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Software Piracy: A critical survey of the theoretical and empirical literature

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Abstract

As devices that used software became available to the masses the problem of software piracy arose. Recent theoretical works modeled the software piracy phenomenon; others tried to empirically explain the determinants that can explain this phenomenon. Empirical literature in the latter case is still in it´s infancy. This chapter reviews the theoretical literature focusing on three major models, those that deal with diffusion models, network externalities and with game theory. It also presents the empirical literature in which we identify eight stylized results that reflect key variables across five macroeconomic dimensions that explain software piracy: Economic, Cultural, Technological, Legal and Educational dimensions.

Keywords: Software Piracy, *Copyright, Intellectual Property Rights*

JEL classification: C50, C70, D85, L86, O34

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1. Introduction

Technology has evolved over the years, being present in almost anything that we use, one example of these are the computers and the Internet. Computers and the Internet play an important role in our lives; they increase productivity of firms, turn easier the lives of households, allowing for instance, home banking or online purchases. Other examples can be added; perhaps one of the tools that significantly improved productivity of firms was the replacement of the typewriter by the computer, this device was used since the 19th century, Christopher Sholes developed the first modern typewriter in 1866. Other devices have beneficiated with these developments and with miniaturization of components. Examples are the mobile phones, tablets, consoles, etc.

These devices cannot run without software, only with it can we use their full potential. An operating system will start these machines, but tools such as Microsoft Office to produce professional documents are also needed, which can increase the initial price. Software and hardware are protected by Copyright laws. It is in the first case that these copyright laws must be better enforced, due to the nature of the software: i) it can be reproduced at almost no cost, with the same quality as the original, ii) it is easily modified by hackers that beat the protection barriers and iii) it is easily distributed.

Software piracy occurs when there is an unauthorized use, duplication or sale of commercially available software (Moores & Dhillon, 2000) that is protected under national or international copyright laws. This piracy can come in many forms[1]. Software piracy affects profits of firms because potential software units are not sold, additional to this it can affect levels of employment. Annually *Business Software Alliance* publishes estimates of piracy losses and rates for a large group of countries. At the moment these estimates are one of the most reliable ones. Nevertheless the full methodology is not publicly available as it uses confidential information provided by its members (Adobe, AVG, Intel, Microsoft, Symantec are some of the members; they cover both the hardware and software industry). These estimates have been widely used in empirical works to analyze the underlining factors that affect software piracy, see for instance (Andrés, 2006a).

[1] Softlifting: purchasing a single licensed copy of software and loading the same copy onto several computers, contrary to the license terms; Internet: making unauthorized copies of copyrighted software available to others electronically; Software counterfeiting: the illegal duplication and distribution of copyrighted software in a form designed to make it appear to be legitimate; OEM unbundling: selling stand-alone software that was intended to be bundled with specific accompanying hardware; Hard disk loading: installing unauthorized copies of software onto the hard disks of personal computers, often as an incentive for the end user to buy the hardware from that particular hardware dealer and Renting: unauthorized rental of software for temporary use, like you would a video.

We must separate two types of piracy, the commercial type in which we buy a DVD from the black market, in this case the reseller has profits and compete with other firms (the competition is asymmetrical[2]); and the end-user piracy, consumers will use software at home, software is not sold to others. Commercial piracy is a form of counterfeiting; it can be used both in hardware and software industry. There are some actions that firms can implement to protect software, one is in the courts enforcing anti-piracy laws, others actions can involve updating the programs, introducing mechanisms that can detect pirated products making them unusable to the user.

Due to the recent importance of software piracy because of the digitalization of the economy the main goal of this chapter is to provide a comprehensive survey of the theoretical and empirical literature that will serve as the building blocks for future empirical studies that is still in it´s infancy. The main conclusions of the empirical works are summarized in a series of eight stylized results.

This work is built upon the recent works of Peitz and Waelbroeck (2006b) that did a critical review of the recent theoretical literature that addresses the economic consequences of end-user copying. And more recently Belleflamme and Peitz (2010) were it is reviewed the theoretical developments made on the subject of digital piracy, in which software piracy is included.

The chapter is organized as follows; section two reviews the theoretical literature focusing the main strategies adopted by authors to model this problem which are diffusion models, network externalities and game theory models. In section three the empirical literature on software piracy is reviewed, describing the stylized facts, finally section four concludes.

2. Theoretical Literature

Different studies from different areas of knowledge present important conclusions for the firms, software developer, consumers and Governments. These agents are important to prevent piracy; they can enforce *Intellectual Property Rights Protection*, can deter consumers from using illegal software through positive incentives (e.g. inclusion of printed manual with legal software) or negative incentives (e.g. increasing penalties from using illegal software, these penalties can range from fines to prison). This section focuses on three theoretical methodologies.

[2] Some authors that model this phenomenon are Peitz and Waelbroeck (2004); Peitz and Waelbroeck (2006a); Duchêne and Waelbroeck (2005) and Zhang (2002).

The first theoretical model considered will be the diffusion model (see Bass (1969)); we introduce this model because it can predict potential sales of software or potential software piracy.

