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

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Abstract
The impact of global piracy on the US software industry has largely been understood through analysis of data from Business Software Alliance, a trade group representing the world’s largest software makers. While the impact of cultural and legal factors on global piracy has been individually examined by prior research, we present a theory-based structural two-stage piracy model that not only includes these extant covariates but also the role of uniform global pricing hitherto adopted by most domestic software firms. Through an empirical analysis of piracy data from 1994-2002 covering all major continents, we compare our structural model of two-stage piracy that separates preventive factors (first stage) from deterring ones (second stage), with extant reduced-form OLS estimates. Several interesting findings result; first, we demonstrate that the two-stage utility-theory based model (which suggests that some consumers buy outright while some others first pirate and turn buyers) is superior to single-stage or other reduced-form models in explaining piracy. Second, we observe that the relative impact of moral and legal costs on prevention and deterrence are distinctly different warranting a closer look at pricing. Third, we do observe a distinct increase in the baseline utility and value for software post-piracy suggesting externality benefits. And finally we observe that price discounts may play a bigger role in deterring piracy (in the second stage) but may not play a significant role in preventing people from engaging in this activity. We then suggest that software firms should eschew global pricing and derive an optimal pricing menu for current country-specific conditions while underscoring the importance of enforcement actions in mitigating piracy.

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

1. Introduction

“For almost fifteen years, the software industry has battled against software theft, recognizing that widespread piracy threatens the very existence of our industry. Despite these efforts, software piracy remains a serious problem throughout the world, accounting for one-
quarter of the software used in the United States, and 40 percent of the software used worldwide. In parts of Asia and the former Soviet Republic, piracy rates approach 90 percent, virtually eliminating sales of legitimate software.”


While the US software industry claims that global piracy is a cause for significant concern, popular belief in some quarters suggest that piracy may even be beneficial (Haruvy, et al. 2004). This belief hinges on the potential externality benefits of piracy, where it is argued that some consumers pirate and get to know more about the product, thus eventually becoming buyers of legitimate copies. While there is no clear empirical evidence to support or deny this claim, industry groups have consistently asserted that upwards of 43 percent of all installed packaged software worldwide is pirated leading to losses to the tune of $50 billion for the US software industry. According to the Seventh Annual Business Software Alliance (BSA) and IDC Global Software study on global piracy, in 2009 for every one hundred dollars worth of PC software purchased legitimately, seventy five dollar’s worth was obtained illegally. In its effort to monitor and prevent piracy, the BSA and its various international affiliates keep track of piracy levels and monetary losses of 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 or even understanding the factors associated with global piracy is more complex given the country-specific variance in legal situations, ethical attitudes toward piracy and affordability of the consumer base. Thus, a rigorous examination of these factors and their impact on global sales and piracy is of importance to both vendors and regulators alike.

In examining piracy, it is important to keep in mind that it is not an isolated trait where consumers are necessarily pre-disposed toward pirating or buying; and neither is it truly costless to the consumer. Theory suggests that consumers trade off purchase (where costs are price-
based) and piracy (where costs may be non-monetary like legal and/or moral costs) decisions. Understanding and calibrating how consumers make these complex tradeoffs is central to formulate effective public policies on piracy and managers’ pricing decisions. While empirical studies on global piracy has identified a number of covariates e.g., a country’s wealth (Gopal and Sanders 2000, Shin, et al. 2004), cultural aspects such as individualism/collectivism (Husted 2000, Marron and Steel 2000, Moores and Dhaliwal 2004), and some law-related elements, such as membership and duration of membership in international intellectual property treaties (e.g., World Intellectual Property (WIPO), World Trade Organization (WTO), Universal Copyright Convention) (Burke 1996, Papadopoulos 2003), we identify three significant shortcomings that we address in our research using the publicly available global piracy data from BSA.

First, previous studies do not necessarily consider legal and cultural factors simultaneously when examining country-specific piracy either for reasons of limited interest or due to potentially high correlation amongst explanatory factors. Moreover, the estimations are typically reduced-form or Ordinary Least Squares (OLS) models that suffer from endogeneity problems that the same unobservable can affect both the explanatory and dependent variables. For example, rich countries may have both strong legal protection for private properties and low piracy rates. Extant research in econometrics shows that R-square can become spurious when endogeneity problems are ignored (Berry, et al. 1995). Therefore, we use a structural model to eliminate these problems.

Second, price has been consistently identified as an important determinant of piracy by both analytical models (Chellappa and Shivendu 2003, Conner and Rumelt 1991, Sundararajan 2004) and survey-based research (Cheng, et al. 1997). However, empirical models of software piracy based on secondary data have ignored the global pricing strategy of software firms, a strategy that has drawn some flak from both academics and the trade press. Extant research
(Gopal and Sanders 1998) on piracy opines that “The key problem is that prices are set at the U.S. levels, which are significantly higher than individuals in most countries can afford.” Trade press reports (Crampton 2005) observed that while hardware prices varied across countries, software prices were the same “… like oil and coal, however, most major software programs sell for a global price, ” and many governmental and non-governmental agencies also find it “appropriate to use the US price index for pre-packaged software adjusted by changes in exchange rates” (Lequiller, et al. 2003, p.49).

Third, while it has been suggested that there are externalities associated with piracy, i.e., past pirates may be influenced to buy and that piracy costs are suffered in two stages, extant empirical research does not accommodate the influence of piracy on future purchases. In this regard, a key contribution of our research is to address these gaps as evinced by the above three characteristics of extant empirical research on piracy.

From a pricing point of view, while it is not surprising that intellectual property rights (IPR) firms act like monopolists since they are often the sole owners of a good (Philips 1998), piracy has the same impact of a competitor albeit illegitimate. Some IPR industries recognized this early on, e.g. to combat intellectual property (IP) violation through photocopying, some book publishers have engaged in price discrimination and/or offer lower print quality versions (e.g., Eastern Economy Edition from Prentice Hall) of its products in countries with higher rates of IP violation. While there have been some recent reports of software vendors like Microsoft reconsidering their global pricing strategy in China and Brazil (Zhu 2008), there is little formal analysis on optimal country-specific prices. Another important goal of our research is to empirically determine optimal country-specific prices taking into account the prevalent piracy-related factors.
For our investigation we construct our dataset from BSA’s piracy data and many other public sources for 53 countries over a period of 9 years (from 1994-2002). We first develop the econometric specification of the two-stage piracy model of Chellappa and Shivendu (2005) through a nested decision tree wherein some consumers make the decision to buy right away while others decide to buy after pirating. Note this structure also recognizes that the piracy costs may possibly have two roles: in the first stage they can prevent people from engaging in piracy at all, while in the second stage they can deter pirates from holding on to their pirated version. After recovering the coefficient estimates, we are able to derive country-specific optimal pricing recommendations that accounts for the prevalent institutional and cultural environment.

