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SOFTWARE PIRACY: AN EMPIRICAL EXAMINATION OF THE IMPACT OF NETWORK EXTERNALITIES AND OPEN SOURCE ALTERNATIVES ON WILLINGNESS TO PAY

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Abstract

Software piracy continues to threaten the profitability of the software development industry. Software publishers have employed both preventive and deterrent controls and made small gains in protecting intellectual property rights. Although deterrent measures are believed to have a positive affect on profits, preventive controls are reported to have a negative affect as the cost of engagement offsets company profits. Commercial software developers are aggressively seeking economical methods of control to prevent piracy through extensive licensing agreements, further elimination of physical distribution networks, and the use of encryption-based software protection systems. However, recent encryption-based efforts have received negative responses from consumers. With the tightening of controls, more users are turning to other alternatives, posing a secondary threat to company profits. In this paper we study the impact of network externalities and the availability of open source software on the commercial software market when extensive piracy controls are in place. We use experimental closed-end contingent valuation to explore how the value of commercial software is impacted by piracy controls and competing software availability. In the complete design, we conduct a 2x2x2 experiment and use survey methods to elicit consumer preferences in determining how much students would be willing to pay (WTP) for commercial software under the following conditions: 1) high and low levels of network externalities, 2) the absence or presence of piracy controls, and 3) when comparable open source software is available. Preliminary results to pretest the survey instrument and experiment are included in this paper.

Keywords: Software piracy; intellectual property; open source software, willingness to pay, network externalities, contingent valuation

Introduction

Software piracy continues to present a significant threat to the commercial software industry. The Internet has provided a thriving venue for many forms of piracy, creating an international dilemma for commercial software vendors. Without a physical distribution network, the Internet facilitates piracy by significantly reducing the costs and risks of physical transportation (Burk 1995). According to the 1999 Global Software Piracy report issued by the Business Software Alliance (BSA), a trade group that tracks software piracy rates around the world, one out of three programs used in 1999 was an illegal copy. Although piracy rates are believed to have decreased, total loss continues to increase as software sales and consumption increases. Recent statistics developed by BSA and the SIIA (Software Information Industry Association) report losses of over $11 billion to illegal software use in 2001 (InfoWorld 2002).

Two measures have typically been employed to combat piracy. Preventive controls such as unique software license keys are used to prevent unauthorized access. Deterrent controls communicate the legal ramifications of piracy to deter criminal activity. Extensive research has been conducted on deterrent strategies based on deterrence theory (Gopal and Sanders 1997, 1998). In the Gopal and Sanders study, deterrent controls are found to potentially increase profits while preventive controls, due to the costs associated with implementing control technology, offset or decrease profits.

Another control measure has possibly emerged from within the software community. The use of open source software presents a natural control for software piracy. Open source refers to an industry of shared software most of which is free for use or modification. As stated by Dan Kusnetzky, vice president of systems research at IDC:

> *"With open source [piracy] is not an issue at all. Under most of the recognized open source software licenses, it is perfectly acceptable to purchase a single copy of software and install it on any number of machines, or simply download it for free off the Internet." (InfoWorld 2002)*

Open source applications are being used extensively outside the United States and have been identified as potential drivers for cost savings. Although not all open source software is free, costs are usually less than those of comparable commercial software applications. Users are also not required to pay annual license fees or royalties. Commercial or proprietary software typically require the payment of license fees to protect the intellectual property rights of the developer. As licensing fees increase, commercial software prices increase accordingly.

Due to this cost factor, the use of open-source software is growing. Government use of open source software within and outside the United States has increased substantially, particularly by those interested in the cost savings associated with open source applications. This trend presents opportunities and threats to the software industry. First, the use of open source software could stem software piracy. In some areas, software piracy rates are as high as 60 percent. As a result, members of Congress have proposed a bill that would require government agencies to use open source software whenever possible. One of the reasons cited for the proposed legislation is to cut down on software piracy.

