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On Infringements of Intellectual Property Rights

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Certified that the Thesis entitled

"On Infringements of Intellectual Property Rights"

submitted by me for the award of the Degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my work carried out under the Supervision of ----------
Professor Tanmoyee Banerjee

And that neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere / elsewhere.

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Contents

List of Figures :

List of Tables :

Chapter 1 : Introduction

Intellectual Property Rights (IPR) gives rights to a person over creations of his mind.[1] The exclusive usage right of the innovations by the inventor for a given period of time is what IPR ensures. IPR is broadly categorised into two genres. The first category protects the novel creation of artists and authors in form of copyrights that bars any form of imitation of their original work. Copyrights are usually imposed on information goods like books, musical compositions, paintings, sculptures, films and so on. The second category of IPR concerns industrial creation. Industrial inventions, innovative technologies are protected through issuance of patents that protects both the proprietorship right and retains the incentive of the producer to innovate further. Trademarks and industrial designs are another form of IPR protection granted to distinguish goods and services manufactured by one enterprise from another. Trade secrets are the last type of industrial product that is granted protection in the form of IPR in order to stimulate innovation.

The primary objective of granting IPR is to ensure legal justice to innovations and creations. However infringement of IPR is as conspicuously existent in real world as IPR itself. Infringement of IPR counterfeits original product and in that way both moderates the profitability of the original producer and minimizes the incentive to innovate. Thus, protection of IPR in the presence of infringement is a notable concern among the inventors and enterprises.

Protection of IPR however is not a modern day concept. It dates back to the 6th century BCE, in Sybaris, an ancient Greek state.[2] It supposedly gave an exclusive right to the bakers for

[1] https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm.

[2] Citation : Abdulrahman Abou Naja, History And Evolution Of Intellectual Property,18 August 2020, https://www.mondaq.com/trademark/977124/history-and-evolution-of-intellectual-property

their culinary invention for a year. The first formal intellectual property law signifying the first legal and institutional background of regulating ownership of knowledge was that for a Venetian statute in 1474 AD. In modern industrialised world the first international agreement to protect intellectual property was signed on 1883 at Paris Convention. The agreement covered exclusive usage rights over inventions (patents), industrial designs and trademarks. Further following a campaign by famous writer Victor Hugo, Berne Convention was held in 1886 to grant protection to literary and artistic work. The first international intellectual property (IP) filing was done on 1891 at Madrid Convention. It granted registration marks to the original works of the inventors. The Secretariats to administer the Paris and Berne Convention united to form the United International Bureaux for the protection of Intellectual Property (BIRPI) in 1893. Finally in 1970, BIRPI was transformed and World Intellectual Property Organisation (WIPO) came into force. WIPO is essentially a member-led intergovernmental organisation that granted exclusive rights to intellectual property owners. In 1974, WIPO became a specialised agency of United Nations and the member states of UN are entitled though not obliged to become members of WIPO. In 1978, WIPO launched the biggest till date international IP filing system called Patent Cooperation Treaty (PCT) worldwide. The General Agreement on Tariffs and trade (GATT) was established in 1947 to promote free international trade among the countries by reducing trade barriers of tariffs and quotas. The Uruguay round of GATT that continued from 1986 till 1994 was one of the most ambitious round of GATT that aimed to develop competence in unexplored areas like intellectual property, capital, services, agriculture and textiles. GATT was transformed into World Trade Organisation (WTO) in 1995 and a multilateral agreement was reached on protecting intellectual property which was named TRIPS – Trade-Related Aspects of Intellectual Property Rights. It was aimed to resolve trade related disputes over IP and formed

a uniform IP framework concerning innovation, technology transfer and social welfare. The primary objective of TRIPS is to reduce trade barriers, providing adequate protection to intellectual properties at the international level.