Another type of models analyzed will be the ones that introduce network externalities. A network effect can be defined as the additional benefit that a consumer retrieves from a product as more consumers use it. For example a single consumer of an operating system has little technical support, as others start also to use it, more technical support is introduced which beneficiate all users, this can be seen as an advantage. As the use of this type of software increases it also increases the probability of virus; when a person or a "team" develops one, their only objective is to maximize damage. Many pirated software which are downloaded from the Internet sometimes bring unwanted "presents" in the form of Trojans or Virus, they attack computers that run Windows operating systems. As the number of consumers increases, some will purchase illicit software, nevertheless the majority will purchase licit software; based on Givon, Mahajan, and Muller (1995), some of pirates will purchase software in a later period.

Models that use game theory can model the behavior of consumers or firms; it is defined as "the study of mathematical models of conflict and cooperation between intelligent rational decision-makers" Myerson (1997). These models allow policymakers to optimize the degree of software protection. Two of the most common representations of game theory models are in the extensive form and in the normal form. In the first case the policymaker draws a tree, the different branches represent the different outcomes of the game, and moves of players are sequential in time. The normal form is represented by a matrix which shows the players, strategies and payoffs. One example of this game is the prisoner's dilemma used in Economics. Other games that are more complex, e.g, have more players and many periods must be implemented mathematically.

2.1. Diffusion Models

We start our analysis by describing the diffusion model first proposed by Bass (1969)**.** This model describes the process of how new products get adopted as an interaction between users and potential users; it models the behavior of the innovator and imitators. Since its publication in 1969, many extensions were introduced; one example was the introduction of prices in the model. The Formula for this model is given by

$$N_t = N_{t-1} + p(m - N_{t-1}) + q\frac{N_{t-1}}{m}(m - N_{t-1}) \quad (1)$$

where m is the market potential, p is the coefficient of external influence, q is the coefficient of internal influence and N_t is the number of companies or consumers at time *t*. Mass media coverage of a certain software product affect *p,* while q is affected by "word-of-mouth" or other influence from those already using the product. Knowing the parameters of interest, we can use this model to forecast the potential use of products. Sultan, Farley, and Lehmann (1990) found that the average value of p is 0,03 and q is 0,38, with this results, this model could be implemented in many areas such as marketing or management.

With known parameters, this model could be applied to the problem of software piracy. Givon et al. (1995) used a diffusion model based on Bass (1969) that could track shadow diffusion (e.g. piracy) and legal diffusion over time. This model is applied to word and spreadsheet software in the United Kingdom; it is analyzed what are the effects of word –of-mouth and pirates. Results show that pirates were responsible for piracy (piracy rate was very high), but at the same time generated more than 80% of software buyers. Shadow diffusion (which is imitation) positively affects legal diffusion (which is innovation). A consumer that pirates today can in the future purchase software. Prasad and Mahajan (2003) also find evidence that controlling piracy or software price can be used to promote sales.

More recently Liu, Cheng, Tang, and Eryarsoy (2011) developed an analytical model that embodied recent empirical findings on software diffusion. The model is constituted by innovators that are influenced by external factors (e.g. reviews, parameter *p*) and imitators that buy the software because of word-to-mouth influence from previous owners of software (parameter *q*). Results show that depending on the pricing schemes, a lower demand of innovators implies a higher profit from implementing multiple price schemes[3].

Summary: Having the ability to control piracy led to several important results: i) the effect of piracy on legal sales (which was positive); ii) track piracy over time and iii) the ability to optimize how many prices can a product have and still manage to obtain a high profit for the firm.

2.2. Network externalities

Network externality have been studied by some authors like Conner and Rumelt (1991), Takeyama (1994) and Slive and Bernhardt (1998). They argue that with the presence of

[3] Windows 7 has various versions; Basic, Home Premium, Professional and Ultimate. Each of these versions has different prices (www.windows.com).

network externalities it is profitable for software developers to allow some degree of piracy. Network externalities affect the valuation that consumers make of software as the value of it is dependent on the number of users. An example of a productivity tool that beneficiate with this effect is the Microsoft Office. Other examples are econometric tools that beneficiate with the increase use of users; some of these will develop programs that will permit compute additional econometric models not initially available with the program.

Authors such as Poddar (2002) tries to show that the existence of externalities cannot be generalized as the only explanation for the existence of software piracy when there is commercial benefit in using illicit software, e.g. more access to information won't necessarily mean more illicit software sold. A model is developed to show that even with network externalities; it is optimal to protect software instead of allowing some piracy. It is assumed the existence of three types of consumer, one that buys, one that pirates and other that do not use any software. It is shown that having the option of protection and non-protection, it is always profitable to protect with or without network externalities. Other argue (see Rasmussen (2003)) that with network externalities, some degree of piracy is beneficial for a software monopoly company (e.g. Microsoft and Apple). The level of network effects explains the degree of protection. With a high level of network externality it is beneficial to lower protection. In a monopoly, market competition induces firm to choose a low level of protection.

