPO ((n)et (w)illingness (t)o (p)ay for an (o)riginal).

There are some methodological problems associated with hypothetical willingness to pay studies.[12] Some of these problems concern issues associated with the difficulty of getting subjects to understand abstract public good issues and/or small probabilities in, e.g., evaluations of health and traffic safety programs. Another issue concerns strategic answers (subjects that want a certain public good may overstate the value at zero cost). It should be stressed that the method is used because there is no obvious alternative method available. For instance, real market data on valuations and market prices on illegal goods are not available. Furthermore, the present study has methodological advantages compared to most other contingent valuations studies, since the question concerns a (legally) private good that ought to be easy to understand. It is also unlikely that strategic aspects matter in this case. However, the hypothetical nature of the question still remains, which means that the results should be interpreted with carefulness.

Computer skills

In the model the cost associated with obtaining and using a copy (i.e., *r*) is important and consists of many components. It is conjectured here that the higher computer skill (denoted by *CS*) an individual has, the lower his cost of obtaining and running a copy. There are several reasons for this. First, those with computer skills are likely to know others with skills and interest in computers. Therefore their network of friends with access to copies is likely to be larger than for the less-skilled. Furthermore, actual copying may involve procedures that are less time consuming for computer-skilled individuals than for others. To indicate skill educational program is used as a proxy. It is conjectured that students pursuing the 4-year program to become computer engineers are more skilled (i.e., $CS = 1$) on computers than students pursuing an economics course ($CS = 0$).

Ethical concerns

By copying, individuals exploit other's intellectual property without compensating for it. To the extent that subjects feel that this is ethically wrong, copying may invoke a psychological cost in terms of bad conscience, etc. This is another component of the cost of the copy (that is, of r_x). Consequently, the prediction is that more ethically concerned individuals are less likely to engage in piracy than others. The degree of ethical tolerance (denoted by *ET*) regarding piracy is measured by a normalized index where 1 indicates the highest possible tolerance (i.e., the lowest possible ethical concern) and 0 indicates the lowest tolerance. The index is based on how subjects

[11] See the question in the Appendix.

[12] See, e.g., Diamond and Hausmann (1994) for a critique against the method and Hanemann (1994) for a defense of it.

rated the ethical seriousness of copying compared to other illegal activities (like shoplifting, speeding, cheating on exams, etc).[13]

Income

In BK, income is not included. However, standard microeconomic theory suggests that income affects copying indirectly both through the valuation side and the cost side. The price a representative individual is willing to pay for a given quantity of a good with positive income elasticity is increasing in income. By the same argument, it is reasonable to assume that the valuation of the original is increasing in income. Furthermore, if we (like BK) assume that the valuation of the copy is proportionate to the valuation of the original (i.e., so that $V_o(x) - V_c(x) = V_o(x) - \alpha V_o(x)$, where $0 < \alpha < 1$) the difference between the value of an original and a copy is clearly increasing in income. An increase in income would, for this reason make the individual less inclined to piracy behavior. In addition to this, higher income suggests a higher opportunity cost of time. Because copying is usually more time consuming than buying an original, this would increase r_x. Consequently, this effect would work in the same direction as the first and also make individuals less inclined to copying through the cost side.

Age and gender

To avoid confounding relationships we also collected data on age and gender (where 1 indicates a male).

3.2. Results

This section contains descriptive statistics and tests of the theoretical predictions. The descriptive statistics are summarized in Table 1. Because of missing values (mainly, depending on incomplete answers and marks that were difficult to interpret) the number of observations (indicated by *N*) differ for the various variables. The index indicating intensity of piracy behavior (*PI*) had an average of 0.31, which means that on average the subjects stated that between 25% and 50% of their different collections consisted of illegal copies.[14] The mean *NWTPO* was relatively low (only 18% of the retail price). Furthermore, subjects exhibited high ethical tolerance regarding piracy behavior (average *ET* was 0.8491). The vast majority of subjects considered illegal copying less serious than each one of the comparison offences (shoplifting, cheating on exams, home distilling, speeding). As all subjects were taking full-time courses their incomes were low and, hence homogeneous. It can finally be noted that the median subject was a 21 years old male.