With the practise of free trade among countries and specifically between developed and developing countries in this digitalised age, infringement of intellectual property rights despite all the attempts and agreements, has amplified with time.[3] The Multinational organisations of both the developed and developing economies are facing huge losses due to illegal imitation of their products, both information and industrial.[4] To be precise, in the information good industry like music (physical and digital copies), books (physical and pdf versions), movies and games this threat of infringement is alarming. In this era of digitalisation, online platforms are playing the most prominent role, be it for social networking or shopping or financial transactions. The cost of such communications or transactions being minimalistic is boosting the online trend in an accelerating pace. Naturally, the platforms to provide these services are upgrading in days. Previously application software of a particular version was run for a substantial number of years, before being upgraded. However, now the rate of this up gradation has been paced to a maximum of few months. This accelerating online trend is undoubtedly pacing up the economic growth but not without glitches. The increasing incidence of piracy is one such glitch which is affecting the economies in more than one way.

Copying of information good seems to pose a trivial hindrance to the potential pirates. Such infringements are generally done in two levels – individual (end-user piracy) and

[3] Estimates of IPR infringement in international trade in 2016 reached to 3.3% of world trade, according to a study carried out by EUIPO and the OECD in 2019. Retrieved from 2019 Status Report on IPR Infringement. (https://euipo.europa.eu)

[4] The Intellectual Property Commission estimates that intellectual property theft in the form of counterfeit goods, trade secret theft, and pirated software costs the US economy $225 billion to $600 billion. According to intellectual property crimes statistics, that's about 1% to 3% of the US's GDP. Retrieved from (https://legaljobs.io/blog/intellectual-property-statistics).

commercial. In the former type, the pirates copy the information good at individual level and in the latter type some firms undertake the job of illegally copying the product and selling them commercially in the market. While piracy apparently seems to be a mere economic way of availing an information good, it has far fetching consequence on the individual's purchasing decision than it reveals. In both forms of piracy the profit of the original good producer is compromised at a large scale. A study that uses macroeconomic modelling shows that U.S. economy alone loses at least $29.2 billion revenue each year due to digital piracy.[5] From this data the magnitude of loses for the world economy, especially that of the developing nations where piracy is more widespread can be assessed. The MNCs adopts several techniques to protect themselves from such infringements like incorporating anti-piracy installations, practising product versioning, lobbying for stricter IPR regimes and so on. The present dissertation studies the infringements of intellectual property rights of information good in forms of product piracy both individual and commercial level, the economic as well as non-economic (cognitive) causes behind piracy and some policy prescriptions that can correct the profit level of the original good producer. *Banerjee et al.* (2008), *Alvisi et al.* (2003), *Cho and Ahn* (2010) and *Cremer and Pestieau* (2008), discoursed end-user piracy in detail with the relevant pricing strategy and quality choices of the incumbent firm, anti-piracy measures, government monitoring policy and so on. Alternatively *Banerjee* (2003,2005), *Banerjee* (2011), *Banerjee and Mukherjee* (2007) *Sanchez* (2010) discussed commercial piracy in detail with regard to the glitches encountered by the incumbent firm. The present dissertation studies product piracy in both forms incorporating both theoretical models and empirical verification. In case of end-user piracy, a monopoly market is considered which is infringed by end-user pirates. The behavioural aspects of the pirates are considered and their impact on

[5]Impacts of digital video piracy on the U.S. economy. (https://www.theglobalipcenter.com)

the price-quality strategy of the monopolist is studied with the help of a theoretical model. The next chapter that follows conducts an empirical study to validate the same behavioural aspect of end-user pirates as discussed in the previous chapter. The consequent chapter discusses commercial piracy in a duopoly market using a theoretical model and the quality choices taken up by the incumbent firm to increase their profit in presence of piracy. The following are the research questions that are relevant to the present dissertation which, to the best of our knowledge has not been considered earlier in any relevant literature.

- The issue of transaction utility which relates to the price differential between the original good and the pirated good has a prominent impact on the monopolist's (incumbent firm's) price-quality decision and has a significant effect on its profitability. This issue has been taken in consideration and a monopoly market infringed by end-user pirates has been theoretically studied.
- The behavioural aspect of transaction utility among potential pirates which is essentially a cognitive concern has been validated by conducting a laboratory experiment consisting of 209 subjects from different streams of Jadavpur University, Kolkata, West Bengal, India. The incorporation of transaction utility in the premise of end-user piracy is a novel concept as perceived while studying the relevant literatures.
- The practise of product versioning in the context of a heterogeneous consumer base in a duopoly market infringed by commercial pirates has been theoretically studied. Considering a stringent monitoring regime undertaken by government that increases the unit cost of production of imitated good by the commercial pirate, versioning regime has been compared with the benchmark model of no versioning, in terms of the incumbent firm's profit.