Summary: When software piracy is for personal use, network externalities are beneficial, but when this illicit behavior has a commercial nature, even with network externalities software piracy is not efficient. One example is illustrative of the benefits of a network externality on a software: as the number of consumers increase, valuation of each one increases because more technical support becomes available. Some degree of piracy is beneficial to Companies as some of these will purchase the software in a later time.

2.3. Game Theory Models

Levels of software protection vary, game theory models allow to model which level of protection is appropriate for a given software. Altinkemer and Guan (2003) develop a game theory model to analyze firms' protection strategies for online software distribution. The basic setup of the models is as follows; there is a software market and two firms *A* and *B* present in both periods. Each firm produces software in period one *s1* an upgrade version in period two *s2,* they both maximize profit. Consumer purchase in each period, one unit of

software and the quality of the pirated software is assumed to be the same as the original ($Q_p = Q_o$). This assumption is not far from the truth, in order to software to run it is necessary all components; one single line of code can make the software unusable. Additional to these two firms a firm that pirates firm's *A* software is introduced *AP* that behaves the same as firms *A* and *B*.

Piracy is present in period one when the price of *AP* is between firm *A* and *B*, in this situation firm *B* has higher pricing power in period one but the combined market share of firm's *A* products (legitimate and pirate) is larger. A firm that protects the software has more pricing power that a firm that do nothing. In period two, two scenarios can occur; pirate software stays in the market or disappears. In the first case price of firm *A* is always lower than firm *B*, when pirate software disappears and if firm *A* has many costumers in period one, a higher pricing power in period two will be achieved. Sometimes it is beneficial to allow some piracy of their products, knowing that in the future consumers will be locked to that software. When possible, firms implement protection with updates that find pirated products and influence pirates to purchase the software.

A group of software's that suffers from piracy is the video-game industry. Gürtler (2005) considers both software and hardware game industry. Home consoles can be modified, losing they warranty, this modification allows the use of contents other than games. Additional to this, games must be hacked in order to be reproduced in a DVD or Blue-Ray. Some firms make games and consoles, while others sell only games for those systems. Consoles can be expensive but they are purchased only once; one the other hand games are constantly being purchased. Some firms can allow some piracy, with this they increase profits that comes from the hardware. In the theoretical framework developed by Gürtler (2005) there are four firms, two competing in the market of hardware and video games (*F1* and *F2*) and two firms compete only in the market of video games (*F3* and *F4*). With complete market covering e.g. consumers choose to purchase hardware and software, both firms have the same probability of being affected by software piracy (they set the same level of protection); with partial market covering e.g. some consumers will not purchase software at all *F1* chooses the lowest possible level of copy protection.

Alliances such as *Business Software Alliance* implement policies to deter piracy and its findings can influence anti-piracy laws. Jaisingh (2009) analyze how innovation with piracy is affected by policies implemented by these alliances. He develops a model in which there are three agents; a firm that develops the software, a pirate that creates an

illegal copy and an alliance such as *Business Software Alliance* that implements anti-piracy policies. Firms and consumers share the market, being the consumers heterogeneous, which will depend on ethics and the cost of piracy. Depending on the quality and the level of policy implemented by the *Business Software Alliance*, the firm can choose to set a low price to make unprofitable (low policy) to pirate or a high price allowing some piracy (high policy). It is possible to increase the surplus of legal users allowing at the same time firms to maximize its profits, this will depend on the bargaining power of both Governments and the *Business Software Alliance*. When *Business Software Alliance* set an aggressive policy against software piracy, making the perceived cost of using illegal software higher by the end-users; this aggressive policy in some cases will increase software piracy and decrease software quality.

Summary: These models allowed determining the optimal level of protection in the presence of piracy. A firm can shift profits from the software to hardware products, in a first moment, allowing some piracy; then it is implemented more protection in the form of hardware protection or software updates. Protection in the Software and Hardware is important to deter piracy.

3. Empirical literature

Empirical literature has used the estimates provided by the *Business Software Alliance* to explain the phenomenon of software piracy; one measure that is present in all the studies is the *Gross Domestic Product per capita (GDPpc).* Several approaches were used: surveys using respondents from universities and in the labor market; longitudinal/panel studies and cross sectional studies, the last two rely on macroeconomic data. Results presented by these studies are very important, complementing each other and at the same time they provide actions for policymakers.

Empirical literature that uses surveys can obtain richer results, being able to model each parameter (age, sex, income), but it relies on the willingness of the respondents to answer truthfully, even if the inquiry is anonymous, due to the nature of the crime they may sometimes underestimate responses. Surveys are used in a particular group of the population (students, business users) in a particular city. Many questionnaires rely on a likert scale[4]. When respondents answer questions it is possible that they go to the extremes

[4] A Likert scale is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research, such that the term is often used

or the middle, neither agree nor disagree, which can be sometimes a problem. In 2010 *Business Software Alliance* with the help of *IPSOS* performed a survey on 15000 computer users[5] to measure the commercial value of unlicensed software and the piracy rates.