[13] See Appendix for the construction of the index.

[14] Like in experimental research, which heavily relies on observing undergraduates the sample is not representative for the general population. However, whereas one can expect that the levels of some variables are different among different groups, there is no obvious reason to expect that *connections* between the variables are different between groups. Needless to say this paper focus on the latter aspect.

TABLE 1. DESCRIPTIVE STATISTICS.

Variable	*N*	*Mean*	*Median*	*StDev*
PI	278	0.3062	0.2222	0.3200
NWTPO	264	0.1822	0.1333	0.1899
CS	289	0.3668	0	0.4828
ET	285	0.8491	0.875	0.1938
Income (SEK)	256	27.38	20.00	34.33
Gender	289	0.5952	1.00	0.4917
Age	285	22.26	21.00	3.675

Testing the theory

To investigate the relationship between the variables we first study some non-parametric tests and non-parametric measures of association. The reason for doing this is that some variables (most notably *PI*) should be regarded as ordinal.[15]

Spearman's rank order correlation coefficient provides a non-parametric measure of the association between ordinal variables, where $\rho_S = 1$ indicates maximum positive association, $\rho_S = -1$ maximum negative association, and $\rho_S = 0$ indicates no association. Table 2 contains the correlation coefficients for the non-binary variables against *PI*. It can be verified that *NWTPO* has the expected sign and is highly significant. The ethical tolerance index (*ET*) also has the expected sign, but is not significant (p = 0.07) at the 5%-level. Similarly, income has the expected sign, but is also insignificant, which is not entirely unexpected given that the variation in income in this group is small.[16] Finally, it should be noted that age is highly significant. Younger subjects have a larger proportion of their collection as copies than older subjects have.

There are also two binary variables to test. The non-parametric Mann-Whitney sum of ranks test is applied to study if computer-skilled subjects' piracy behavior differ from less computer skilled and if there is a gender difference. The test rejects that the distribution of *PI* from the group of computer-skilled subjects is the same as the corresponding distribution obtained from the other group ($p < 0.01$). In fact, the average *PI* is almost 20 percentage units higher for the skilled than the less-skilled group. The same test also rejects that the observations of male and female *PI* are obtained from the same underlying distribution ($p < 0.01$). Males have a significantly larger proportion of copies than females.

TABLE 2. ASSOCIATION BETWEEN PIRACY BEHAVIOR (*PI*) AND THE NON-BINARY VARIABLES.

Variable	ρ_S
NWTPO	-0.236**
ET	0.107
Income	-0.059
Age	-0.231**

Spearman's rank order correlation coefficient (ρ_S).** = significant at 1%.

[15] See Siegel and Castellan (1988) for an introduction to non-parametric statistics.

[16] Furthermore, income in this group is a weak measure of real budget constraints, since these are likely to be heavily influenced by factors such as parents' income, if they live by their parents, etc.

Regression

A concern with non-parametric tests is that they are unconditional. This means that what appears to be a relationship could be confounded by demographic variables. For instance, subjects with computer skills were younger and a higher percentage of this group was male. Thus, it is possible that the difference between the computer-skilled and others with regard to the *PI* variable might be explained by demographics. In order to investigate this we also run a multiple least squares regression with *PI* as dependent variable and *NWTPO, CS, ET, Income, Gender* and *Age* as independent variables. The regression results are given in Table 3.[17]

It can be verified in Table 3 that all signs of the variables are the expected ones. However, *ET* and *Income* are not significant. It can be noted that *Gender* is still significant but age is not. Together these variables account for one third of the variation in the *PI* variable ($R^2(adj) = 0.337$). Thus, economic theory and two standard demographic variables explain a notable part of piracy behavior in this subject group.[18]

TABLE 3. REGRESSION RESULTS.

