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# *Software copyright infringement among college students*

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In recent years, the issue of infringement in the software industry has gained international attention as the demand for software continues to grow. The growing presence of unauthorized reproduction of copyrighted products inhibits full potential growth and discourages creative activity. This study analyses the extent of software copyright infringement among college students and attitudes of these students with regard to risk of apprehension and conviction. This study finds a significantly higher likelihood of infringement for computer majors and male students, and a decrease in the likelihood of infringement for older students. This study also uncovers differences in attitudes toward risk of apprehension and conviction between majors in scientific fields and those in business and economics. Whereas the first group of majors appears to exhibit risky behaviour, the latter tends to be more risk averse.

## I. INTRODUCTION

Intellectual property rights (IPR) involve the protection of an invention, literary work, and all other intellectually produced items from its unauthorized use, production, and sale by anyone except the creator and its licensees. The primary means of protection include the patent, trademark, and copyright. Whereas the patent and trademark are more often used to protect against competing firms, the copyright is the most widely used method of protecting consumer products, including computer software, music items, and books. These products have been one of the leading issues in recent international trade negotiations, because they require extensive amounts of research and money to create and yet they are easily reproduced and illegally sold by pirates at the expense of the developers (e.g., Besen and Raskind, 1991; Scotchmer, 1991).

The copyright law regarding computer software is spelled out extensively in the Copyright Amendments of 1990. Since then, numerous amendments have been made in order to keep up with the trends of the changing computer industry. The protection of computer software has often led to debate on how and to what extent protection should be granted. Current law protects the 'expression' of non-copyrighted ideas. These expressions include all software programs and games, as well as interface designs (such as Microsoft Windows©). However, these provisions in copyright laws concern the protection of software producers from its competitors. The other provisions are intended to protect software from individual pirates or pirating firms, both abroad and within the US. The 1980 Amendment of Copyright Law prohibits the unauthorized use of software without the permission of the copyright holder; these acts include reproduction, the creation of adaptations, public distribution, public performance, and display (US Congress, 1990). Furthermore, recent laws have been added regarding the lending of software. There are a number of exceptions to these statutes, the most prevalent and controversial being the doctrine of 'fair use'.

The doctrine of 'fair use' states that the unauthorised reproduction may be excluded from copyright law in very limited circumstances; the primary uses that are not considered infringement include: (1) making one back up copy which must be destroyed when the original license is no

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longer valid, (2) altering a program in order to allow it to function on a special machine, (3) copying a program for the sole purpose of studying the inherent ideas of software production, of which is not copyrighted (US Congress, 1990). The vast majority of software reproduction that currently occurs does not fall into one of these categories; thus, much of the software reproduction that occurs in the home or office may legally constitute software infringement, and may be liable for penalties, of which the maximum fine for the most severe infringers (more than 50 programs within six months) is $100,000 and/or one year imprisonment.

Unfortunately, many consumers are often indifferent to copyright laws, and sometimes view unauthorized reproductions of copyrighted products to be an opportune way of obtaining near-exact replicas for a fraction of the full price. This study concerns software copyright infringement in one major group: the college student. A number of basic findings emerge. Among these, the temptation to infringe is prevalent among college students. In particular, this study finds a significantly higher likelihood of infringement for computer majors and male students, and a decrease in the likelihood of infringement by older students. This study also uncovers differences in attitudes toward risk of apprehension and conviction between majors in scientific fields and those in business and economics. Whereas the first group of majors appears to exhibit risk prone behaviour, the latter tends to be more risk averse. The study proceeds as follows. Section II provides an overview of the extent of IPR infringement on the college campus. In Section III, the econometric method and data are described. Section IV analyses the empirical findings. And finally, Section V concludes the analysis.

## II. INFRINGEMENT AMONG COLLEGE STUDENTS

The college campus is an opportune location to study the extent of IPR infringement among college students. College students possess a number of characteristics that may make them more likely to resort to illegal software reproduction and the purchase of unlicensed products. First, the majority of college courses require the use of computers; therefore, there is a high demand for software among students. Secondly, the average full-time college student possesses a low level of disposable income which rarely allows for the purchase of common software programs, and even more rarely the purchase of specialized software, which may cost hundreds or thousands of dollars. A third factor among college students is present: the knowledge and access to infringe. Whereas an average adult may face difficulty locating the desired software to be copied and may lack the knowledge to break anti-copy devices, the average college student lives in a Mecca of computer users, which includes computer hackers and pirates. Thus the ability to learn illegal reproduction methods is greater while software programs are more available. Finally, the taste for this illegal activity among admitted infringers is reinforced by a perceived low risk of apprehension and conviction, which may be explained either by (i) risk preferrer attitudes, or (ii) high cost of detection, especially at the individual student level.