A second issue presents an immediate downside for commercial software developers. The recent use of tighter piracy prevention controls, e.g. online registration and activation requirements, copy protection software or "spyware", etc. coupled with increased costs for commercial software has motivated consumers to seek software alternatives. The response from consumers to TurboTax's decision to include copy protection features in their 2002 version of tax software has been negative, expressing quality concerns and loss of customer confidence. Consumer reviews report the following comments:

> *"This has got to be the worst experience ever! The software is only allowed to be used from one machine; you cannot install and print on another. On top of that, this software has spyware (CDILLA)[1] that installs onto your system, which runs all the time!! ...I cannot copy CDs anymore; the spyware gets installed on a section of the hard drive that could make your pc unstable!"*

> *"TurboTax has performed well in the past, but this year it has failed to perform at an acceptable level. The new TurboTax requires online activation. It also tries to limit software sharing and in doing so makes file storage, back-up and retrieval difficult. I have been unable to re-open my work because of these protections and have had to start completely over on a long return. TurboTax also seems a bit less user-friendly this year. I have had to abandon TurboTax because of these problems and am now using TaxCut instead."*

> *"Tax Cut has been an easy transition and they have no activation/spyware programs that stay active. I strongly concur with the many negative comments from other experienced TurboTax users. Mossberg (Wall Street Journal (1/30/03)) hates what Intuit did to TurboTax! And you will too. Don't buy it. Send a message to the software industry that such outrageous "big brother" business practices are absolutely unacceptable."*

We are interested in the effect of piracy prevention efforts on profitability in the commercial software industry. In this paper, we employ experiments using contingent valuation to study the impact of network externalities and the availability of open source software alternatives on willingness to pay for commercial software under high and low levels of piracy control. The remainder

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[1] Ç-Dilla (renamed Macrovision Europe) is a development company specializing in content protection, marketing tools and secure transactions for digital products. This includes copy protection for CD-ROM and DVD products and the secure distribution of data products and software applications from Web sites.

of this paper is organized as follows: section 2 develops the hypotheses and discusses contributions made by this research; section 3 presents the research design and data collection method; section 4 provides the analysis and preliminary findings. Concluding remarks and plans for future research are presented in section 5.

Hypothesis Development

Software piracy has been analyzed extensively in behavioral and economic research. Behavioral studies have focused on the social and ethical aspects of software piracy (Glass and Wood 1996; Harrington 1989). Other studies have attempted to define the nature and behavioral patterns of the software pirate (Gopal and Sanders 1997; Solomon and O'Brien 1991). An organizational study by Banerjee et al (1998) suggests that ethical context is the most important variable explaining ethical behaviors for IS employees. Further findings support a positive relationship between ethical behavior intentions, individual beliefs, and the corporate ethical environment. A recent study by Wagner and Sanders (2001) support these findings, suggesting that an individual's ethical and moral dispositions may indicate their likelihood to pirate software.

Economic research has taken a complementary focus using theoretical models to evaluate software piracy and consumer purchase decisions (Chen, Sims, and Teegen 1997). Research indicates that a consumer's final decision to purchase software depends on three factors: 1) the cost of pirating software; 2) the price of the software, and 3) the individual's reservation price. A purchase decision will be made only if the price of the software is the smallest of the three variables. The purchase decision can be represented as shown in Figure 1:
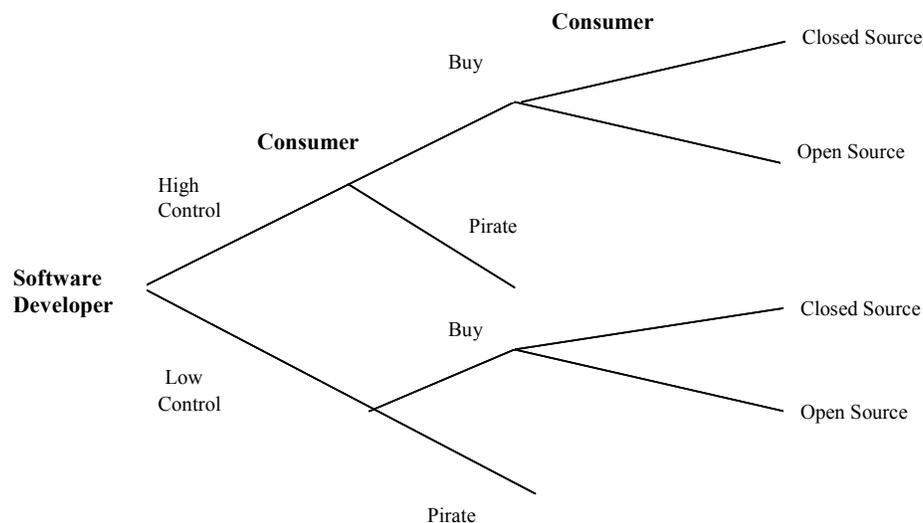

