An Empirical Examination of Global Software Piracy: Implications for Pricing and Public Policy

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Abstract

Our research reconciles analytical and empirical approaches to piracy and through a panel of 53 countries over a period of 11 years, we empirically show that piracy is indeed a two-stage behavior as suggested by extant analytical models. Global piracy has two non-monetary cost components; moral costs that are representative of ethical propensities to pirate and legal costs that represent consumers' fear of getting caught and the punitive damage in that event. Our results validate the argument that piracy is not a price-dependent decision alone and it further delineates the differential impact of legal and moral factors on piracy. Interestingly, we find that while moral costs are significant in preventing a consumer from pirating, legal costs affect piracy in two ways. First, they prevent a portion of the market from choosing the piracy route, and second, to a larger extent they deter some of the pirates from holding on to the pirated copy thus incentivizing some to buy during the second stage. We also observe that buyers in the second stage have higher product valuation than pirates lending some support to the potential externality benefits of piracy. However, contrary to some popular arguments that piracy necessarily leads to future sales, the overall beneficial effects of software piracy while indeed present, are quite limited across the industry. We conclude our research with pricing and policy implications; first we demonstrate the superiority of adopting discriminatory country-specific pricing as a function of the prevailing moral and legal costs. Second, we underscore the importance of enforcement actions such as law-suits in mitigating piracy and conclude that a focus on deterrence is superior to prevention strategies.

Keywords: piracy, digital goods, price discrimination, public policy

1 Introduction

Piracy is perhaps one of the most important factors threatening the US software industry in its effort to create a global marketplace for its products (Business Software Alliance 2005). About thirty-five percent of all installed packaged software worldwide was pirated, causing $34 billion

in global losses to software industry (Business Software Alliance 2005). In its effort to monitor, if not prevent piracy, the Business Software Alliance (BSA) and its various international affiliates keep track of piracy levels and monetary losses of US software firms across the globe. While domestically BSA has pursued legal action against pirates through active enforcement of the Digital Millennium Copyright Act (DMCA), managing global piracy is perhaps more complex given the variance in legal situations, ethical attitudes towards piracy and affordability of the consumer base. Further complicating these efforts is the popular belief in some quarters that piracy may even be beneficial – this belief hinges on the potential externality benefits of piracy where it is argued that some consumers pirate, get to know more about the product thus eventually becoming buyers of legitimate copies. However, at a global level it is not clear as to which of these forces, e.g. legal measures, externality effects, or perhaps even country-specific elements are at work and to what extent they influence piracy. An examination of these factors and their impact on sales and piracy is of importance to both vendors and regulators alike.

2 Econometric Model - Empirical operationalization of the two-stage model as a nested discrete choice model

In the two-stage model introduced by Chellappa and Shivendu (2005) as shown in Figure 1, consumers do not fully incur the piracy costs in the first stage itself, rather since there is always the possibility of buying in the second stage only those that keep a pirated copy incur the full costs of piracy. Discrete choice models have been extensively used in marketing and economics to understand consumer decisions (Chintagunta 1993, Guadagni and Little 1983, Gupta 1988). An important feature of these models is that they allow for a statistical calibration of the complex tradeoffs that consumers undertake while making discrete decisions like purchase/non-purchase of a good. In the traditional logit choice model where a consumer is presented with choices i, j, and where the utility from choice i is given by $U_i = u_i + \varepsilon_i$ and j is given by $U_j = u_j + \varepsilon_j$, the probability of choosing i is given by $\Pr(i) = \frac{e^{u_i}}{e^{u_i} + e^{u_j}}$. Similarly, the probability of choosing j is given by $\Pr(j) = \frac{e^{u_j}}{e^{u_i} + e^{u_j}}$. These choice probability expressions are derived by assuming that the ε's are independent and identically (*iid*) distributed with an extreme-value distribution (McFadden 1981).