There are indeed exceptions to these factors. First, many software companies offer student discounts on popular software, which makes the cost issue less influential. Second, the increasingly common use of CD-ROMs, which require the use of costly CD writers to replicate, may make illegal reproduction less practical.[1] Third, most universities are equipped with state-of-the-art computer labs with site licenses on most popular software programs, which can reduce the need to own a computer. And finally, college students may be more knowledgeable of copyright laws and sensitive to the likelihood of conviction and punishment than the average adult, which may act as a deterrent against infringement.

## III. ECONOMETRIC METHOD AND DATA

The net benefit of infringing the copyright of an original work can be modeled as:

$$Y^* = \beta' X + \varepsilon \tag{1}$$

where $Y^*$ is a latent variable measuring the 'propensity to infringe', $\beta$ is the vector of parameters to be estimated, $X$ is the vector of independent variables expected to affect the infringement decision, and $\varepsilon$ is the stochastic disturbance term, which is assumed to be normally distributed with mean zero and constant variance, $\sigma^2$. Although $Y^*$ is not observable, in practice, it can be observed and recorded whether a randomly selected student has in fact infringed an original software item. The outcome of this decision can be defined as a dichotomous variable:

$$\begin{aligned} \text{INFRINGE} &= \text{yes} = 1 \text{ if } Y^* > 0 \\ &= \text{no} = 0 \text{ if } Y^* < 0 \end{aligned} \tag{2}$$

The probability of positive infringement is $1 - F(-X'\beta/\sigma)$, while the probability of no infringement is $F(-X'\beta/\sigma)$,

[1] Another important issue regarding CD-ROMs is the presence of unauthorized mass reproduction by foreign firms: many of these products are offered in black markets throughout the world as well as in the US, at significant savings over the full licensed version.

where $F(.)$ is the cumulative distribution function of the normal distribution. The likelihood function is therefore given by $L(.) = \Pi_{I=1}[1 - F(-X'\beta/\sigma)]\ \Pi_{I=0}[F(-X'\beta/\sigma)]$ which, when maximised by using the standard probit procedure, yields estimates of the $\beta$ coefficients.

### *Data*

Most data available in the area of intellectual property rights are aggregated (e.g., Lee and Mansfield, 1996; Gould and Gruben, 1996). There is very little data relating to IPR at the individual level, such as for college students. This is because micro data are very costly to gather. In addition, they involve specific individual actions of IPR infringement, which may imply asking subjects to admit to a criminal act. The data for this study were obtained by a random sample of college students by an anonymous survey of US college students. In order to avoid a selectivity bias of a particular group, the data were collected in settings where a mixture of different students were present, including non-specialized classes that have a variety of ages and majors present, in dormitory settings that have a fair mixture of upper- and lower-class students, and on four different campuses. The campuses were chosen based on their diversity of region, size, age range, ethnic diversity, and the prevalence of different majors. The first campus is a mid-size public university in the West, which has a moderate level of ethnic diversity, a large number of older students (over age 25), and a fairly wide spread of majors. The second campus is a large public university located in the Midwest which has little ethnic diversity, a fairly young student population, and a specialization in the sciences and in engineering. The third campus is a large public university in the West, which has a very ethnically diverse campus, a wide range of ages and majors. Finally, surveys were conducted at a small private college in the Midwest, with little ethnic diversity and a fair range of ages and majors.