Variable	*Coefficient*	*Standard Error*
Constant	0,1798	0,1638
NWTPO	-0,2249*	0,1009
CS	0,19863**	0,04120
ET	0,1425	0,1019
Income	-0,0000530	0,0005415
Gender	0,21949**	0,04182
Age	-0,007268	0,005823

$N = 222$. * = significant at 5%; ** = significant at 1%.

4. PIRACY FROM AN INTERNATIONAL MACRO PERSPECTIVE

In the previous section it was demonstrated that economic theory has some power in explaining individuals' differences in piracy behavior. This does not necessarily mean that it can explain differences in piracy behavior at an aggregate level. In order to investigate this, we will study if economic predictions hold when confronted with actual data on different countries' piracy rates. We will derive the predictions from a simple specification of the BK model that assumes one global price on originals.

If the owner of the intellectual property treats the whole world as a gigantic integrated market, she will set a uniform monopoly price on the original that consumers have to pay all over the world. Clearly, this is the case if it is costly for the owner to distinguish among consumers in different countries or if it is difficult to stop consumers from buying originals in low-price countries, or both. Whereas language differences and technological differences in standards may facilitate price discrimination, parallel import and communication possibilities through Internet make it more difficult. Making the assumption of a uniform global price stresses the latter

[17] The reader should be reminded to interpret the regression results with care since some standard assumptions in this parametric test are not satisfied.

[18] It shall be noted that the subject group of university undergraduates is a relatively homogeneous one with respect to income and other socioeconomic factors. It is not unlikely that economic theory is even more powerful in more heterogeneous groups.

aspects.[19] In this case piracy behavior is determined by the inequality in (1). Instead of an individual consumer, x, one might consider a country's average (or representative) consumer as x.

4.1. Variables to Test

Direct indicators of the variables in the BK model (e.g., valuations of originals vs. copies, ethical concerns, skills, etc.) are not available at the aggregate level. This means that a study of aggregate variables has to be based on general proxies.

We will use three variables in this study. As a dependent variable we will use the piracy rates for 75 countries provided by IPRC (2000) for the Business Software Alliance and the Software & Information Industry Association.[20] We will use two independent variables that can be motivated from theory. One indicates average income (measured by GNI per capita, year 1999, from the 2001 Development Indicators database, World Bank, 4/11/01) and the other is an institutional proxy indicating the efficiency of law, which is assumed to be related to the expected cost of committing a crime. In this study, we will not include variables like individualism, R&D, and education that are considered by Marron and Steele (2000). The reason for this is not that these variables are considered unimportant, but that their connection to piracy behavior from the perspective of economic theory is relatively unclear.[21] For instance, while citizens of individualistic cultures could more readily understand concepts of intellectual property, individualists could also be more sensitive to personal gains from copying opportunities, and also more creative in designing strategies that undermine intellectual property protection.

Below we will present the result and explain the theoretical connection between the independent variable and the dependent variables in this model.

4.2. Income

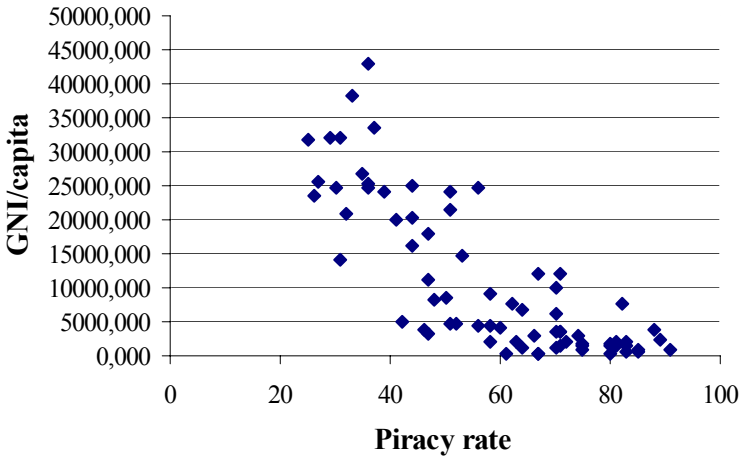
When the owner of intellectual property sets a uniform price, the piracy rate should be decreasing in a country's average income for the reasons mentioned in section 3.1. The relationship between income and piracy rates is displayed in Figure 1. The figure suggests that there is a strong negative relationship between income and piracy rates. The strongly negative and highly significant Pearson correlation coefficient ($\rho_P = -0.798$) confirms this.