The rest of the paper is organized as follows. In the second section, we derive the structural model of two-stage piracy behavior, followed by the empirical operationalization of the model as a nested discrete choice model. In the third section, we describe the data collection procedure, empirical analysis and results. We conclude the paper with a discussion of implications for global policy makers and software vendors, as well as directions for future work.

2. Structural model of two-stage piracy behavior

Analytical models of piracy are unconstrained by data requirements and have had the luxury of studying the problem at a granular level, i.e. through a consumer’s utility function. Hence, these models have been able to truly capture the utilitarian nature of a consumer’s tradeoff between buying and pirating. First, these models show that any impact of moral and legal costs is bounded by price, i.e., they are important only to the extent that the combined costs are less than the price of the software itself (Chellappa and Shivendu 2003, Conner and Rumelt 1991). Second, these models have shown that piracy is not a single-stage decision. Rather, consistent with theories of experience goods consumption, some consumers may initially pirate to
experience the good and update their value perception of the product; post-sampling some of the pirates may turn buyers (Chellappa and Shivendu 2005, Givon, et al. 1995). This suggests that any externality benefits, if present, will manifest themselves in the second stage. While these theory models provide rich insights into the underlying piracy behavior, it is empirical work on global piracy that has identified several market-level factors influencing piracy, e.g. cultural and legal factors (Gopal and Sanders 2000, Marron and Steel 2000). So far, there has been no research (that we are aware of) that has reconciled the approaches of the two research streams. In this section we begin by presenting the conceptual setup before deriving an empirically testable model.

2.1. Theoretical model

Our objective in this section is to provide a simple conceptual set-up that summarizes the two primary approaches to modeling consumers’ decision to buy or pirate a good. We pose this in the context of the global piracy problem that we are interested in. Consider a representative consumer for each country such that the consumers are defined by some value \( v \) for a software good such that this value is heterogeneous across countries where \( v \sim K(\cdot) \).

Similarly, the representative consumer in different countries suffer different moral \( (m) \) and legal \( (l) \) costs, where the respective distributions are given by \( m \sim G(\cdot) \) and \( l \sim H(\cdot) \). If the price of the good is given by \( p \), we can write the utility from buying as \( u_b = v - p \) and that from pirating as \( u_p = v - (m + l) \). In a model where consumers make the decision between pirating and buying in one go (henceforth referred to as the single-stage model), he will buy a product if and only if \( u_b \geq 0 \) (individual rationality (IR) constraint) and \( u_b \geq u_p \) (incentive compatibility (IC) constraint). The latter constraint implies that consumers will pirate if \( p > m + l \). Thus for a market of \( N \) consumers, we can write the demand in the presence of piracy for the single-
stage model as \( d_1(p \mid v, m, l) = N(1 - K(p))(1 - R(p)) \) where \( R(p) \) is the joint distribution of \( G(.) \) and \( H(.) \).

However, in the two-stage model introduced by Chellappa and Shivendu (2005), 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. Let \( \delta \) be the transient parameter such that the consumer who pirates in the first stage incurs only a portion of the piracy costs \( \delta (m + l) \), and suffers the rest \((1 - \delta)(m + l)\) only if he decides to keep the pirated product. Furthermore, the pirates have now updated their value of the product from \( v \) to \( \hat{v} \mid \hat{v} \sim J(.) \), where \( \hat{v} > v(\hat{v} < v) \) if the product was initially underestimated (overestimated). The pirates would, therefore, now reevaluate their piracy decision with the new value. Thus in the first stage, consumers will buy if and only if \( v > p \) and \( p < \delta (m + l) \Rightarrow \frac{p}{\delta} < m + l \) and in the second stage the pirates will buy if and only if \( \hat{v} > p \) and \( p < (1 - \delta)(m + l) \Rightarrow \frac{p}{1 - \delta} < m + l \).

We can, therefore, write the demand in the first stage as

\[
D_1(p \mid v, m, l) = N(1 - K(p))R\left(\frac{p}{\delta}\right)
\]  

and during the second stage as

\[
D_2(p \mid \hat{v}, m, l) = N(1 - J(p))\left[R\left(\frac{p}{1 - \delta}\right)\left[1 - R\left(\frac{p}{\delta}\right)\right]\right]
\]  

Therefore the total price dependent demand from a two-stage model can be written as

\[
D(p \mid v, \hat{v}, m, l) = D_1(p \mid v, m, l) + D_2(p \mid \hat{v}, m, l) = N\left((1 - K(p))R\left(\frac{p}{\delta}\right) + (1 - J(p))\left[R\left(\frac{p}{1 - \delta}\right)\left[1 - R\left(\frac{p}{\delta}\right)\right]\right]\right)
\]
In order to set optimal prices, a vendor will have to maximize revenue, i.e. set \( \frac{\partial \pi}{\partial p} = pD(p) = 0 \). While optimal prices under some restrictive distributional assumptions have been derived elsewhere (Chellappa and Shivendu 2005), we can easily see what they will be in terms of the distributions of values, legal and moral costs, and the transient parameter.

Data on global piracy, however, is available only at the aggregate (country) level (described in greater detail in section 3). To bridge this gap between granular theory models and aggregate data, recent research in economics and marketing developed structural econometric models where such data have been used to calibrate structural demand systems. These include multi-nation national-level yearly sales data (Goldberg and Verboven 2001), single country national-level sales data (Sudhir 2001, Sudhir et al. 2005), market-level sales data (Christen et al. 1997; Nevo 2001) or store-level sales data (Davis 2001; Chintagunta et al. 2003). Similarly we can transform the conceptual model presented above into country-specific piracy demand system that can be viewed as the aggregate piracy-influenced demand derived from aggregating the utility maximizing choices of representative consumers from each of the different countries.