In each campus setting, surveys were conducted by a third party, one who is trusted by the surveyees. Despite the pledge of anonymity, trust is important given the private nature of the questions asked. The response rate for this study varied according to how the survey was conducted in each setting. For example, at the large public university in the Midwest, each resident (40) of one representative dorm floor was given a survey from the floor counselor. The purpose of the survey was explained, and each surveyee was asked to return their responses to a designated envelope. The response rate was 36/40 (90%); it is likely that the close relationship between the counselor and residents resulted in the high level of quality responses. A similar procedure of collecting responses was undertaken at the two public universities in the West, except there the setting was non-specialized academic classes. In each case either the instructor or a selected student distributed and collected the surveys. Because class time was used for this purpose, the response rate was near 100%. Finally, in the case of the small private college, this study found that given the regimented curriculum and on-campus residence restrictions, it was not possible to locate a suffciently diverse class nor residence hall. Therefore, surveys were conducted by direct contact at the student union. Because of the familiarity of students at this college, cooperation was not difficult, and 40 responses were collected.

The main question was a blunt yet clear inquiry as to whether the respondent owned any unlicensed software programs. In addition, each respondent was asked whether cost was a factor in the infringement decision, whether they work, whether they were familiar with copyright laws and penalties, and whether they perceived being caught. Finally, the survey data was supplemented with information about personal profiles of each respondent. The overall sample consisted of 148 computer owners as well as non-computer owners, having a variety of backgrounds and majors. The appendix at the end of the paper reports the exact wording of the questions used.

### *Statistical summary*

Table 1 provides the definition and summary statistics of the variables expected to affect the infringement decision. The explanatory variables employed and their *a priori* effects on the likelihood of infringement are as follows.

*Major*. Three explanatory variables were used to capture the effect of major: computer-related majors (COMP), science and engineering-related majors (SCIENGIN), and business and economics-related majors (BUSECON). These variables represented 10.2%, 32.6%, and 14.3% of the sample, respectively. Overall, these groups of majors represented 57.1% of the sample , while the remaining students were scattered among other majors. Indeed, the variety of software used by these three majors is likely to be greater compared to less-technical majors, which may result in a greater incidence of infringement. Hence, the coefficients on COMP, SCIENGIN, and BUSECON should be positive.

*Law*. To account for specifc deterrent effects, the factor 'familiarity with software copyrights law' is considered. LAW is a dummy variable equaling 0 if one claims to be unfamiliar with copyright law and penalties, and 1, otherwise; 47.3% of the sampled students claim to be aware of software copyright law. It is expected that this variable will negatively impact the likelihood of infringement.

*Gender*. A binary variable was employed, equaling 1 for male student and 0 for female student; overall, 64.9% of the sampled students were males, while 35.1% were females.

Table 1. *Variables description, expected signs and descriptive statistics*

| Variables (expected signs) | Definition | Mean (standard deviation) |
|---|---|---|
| *Dependent variable* | | |
| INFRINGE | =1 if have infringed | 0.512 (0.501) |
| *Independent variables* | | |
| LAW (−) | =1 if familiar with software copyright law | 0.473 (0.367) |
| MALE (+) | =1 if male | 0.649 (0.429) |
| WHITE (?) | =1 if Caucasian | 0.752 (0.520) |
| ASIAN (?) | =1 if Asian/Asian-American | 0.112 (0.216) |
| COMP (+) | =1 if computer-related major | 0.102 (0.197) |
| SCIENGIN (+) | =1 if (science/engineering)-related major | 0.326 (0.351) |
| BUSECON (+) | =1 if (business/economics)-related major | 0.143 (0.201) |
| UNDER20 (−) | =1 if age 19 and under | 0.601 (0.365) |
| OVER22 (−) | =1 if age 23 and over | 0.071 (0.031) |
| SCIUNDER20 (−) | =1 if SCIENGIN and UNDER20 | 0.246 (0.313) |
| SCIOVER22 (+) | =1 if SCIENGIN and OVERR22 | 0.016 (0.292) |
| WHITEUNDER20 (−) | =1 if WHITE and UNDER20 | 0.498 (0.411) |

Empirical work (e.g, Blumstein, 1995; Freeman, 1996) accord with demographic trends (e.g., Bureau of Justice Statistics, 1995) about the high incidence of crimes perpetrated by many young men. Hence we will expect the coefficient of gender to be positive.

*Ethnicity*. The variable ethnicity was used to capture the impact of two highly visible ethnic groups on campus: Caucasians (WHITE) and Asians (ASIAN) which represented 75.2% and 11.2% of the sample, respectively. Owing to the lack of sufficient observations from other ethnic groups, it was not feasible to add further ethnic variables. But a look into the ethnic mix of a typical American campus indicates that the sample is a fairly good representation of the ethnic composition. Serious methodological issues arise with these variables, however, which makes the direction of their effect ambiguous. For instance, there is a difference between Asian- Americans and Asians from Asia, as well as differences between Caucasians from the US and those from Europe. Furthermore, the presence of cross-ethnicities and ethnic subgroups adds to the difficulty of characterizing the various groups into specific categories. For simplicity, this study assumed that each ethnic group acted similarly despite different backgrounds.