When surveys are implemented they suffer from a population bias problem which can influence the main findings and extension of results. These studies covered specific population, students Gopal and Sanders (1998), Butt (2006), Higgin (2006) and Gan and Koh (2006); business users Lau (2004). To overcome these problems authors such as Gopal and Sanders (1998) and Holm (2003) used a cross sectional model that explained the phenomenon at a country level, complementing the results from the surveys.

Several factors can influence questionnaires, from the group of people surveyed, age, sex and location of the survey. Among the questions which can be asked are the following:

-Do you use pirated software and how often do you use it?
- Do you use legal, illegal or open source software?
- Income plays an important factor in the choice to pirate?
- Culture, education or legal system plays an important factor in this decision?

These four examples can measure many influences at the same time that cross-sectional or panel data analysis miss. The location in which the survey is made can affect results, Lau (2004) conducted a survey in Hong Kong, which is a place with one of the highest piracy rates compared with the Western Europe (33%), North America (21%) and the European Union (35%); in 2010 the piracy rate was 45%. The main conclusion of this study is that knowledge of software copyright law and availability of original software have direct effects on self-reported leniency towards software piracy.

Being the empirical literature an important source for both policymakers and researchers, being at the same time still in it´s infancy, we compile the major macroeconomic findings found by previous authors. Several dimensions have been found to affect piracy: Economic, Cultural, Educational, Technological and Legal dimensions; these will be discussed on the next subsections.

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interchangeably with rating scale. Usually it is divided into 5 scales: 1. Strongly disagree, 2. Disagree; 3. Neither agree nor disagree; 4. Agree and 5. Strongly agree. See http://en.wikipedia.org/wiki/Likert_scale

[5] For more information see http://portal.bsa.org/globalpiracy2010/

3.1. Economic dimensions

Stylized fact 1: Gross Domestic Product per capita affects negatively software piracy.

Income affects the decision to purchase or to pirate by the consumers or firms. One measure that is present in many studies on the determinants of software piracy is the *Gross Domestic Product per capita*. Some examples are Gopal and Sanders (1998), Marron and Steel (2000) and Goel and Nelson (2009). The results show that an increase in income can decrease software piracy. Other measures can be used that reflect the levels of income of a country; Holm (2003) used the *Gross National Income per capita (GNIpc)* and obtained the same results. Levels of income are heterogeneous among countries, furthermore, many software products are sold at the same price across countries; examples are movies, video-games and music. Shin, Gopal, Sanders, and Whinston (2004) split the *GDPpc* into two subsamples, one which represents income less than 6000$ and one that represents more than 6000$. In countries that have *GDPpc* less than 6000$, income affects negatively software piracy (-0.0032), but when *GDPpc* is higher than 6000$, this negative effect becomes marginal (-0.0008). This result indicate that on households that have more disposable income the fraction of their income that is allocated to software is reduced, on the other hand, when the income is low this fraction increases. Increasing income on households with less income will result in less software piracy.

Stylized fact 2: Income inequality measured by the GINI index affects negatively software piracy.

Additional work was done in explaining these differences using the *GINI* Index. To check this, Fischer and Andrés (2005) used a sample of 71 countries to analyze the relationship between income distribution and software piracy rates. To analyze this income inequality it is used quintile shares. This quintile analysis is divided into three classes, Q1 is low income class, Q2-Q4 is middle income class and Q5 is upper income class. Software piracy is a middle class crime in Latin America, Caribbean, East Asia and the Pacific Regions. Software piracy is a crime committed by middle and lower class in the Central Asia and Eastern Europe and is an upper class crime in Western Europe and North America. In a recent study, Andrés (2006b) using a sample of 35 countries, income

inequality was found to be negatively related with software piracy, more equal societies have higher piracy rates.

This result was also found in a theoretical paper that tried to study differences of software piracy across countries; it is a theoretical one but provides information about variables of interest *(GINI index)*. Poddar (2005) developed a model that assumes that software firms undertake R&D to prevent piracy, which can be replicated with measures of IPR (*Intellectual Property Rights protection*). He considers three types of consumers, one that buys, one that pirates and other that do not use any type of software. These consumers are a simplification of the reality, each can at the same time use both legal and illegal software. A high income gap among users and low protection cannot stop software piracy, when this gap is reduced and with existence of some protection, it has a probability of mitigating software piracy. This result was studied by Fischer and Andrés (2005) and Andrés (2006b) using the *GINI* index, this variable "measure the extent to which the distribution of income among individuals within an economy deviates from perfectly equal distribution". A low value of this index represents an equal society while a high value represents an extremely unequal society. *Source: Key Indicators of the Labour Market (KILM):2001-2002, International Labour Organization, Geneva, 2002, page 704.*

Stylized fact 3: HDI affects positively software piracy

Software piracy can affect the development of a country, this sector gives jobs to thousands of people, but these jobs are not necessarily made available where we buy the software. It can happen that national companies outsource software development to countries with highly qualified labor force but with lower wages. Using a panel data combining three years (1995, 2000 and 2002), Bezmen and Depken (2005) study this phenomenon. The measure of economic development is introduced with the *HDI* (*Human Development Index*). They used an equation system, in the first equation, piracy rates was the dependent variable; in the second *HDI* was the dependent variable. This measure was used by Boyce (2011) introducing GINI index as well. In both works this variable had positive impact on software piracy rates.