Such models rely on the pioneering work of Small and Rosen (1981) who were the first to demonstrate that the aggregation of standard choice models (e.g. logit and probit) generates viable economic demand systems. Typically, one estimates a discrete choice model using microeconomic data containing individual choices, such as the scanner panels (see Guadagni and Little (1983)). However, in instances for which only aggregate data are available, one may still be able to identify the parameters of the choice model by estimating the demand system directly (Allenby 1989; Allenby and Rossi 1991, and Berry 1994). Along these lines we first operationalize the above decision structure and incorporate country-specific moral and legal costs into an equivalent two-stage nested discrete choice model.
2.2. Econometric Specification

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 statistical calibration of the complex tradeoffs that consumers undertake while making discrete decisions like purchase/non-purchase of a good. For the most part, these models are consistent with utility maximization. Since the recovered demand model parameters are consumer-preference parameters and assumed to be invariant to structural changes, we can conduct ‘what-if’ counterfactuals to understand the economic implications of changes in one/more covariates. The parameters of these models are estimated using either micro-level observed choice data (individual/household level) or macro-level (aggregate) sales data.

Our theory suggests that at the first stage consumers make one of two choices, buy outright or pirating. After having pirated, at the second stage they choose between keeping the pirated copy and buying, where the consumers have new realized value for the product. Now suppose we are able to observe the total number of buyers and pirates, and we also know the costs and price associated with the product. Then we should be able to estimate the relative impacts of the various parameters on market demand.

In the traditional logit choice model (which is an equivalent of our single-stage 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 $\varepsilon$'s are independent and identically (iid) distributed with an extreme-value distribution (McFadden 1981).
For the two-stage model discussed earlier, we develop a *nested* logit choice model akin to Ben-Akiva and Lerman (1985). We begin by discussing the second-stage of this model, which represents the choices faced by the consumer who has pirated in the first stage. Once again, let $p, v, m, l$ represent price, product value, moral and legal costs (measurement of these variables has been described in the next section). As depicted in Figure 1, some consumers may choose to buy after having chosen to pirate earlier. For these buyers, the utility is given by

$$U_{R-B_u} = u_{R-B_u} + \varepsilon_{R-B_u} = \beta_4 + \beta_5v + \beta_6p + \beta_7m + \varepsilon_{R-B_u}$$

The utility for those who choose the option to retain the pirated good can be written as

$$U_{R-R_u} = u_{R-R_u} + \varepsilon_{R-R_u} = \beta_4 + \beta_5v + \beta_6l + \beta_7m + \varepsilon_{R-R_u}$$

Figure 1: Discrete Choice Model Structure
Thus the choice probabilities from buying and pirating, conditional on having pirated in the first stage, are given by

\begin{align*}
\Pr(R_{Bt}) &= \frac{e^{\beta_1 + \beta_2 v_{R} + \beta_3 p_{R}}}{e^{\beta_1 + \beta_2 v_{R} + \beta_3 p_{R}} + e^{\beta_4 + \beta_5 v_{R} + \beta_6 d_{R} + \beta_7 m_{R}}} \\
\Pr(R_{Rt}) &= \frac{e^{\beta_4 + \beta_5 v_{R} + \beta_6 d_{R} + \beta_7 m_{R}}}{e^{\beta_1 + \beta_2 v_{R} + \beta_3 p_{R}} + e^{\beta_4 + \beta_5 v_{R} + \beta_6 d_{R} + \beta_7 m_{R}}} \quad (4)
\end{align*}

The inclusive value from pirating in the first stage is given by

\[ IV_{Rt} = \frac{1}{\mu_R} \ln \left( e^{\beta_1 + \beta_2 v_{R} + \beta_3 p_{R}} + e^{\beta_4 + \beta_5 v_{R} + \beta_6 d_{R} + \beta_7 m_{R}} \right) \quad (5) \]

As explained in Ben-Akiva and Lerman (1985), the inclusive value in equation (5) is the maximum expected utility (EMU) from all underlying choices conditional on pirating in the first stage. Therefore, the first stage utilities are given by

\begin{align*}
U_{Bt} &= u_{Bt} + \varepsilon_{Bt} = \alpha_1 + \alpha_2 v_{B} + \alpha_3 p_{B} + \varepsilon_{Bt} \\
U_{Rt} &= u_{Rt} + \varepsilon_{Rt} = \alpha_4 + \alpha_5 v_{R} + \alpha_6 d_{R} + \alpha_7 m_{R} + \frac{1}{\mu_R} IV_{Rt} + \varepsilon_{Rt} \quad (6)
\end{align*}

Similar to equation (4), the unconditional first-stage choice probabilities of buying and pirating at time \( t \) are given by

\begin{align*}
\Pr(B_{it}) &= \frac{e^{\alpha_1 + \alpha_2 v_{i} + \alpha_3 p_{i}}}{e^{\alpha_1 + \alpha_2 v_{i} + \alpha_3 p_{i}} + e^{\alpha_4 + \alpha_5 v_{i} + \alpha_6 d_{i} + \alpha_7 m_{i} + \frac{1}{\mu_R} IV_{Ri}}} \\
\Pr(R_{it}) &= \frac{e^{\alpha_4 + \alpha_5 v_{i} + \alpha_6 d_{i} + \alpha_7 m_{i} + \frac{1}{\mu_R} IV_{Ri}}}{e^{\alpha_1 + \alpha_2 v_{i} + \alpha_3 p_{i}} + e^{\alpha_4 + \alpha_5 v_{i} + \alpha_6 d_{i} + \alpha_7 m_{i} + \frac{1}{\mu_R} IV_{Ri}}} \quad (7)
\end{align*}

Simplifying equation (5) we have

\[ \Pr(B_{it}) = \frac{1}{1 + e^{\gamma_1 + \gamma_2 v_{R} - \alpha_2 p_{R} + \alpha_6 d_{R} + \alpha_7 m_{R} + \frac{1}{\mu_R} \ln \left( e^{\beta_1 + \beta_2 v_{R} + \beta_3 p_{R}} + e^{\beta_4 + \beta_5 v_{R} + \beta_6 d_{R} + \beta_7 m_{R}} \right)}} \quad (9) \]

where
\[ \gamma_1 = \alpha_1 - \alpha_2 + \frac{1}{\mu_R} \beta_1 \quad \gamma_2 = \alpha_5 - \alpha_2 + \frac{1}{\mu_R} \beta_2 \quad \beta_8 = \beta_4 - \beta_1 \quad \beta_9 = \beta_5 - \beta_2 \]

The above implies that the total percentage of buyers needs to be derived by including those who bought right away and those who bought after pirating:

\[
\Pr(Total \_Buy_u) = \Pr(B_u) + \Pr(R_u) \Pr(R \_B_u)
\]

(10)

In order to provide empirical support for the two-stage demand model while being consistent with utility maximization, our results must yield statistically significant parameters \(\gamma_1, \gamma_2, \alpha_3, \alpha_6, \alpha_7, \beta_3, \beta_6, \beta_7, \beta_8, \beta_9, \mu_R\) and \(\mu_R \in (0,1)\).