*Age*. The effect of age was captured by grouping students in two categories. Those under 20 (UNDER2O) and those 23 or over (OVER22). The ages were divided in this manner because the majority of students under 20 (60.1% of the sample) are in their first or second year of college, and those 23 and over (7.1%) are generally graduate students or older undergraduates. Overall, the age distribution of the sample is fairly representative of a typical campus in which the majority of students entered immediately after high school. This study hypothesized that there is a difference in computer usage, and therefore software infringement, between lower-classmen (UNDER2O), upper-classmen, and older students (OVER22). This study expects the coefficients of both variables to be negative. When students first enter college, they generally enroll in core classes, which do not require the use of technical and specialized software programs. These students are more likely to use mainstream programs such as word processing; since many of these programs are fully licensed and pre-installed when a computer is purchased, illegal reproduction is thus not necessary. In addition, new students often have not been exposed to the various means of software infringement, which may be acquired as one interacts with peers who are more knowledgeable of such techniques. Once students have been in college for a year or so, however, they may begin to enroll in courses requiring a greater use of specialized software. It is expected that this is when students are most likely to infringe on copyrights because of their need for software, their knowledge and access to unauthorized software, and a peaking burden of debt. Likewise, this study expects a decrease in the likelihood of infringement among older students. They are likely more aware of IPR laws and have higher levels of income, making the price of software less problematic to them.

*Interaction variables*. The interaction of age with ethnicity and major variables is considered. Because the variable WHITE consisted of a large portion of the sample, an interaction variable WHITEUNDER2O was added to separate younger and older Caucasian students. The sign of WHITEUNDER2O is expected to be negative, the direction of the sign being largely influenced by the age variable, UNDER2O. Moreover, the variables SCIUNDER2O and SCIOVER22 were used as proxies to explain the relationship between the types of software used by science and engineering majors and their class standing. It is hypothesized that because science and engineering students under 20 do not usually need sophisticated software, the sign of SCIUNDER2O will be negative. On the other hand, advanced students (SCIOVER22) are likely to devote the bulk of their studies to technical work, which may require the use of specialized software and hence increase the incidence of infringement. The direction of the effect in this case will therefore be positive.

Before discussing the empirical results, a word of caution is in order about potential sources of bias due to omission of such conventional variables as price or income. Indeed, price was initially measured in our survey as a binary variable, equaling 1 whenever cost was an important factor in the infringement decision. The omission of this variable was justified, however, on the grounds that all respondents perceived cost as very important. Moreover, to account for the effect of income on the infringement decision, students were asked if they work. Interestingly, their responses were mainly dependent on age: Older students (OVER22) indicated that they work, while the younger students (UNDER2O) responded to the contrary. Hence, age is as well indicative of income.

## IV. EMPIRICAL RESULTS

This study provides two types of evidence that highlight the extent of software copyright infringement among college students. This paper begins by presenting probit models that analyse factors affecting the infringement decision, then turns to regression models with a selectivity correction term to provide insights into students' attitudes with regard to IPR laws and risk of apprehension and conviction.

### *Determinants of infringement behaviour*

Table 2 contains probit estimates of the determinants of software infringement which are insensitive to alternative specifications. The signs of the coefficient estimates are in accord with expectation and values of the log-likelihood ratio suggest that the included explanatory variables are significantly related at any conventional level to the infringement decision.

With regard to variables grouped under 'major', the results indicate that computer-related majors are more likely to infringe on software. This is reasonable since these students are generally the most knowledgeable about computer programming. The sign for SCIENGIN is positive but the low *t*-ratio is contrary to intuition, given the high demand for computers by students majoring in science and engineering fields. The lack of effect may be explained by the presence of interaction terms that would control for the different types of software used by science and engineering students. Moreover, the positive but insignificant coefficient of BUSECON may (though weakly) infer that, like other majors, business and economics students are likely to use more unauthorized software than other non-computer majors.