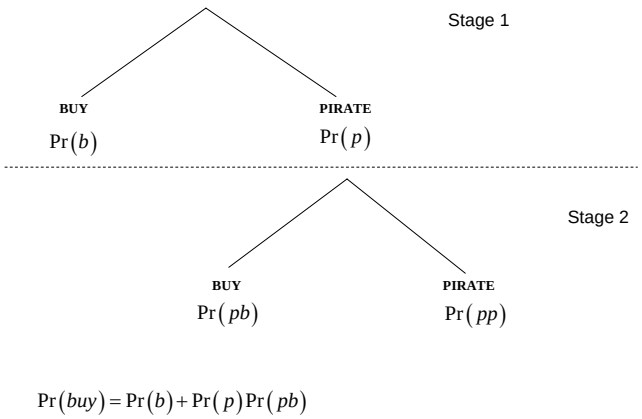

Figure 1: Choice model structure

We propose a nested logit choice model akin to Ben-Akiva (1985) to capture the two-stage decision discussed in our theory section. We begin by discussing the second stage model, which represents the choices faced by the consumer who has pirated in the first stage. Let p, v, m, l represent price, product value, moral and legal costs as before. Some consumers may choose to buy after having chosen to pirate earlier. For these buyers, the utility is given by $U_{pb} = u_{pb} + \varepsilon_{pb} = \beta_1 + \beta_2 v + \beta_3 p + \varepsilon_{pb}$. The utility for those who choose the option to retain the pirated good can be written as $U_{pp} = u_{pp} + \varepsilon_{pp} = \beta_4 + \beta_5 v + \beta_6 m + \beta_7 l + \varepsilon_{pp}$. Thus the choice probabilities from buying and pirating, conditional on having pirated in the first stage are given by

$$\Pr(pb) = \frac{e^{\beta_1 + \beta_2 v + \beta_3 p}}{e^{\beta_1 + \beta_2 v + \beta_3 p} + e^{\beta_4 + \beta_5 v + \beta_6 m + \beta_7 l}}; \Pr(pp) = \frac{e^{\beta_4 + \beta_5 v + \beta_6 m + \beta_7 l}}{e^{\beta_1 + \beta_2 v + \beta_3 p} + e^{\beta_4 + \beta_5 v + \beta_6 m + \beta_7 l}} \quad (1)$$

The inclusive value or expected maximum utility (EMU) from pirating in the first stage is given by

$$IV_p = \frac{1}{\mu_p} \ln\left(e^{\beta_1 + \beta_2 v + \beta_3 p} + e^{\beta_4 + \beta_5 v + \beta_6 m + \beta_7 l}\right) \quad (2)$$

As explained in Ben-Akiva (1985), the inclusive value in equation (2) is the maximum expected utility from all underlying choices conditional on pirating in the first stage. Therefore the first stage utilities are given by

$$U_b = \alpha_1 + \alpha_2 v + \alpha_3 p + \varepsilon_b \Rightarrow u_b + \varepsilon_b; U_p = \alpha_4 + \alpha_5 v + \alpha_6 m + \alpha_7 l + \frac{\alpha_8}{\mu_p} IV_p + \varepsilon_p \Rightarrow u_p + \varepsilon_p \quad (3)$$

Similar to equation (1), the unconditional first-stage choice probabilities of buying and pirating are given by

$$\Pr(b)=\frac{e^{\alpha_1+\alpha_2 v+\alpha_3 p}}{e^{\alpha_1+\alpha_2 v+\alpha_3 p}+e^{\alpha_4+\alpha_5 v+\alpha_6 m+\alpha_7 l+\frac{\alpha_8}{\mu_p}IV_p}};\Pr(p)=\frac{e^{\alpha_4+\alpha_5 v+\alpha_6 m+\alpha_7 l+\frac{1}{\mu}IV_p}}{e^{\alpha_1+\alpha_2 v+\alpha_3 p}+e^{\alpha_4+\alpha_5 v+\alpha_6 m+\alpha_7 l+\frac{\alpha_8}{\mu_p}IV_p}} \tag{4}$$

We transform equation (4) into a linear model that can be empirically estimated:

$$\begin{aligned}&\ln\left(\frac{\Pr(p)}{1-\Pr(p)}\right)=\gamma_1+\gamma_2 v-\alpha_3 p+\alpha_6 m+\alpha_7 l+\frac{\alpha_8}{\mu_p}\ln\left(e^{\beta_8+\beta_9 v+\beta_3 p}+e^{\beta_6 m+\beta_7 l}\right)\\&\gamma_1=\alpha_4-\alpha_1+\frac{\alpha_8}{\mu_p}\beta_4;\quad \gamma_2=\alpha_5-\alpha_2+\frac{\alpha_8}{\mu_p}\beta_5;\quad \beta_8=\beta_1-\beta_4;\quad \beta_9=\beta_2-\beta_5\end{aligned} \tag{5}$$

3 Preliminary results

Our data is collected from multiple sources and spans 53 countries over 11 years (1994-2004). We then first construct indices for the latent constructs of moral and legal costs from cultural and institutional factors, e.g., *Rule of Law Index* and *Control of Corruption Index* from governance research, *Property Right Indicator* from the Index of Economic Freedom, and *Number of International Intellectual Property (IP) Agreements* (*IP Agreements*) from World Intellectual Property Organization (WIPO).