3.2. Cultural dimensions

Stylized fact 4: Hofstede cultural dimensions explain levels of software piracy across countries.

The Hofstede cultural dimensions (see G. Hofstede (2004)) that cover several dimensions: power distance (PDI)[6], individualism (IDV), uncertainty avoidance (UAI)[7] and masculinity (MAS)[8]; represent "four anthropological problem areas that different national societies handle differently: ways of coping with inequality, ways of coping with uncertainty, the relationship of the individual with her or his primary group, and the emotional implications of having been born as a girl or as a boy"[9]. They allow a comparative analysis between the national culture and the levels of software piracy. Although this measure allows a rich analysis, it suffers some drawbacks as it does not vary over time, and the sample covered is not large. In 1991 it was introduced a fifth dimension, Long-Term Orientation (LTO)[10], this dimension was developed by Minkov (2007). More recently in 2010 it was introduced a sixth dimension, Indulgence versus Restraint (IVR)[11], developed by Geert Hofstede, Hofstede, and Minkov (2010).

Nevertheless, several authors used these dimensions to explain the levels of software piracy rates across countries. Some examples are Marron and Steel (2000), Moores (2003), Shin et al. (2004)[12] and Kovačić (2007). These studies used a cross sectional analysis, covering at most 72 observations. Results show that individualism is negative and significant. Additional to this, Masculinity has a negative value and power distance a positive value. Other studies analyzed the effect of religion on the decision to pirate, Al-Rafee and Rouibah (2010) found that religion factors affect the decision to pirate.

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[6] This dimension expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally

[7] The uncertainty avoidance dimension expresses the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity.

[8] The masculinity side of this dimension represents a preference in society for achievement, heroism, assertiveness and material reward for success.

[9] http://www.geerthofstede.nl/

[10] The long-term orientation dimension can be interpreted as dealing with society's search for virtue.

[11] Indulgence stands for a society that allows relatively free gratification of basic and natural human drives related to enjoying life and having fun.

[12] These authors used collectivism which is the opposite of individualism. The high side of this dimension, called Individualism, can be defined as a preference for a loosely-knit social framework in which individuals are expected to take care of themselves and their immediate families only. Its opposite, Collectivism, represents a preference for a tightly-knit framework in society in which individuals can expect their relatives or members of a particular in-group to look after them in exchange for unquestioning loyalty. A society's position on this dimension is reflected in whether people's self-image is defined in terms of "I" or "we."

3.3. Educational dimensions

Stylized fact 5:Overall level of Education affects negatively the levels of software piracy.

Education plays an important factor in the construction of the perception of an individual towards using or not legal or illegal software. Several questions are raised with this respect: (i) More education can affect the levels of software piracy? ; (ii) Education can bring an increase use of legal, illegal or both types of software? Several dimensions that relate to education can be used, from the literacy rate to the level of education attained. A challenge is posed on the availability of data for large group of countries. The World Bank has information on several dimensions related to education from the school enrolment ratio (primary, secondary, and tertiary), expenditure on education and years of primary and secondary schooling. The Eurostat provides a broader picture, introducing additional financial and not financial measures, but information is only available for a small group of countries (the European Union).

In spite of a broad range of variables available in this dimension, but due to data restrictions; cross-sectional analysis were implemented which restricted the analysis. This dimension has been studied by Marron and Steel (2000) and Andrés (2006b) with the introduction of average years of secondary education of people with more than 25 years old, results show that more education reduces software piracy. Goel and Nelson (2009) and Andrés and Goel (2011) used literacy rate, this variable has a positive sign. The statistical significance of this variable in the first study was at most 5%, in the second study significance was not achieved. Literacy rate omits the level of education attained; a person can be literate and have a low level of education, it omits the various ISCED (International Standard Classification of education) levels. Measures that reflect the specific level attained by person measured by the ISCED 1997 or ISCED 2011 classification and reflect the expenditure on education can improve results. Other measure that has been studied by MacDonald and Fougere (2003) is the inclusion of the word "software piracy" in textbooks. For this purpose he analyzes the MIS textbooks. Software piracy is present on 72% of the textbooks of ethics; Ethics is present in 67%, software license in 50%, copyright (50%) and Intellectual Property 39%. This is only an example of a particular field of knowledge; introduction of additional fields of knowledge such as Management and Economics could improve results.

3.4. Technological dimensions

Stylized fact 6: Types of software protection affects levels of software piracy. Choice of type of Internet access and associated services will depend on its price, availability and the utility given by additional services, which will affect the availability of software.

Before the rise of the Internet, software piracy was made with the replication of the original software to several pirated CDs or floppy-disks; protection was both in the software itself in the form of serial keys, some with many digits, and requiring a special number that was provided by telephone as an additional protection barrier. The hardware protection in PC software is present in the CD and not in the PC itself. It is often hacked with more or less effort.