Moreover, the coefficient of the LAW variable is negative but significant only in Equation IV – the full model that contains all the explanatory variables. The lack of information on institutional settings and particularly on how law has actually been enforced in any of the four campuses is a drawback, which may perhaps justify the weak impact of LAW on infringement behaviour.

The result for gender clearly shows a significantly higher likelihood of infringement by males. This finding is consistent with existing literature on crimes where males in general tend to commit crimes with greater probability than females. Such criminal behaviour seems to extend into copyright infringement.

For ethnicity, the coefficients for both Asians and Caucasians are positive but insignificant. The negative coefficient of the interaction term WHITEUNDER2O may indicate that lower-division Caucasians are less likely to infringe. Because the sample was not large enough to adequately test for Asians under 20 as well as other ethnicities, it is difficult to infer behavioural differences across ethnic groups in infringement offenses.

Table 2. *Probit estimates of the determinants of software copyright infringement*

| | I | II | III | IV |
|---|---|---|---|---|
| Constant | −0.625* | −0.624*** | −0.235* | −0.557** |
| | (1.760) | (2.981) | (1.862) | (1.9931) |
| MAJOR | | | | |
| COMP | 0.749* | 0.767* | 0.906* | 0.883* |
| | (1.745) | (1.792) | (1.789) | (1.713) |
| SCIENGIN | 0.325 | 0.304 | 0.295 | 0.151 |
| | (1.182) | (1.116) | (1.036) | (1.254) |
| BUSECON | 0.024 | 0.068 | 0.007 | 0.041 |
| | (1.456) | (1.547) | (1.243) | (1.498) |
| DETERRENT EFFECTS | | | | |
| LAW | −0.012 | −0.010 | −0.023 | −0.021* |
| | (1.476) | (1.056) | (1.556) | (1.8751) |
| GENDER | | | | |
| MALE | 1.021*** | 1.018*** | 1.056*** | 1.094*** |
| | (3.904) | (3.927) | (3.988) | (4.016) |
| ETHNICITY | | | | |
| WHITE | 0.009 | | 0.269 | 0.202 |
| | (1.245) | | (1.563) | (1.356) |
| ASIAN | 0.210 | | 0.088 | 0.273 |
| | (1.433) | | (1.098) | (1.545) |
| AGE | | | | |
| UNDER20 | | | −0.375 | −0.224 |
| | | | (0.903) | (0.039) |
| OVER22 | | | −0.899 | −0.954* |
| | | | (1.629) | (1.791) |
| INTERACTION EFFECTS | | | | |
| SCIUNDER20 | | | | −0.732* |
| | | | | (1.819) |
| SCIOVER22 | | | | 0.610* |
| | | | | (1.783) |
| WHITEUNDER20 | | | | −0.432 |
| | | | | (0.676) |
| Log-likelihood | −87.37 | −95.53 | −80.86 | −75.67 |
| Number of observations | 148 | 148 | 148 | 148 |

*Note*: Absolute *t*-values are in parentheses below each individual coefficient. (*), (**) and (***) indicate statistical significance at the 0.1, 0.05 and 0.01 levels, respectively.

Finally, the signs of the coefficients of the age variables are as expected. Both variables, UNDER2O and OVER22, negatively affect infringement activity; and older students are significantly less inclined to infringe.[2] By contrast, the conflicting signs of the interaction variables, SCIUNDER2O and SCIOVER22, may at least infer for science and engineering majors that their standing does matter. Whereas under-classmen are less likely to infringe, there is a high incidence of infringement among older science and engineering students.

### *Risk perception*

To account for specific deterrent effects on infringement behaviour, factors such as ‘familiarity with software copyright law’ (LAW) and ‘perception of risk of apprehension and conviction’ (RISK) are considered simultaneously. The RISK variable is defined as an index ranging from 1 to 6, with 1 representing ‘virtually no chance’ of being caught and 6 being conviction with ‘certainty’, Table 3 shows the distribution of surveyees with respect to risk for the full sample and the sample of infringers, respectively. The sum-

[2] The age variable is also likely to confound the influence of duration at a university with work experience and student type (traditional *v.* part-time). Students who are professionally employed may be less inclined to violate IPR law because they are better informed, risk of detection may be higher on company machines than on personal machines, employment consequences are more severe, and such non-traditional students may have more limited access to informal campus networks.