Legal Costs					
Items	**Factor Loading**	**1**	**2**	**3**	**4**
1. Corruption Control	**-0.98**	1.00			
2. Rule law	**-0.98**	**0.96**	1.00		
3. IP Agreement	-0.12	**0.12**	**0.12**	1.00	
4. IP right protection	-0.10	**0.09**	**0.10**	0.02	1.00

Moral Costs						
Items	**Factor Loading**	**1**	**2**	**3**	**4**	**5**
1. Power Distance	**-0.89**	1.00				
2. Collectivism	**-0.91**	**0.67**	1.00			
3. Masculine	0.00	**0.11**	**-0.09**	1.00		
4. Uncertainty Avoidance	-0.21	**0.19**	**0.32**	0.06	1.00	
5. Interaction	**-0.99**	**0.89**	**0.91**	0.00	**0.21**	1.00

We subsequently estimate equation (5) . Of particular interest is the estimation of the transient cost parameter δ Intuition and prior empirical work might suggest that low levels of piracy in a country equate to consumers not engaging in piracy at all, i.e. $\delta \to 1$ wherein all costs come into play in the preventive stage itself. However, our results show that δ is actually smaller in countries with low piracy levels Remember that higher δ implies that a majority of the piracy

costs are suffered in the *first* stage, i.e., more likely that people don't pirate at all and a lower δ implies that a majority of the piracy costs are suffered in the *second* stage, i.e., consumers are more likely to be deterred from holding on to a pirated copy.

Variables	Estimates	STD
Stage 1		
$\gamma_1 = \alpha_4 - \alpha_1 + \frac{\alpha_8}{\mu_p}\beta_4$	**1.22****	0.54
$\gamma_2 = \alpha_5 - \alpha_2 + \frac{\alpha_8}{\mu_p}\beta_5$	0.00	0.00
α_6 (moral cost)	**-0.36*****	0.04
α_7 (legal cost)	**-0.42*****	0.05
α_3 (price)$^+$	**0.04*****	0.01
Stage 2		
$\beta_8 = \beta_1 - \beta_4$	**18.17***	13.37
$\beta_9 = \beta_2 - \beta_5$	**0.64*****	0.27
β_6 (moral cost)	5.64	4.83
β_7 (legal cost)	**-6.01****	3.71
β_3 (price)	**-0.26*****	0.10
Year1995	-0.06	0.10
Year1996	**-0.49*****	0.09
Year1997	**-0.31*****	0.10
Year1998	**0.35*****	0.10
Year1999	0.18	0.10
Year2000	0.04	0.11
Year2001	-0.14	0.11
Year2002	-0.14	0.10
Year2003	-0.02	0.14
Year2004	-0.01	0.11
μ_p ++	0.1	
n	569	
R^2	0.71	
Adj. R^2	0.70	
Log-Likelihood	-447.17	

Significance: *** p <0.001, ** p <0.01, * p <0.05
\+ Price variable negative
++ Calculated numerically by minimizing SSE

Table 1: Regression Results

Our findings show that lower piracy is *not* merely a result of consumers not pirating at all, rather it is a result of pirates turning buyers in the second stage. The latter is possibly due to the fact that post-updating, those who turn buyers perceive a greater value for the product than those who remain pirates (an indication of piracy's sampling effect) and/or consumers are stopped by the deterrence costs in the second stage and hence end up buyers. Our results suggest that there is ample evidence of both. First, we can see that $\beta_8 = \beta_1 - \beta_4$ (where β_1 and β_4 are value coefficients of buyers and pirates in the second stage) is both significant and positive supporting the former argument. And second, we also see that the legal cost coefficient in the second stage is relatively high even if moral costs themselves do not appear to play a role in this stage.

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