Summarising, the present dissertation focuses on optimising the incumbent firm's behaviour in the context of both end-user and commercial piracy. Cognitive motivation behind end-user

piracy has been considered to study its impact on the profitability of the incumbent firm. Finally the strategy of product versioning has been studied as a tool to combat commercial piracy.

Methodology

The dissertation implements different theoretic model of Industrial Organisation to analyse the product piracy problem in either a monopolistic market or a duopolistic market. Two of the consequent chapters use sequential game theoretic structure involving different economic agents like the incumbent firm, pirate (s), monitoring government and consumers. They are solved by backward induction method to obtain the Sub game perfect Nash Equilibrium (SPNE). The chapter concerning the empirical study uses standard logistic regression model with clustered standard error at the individual level and standard software package of STATA 15 has been used for analysing the results obtained.

Organisation of Chapters

The rest of the dissertation is organised in the following way. The next chapter namely '***Review of Literatures***' includes a detailed review of the relevant literatures. Literatures on both end-user and commercial piracy with their respective impacts on the price-quality decision of the incumbent firms as well as on their profitability have been studied and reviewed in detail. Both the theoretical and empirical literatures have been reviewed in separate segments. Issues like product versioning as a tool to combat product piracy and transaction utility working as a motivation behind practising piracy have also been studied with their respective literatures.

Chapter 3 entitled '***Transaction Utility of End-User Pirates***' studies the behavioural motivation of transaction utility which depends upon the price differential between original good and pirated good behind practising end-user piracy in a detailed theoretical structure.

Chapter 4 entitled as '***An Experimental Understanding of Transaction Utility in End-User Piracy***' encompasses a laboratory experiment to validate the existence of transaction utility. The survey results are further analysed by econometric tool of standard logistic regression model.

Chapter 5 namely '***A Theoretical Analysis of Product Versioning in the context of Commercial Piracy***' studies the efficacy of the strategy of product versioning by an incumbent firm producing an original good in the duopoly market infringed by commercial pirates.

Finally chapter 6 gives the detail ***conclusion*** of the present dissertation.

Chapter 2 : Literature Review

As discussed in the previous chapter, infringement of IPR in the form of piracy can be practised in two forms – end-user piracy and commercial piracy. For the former, the pirates copy the original product individually in an illegal manner over any digital platform and for the latter a firm illegally reproduces the good and sells commercially in the market. However, for both the forms of piracy the profit of the original good producer is hampered. Hence, in the presence of piracy threat, it is easily intuited that the original good producer would optimise their price-quality strategy so as to maximise profit in the infringed market. Thus, the behaviour of the incumbent or monopolist firm which produces original good in the presence of piracy has provided a wide spectrum of discussion in the larger area of intellectual property right studies. In the present chapter, we have studied literatures dealing with both end-user piracy and commercial piracy and their respective impact on the optimal behaviour of the firm followed by their choice of equilibrium price-quality. Further literatures dealing with ways to combat piracy both at the firm level as well as the government level have also been vividly discussed in the present chapter. For the sake of convenience the literatures are broadly divided into two spectrums – end-user piracy and commercial piracy. Further each of the spectrums consists of a variety of both theoretical modelling and empirical researches. Thus, the related literatures are studied in the context of the present dissertation in a methodical manner.

2.1.1: Theoretical Literature on End-user piracy

The first group of literature discusses end-user piracy and its subsequent impact on the profit of the firm, welfare of the consumer and governments and firms' policy to fight it, if any. The

first few papers study the theoretical aspects related to end-user piracy and the latter papers discuss the empirical researches related to the same issue.