Table 3. *Distribution of respondents with respect to risk of apprehension and conviction*

| | Full sample | Infringers |
|---|---|---|
| Virtually no chance (=1) | 0.234 | 0.263 |
| Very unlikely (=2) | 0.217 | 0.232 |
| Maybe, but unlikely (=3) | 0.123 | 0.179 |
| Quite probable (=4) | 0.138 | 0.128 |
| Maybe someday (=5) | 0.172 | 0.118 |
| Conviction with certainty (=6) | 0.116 | 0.080 |
| Sample size | 148 | 76 |

mary results clearly show the tendency for sampled students and particularly for admitted infringers to downplay the risk of conviction.[3] Moreover, since 18 respondents or about 12.2% of the sample size did not provide information on risk perception, this study addresses the possibility of sample selection bias by using the two-step estimation procedure described by Heckman (1976) and Greene (1997) and implemented in Maddala (1983) and Viscusi (1995).[4] Accounting for risk, Equations 1 and 2 can be rewritten as:

$$\text{INFRINGE} = \beta' X + \alpha \text{ RISK} + u \qquad (3)$$

where $X$ is defined as before and $u$ is the random error term. On the other hand, the RISK equation treats the potential for selectivity bias by including LAMBDA, the inverse of Mill's ratio as well as the INFRINGE variable. Risk perception is therefore specified as:

$$\text{RISK} = \beta' X + \gamma \text{ INFRINGE} + \eta \text{ LAMBDA} + v \qquad (4)$$

Following Maddala (1983) and Viscusi (1995), the estimation of the simultaneous Equations 3 and 4 entails forming the reduced form equivalents of INFRINGE and RISK. In the first estimation procedure, this study obtains probit maximum likelihood estimates of Equation 3. In the second step, this study estimates Equation 4 using OLS, contingent on the infringement decision in the first step and also on LAMBDA, derived from the first step regression and used as an additional exogenous variable in the RISK equation. The results are reported in Table 4 by considering a subset of the vector $X$ of explanatory variables for parsimony reasons.

As expected, the knowledge of copyright laws heightens the perceived risk of being caught. This implies that those who are familiar with copyright laws feel they are more at risk of being caught than someone who is ignorant of the laws. Further, findings regarding the other explanatory variables corroborate those of Table 2 (and column 1 of Table 4). For instance, whereas the variable MALE is positively correlated with the likelihood of infringement, in Table 4 this variable is associated with a perceived low risk of apprehension and conviction. While age (UNDER2O, OVER22) negatively impacts the infringement decision, this age-group, nonetheless, perceives little chance of being apprehended and convicted. Meanwhile, the coeffcient of the selectivity bias term, LAMBDA, is positive but statistically insignificant, indicating a weak effect of non-respondents on perceived risk. Turning to the 'major' variables, a difference in behaviour between majors in scientific fields and those in business and economics is noted. This is clearly illustrated when the two scientific (fields) variables COMP and SCIENGIN are combined to create a SCIENCE variable. Whereas for both BUSECON and SCIENCE majors there exists a genuine propensity to infringe, the two groups of majors display different attitudes toward risk of apprehension and conviction. The coefficient of BUSECON is positive and insignificant, while that of SCIENCE is negative and statistically significant. This difference in risk perception is further uncovered by contrasting the frequency distribution of the two groups of majors with respect to the risk of apprehension and conviction. Figure 1 indicates that more than half of science majors downplay the risk of being caught, as compared to a quarter of business and economics majors. Likewise, turning to the other tail of the distribution, it can be seen that, whereas a third of business and economics majors perceive a high likelihood of being caught, only one tenth of their counterparts in science indicate such a possibility. A straightforward justification is that, compared to scientific fields, business and economics

[3] By primarily emphasizing the effects of LAW and RISK and their interaction on the infringement decision, the probit model yields the following results:

$$\text{Infringe} = -0.956 - 0.026 \text{ LAW} - 0.006 \text{ RISK} - 0.465 \text{ LAW*RISK}$$
$$(1.345) \quad (1.623) \quad (1.432) \qquad (1.9465)^{**}$$
$$\text{Log-likelihood} = -102.4$$

Hence, as expected the knowledge of copyright laws and the perceived chance of being caught contribute to reduce the likelihood of infringement. The negative effect of the variables LAW and RISK is further pronounced and significant when the two variables are interacted.