Figure 1. Consumer Purchase Decision

In environments with low levels of piracy control, consumers are faced with the choice of purchasing or pirating software. In purchasing software, consumers can choose between commercial (closed source) applications or open source software. In environments with high levels of piracy control, consumers face the same choice but with higher costs associated with engaging in piracy. Alternatively, the consumer could choose neither to purchase nor pirate software. Considering the increasing need for software applications and industry efforts to incorporate higher levels of piracy control, we anticipate more buyers willing to pay for software. Considering the availability of open source applications, we ask: *What is the effect of piracy controls on a consumer's willingness to pay for commercial software applications given an open source software alternative?*

From this position, we develop the following hypotheses:

> **H1**: Piracy prevention controls may increase consumers willingness to pay for software.
> **H2**: Consumers' willingness to use open source alternatives is affected by piracy prevention controls in the commercial software industry.

H3: Piracy prevention controls may increase consumers willingness to use open source alternatives even though externality implications (learning capability, application availability) say otherwise.

We would test for the following effects:

1) Adding preventive controls in the presence of (low, high) externalities and in the presence of open source alternatives has (XX) effect.
2) For a product with (low, high) externalities, adding (low, high) preventive controls lead to higher affinity towards (closed, open source software).

In this phase of the study, we pre-test the survey instrument and run trial experiments to establish reliable and valid measurement and experimental procedures for the complete study.

Contribution

Few empirical studies in Information Systems (IS) have addressed the relationship between piracy and willingness to pay (WTP). Most WTP research has been performed from a marketing perspective using behavioral research methods that focus on the nature and attitudes towards willingness to pay for public goods (Wertenbroch and Skiera 2002; Soloman and O'Brien 1991). Although conventional wisdom suggests that piracy reduces profit for software developers, studies have shown that a reasonable level of piracy actually promotes software sharing and development, thus increasing firm profits (Osorio 2002). Slive and Bernhardt (1998) support this position by presenting limited piracy as a form of price discrimination. Their work suggests that software developers may maximize profit by tolerating piracy to home consumers, most of whom have a low willingness to pay.

Lack of prior research in this area supports the need to further evaluate the issues around software piracy. In this study, we empirically investigate how various environments (network externalities, purchase alternatives, and control levels) impact the economic relationship between software piracy and software publisher profits. This paper contributes to academic research by empirically investigating willingness to pay for commercial software in an open source software environment under high and low levels of piracy control. Practitioners can also benefit from this study with a better understanding of the impact of increased piracy control levels on firm profitability.

Methodology

Research techniques differ for measuring consumers' willingness to pay. Contingent valuation (CV) is one of the most frequently used methods for measuring and analyzing the value of public or reproducible goods (Wertenbroch and Skiera 2002). Although conjoint analysis techniques have been employed in marketing to model consumer purchase behavior, results are often whimsical which questions the reliability of the method (McCullough 2002; Sapede and Girod 2002). Contingent valuation uses survey methods to elicit consumer preferences by finding how much individuals are willing to pay for specified changes in levels of provision of a good. One concern with this approach is that external validity may be limited in that it provides little incentive to consumers to truthfully reveal their willingness to pay because responses are hypothetical. Response incentive effects can occur when surveys prompt respondents to make inferences about the value of a good. A recommended solution is to cross-validate results using a variety of WTP measurement procedures. Becker, DeGroot, and Marschak (1964) present a procedure for using lotteries that yield lower WTP estimates than contingent valuation methods alone. In the full deployment of this study, results will be validated by administering a second survey that will use lottery methods to determine the true willingness to pay of each participant.