We will now proceed to discuss our data and the estimation procedure, followed by a discussion of our empirical findings.

3. Data and analyses

Our annual time-series data span nine years (1994-2002), and cover all the major continents. Akin to the BSA Global Software Piracy Study\(^1\), representative countries from each continent are randomly sampled such that every region of piracy is represented. The resulting sample consists of 460 observations spanning 53 countries. To the best of our knowledge, the BSA statistics are the most reliable and granular global piracy numbers available to date. A recent work (Png 2010) suggests that this piracy data may have biases; first, pre- and post- 2003 data collection follow slightly different methods (potentially inflating piracy numbers by up to 4% points) and second, the methods employed by BSA might actually be measuring legitimate demand in a correct fashion rather than piracy rates. Prior researchers (Husted 2000, Marron and Steel 2000) have also raised potential concerns about this data but have dismissed it.

\(^1\) The BSA software piracy study lists 80 countries and seven regions, while the Hofstede sample consists of 50 countries and five regions, with 53 countries in common. [http://www.bsa.org/globalstudy](http://www.bsa.org/globalstudy). Appendix B summarizes the methodology and process that are used to measure piracy rates by BSA. Note that this data does not differentiate between users pirating themselves and buying from counterfeiters for a low price and includes both forms of piracy.
themselves after further analysis. We choose to be conservative and following Png’s (2010) main recommendations we restrict our data analysis to 1994-2002 and in our main estimation equation the dependent variable is legitimate sales rather than piracy.

3.1. Price and \( v \) measures

For each country, piracy levels and corresponding monetary-loss data are acquired from public and private BSA reports. World Bank’s World Development Indicators Database is used to generate a) number of personal computers in use for each country-year pair and b) country-specific value \( v \). Global software prices are set to US levels (Gopal and Sanders 1998) and based on the country-specific producer price index (PPI) for pre-packaged software (Buisson 2003). As separate country-specific PPIs for pre-packaged software have not yet been developed, the Organization for Economic Co-operation and Development (OECD) suggests, “as long as price indices are not available, it might still be better to use the US Producer Price Index (PPI) adjusted by the relative inflation rate between a country and US preferably PPI for a country vis-à-vis PPI for US…” (Lequiller, et al. 2003, p.50). The US PPI for pre-packaged software is obtained from the reported by the U.S. Department of Labor. The PPI tracks average prices of domestically produced and consumed commodities. These are derived from the value of shipments of products as reported by producers for the economic census\(^2\). The Department of Labor reports PPI from 1997-2003. In order to adjust for price trending, we use data belonging to 1997 as the baseline data to derive our PPI index for years’ 1994-1996. For example, PPI of Year 1994 is derived from \( PPI_{1994} = \frac{Sales_{1994}}{Sales_{1997}} \times PPI_{1997} \). We then adjusted US PPI by the

\(^2\)Appendix C demonstrates how the Producer Pricing Index is created by the U.S. Department of Labor. Detailed information about Producer Price Index is available on the Department of Labor website: [http://www.bls.gov/ppi](http://www.bls.gov/ppi)
relative inflation rate for countries other than US. This price also differs year-to-year, as software firms generally do revise prices each year (Philips 1998).

3.2. Measures of moral $m$ and legal $l$ costs

Literature models moral and legal costs as non-monetary price-equivalent costs faced by a consumer during his decision to pirate (Chellappa and Shivendu 2003). While moral costs or ethical propensity to pirate are suggested to be driven by the cultural background of a consumer (Gopal and Sanders 1998), legal costs or legal ramifications of pirating are suggested to be a result of institutional factors (Bagchi, et al. 2006). Prior literature$^3$ finds that some of the cultural indicator developed by Hofstede (1997) are highly influential in determining piracy (Gupta, et al. 2004, Husted 2000, Marron and Steel 2000, Shin, et al. 2004). It is suggested that consumers vary in their natural predisposition toward committing an immoral activity such as piracy depending upon the cultural background they come from. Hofstede (1997) suggests that there are four indicators that capture cultural differences across the globe -- namely power distance (PDI), collectivism (COL), masculinity (MAS), and uncertainty avoidance (UAI). Of these factors, Gopal and Sanders (2000) provide empirical support for collectivistic societies not valuing individuals’ property rights and hence engaging in higher levels of piracy. Marron and Steel (2000), also find statistically significant correlation between collectivism and piracy level. While there is no empirical support that links MAS and UAI to piracy, Husted (2000) suggests that piracy is not only related to collectivism (COL) but also to power distance (PDI). Thus in our study we use both these country-specific constructs as measures of moral cost.

Piracy research also suggests that a second component of piracy costs arises from a consumers’ expectation of getting caught and the punitive damage he might suffer in that case.

$^3$ Please see online appendix for a summary of all empirical and analytical literature on all types of piracy.
(Chellappa and Shivendu 2003, Globerman 1988). Extant empirical work on global piracy suggests that drivers of legal barriers to piracy stem from a country’s institutional infrastructure (Andrés 2006, Van Kranenburg and Hogenbirk 2005). Some have constructed indices that specifically examine aspects of legal protection of patent rights, coverage, and participation in international patent agreements (Burke 1996, Park and Ginarte 1997) while other investigate the provisions for loss protection (Van Kranenburg and Hogenbirk 2005). A shortcoming of using these measures alone is that while they capture punitive aspects of protection (through laws) if caught, they do not address the reality of a country’s actual enforcement of these laws, which would influence a consumer’s expectation of getting caught (Andrés 2006, Samuelson 1999). Independently however, some literature (Ronkainen and Guerrero-Cusumano 2001) has used the Corruption Perceptions Index (compiled annually by Transparency International) as a proxy measure of the law enforcement of IPR. Given that both the laws relating to IPR and their enforcement are relevant to consumers’ attitudes toward piracy, it is critical to include a measure of both in identifying a consumer’s legal cost of pirating (Ostergard 2000, Samuelson 1999). Thus, we use both corruption control and effective of legal legislation related indices as measures of legal cost of pirating.