[4] The characteristics on non-respondents were in every respect similar to those who provided information on risk perception. This, according to a referee may perhaps lead one to think either that (i) the non-respondents did not understand the question regarding risk perception or that (ii) they found the survey too time consuming. The second point is unlikely given the brievity of the survey questionnaires in the appendix.

Table 4. *Two-stage Heckman estimates*

| | Probit ML results (Likelihood of infringement) | OLS estimates results adjusted for sample selection (Perceived risk) |
|---|---|---|
| Constant | −0.817* | 0.332** |
| | (1.789) | (2.028) |
| LAW | −0.012* | 0.030* |
| | (1.706) | (1.812) |
| INFRINGE | | −0.317* |
| | | (1.819) |
| RISK | −0.019 | |
| | (1.345) | |
| SCIENCE | 0.655* | −0.824* |
| | (1.902) | (2.112) |
| BUSECON | 0.119 | 0.433 |
| | (1.564) | (1.456) |
| MALE | 1.676*** | −1.102*** |
| | (2.392) | (2.451) |
| UNDER20 | −0.198 | −0.345* |
| | (1.607) | (1.712) |
| OVER22 | −0.531* | −0.745** |
| | (1.775) | (1.905) |
| LAMBDA (Selectivity bias term) | | 0.0021 |
| | | (1.203) |
| Log-likelihood | −77.98 | |
| $R^2$-adjusted | | 0.17 |

*Note*: See Table 2.

majors (and in fact, non-scientifc majors in general) are less knowledgeable about computer programming. As such, they are less inclined to challenge cleverly designed anti-copy devices. An important but subtle justification deserves further consideration. Although speculative, yet tempting, we argue that this difference in attitude is intrinsically rooted in the foundation of these two fields of study. Scientific fields epitomize inquisitive minds with daring and can-do attitudes, a trait that may well explain the 'reckless' attitude toward infringement opportunities (this is the hacker mentality of being too clever to be caught). On the other hand, business and economics fields focus on rational behaviour in response to opportunity. An attitude that amounts to weighing the benefits accruing from IPR infringement activity against the costs of conviction and punishment, which presumably make business and economics majors more cautious, creating an aversion to risk.[5]

## V. CONCLUSIONS

The study offers a cursory view into the extent of software infringement among college students and attitudes of these students with regard to risk of apprehension and conviction. Our findings provide evidence that students do engage in this illegal activity. In particular, it is found that male and computer majors tend to show a strong propensity to infringe on software, while older students are less likely to infringe. The results also indicate (though weakly) that Caucasian, Asian, science and engineering majors, and business and economics majors are more likely to use unauthorized software. By contrast, the age variable has a negative incidence on infringement decisions. Furthermore, a high correlation is found between infringement and attitude toward risk of apprehension and conviction. For instance, admitted infringers such as males and science majors are also likely to minimize the risk of being

[5] Aversion to risk by business and economics majors is consistent with criminals' risks attitudes such as those described by Neilson and Winter (1997), in which it is changes in (perceived) certainty of apprehension and conviction rather than the severity of punishment that explains risk aversion behaviour.