There are different ways to protect software; some of these are License Keys and Product Activation[13] (Anckaert, Sutter, & Bosschere, 2004). Djekic and Loebbecke (2007) studies the influence of technical copy protections on application software piracy, following Gopal and Sanders (1997), Prasad and Mahajan (2003) and Anckaert et al. (2004), they distinguish between software-based and hardware-based technical copy protections. A survey is conducted using 219 professional users and an amateur group. Software based protection and hardware based protection are analyzed separately.

Personal context variables are always significant and positive. This context is represented by income, requirements of usage in the workplace and the intensity of application software usage. These variables affect more the amateur group. Software that is protected with license key or product activation is higher in the professional group while software that is protected with hardware protection is higher in the amateur group. This work shows that being able to work properly with software can affect their valuation of the software; the full capabilities and price of the software are understood. Some productivity tools like Photoshop can be pirated by home users but the full capabilities are not used. This can be seen by the firm as a loss, but this might not be true if we consider an

[13] One example is the Windows Genuine Advantage (WGA). It is an anti-piracy system created by Microsoft that enforces online validation of the licensing of several recent Microsoft Windows operating systems when accessing several services, such as Windows Update, and downloading Windows components from the Microsoft Download Center. In Windows 7, WGA is renamed Windows Activation Technology. WGA consists of two components: an installable component called WGA Notifications that hooks into Winlogon and validates the Windows license upon each logon and an ActiveX control that checks the validity of the Windows license when downloading certain updates from the Microsoft Download Center or Windows Update. http://en.wikipedia.org/wiki/Windows_Genuine_Advantage

inexperienced user. On the other hand if this software is used illegally at the workplace this is not true; it is a loss, the worker knows how to use the software at its full.

When the hardware protection and Software protection is overcome by hackers, the next step is to upload the software, which will depend on the type of Internet access and upload speeds. Hackers may use public Internet providers such as universities. Broadband Internet access plays an important role in the decisions to download legal or illegal software by potential pirates. One of the first studies in Europe that focuses on the demand for broadband Internet services in Austria focusing on residential consumers was conducted by Cardona, Schwarz, Yurtoglu, and Zulehner (2009). Using 3000 households and analyzing four types of Internet access: narrowband, cable, DSL and mobile they found that demand for DSL is elastic and cable networks are likely to be in the same market as DSL connections. This study must be contextualized; narrowband was the first to arrive and it is not an option anymore, the three remaining services will strongly depend on the development of the infrastructures. Since this study Internet services have evolved, in A1, an Internet provider in Austria, prices of Internet at speeds of 50MBPS and 100MBPS are 29,90€ and 44,90€ respectively.

Choice of alternative types of Internet access will depend on price, availability, but also the utility that consumers give to this service. Some are willing to pay more for the same service. Using a large sample of individuals, Rosston, Savage, and Waldman (2010) study this phenomenon, comparing experience users to inexperience users. In their sample, 5799 were experience users and 479 inexperience users, the willingness to pay is estimated which is represented by the marginal utility of changing from one service (Internet speed) to other service but with higher speeds. In this context an experienced user is a user that had used Internet more than twelve months. Several measures are included in their analysis; cost, connection speed, reliability, use internet away from home, watch high definition content, interaction with health specialists and being able to perform free videophone calls over the Internet. An experienced household is willing to pay 59$ for a basic service[14], 85$ for a premium service[15] and 98$ for a premium plus service[16], while an inexperienced user is only willing to pay 31$, 59$ and 71$ respectively for an improvement of these services.

[14] "Basic" Internet service has fast speed and less reliable service

[15] "Premium" service has fast speed, very reliable service and the ability to designate some downloads s as high priority

[16] "Premium Plus" service has fast speed, very reliable service plus all other activities bundled into the service

These results show that being able to work with Internet will affect its utility and that the willingness to pay for additional services depend as well on his utility.

These numbers reported here cannot be extended to countries in Europe; the willingness to pay in Europe would be far less than the reported by this study, infrastructures in Europe allow smaller prices and higher speeds. Each country has several Internet providers that cover a small geographical area while the USA has the same geographical are as Europe which can make difficult the development of infrastructures that allow higher Internet speeds. Prices for a service of home phone & Internet cost 37$; home phone, Internet & Wireless cost 89.94$ and Home Phone, Internet & TV cost 93.94$ for an Internet speed of 30MBPS in AT&T[17]. VOO, a Internet provider in Belgium offers Internet, Telephone and Television for 62,41€ for Internet speeds of 50MBPS and 81.96€ for 100MBPS[18]. With respect to mobile broadband Internet access, Portugal is ahead of countries such as the United States, both at speeds and prices. In the US, Verizon sells mobile broadband plans that range from 2GB-30$/Month to 10GB-80$/Month[19]. For the same Internet speeds, Internet providers in Europe offer a lower price than those in the USA. In the USA Internet speeds only reach 30MBPS while in Europe these speeds can reach 50MBPS or 100MBPS.