These measures are available from the World Bank⁴ as collected from multiple sources where the Rule of Law Index and Control of Corruption Index are from governance research. World Bank releases reports on the aggregate governance research indicators bi-annually from 1996 to 2002. First, the Rule of Law Index is a composite measure and includes several indicators, including perceptions of the incidence of crime, the effectiveness and predictability of the judiciary and the enforceability of contracts. It is a proxy for the extent to which agents

have confidence in and abide by the rule of society, and is understood to be indicative of the success of a society in developing an environment in which fair and predictable rules form the basis for economic and social interactions and the extent to which property rights are protected (Cass 2003). The other indicator, *Control of Corruption Index*, measures perceptions of corruption and represents control of governance failure. It also assesses the likelihood that private property will be expropriated and analyzes the independence of the judiciary, the existence of corruption within the judiciary and the ability of individuals and businesses to enforce contracts. It represents the degree to which a country’s laws protect private property rights and the degree to which its government enforces those laws.

### 3.2. Estimation results

The parameters of equation (7) are estimated using the aforementioned data. We restate this below

\[
\Pr(B_{it}) = \left[1 + \exp\left(\frac{\gamma_1 + \gamma_2 v_{it} - \alpha_3 p_{it} + \alpha_6 l_{it} + \alpha_7 m_{it}}{\mu_R} + \ln\left(\frac{e^{\beta_3 v_{it} + \beta_4 l_{it} + \beta_5 m_{it}}}{\mu_R}\right)\right)\right]^{-1}
\]  

Note that, the inclusive value coefficient \(\frac{1}{\mu_R}\) cannot be separately identified, it is estimated via repeated iterations with different starting points and the estimate that generates the lowest Sum of Square Error (SSE) is chosen.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean (Std. Dev)</th>
<th>Min</th>
<th>Max</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
<tr>
<td>Legal Purchase</td>
<td>Percentage of legal purchase</td>
<td>0.41 (0.20)</td>
<td>0.02</td>
<td>0.77</td>
<td>1.00</td>
<td></td>
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<tr>
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<td>Control of corruptions from</td>
<td>3.26 (1.08)</td>
<td>1.35</td>
<td>5.08</td>
<td>0.75</td>
<td>1.00</td>
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<td>Index</td>
<td>Governance Index</td>
<td>Rule of law index</td>
<td>3.29</td>
<td>1.44</td>
<td>4.86</td>
<td>0.72</td>
<td>0.96</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------</td>
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<td>------</td>
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<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PDI</td>
<td>Power distance index</td>
<td>57.26</td>
<td>11.00</td>
<td>104.00</td>
<td>-0.62</td>
<td>-0.71</td>
<td>-0.68</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COL</td>
<td>Collectivism</td>
<td>54.38</td>
<td>9.00</td>
<td>94.00</td>
<td>-0.71</td>
<td>-0.73</td>
<td>-0.74</td>
<td>0.67</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>Producer price index from Bureau of Labor adjusted by inflation rate</td>
<td>107.74</td>
<td>54.63</td>
<td>163.83</td>
<td>-0.26</td>
<td>0.00</td>
<td>0.06</td>
<td>0.00</td>
<td>-0.01</td>
<td>1.00</td>
</tr>
<tr>
<td>Value</td>
<td>Country’s total software market revenue divided by its number of personal computers in use</td>
<td>94.08</td>
<td>6.82</td>
<td>460.26</td>
<td>-0.20</td>
<td>-0.08</td>
<td>-0.05</td>
<td>0.06</td>
<td>0.02</td>
<td>0.41</td>
</tr>
</tbody>
</table>

N=460 (excluding 17 observations with missing values)

3.3. Discussion of results

We estimate one reduced-form model (Model 1) and two structural demand models (Models 2-3). Recall that the central objective of reduced-form analysis is to either describe or forecast actions of economic agents (consumers and/or firms) using marketplace data. Here we fit a statistical/econometric model involving selected variables without developing an underlying theoretical model that guides associations between the variables included in the model. By imposing less structure this approach potentially affords us improved forecastability (Erdem, et al. 2007). However, reduced-form or OLS analysis may be limited in their usefulness to assess impact of big policy changes (like new pricing scheme, increased legal/moral costs) using existing data. First, statistical inference in reduced-form analysis relies on fitting the conditional distribution amongst variables. Hence predicting the impact of a policy change in variables that are ‘too far’ from what is observed in the data used for inference can generate very erroneous
predictions. Second, if the policy change itself results in change in decision rule employed by agents whose behavior is being modeled, that too can result in inaccurate predictions.

By contrast our *structural analysis* (single stage and two-stage models) relies on microeconomic theories of the consumer and/or the firm (i.e. utility maximizing by consumers, profit maximizing by firms etc.). After specifying a utility function, optimality conditions are derived for the economic agents (Equations 4 and 5). These optimizing conditions guide the econometric specification which is then taken to data (Equation 7). The parameters of the resulting econometric model therefore have behavioral interpretation because they reflect the behavioral primitives of the economic agents whose observed decisions are being modeled. This feature of structural analysis paradigm allows one to test various behavioral theories from which the econometric models are derived, and obtain behavioral predictions that are invariant to the effects of policy changes (Lucas Jr 1976).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intercept</strong></td>
<td>0.554***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\gamma_1 = \alpha_4 - \alpha_1$</td>
<td>0.214</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.287)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\gamma_1 = \alpha_4 - \alpha_1 + \frac{1}{\mu R} \beta_1$</td>
<td></td>
<td>-1.319**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.545)</td>
<td></td>
</tr>
<tr>
<td>$\alpha_2$ (Value)</td>
<td>-0.000*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\gamma_2 = \alpha_5 - \alpha_2$ (Value)</td>
<td></td>
<td>-0.001**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>$\gamma_2 = \alpha_5 - \alpha_2 + \frac{1}{\mu R} \beta_2$ (Value)</td>
<td></td>
<td>-0.004**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>$\alpha_6$ (Corruption control)</td>
<td>0.077***</td>
<td>0.003*</td>
<td>0.538***</td>
</tr>
<tr>
<td></td>
<td>(0.0187)</td>
<td>(0.002)</td>
<td>(0.157)</td>
</tr>
<tr>
<td>$\alpha_7$ (Rule of law)</td>
<td>0.007**</td>
<td>0.012***</td>
<td>0.173</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.156)</td>
</tr>
<tr>
<td>$\alpha_9$ (PDI)</td>
<td>-0.001**</td>
<td>-0.141</td>
<td>-0.008***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.117)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>$\alpha_{10}$ (COL)</td>
<td>-0.003***</td>
<td>-0.294**</td>
<td>-0.013***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.105)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>( \alpha_3 ) (Price)</td>
<td>-0.002***</td>
<td>-0.011***</td>
<td>-0.004*</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.002)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Second Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_8 = \beta_4 - \beta_1 )</td>
</tr>
<tr>
<td>13.116*</td>
</tr>
<tr>
<td>(7.223)</td>
</tr>
<tr>
<td>( \beta_9 = \beta_3 - \beta_2 ) (Value)</td>
</tr>
<tr>
<td>0.076***</td>
</tr>
<tr>
<td>(0.018)</td>
</tr>
<tr>
<td>( \beta_6 ) (Corruption control)</td>
</tr>
<tr>
<td>5.343**</td>
</tr>
<tr>
<td>(2.434)</td>
</tr>
<tr>
<td>( \beta_7 ) (Rule of law)</td>
</tr>
<tr>
<td>5.302**</td>
</tr>
<tr>
<td>(2.545)</td>
</tr>
<tr>
<td>( \beta_{10} ) (PDI)</td>
</tr>
<tr>
<td>-0.005</td>
</tr>
<tr>
<td>(0.040)</td>
</tr>
<tr>
<td>( \beta_{11} ) (COL)</td>
</tr>
<tr>
<td>-0.078**</td>
</tr>
<tr>
<td>(0.039)</td>
</tr>
<tr>
<td>( \beta_3 ) (Price)</td>
</tr>
<tr>
<td>-0.136***</td>
</tr>
<tr>
<td>(0.032)</td>
</tr>
<tr>
<td>( \frac{1}{\mu_R} )</td>
</tr>
<tr>
<td>0.1</td>
</tr>
<tr>
<td>( n )</td>
</tr>
<tr>
<td>460</td>
</tr>
<tr>
<td>( \text{Adj. } R^2 )</td>
</tr>
<tr>
<td>0.70</td>
</tr>
<tr>
<td>( \text{likelihood ratio test} )</td>
</tr>
<tr>
<td>59.98</td>
</tr>
</tbody>
</table>