[19] Derivations of predictions from the BK model with country-wise price discrimination are available upon request by the author.

[20] This report is based on the industry's own estimations and do only concern PC business software applications.

[21] The variables chosen by Marron and Steele (2000) may partly be explained by their approach to view piracy rates as a measure of the different countries' *policies* regarding intellectual property. The approach adopted here is more straightforward, namely "to use a traditional law and economics framework to analyze how individuals decide whether to pirate based on the costs and benefits facing them."(p. 162, Ibid.)

FIGURE 1. PIRACY RATES (1999) AND GNI/CAPITA (1999).
Sources: IPRC (2000) and the World Bank.



4.3. The Rule of Law

The cost of obtaining a copy often involves a chain of actions, some of which are likely to be illegal. According to economic theory, individuals that undertake illegal actions require compensation for the expected cost of being caught (see, e.g., Becker, 1968). Consequently, the cost for copies should be higher in countries that have efficient institutions for enforcing the rule of law than in countries where this is not the case. Furthermore, in countries with efficient institutions for enforcing the law, illegal markets are pushed further underground, making them more difficult to find. This, in turn, will increase transactions costs connected with illegal copies. Clearly, these costs are linked to the *r* variable in the BK model.

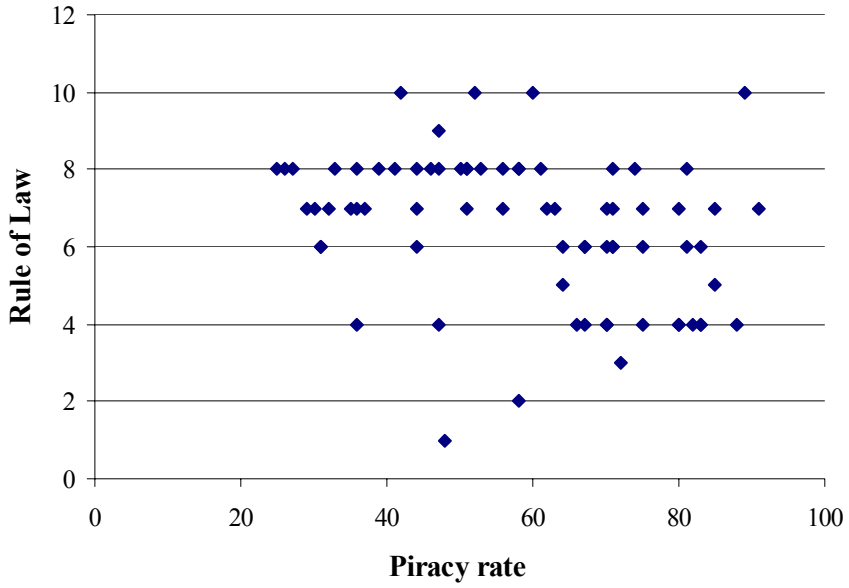
There are obvious problems in defining and measuring institutional aspects of different countries. The best one can do, in this respect, is to use adequate proxies. One ambitious effort in this direction, presented by Kaufmann et al. (1999a,b), is an aggregation of governance indicators. The most appropriate proxy for this study is the indicator of the "Rule of Law" that aims to measure the efficiency of the judicial system in a country. Ideally, one would need a more narrowly defined indicator that directly relates to legislation and judicial efficiency regarding piracy. However, because such data is not available we will assume that the rule of law concerning software property rights is not an exception but correlated to the overall judicial efficiency in a country.