3.5. Legal dimensions

Stylized fact 7: Rule of Law affects levels of software piracy.

Some of the world governance indicators (*WGI*) that analyze several dimensions like the effectiveness of the legal system were used both in cross-sectional and panel data. They represent six dimensions, Voice and Accountability[20], Political Stability and Absence of Violence/Terrorism[21], Government Effectiveness[22], Regulatory Quality[23], Rule of law and

[17] http://www.att.com/gen/general?pid=11623&CI=CJ_AFFILIATE&RI=CJ1&RD=37922269&source=ECdAAT11600aff12A&CJPID=2432921

[18] http://www.voo.be/fr/pack/trio/

[19] http://www.verizonwireless.com/b2c/plan-information/?page=mobileBroadband

[20] Voice and accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

[21] Political stability and absence of violence measures the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including domestic violence and terrorism

Control of Corruption[24]. The rule of Law reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence[25] . Rule of Law was used by Andrés (2006a); Goel and Nelson (2009); Png (2010) and Boyce (2011) having mixed signs. Introduction of additional measures such as the Government effectiveness could improve results.

The use of the *WGI* have no significance if we consider homogeneous countries such as the European Union; small variations exist but they cannot explain this phenomenon. More recently Andrés and Goel (2011) analyze the impact that corruption has on the levels of software piracy; they construct a corruption perception index[26] that measures the level of corruption in a country. This measure is different than those provided by the World Bank[27]; this index is not available for many countries of the European Union.

Stylized fact 8: International organizations can prevent software piracy, enforcing copyright treaties, making pressure and improving software protection.

Software is Copyright protected, unfortunately it is often pirated; this piracy can come in the form of commercial software, corporate piracy or softlifting, which occurs when a software is copied to computers, violating licensing agreement. Due to the high market that software has (computers, tables, smartphones, consoles), this industry have been subject of several campaigns (on the Internet, journal, etc.) to deter potential pirates. Nowadays *Business Software Alliance* serves as a group pressure to ensure property rights protection. These can come in the form of trade secrets, patents, licensing, copyright, civil liberties (they grant civil rights to software owners) and criminal liabilities. Unfortunately not all countries offers strong property rights protection, examples of these are countries with piracy above 80% that are present in the least developing countries (Africa, Latin

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[22] Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

[23] Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
Code

[24] Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

[25] http://info.worldbank.org/governance/wgi/index.asp

[26] This Index is measured as: $CPI_{index} = \log\left(\frac{10-CPI}{CPI}\right)$, higher values means higher corruption.

[27] They consulted the www.transparency.org webpage in order to make this alternative index.

America). On the other end, there are countries that protect software such as the USA; the piracy rate is only 20%. (See Clifford and Jin (1997)).

The exponential growth of the information society led to a necessity of protection of the owners of these advances (hardware industry and software industry). Countries must implement protection mechanisms. Shadlen, Schrank, and Kurtz (2005) study in what extend software protection is sufficient to deter piracy. Many Companies like Microsoft have his headquarters in the US, but sell the products worldwide. At home they are protected by strong intellectual property rights laws; the problem arises when dealing with countries that don't have this type of protection and do not signed international treaties or do not make part of international organizations. They analyze the direct pressures exerted by the US (US Special 301[28]), for the foreign countries to increase or to exert more efficiently intellectual property rights protection. Bilateral Political Pressures, TRIPS[29] and Trade dependence on US can explain the levels of piracy in these countries. Software protection must be accompanied and legislated by international organizations.

Countries which make part of international organization have power to propose actions to protect their domestic market. Andrés (2006a) constructed an index of copyright protection for the European Union that measures in what extend software is protected. Within the European Union each country must transpose Norms and Directives that deal with copyright laws, some room is left for each country to legislate. It is difficult for an Index to capture all legal aspects; some cannot be quantified into numbers. For the construction of this index the author used two proxy's for the strength of software protection: i) membership in international copyright treaties, this variable includes the signatories of the Bern convention (1886), WIPO (1996) and TRIPs (1994) and ii) enforcement provisions which is a measure of severity of punishments (jail, fines) and how these laws are being applied (Ostergard, 2000; Samuelson, 1999). In the absence of theoretical background the author uses the same weight for each country. It is used a panel data analysis using 69 observation for 1994, 1997 and 2000. Fixed effects model was adopted; the Index had negative effects, which means that a lack of protection can increase

[28] The Special 301 Report is prepared annually by the Office of the United States Trade Representative (USTR) under Section 301 as amended of the Trade Act of 1974. The reports identify trade barriers to US companies and products due to the intellectual property laws, such as copyright, patents and trademarks, in other countries. Each year the USTR must identify countries which do not provide "adequate and effective" protection of intellectual property rights or "fair and equitable market access to United States persons that rely upon intellectual property rights". http://en.wikipedia.org/wiki/Special_301_Report

[29] Agreement on Trade-Related Aspects of Intellectual Property Rights

piracy. This index constructed was based on homogeneous countries that must obey minimum rules set by the European Commission.