Note: *** \( p<0.01 \), ** \( p<0.05 \), * \( p<0.10 \). Standard errors in parentheses
Time dummies are not significant, therefore not reported here

Model 1 (Table 2) provides the results of our reduced-form analysis and consistent with demand theory, legal sales reduce as price increases. We also notice that purchase probability increases as corruption control and rule of law increase.

Our reduced-form results provide empirical evidence that regulatory controls can deter piracy levels. However, despite its simplicity and good descriptive power \( \text{(Adj. } R^2 = 0.70) \), the reduced-form analysis does not allow us to ascertain tradeoffs that consumers make as they weigh-in on the various factors and attributes while making purchase decisions. For example, from a reduced form model, one might be led to believe that as the legal environment keeps getting better, sales will continue to increase. However, we know that sales is really a function of the consumers’ value (and the price) but the legal environment is relevant to the extent that
it acts as a counter to the pirating option. To assess these tradeoffs that consumers make, we have to rely on estimating the structural models detailed in the previous section.

The single stage model (Model 2) is a demand model where piracy is constrained to occur in one stage, i.e. consumers purchase or pirate. Unlike in Model 3, there are no externality benefits in that there is no allowance for pirates to turn into buyers once they have updated their fit. While structural models should only be compared using the likelihood-ratio tests, we also manually computed the adjusted R-squared for all the models. We can see that Model 3 outperforms all other models in both model statistics. While we report the results for all models in Table 2, for parsimony we limit the discussion of our analysis to our results for Model 3 alone.

First note that we are not able to individually identify some of the coefficients ($\alpha_{1,2,4,5}$ and $\beta_{1,2,4,5}$) of the original utility model, rather we only estimate $\gamma_1$ and $\gamma_2$ which are some aggregate measure of the consumers’ baseline utilities and value for software in the two stages. The simple reason for this is that we do not have granular data on the intermediate step; this should also give pause to the reader who might be concerned about over-identification given that we only have data at the aggregate level. However, note that this does not detract us from understanding the role played by the key independent variables (price, moral and legal cost) and their relative importance in the two stages – which is the primary objective of this paper.

First note that prevalent legal environment or rule of law in terms of code of punishment has little impact on the basic decision of a consumer to pirate ($\alpha_7$ is not statistically significant) but is an important factor in deterring consumers ($\beta_7 = 5.302^{**}$) from permanent use of the pirated software. On the other hand note that legal enforcement or legislative effectiveness (as measured by corruption control) plays an important role in both preventing consumers (first stage $0.538^{***}$) from pirating and deterring (second stage $5.343^{**}$) them from permanent use of
pirated software. This simply means that the punishment component may not kick in until users have decided to keep the pirated software while the prevailing enforcement levels of these laws are always critical. Also note that the moral cost which is a function of the prevalent ethical indices or culture of a country is generally significant as one expects from prior literature. What might be interesting is the strong statistical significance at the prevention stage implying that basic decision to use pirated goods is greatly influenced by the cultural environment even if they appear to play a lesser role to legal costs in the eventual decision to keep the pirated good.

Perhaps the most telling observation is with regards to the role of price. While the coefficient for price is weakly significant (at 90% confidence) in the first stage, we can see it is strongly significant (at 99% confidence) and of a higher magnitude in the second stage. The negative sign means that with higher prices, sales will be lower. From a piracy point of view, this can imply that price plays a relatively smaller role in consumers’ initial decision to engage in piracy but can be a determining factor in their eventual decision to continue with the pirated good. Finally note that even if unable to individually identify value-coefficients we find positive and significant values for $\beta_8 = \beta_4 - \beta_1$ and $\beta_9 = \beta_5 - \beta_2$; this implies that consumers who buy in the second stage have higher baseline utility and valuation for software, compared to those who continue to hold on their pirated copy. This suggests that there are perhaps potential benefits of piracy due to sampling the good in the first stage.

In sum, price and varying levels of regulatory controls across countries, warrant that firms and policy makers work in concert while formulating their strategies. Failure to do so limits firms’ ability to extract profits and public policy officials’ ability to control piracy. Also note that while the data does not distinguish between pirating by the consumer himself and the consumer buying a pirated copy, in the former case also the consumer incurs a monetary
equivalent opportunity cost due to search, technological know-how, etc. From an empirical point of view the impact of the price coefficient would be considered overestimated, although we have no data or extant evidence to distinguish between pirating oneself and buying from a counterfeiter. However, this should not affect our two-stage model since even the consumer buying a counterfeit copy is unlikely to be unaware of the fact that he is buying pirated software. Not only is this copy likely to cost significantly less but he would also be warned that he cannot register this software and use it to get updates and patches. Hence the moral and legal costs remain.