The Rule of Law indicator for a country is a number between 0 and 10; the higher number the more efficient judicial system. Thus, economic theory predicts that the relationship between piracy rates and this indicator is negative.

Figure 2 displays the unconditional relationship between piracy rates and the rule of law indicator. It can be verified that the association between the variables is negative. This is also confirmed with the Spearman's rank order correlation coefficient ($\rho_S = -0.380$) that is highly

significant ($p = 0.001$). Hence, economic theory is also verified in this respect, the less efficient the judicial system is the lower piracy rates.

FIGURE 2. PIRACY RATES AND THE RULE OF LAW INDICATOR.
Sources: IPRC (2000) and Kaufmann et al. (1999b).



4.4. Regression

It is well known that indicators of governance are positively related to per capita income (see Kaufmann et al., 1999b). Hence, one could not a priori exclude that the relationship between piracy rates and rule of law indicators is spurious. To investigate if both of these factors contribute in explaining piracy rates we will employ a regression analysis. The results of a multiple least squares estimation are presented in Table 4.

TABLE 4. REGRESSION RESULTS.

Variable	*Coefficient*	*Standard Error*
Constant	85.85**	4.60
Income	-0.00129**	0.000114
RuleLaw	-2.00**	0.680

$N = 75$. $R^2(adj) = 0.667$.

Table 4 shows that both variables are highly significant and have the theoretically expected signs in the fitted regression equation, which means that both variables help to explain piracy rates in this sample. Two thirds of the variation in country-wise piracy rates can be explained by variables with a strong foundation in economic theory. The coefficients also reveal substantial effects, a USD 1000 increase in GNI per capita reduces the piracy rate by more than one percentage point and each point on the Rule of Law indicator reduces the piracy rate by 2 percentage points.

5. CONCLUDING REMARKS

The purpose of this paper is to study if economic theory can explain piracy behavior. First, a simple model of Besen and Kirby (1989) is tested on a unique micro-data-set obtained from a survey on responders' valuations of obtaining originals when copies are available, their piracy behavior, their ethical judgements, etc. The conclusion is that economic theory, together with demographics variables (age and gender), can explain a notable part of the variation in individual piracy behavior. The result suggests that individual piracy behavior is significantly more intense for subjects: i) with a low net valuation of an original, ii) with computer skill, and iii) who are male. The subjects' ethical concerns regarding piracy had no statistically significant effect.

The same model was also tested against aggregate data on international country-wise piracy rates. According to the model, countries with high (low) incomes should have low (high) piracy rates. Furthermore, countries with efficient judicial institutions should have lower piracy rates than those with inefficient ones. Income was measured by GNI per capita and judicial efficiency by a proxy. Both variables were highly significant and had the expected signs.

The study has some policy implications. For instance, the micro data results suggest that campaigns aimed at making individuals more ethically concerned about illegal piracy may be more naïve than efficient. The results of the macro study suggest that it is difficult to separate issues of piracy from issues of poverty and governance.

The purpose of this study is not to provide the final answer to the question of whether and to what extent economic theory explains piracy behavior. A simple theoretical model is used and the data set was obtained from an easily designed questionnaire. A number of issues can be raised about the interpretation of variables, the non-representativeness of students, the choice and construction of macro indicators, etc. As a consequence, the results should be interpreted with care. The area needs more elaborate models of piracy and additional data in order to produce fully convincing results. However, until such tools and empirical material are available we hope that our preliminary result, that economic theory can help explain differences in both individual and aggregate piracy behaviors, may stimulate economic research in the area.