In this study, a closed-ended (dichotomous choice) contingent valuation method is used that requires respondents to state their WTP for commercial software given repeated choices of whether the participant would buy the good at a given price. Figure 2 illustrates this procedure:

"Given the availability of Star Office, how much would you be willing to pay for Microsoft Office if the market price is $180?"

½ Price?

No (47%)	Yes (53%)
¼ Price?	¾ Price?

No (72%)	Yes (28%)	No (35%)	Yes (65%)
Anything?	Done	Done	Max WTP?
			$188 avg.

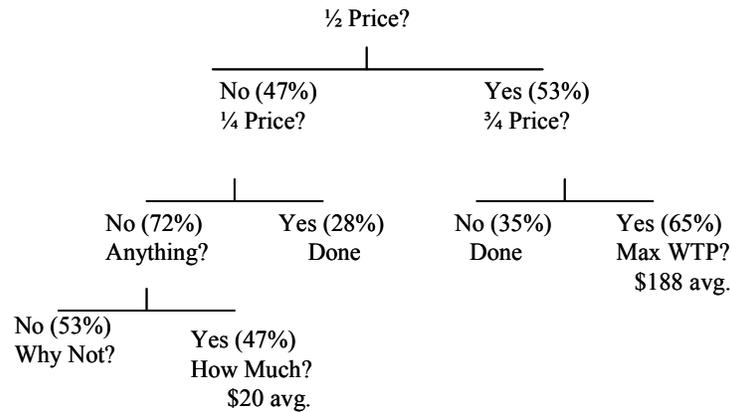|	
No (53%)	Yes (47%)
Why Not?	How Much?
	$20 avg.

Figure 2. Flow of Dichotomous Choice Procedure

The figure includes actual results from the pretest experiment. Percentages and prices will be discussed in the preliminary results section of this paper.

Survey data collected from experimental methods used in contingent valuation have typically been analyzed using the Multinomial Logit model (Haaijer et al 1998). However, problems have been associated with the standard MNL model due to assumptions that the error terms are independent across alternatives. The Multinomial Probit model (MNP) alleviates this assumption. We propose using the MNP model to empirically analyze consumer preferences regarding willingness to pay for commercial (closed source) software in the presence of piracy controls and open source alternatives. In the following sections we discuss the experiment designed for this study and preliminary results from the survey.

Data Collection

Given the issues defined above, we collect data in four areas: 1) perceived compatibility in user interface and data interchange, 2) user sophistication in terms of computer experience, 3) demographic data and other information to control for intrinsic affects, and 4) willingness to pay responses. A four-part survey instrument was developed to assess degrees of externality and to determine an individual's willingness to pay for a closed source product such as Microsoft Office. Survey questions were designed to capture degrees of externality, sophistication of user (computer experience), demographic information, and overall perceptions about piracy and the administration of the survey. The network externality construct was evaluated based on levels of user interface and data interchange between the open source and closed source applications. We ask questions to determine specific levels of usability, interface, interchange, and bias.

The data used in this study was collected from a population of seventy-five undergraduate and graduate students. Participants were told to assume they are in the market to purchase a new computer. Participants have two choices: purchase a computer with pre-installed open source software at one price; or, purchase the same computer pre-installed with Microsoft Office at a higher price. In this phase of the experiment, participants were warned that extensive piracy controls are in place. They would not be able to use previously acquired software or obtain copies from any other source. Participants were then instructed to watch a video developed for this study that compares Microsoft Office with Star Office—an open source alternative. The video focuses specifically on the document generation and editing features of Microsoft Word and OpenOffice Writer. After viewing the video, participants were asked to respond to the on-line survey.

Experimental Design

The proposed experiment involves a 2x2x2 design. Two variables are used to measure externality levels. The first variable—user interface—is varied at two levels and manipulated on a between subjects basis. Participants in the study are provided with a description of user interface (what is seen in each application and the keystrokes used for each task) and a keystroke comparison

chart. The second variable—data interchange—is also varied at two levels and manipulated on a between subjects basis. Participants are again provided with a description of data interchange (how well documents transfer between applications). In the full experiment, piracy control and open source availability are both evaluated as independent variables at two levels (high, low/presence, absence).