4. Global Policy and Pricing Strategies

Our model and empirical estimates provide certain important insights into policy and pricing strategies in a global context. In this section we shall first examine optimal global pricing strategies that vendors should adopt, followed by a discussion on the implication of preventive versus post-piracy punitive actions to thwart piracy.

4.1. Optimal global pricing strategies

“How much does a Big Mac cost in India versus in New York versus in Taipei, and how do you map a similar Big Mac index to software? It's a very difficult problem. We do know that we need to work with these governments so we do have software and the right offerings priced in a way that's relevant to them and their consumers and their constituencies.”

-- Martin Taylor, Microsoft's general manager of platform strategy

That price in itself is significant at both stages is not surprising, however, that still leaves the vendor with the question of how to set optimal prices. For example, while ideally the vendor would like to set two prices one for pirates and one for buyers (or prices differently at the two levels), price itself is endogenous to the decision to buy/pirate. Further, it is practically impossible to set two different prices for these two consumer segments. On the other hand, the heterogeneities in the piracy cost indices make evident that it is prudent to develop a
discriminatory strategy of pricing. Increasingly firms have begun to recognize this, e.g., Microsoft has decided to deviate from its “one-rate policy” in dealing with certain countries (Fried 2004). In order to develop the optimal country-specific pricing, we examine the total profit from both stages as follows

\[ \frac{\partial \pi}{\partial p} = \frac{\partial}{\partial p} \left[ (\Pr(B_u) + \Pr(R_u)\Pr(R\_B_u)) \ast M \right] = 0 \]  

(12)

\( M \) is the market size of a country, and from equation 9, we can compute the probabilities by plugging in the appropriate estimates (the derivations and details are available from the authors). The results of this price discrimination strategy are clearly superior to the profits from uniform global pricing, while taking into account both the piracy costs as well as the two-stage behavior.

The importance of pricing cannot be overemphasized given the two-stage behavior. If prices are low, then more people buy outright, increasing the share of legitimate sales but eroding unit margins. However, if prices are high, then more people pirate in the first stage. The latter may even be good under some circumstances, such as if it helps consumers update their valuation of the product. Thus while a firm may not want to necessarily encourage piracy, some situations may warrant managing piracy as reflected in the piracy costs in a country.

Clearly, piracy costs are meaningful only to the extent that they are comparable with both prices and generic product valuation \( v \), and when we compare the optimal prices to the product valuation, we see a distinct pattern emerging (see Figure 2).
We can observe that while product valuation and optimal prices are closer to each other for countries with higher piracy costs, for those with lower piracy costs, the distance is larger. The economic intuition behind this observation is particularly interesting for an industry where firms have long been considered to be endowed with monopoly power. For all practical purposes, IPR-based firms are monopolists in that they are often the sole owners of a product, and the basic principle behind monopoly pricing is to extract all consumer surplus, i.e., prices are close to product valuation. However, piracy acts like a competitor in this industry even if the competing firm itself is not engaging in any sort of profit maximizing. This effectively restricts prices to be \( p = \min\{\text{value}, \text{piracy-costs}\} \). From a firm’s point of view, our results suggest that a trade-off matrix (Figure 3) between value and piracy costs can provide broad recommendations for prices.

The broad implication for a software vendor is that under certain conditions, pricing may have to be driven by piracy and enforcement situations, as monopoly strategy of zero
consumer surplus is not possible. Rather, competitive pricing, i.e., setting prices closer to the competitor (in this case piracy costs), is perhaps optimal. Ideally, of course, firms might like to influence the prevalent legal costs, as moral costs are more intrinsic and generic to country.

![Figure 3: Optimal pricing strategies](image)

4.2. Policy implications

It is not surprising to see that total piracy costs are lower in countries like China and India but higher in the United States (see Figure 4). But the total piracy costs (sum of legal and moral costs), are split across the two levels. The share of total piracy costs in stage one \( (\delta) \) can be calculated as

\[
\delta = \frac{\alpha_s m + \alpha_l l}{\alpha_s m + \alpha_l l + \frac{1}{\mu_r} (\beta_s m + \beta_l l)}
\]
Since legal and moral costs vary by country and time, one can calculate $\delta$ for each country. 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. $\delta \rightarrow 1$ wherein all costs come into play in the preventive stage itself. However, our results show that $\delta$ is actually smaller in countries with low piracy levels (see example in Figure 5). Remember that higher $\delta$ 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 $\delta$ 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 a pirated copy.

Our findings also show that lower piracy is not merely a result of consumers not pirating at all. Rather, it is a result of some pirates becoming buyers in the second stage. The latter is possibly due to the fact that post-updating, those who become buyers perceive a greater value for the product than those who remain pirates (an indication of piracy’s sampling effect). Or it could be that 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.
Note that in constructing regulatory implications, we should keep in mind that there is no one global regulator of public policy. Rather, the results should be meaningfully interpreted by the U.S. software industry so as to influence IPR protection in different countries. The impact of legal costs in the second stage can largely be associated with enforcement-related activities; our findings point out that in countries with low piracy, the second-stage costs dominate the first-stage ones. And since the second-stage legal costs are entirely composed of legal enforcement, an important implication is that the industry should not only push for countries to enact laws to protect IP, but rather the enforcement of these laws should be emphasized. This implies that just because a country has signed a WTO agreement, it doesn’t mean that piracy will reduce, follow-up actions regarding overall enforcement continue to be important. Indeed a recent event study on piracy pre and post legal actions pursued by the Recording Industry Association of America, finds that while such actions cannot eliminate piracy they do have positive outcomes that are important to managing piracy (Bhattacharjee, et al. 2006).
To summarize, we provide compelling evidence for the differential impact of legal and moral costs on piracy levels in different countries. Clearly, legal costs, an outcome of legal controls put forth by regulators thwart piracy albeit to different degrees across different countries. This study therefore calls for regulators to critically examine their legal controls geared to deter piracy.

4.3 Limitations and future research

An important limitation of our work is that due to constraints, we only have aggregate information on software piracy. It would be interesting to break down piracy based on software categories (e.g., counterfeiting and individual pirating) to see if some suffer more piracy than others. The specific impact of sampling effects of piracy and the price points could be better understood if data were available at this granular level. Further, we also do not include the size of the local software industry in each country. Note that while all piracy data is restricted to software from U.S.-based firms, one important indicator could be the local production itself. Countries with a large installed local base might do a better job of production and enforcement. Finally, we believe that the results from this study could be extended to study piracy in the music, movie and video-games piracy industries.