6. COLOPHON

Valuable comments by two anonymous referees and the editor, Benjamin Hermalin, are gratefully acknowledged. The author is associate professor at the Department of Economics at the School of Economics and Management at Lund University in Sweden. E-mail address:Hakan.Holm@nek.lu.se.

REFERENCES

Bakos, Yannis, Brynjolfsson, Erik, and Lichtman, Douglas, "Shared Information Goods," *Journal of Law and Economics*, 1999, 42 (1), 117-55.

Becker, Gary S., "Crime and Punishment: An Economic Approach," *Journal of Political Economy*, 1968, 169-217.

Besen, Stanley M., "Private Copying, Reproduction Costs, and the Supply of Intellectual Property," *Information Economics and Policy*, 1986, 2(1), 5-22.

Besen, Stanley M., and Kirby, Sheila N., "Private Copying, Appropriability, and Optimal Copying Royalties," *Journal of Law and Economics*, 1989, 32(2), 255-80.

Boldrin, Michele, and Levine, David, "The Case against Intellectual Property," *The American Economic Review, Papers and Proceedings*, 2002, 92(2), 209-212.

Chen, Hsing K, Sims, Ronald, and Teegen, Hildy, "To Purchase or to Pirate Software: An Empirical Study," *Journal of Management Information System*, 1997, 13 (4), 49-60.

Commission of the European Communities, "Green Paper Combating Counterfeiting and Piracy in the Single Market," 1998, COM(98): 569.

Connor, Kathleen R., and Rumelt Richard P., "Software Piracy: An Analysis of Protection Strategies," *Management Science*, 1991, 37, 125-139.

Diamond, Peter A. and Hausman Jerry A., "Contingent Valuation: "Is Some Number Better than No Number?" *Journal of Economic Perspectives*, 1994, 8(4), 45-64.

Gopal, Ram and Sanders, Lawrence, "Preventive and Deterrent Controls for Software Piracy," *Journal of Management Information System*, 1997, 13(4), 29-47.

Hanemann, W. Michael, "Valuing the Environment through Contingent Valuation," *Journal of Economic Perspectives*, 1994, 8(4), 19-43.

Hui, Kai-Lung and Png, I. P. L., "On the Supply of Creative Work: Evidence from the Movies," *The American Economic Review, Papers and Proceedings*, 2002, 92(2), 217-220.

IPRC, 1999 Global Software Piracy Report, (for the Business Software Alliance and Software & Information Industry Association), May 2000.

Johnson, William R., "The Economics of Copying," *Journal of Political Economy*, 1985, 93(1), 158-74.

Kaufmann, Daniel., Kraay, Aart, and Zoido-Lobatón, Pablo, "Aggregating Governance Indicators," Policy Research Working Paper 2195, 1999a, The World Bank Research Group.

Kaufmann, Daniel., Kraay, Aart, and Zoido-Lobatón, Pablo, "Governance Matters," Policy Research Working Paper 2196, 1999b, The World Bank Research Group.

Klein, Benjamin, Lerner, Andres, and Murphy, Kevin, "The Economics of Copyright "Fair Use" in a Networked World," *The American Economic Review, Papers and Proceedings*, 2002, 92(2), 205-208.

Liebowitz, Stan J., "Copying and Indirect Appropriability: Photocopying of Journals," *Journal of Political Economy*, 1985, 93(5), 945-57.

Marron, Donald B. and Steel David G., "Which Countries Protect Intellectual Property? The Case of Software Piracy," *Economic Inquiry*, 2000, 38(2), 147-74.

Novos, Ian E. and Waldman, Michael, "The Effects of Increased Copyright Protection: An Analytic Approach," *Journal of Political Economy*, 1984, 92(2), 236-46.

Romer, Paul, "When Should We Use Intellectual Property Rights?" *The American Economic Review, Papers and Proceedings*, 2002, 92(2), 213-216.

Shapiro, Carl and Varian, Hal, *Information Rules, a Strategic Guide to the Network Economy*, 1999, Harvard Business School Press: Boston.