For the dependent variable, we ask participants to evaluate their willingness to pay for the commercial application. Prices are presented as a dichotomous choice, incrementing above and below the selling price and beginning at different levels in each survey.

Preliminary Results of Data Collected

User Sophistication

We were able to characterize a typical respondent as an individual with 7 to 10 years computer experience, 5 to 10 years using a word processing application, 5 to 7 years familiarity with Microsoft Word. Although the typical respondent used a computer 16 to 20 hours per week, most did not currently use an open source application. Most respondents were not familiar with open source software. After viewing the video, most respondents believed open source applications were generally more difficult to use than commercial applications. However, most respondents believed open source applications were as reliable as commercial applications. In general, most respondents expected open source software to be comparable to commercial or closed source software.

User Interface and Data Interchange

Survey questions were developed to measure usability, interface, interchange, and application bias. We performed a factor analysis to determine how well the questions measured what we intended them to measure. Factor analysis results revealed that respondents did not clearly distinguish between user interface and data interchange in the survey. We therefore checked the reliability of our survey instrument using Cronbach alpha measures. Specifically, we wanted to know how well each set of questions fit together. Cronbach alpha measures ranged from 0.534 to 0.826 for the four categories and agreed closely with loadings from the factor analysis. Alpha measures greater than 0.6 imply reliability. Overall results indicate a need to reassign and reword 5 of the 18 questions to accurately measure the variables of interest.

Willingness to Pay

Data collected from the dichotomous choice section of the survey are summarized in Figure 2. Preliminary findings indicate that when piracy controls are high and comparable open source software is available, consumers are willing to pay no more than $75 on the average for Microsoft Office given a market price of $180. WTP prices ranged from 0 to $350 with over 30% of the respondents not willing to pay anything for the commercial application. If findings are confirmed in the full experiment, this could indicate that implementing piracy controls in an open source environment could reduce firm profitability by over 50%.

Discussion and Conclusion

The first phase of this study serves as a pretest for the survey instrument and the experiment designed to evaluate measures of willingness to pay for commercial software by consumers. Results indicate that, with suggested modifications, the survey and experiment will provide reliable results for the complete study. In the full survey, we will capture responses from 200 MBA and PhD students to have a sample of experienced respondents large enough to produce reliable results. Modifications as defined by factor analysis findings will be incorporated in the revised survey. We will use the Multinomial Probit (MNP) model to analyze data.

Preliminary findings indicate possible support for all three hypotheses presented. Prior research indicates that a consumer's final decision to purchase software depends on the cost of pirating software, the price of the software, and the individual's reservation price. Initial results indicate that, under high levels of piracy control, consumers are willing to use open source software applications given a market-determined price for Microsoft Office. These results hold in the presence of network externalities,

indicating that positive network effects through software sharing do not significantly affect consumer choice. This would indicate that the use of piracy controls for commercial software could adversely impact profitability in this industry. However, further study must be conducted to confirm these results.

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Appendix: Sample Dichotomous Choice Questions

Given the availability of OpenOffice, how much would you be willing to pay to for Microsoft Office?

1. Would you consider paying $40?
    Yes_____ (go to Question #3)
    No _____(go to Question #2)

2. Would you consider paying $20?
    Yes_____ (Thank you! You have completed this section of the survey. Please proceed to the next section.)
    No _____(go to Question #5)

3. Would you consider paying $60?
    Yes_____ (go to Question #4)
    No _____(Thank you! You have completed this section of the survey. Please proceed to the next section.)

4. What is the maximum you would pay for Microsoft Office?
    _____ (You have completed this section of the survey. Please proceed to the next section.)

5. Would you be willing to pay anything at all for Microsoft Office?
    Yes_____ Please state the amount: _____ (Thank you! You have completed this section of the survey. Please proceed to the next section.)
    No_____ (go to Question #6)

6. I would not pay anything for Microsoft Office because:
    ____ I would use the free open source version that was provided with the computer.
    ____I would purchase a different bundled software application.
    ____I would obtain a copy of a previous version of Microsoft Office from a friend.
    ____other (please state reason):_____
    _____