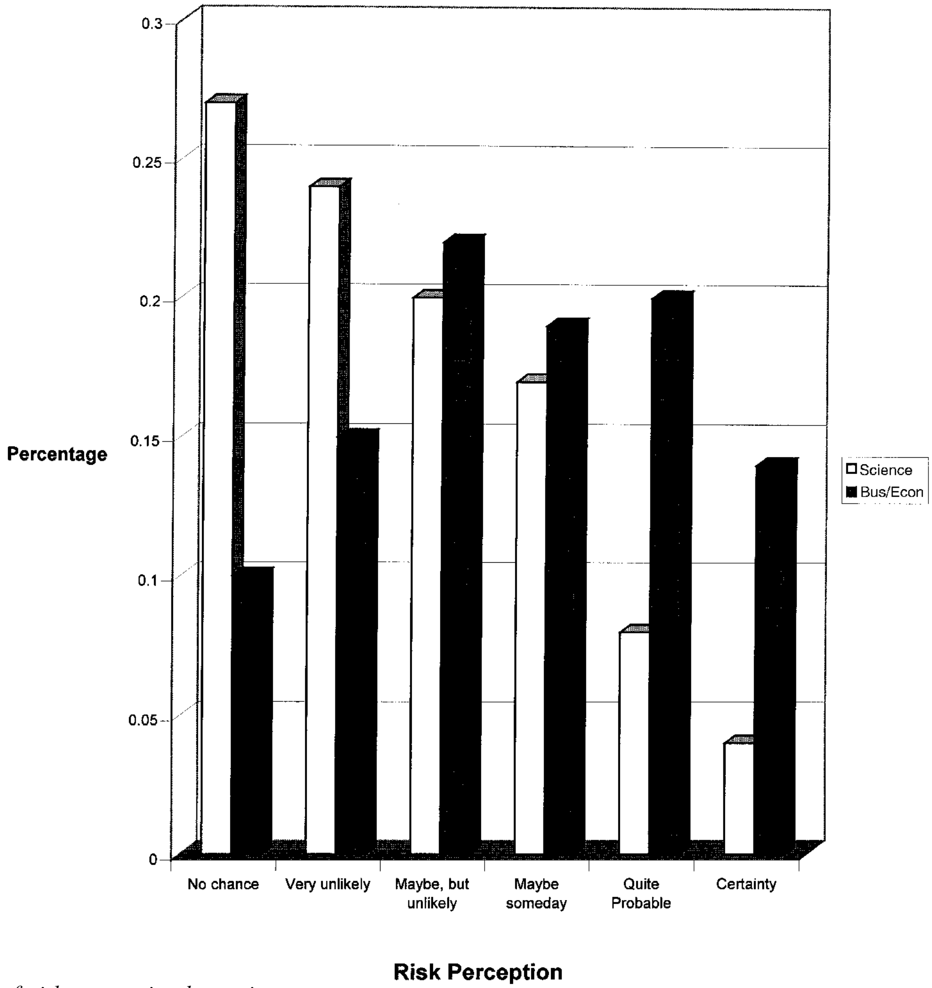


Fig. 1. *Distribution of risk perception by majors*

caught. An interesting result in this setting is that because of their underlying values, scientific majors and business and economics majors tend to show divergent attitudes toward risk. Whereas the former appears to exhibit a risky behaviour, the latter tends to be more risk averse. This analysis, however, must be regarded as highly tentative given the limitations inherent in using survey data. Further economic modeling is therefore needed to provide insight into unauthorised reproduction of copyrighted software products.

The protection of IPR is vital to the continued development of technology and innovation, which leads to economic growth. Infringement in IPR restricts innovators from receiving full compensation for their contributions, and acts as a disincentive to innovate. For the college student, the temptation to infringe is still prevalent, which suggests that new approaches to enforcement must be taken in order to minimize its occurrence, such as increased warnings and more IPR prosecutions in order to raise student awareness and perception of the risks of owning unlicensed intellectual property.

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## APPENDIX A: 2 MINUTE QUESTIONAIRE ON SOFTWARE USAGE

*Please do not write your name. All answers are confidential.*

1. Do you use a computer on a regular basis? Yes ____ No ____

2. Do you currently own a personal computer? Yes ____ No ____

3. Do you own any software that is not licensed to you? Yes ____ No ____
   (this includes any software you may have copied from friends, borrowed from family members using a different computer than yours, purchased from any unauthorized dealer, and so forth)

   If you answered No to question 3, please proceed to question 7.

4. Which of the following categories of software do you own unlicensed copies?

   word processing ______ spreadsheet/database ______ technical/statistical ______

   graphics/presentation design ______ games ______

5. Is "cost" the main reason that you own unlicensed software? Yes ____ No ____

6. Do you feel you will ever be caught and punished for using unlicensed software?
   Virtually no chance ______ Very unlikely ______
   Maybe, but unlikely ______ Maybe someday ______
   It's quite probable ______ I think I will be caught ______

7. Are you aware of the current law & penalties regarding unlicensed software?
   Yes, I known it very well ____
   Somewhat familiar ____
   No, I don't know _____

**Your profile:**
Age: ______ Gender: F ______ M ______ Ethnic background ______________________ _

The name of your university _____________________ _ Your Major _________________________ _

Are you a: freshman ______ sophomore ______ junior ______ senior ______ grad student ______

Do you: live on campus ______ live off campus ______ currently work ______

*Thanks again for your time. Please return completed surveys to the designated return box.*