Siegel Sidney and Castellan, John, *Non-Parametric Statistics – For the Behavioral Sciences*, 1988, McGraw-Hill: Boston, 2nd ed.

Solomon S. L. and O'Brien, J. A., "The Effect of Demographic Factors on Attitudes toward Software Piracy," in R. DeJoie, G. Fowler, and D. Paradice (eds.), *Ethical Issues in Information Systems*, 1991, Southwestern Publishing, 168-181.

Swinyard, William R., "The Morality of Software Piracy: a cross-cultural analysis," *Journal of Business Ethics*, 1990, 9, 655-664.

Takeyama, Lisa N., "The Welfare Implications of Unauthorized Reproduction of Intellectual Property in the Presence of Demand Network Externalities," *Journal of Industrial Economics*, 1994, 42(2), 155-66.

Takeyama, Lisa N., "The Intertemporal Consequences of Unauthorized Reproduction of Intellectual Property," *Journal of Law and Economics*, 1997, 40(2), 511-22.

APPENDIX:
Translations of questions and construction of variables

Piracy Behavior:
The following question was asked.
How large share of your collection of:

a) music is illegally copied?	*0-25%*	*26-50%*	*51-75%*	*76-100%*
b) computer games are illegally copied?	*0-25%*	*26-50%*	*51-75%*	*76-100%*
c) software programs are illegally copied?	*0-25%*	*26-50%*	*51-75%*	*76-100%*

The index of piracy behavior was constructed by coding each answer so that 0-25% was given the value 1, 26-50% was given the value 2 and so forth up to the maximum value that was 4. Let now $x_i \in \{1,2,3,4\}$ denote the answer on sub-question $i = a,b,c$. To construct a normalized index denoted as *PI* that is not greater than one and not less than zero, the sum of the sub-questions was subtracted by 3 and then divided by 9 (i.e., $PI = (x_a + x_b + x_c - 3)/9$).

Net willingness to pay for an original
The following question was posed to the subjects:

"Assume that your friend has a computer program that is priced in retail stores at SEK X and that you are very anxious to get. Assume also that you are offered to copy your friend's program for free. What is the maximum amount you would be willing to pay for the program in a retail store under these circumstances?

I would be willing to pay SEK _____."

In each subgroup half the subjects received a subject retail price of SEK 1000 (= *X*) and half the subjects received a price of SEK 3000 (= *X*).[22] It appears that the retail price mattered somewhat to the subjects in that a higher retail price resulted in a somewhat higher (but not proportionately higher) net willingness to pay. To ward off this effect, the willingness to pay was divided with the retail price that the subject received. Thus, the variable NWTPO is the proportion of the retail price that the subject is willing to pay in order to get the original when a copy is freely available by a friend.

Computer skills
Computer skills (CS) is measured by a dummy variable that takes the value of one if the subjects pursued the computer engineering program and zero otherwise.

Ethical concerns:
Each individual received the following question:
How serious to you consider illegal copying to be? Please, answer the question from an ethical (and not judicial) perspective?
(1 = Agree, 2 = Equally serious, 3 = Do not agree)
Illegal copying is more serious than:

a) shoplifting	*1*	*2*	*3*
b) cheating on exams	*1*	*2*	*3*
c) home distilling	*1*	*2*	*3*
d) speeding	*1*	*2*	*3*

[22] One dollar was about nine Swedish crowns (SEK) at the time the study was conducted.

Let $x_i \in \{1,2,3\}$ denote the answer on sub-question $i = a,b,c,d$. To construct a normalized index denoted as *ET* that is not greater than one and not less than zero, the sum of the sub-questions was subtracted by 4 and then divided by 8 (i.e., $ET = (x_a + x_b + x_c + x_d - 4)/8$). Thus, 0 (1) indicates the highest (lowest) possible ethical concern.

Income:
In order to get information about incomes, subjects were asked to estimate their annual income in excess of their annual governmental study grant.