International organizations are important to enforce Intellectual Property Rights; examples are the WTO (World Trade Organization and WIPO (World Intellectual Property Organization). Dordi (2008) analyzes the improvements made, namely the road that resulted in the ACTA (Anti-Counterfeiting Trade Agreement)[30]. In the European Union, Regulation 1383/2003 and the Directive 2004/48/EC provide a good level of enforcement of intellectual property rights. The final version was published on April of 2011, being not yet in force[31]. This treaty has a problem of not including developing countries.

When macroeconomic data is available on variables such as the type of legal system Goel and Nelson (2009), effectiveness of courts and legal implications, econometric methods such as OLS (ordinary least squares), FE (fixed effects) or RE (random effects) are used; but these variables miss the behavior of each potential software consumer. To empirically analyze this behavior a survey is implemented that allow a richer analysis. Using a sample of students at a leading college of business administration summing 319 observations, 190 females and 129 males, Al-Rafee and Rouibah (2010) studied the impact that religious factors, awareness factors and legal factors has in decision to pirate. The author splits the group into four treatment groups performing a pre and post questionnaire. The control group that reflects the unchanged behavior, legal and awareness groups are supported, the religious group is rejected. Awareness and religion factors have impact on the decision to pirate; legal factors was not significant. More information on legal consequences of violating property rights will lower piracy.

These results support that our perception evolves over time, being the most important factor the awareness of penalties related to violation of property rights. In a cross sectional data the results that relate to awareness factors and legal factors can be implemented with the world governance indicators, namely the rule of law and government effectiveness.

[30] The Anti-Counterfeiting Trade Agreement (ACTA) is a multinational treaty for the purpose of establishing international standards for intellectual property rights enforcement. The agreement aims to establish an international legal framework for targeting counterfeit goods, generic medicines and copyright infringement on the Internet, and would create a new governing body outside existing forums, such as the World Trade Organization, the World Intellectual Property Organization, or the United Nations.

[31] The Negotiators where: Australia, Canada, the European Union, Japan, Mexico, Morocco, New Zealand, Korea, Singapore, Switzerland and the United States and the signatories where the United States, the European Union and 22 of its Member States, Australia, Canada, Japan, Morocco, New Zealand, Singapore, and South Korea.

More recently Hashim, Kannan, and Wegener (2009) extending the model of Beck and Ajzen (1991) of the theory of planned behavior[32] introduced an additional variable that is a message of anti-piracy.

The model proposed by Ajzen (1991) assumes that the individual has behavioral beliefs, normative beliefs and control beliefs that will affect its perception of the reality, the attitude towards the behavior, subjective norms and perceived behavioral control respectively. Each individual gives different importance to these factors, these affect its intention and behavior. The perceived behavior control can predict the behavior. In this survey, pirates will be nudged by this message and will not undertake deviant behavior. A survey was made on 218 undergraduates students at a large university in the Midwest region of the United States, out of these 218, 98 questionnaires presented a message of anti-piracy. They identify in witch circumstances an individual is susceptible to exogenous nudging from a software company. The anti-piracy message can affect the behavior of a software pirate.

Chtouki (2008) addresses the effects on Government and Law of this crime; depending on the legal systems, punishments are different. Portugal punish the crime of violation of property rights with prison until three years, depending on the severity of the crime or the perception of the infringing, the penalty will be set accordingly. European Union sets the basic copyright principles but leaves the rest to the Member-States. United States are more severe with respect to this crime. Availability of software affects the choice to pirate or not Lau (2004). Some software is released simultaneously worldwide, such as an operating system, other are that we must wait months until the official release in a country (video-games).

4. Conclusions

Software firms face the problem of software piracy, with the digitalization of content this phenomenon will only worsen. Firms suffering from this phenomenon will have difficulties promoting new jobs, profits are not taxed. This will lead to an overall increase in software price in order to maintain the same revenue. On the other side the "shadow economy" in which illicit software is sold will bloom and create jobs. To combat this,

[32] In psychology, the theory of planned behavior is a theory about the link between attitudes and behavior. The concept was proposed by Icek Ajzen to improve on the predictive power of the theory of reasoned action by including perceived behavioral control. For additional information see http://people.umass.edu/aizen/tpb.diag.html

Companies such as Microsoft sell their Office suit at different prices that attract even consumers with low valuation for their software.

Nowadays the only methodology that covers a large group of countries over a large period of time is the one provided by the Business Software Alliance. Over the years this methodology was improved with the introduction of more countries and consumers in the analysis. These estimates were used in empirical studies analysis, nevertheless the studies relied on small samples (in-cross section) and in the panel data analysis; few years were studied. Further research must be implemented considering these five dimensions. Empirical works can be extended to allow a disaggregated analysis in the educational dimension; education can be divided into ISCED 1997 levels, this disaggregation will help policymakers to better implement policies. Additional to this, more indicators that reflect the effectiveness of Governments must be used to analyze the laws and the legal system.

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