References


### Appendix A

<table>
<thead>
<tr>
<th>Sources</th>
<th>Concept Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Columbia University (CUD)</strong></td>
<td><strong>1. Rule of Law</strong>&lt;br&gt;For the most part, is the state seen as legitimately representing its citizens?&lt;br&gt;Rate the state’s adherence to the rule of law, considering the country as a whole.&lt;br&gt;Losses and Costs of Crime: A 1-point increase on a scale from 0&quot; to &quot;10&quot; in crime during any 12-month period.&lt;br&gt;Kidnapping of Foreigners: An increase in scope, intensity, or frequency of kidnapping of foreigners that reduces the GDP growth rate by 1% during any 12-month period.&lt;br&gt;Enforceability of Government Contracts: A 1 point decline on a scale from 0&quot; to &quot;10&quot; in the enforceability of contracts during any 12-month period.&lt;br&gt;Enforceability of Private Contracts: A 1-point decline on a scale from 0&quot; to &quot;10&quot; in the legal enforceability of contracts during any 12-month period.</td>
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<tr>
<td><strong>Global Insight (DRI)</strong></td>
<td>Violent crime&lt;br&gt;Organized crime&lt;br&gt;Fairness of judicial process&lt;br&gt;Enforceability of contracts&lt;br&gt;Speediness of judicial process&lt;br&gt;Confiscation/expropriation</td>
</tr>
<tr>
<td><strong>Economist Intelligence Unit (EUI)</strong></td>
<td>Black market&lt;br&gt;Property Rights</td>
</tr>
<tr>
<td><strong>Heritage Foundation (HER)</strong></td>
<td>Independence of Judiciary</td>
</tr>
<tr>
<td><strong>Amnesty International (HUM)</strong></td>
<td>Law and Order.</td>
</tr>
<tr>
<td><strong>Political Risk Services (PRS)</strong></td>
<td>Direct Financial Fraud, Money Laundering and Organized Crime</td>
</tr>
<tr>
<td><strong>Business Environment Risk Intelligence</strong></td>
<td>Judicial Independence An assessment of how far the state and other outside actors can influence and distort the legal system. This will determine the level of legal impartiality investors can expect. Crime How much of a threat businesses face from crime such as</td>
</tr>
</tbody>
</table>
kidnapping, extortion, street violence, burglary and so on. These problems can cause major inconvenience for foreign investors and require them to take expensive security precautions.

2. Control of Corruption
Rate the severity of corruption within the state
To what extent do the country’s primary political decision makers (e.g. chief executive and cabinet members) engage in patterns of nepotism, cronyism and patronage?
To what extent do the country’s civil services (occupying middle and higher management roles) engage in patterns of nepotism, cronyism and patronage?
To what extent do patterns of nepotism, cronyism and patronage undermine the state’s ability to exercise the basic functions of government effectively?
To what extent do patterns of nepotism, cronyism and patronage distort broad patterns of economic development?

Global Insight's (DRI) Risk Event Outcome non-price: Losses and Costs of Corruption: A 1-point increase on a scale from 0 to 10 in corruption during any 12-month period.

Economist Intelligence Unit (EIU) Corruption

Political Risk Services (PRS) Corruption within the political system, which distorts the economic and financial environment, reduces the efficiency of government and business by enabling people to assume positions of power through patronage rather than ability, and introduces an inherently instability in the political system.

Business Environment Risk Intelligence Indirect Diversion of Funds

World Markets Research Center (WMO) Corruption: This assesses the intrusiveness of the country’s bureaucracy. The amount of red tape likely to countered is assessed, as is the likelihood of encountering corrupt officials and other groups


We choose to use Control of Corruption Index from World Bank Governance & Anti-Corruption (WBG) instead of Transparency International Corruption Perception Index (TI) because TI index relies on a subset of the sources WBG use to create the index (10 data sources in TI vs. 14 sources in WBG). In addition, TI index uses simple average of scores as the estimate of corruption, while WBG construct Control of Corruption Index based on a weighted average of scores.
Appendix B

Measures of Piracy Rates

<table>
<thead>
<tr>
<th>Measure</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td></td>
</tr>
<tr>
<td>PC Shipments</td>
<td>Proprietary and confidential data supplied by BSA member companies</td>
</tr>
<tr>
<td># of Software installed/PC for three categories of software</td>
<td>Technology User Profile market research of Metafacts Inc.</td>
</tr>
<tr>
<td>Supply</td>
<td></td>
</tr>
<tr>
<td>Software shipment data (only for business software application)</td>
<td>Proprietary and confidential data supplied by BSA member companies</td>
</tr>
<tr>
<td>Uplift factors reflecting an estimate of shipments by companies participating in the study</td>
<td>Developed by International Planning and Research (IPR)</td>
</tr>
<tr>
<td>Average wholesale price of SW</td>
<td>Proprietary and confidential price data supplied by BSA member companies weighted by the amount of shipments within each SW category</td>
</tr>
</tbody>
</table>

PC Shipments × Software Load = # SW Installed

# Software Shipment by Companies × Uplift Factors for Companies = # SW Shipment

# SW Installed - # SW Shipment = # SW Pirated

# SW Pirated ÷ # SW Installed = Piracy Level

(# SW Installed - # SW Shipment) × Average Wholesale Price of SW = Piracy Loss

---

5 Source: Seven Annual BSA Global Software Piracy Study, 2002
Appendix C

Computing Producer Pricing Index\(^6\)

Producer Pricing Index (PPI) is created based on the survey on producers in each industry. For any given industry, producers are selected for the survey via a systematic sampling from a listing of all firms that file with the Unemployment Insurance System. After a firm is selected and agrees to participate in the survey, a probability sampling technique called disaggregation is used to determine which specific products or services will be in the PPI. The formula used to calculate the PPIs is a modified Laspeyres index. The Laspeyres index compares the base period revenue for a set of goods to the current period revenue for the same set of goods.

The following formula closely approximates the actual computation procedure:

\[
I_i = \left( \frac{\sum Q_0 P_0 (P_i / P_0)}{\sum Q_0 P_0} \right) \times 100
\]

Where:

- \(P_0\) is the price of a commodity in the base period;
- \(P_i\) is the price of a commodity in the current period; and
- \(Q_0\) is the quantity of the commodity shipped during the base period. In this form, the index is the weighted average of price relatives (price ratios for each item = \(P_i / P_0\)). The expression \(Q_0 P_0\) represents the weights in value form.

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