Slive and Bernhardt (1998) have shown an interesting result in their literature. A vertically differentiated market consisting of business consumers and home consumers is served by a monopolist whose marginal cost of production is assumed to be zero. A significant level of network externality has been assumed with different cost of piracy in terms of the penalty they pay if they get caught. The business consumers are assumed to have higher network externality and higher cost of piracy with respect to that of home consumers. In this context the paper develops a result where the monopolist is shown to allow piracy to a tolerated extent as it enhances its profit level. The paper suggests that in presence of sufficient network externality, the monopolist producing software wants to make piracy costless as if differentiating its product and selling the low quality product at price zero. However when network externality is relatively small, the manufacturer wants to make piracy costly so that it can deter the home consumers from pirating.

In his literature, ***Banerjee*** (2003) focuses on effect of network externality on end-user piracy. Further government social welfare maximising policy is seen to be the key determinate of the level of piracy in the market. Three price regimes have been distinctly studied – Bertrand, leader-follower and monopoly. Out of them, only the monopoly regime and the leader-follower pricing regime have given sub game perfect Nash Equilibrium (SPNE). The monitoring rate is presumably determining the existence of pirates in the market and social welfare is found to be decreasing in monitoring rate. Thus, the significance of social welfare parameter is that it determines the aggressiveness or passiveness of the government's monitoring strategy which in turn endogenously determines the piracy rate in the market. The reliability of pirated good in terms of quality of it is found to be yet another crucial factor in

determining the equilibrium. As increase in pirated good's quality increases piracy and thereby government's monitoring activity, monopoly outcome is determined at the equilibrium. However, in case of leader-follower regime the outcome is revealed to be not same. An increase in reliability factor of the pirated good is seen to increase the market share of the pirate and thus entry of pirate in the market is rendered to be the equilibrium situation.

Cremer and Pestieau (2007) have developed a theoretical model to study the impact of end user piracy on the pricing decision of the original good producer as well as on the welfare of the economy. The issue of enforcement policy regarding piracy control has also been analysed in the literature. The model assumes a non-linear pricing under three different regimes – one, where a profit maximizing monopolist produces and sells the original information good, the second, where a welfare maximizing monopolist produces and sells the same and the third where the original good is produced by the profit maximising monopolist but the level of piracy control is determined by the social welfare maximising authority. The consumer base is differentiated with institutional consumer, having rather a high valuation for the product and individual consumer having relatively lower valuation of product. The institutional consumers are assumed to be non-participant of piracy on account of their cost of reputation. But the individual consumers are assumed to have access to practice piracy with a tainted quality of the original at zero cost. Under the assumption of piracy enhancing social welfare, there are three levels of piracy control measures being observed. The highest control is observed to be in the case where the original good is sold by the profit-maximising monopolist. The next level of piracy control is chosen by the welfare maximising monopolist producing the original. Finally, the lowest level of piracy control is observed when the private monopolist sells the good and the welfare maximising public authority sets the control.

Lahiri and Dey (2013) theorises an interesting result in their paper. In a market that is infringed by end-user piracy the original good producer gets to decide the quality level of its good based on the level of anti-piracy enforcement. The market concerns a heterogeneous consumer base that varies across their valuation for the product. The pirated product is nothing but a degraded version of the original product and the degree of degradation depends upon the quality of the original product. The original good manufacturer is assumed to have zero marginal cost of production but quadratic cost of quality development. The cost of piracy is assumed to be same as the level of enforcement. In this structure it shows a counterintuitive result that quality provision of the original good manufacturer is a decreasing function of the enforcement level. Hence, it is seen that the optimal investment in quality increases as the level of anti-piracy enforcement is loosened. This result does not hold when the manufacturer successfully prevents piracy. This positive relationship between the level of piracy and quality provision of the original good producer is contradictory to most of the literature. The paper further shows that consumer surplus of the consumers who consumes the legal product is non-monotonically increasing in piracy cost or the level of investment. The paper thus contributes the result that piracy is always not a hindrance in case of quality provision of the original good or consumer surplus. The optimal level of enforcement determines the welfare maximising quality of the original version.

Some theoretical literature have shown that adopting the strategy of product versioning by the original good producing firm would enhance the profit in presence of end-user piracy. Thus, the following set of literature studies the optimality of product versioning strategy adopted by an incumbent firm to fight end-user piracy.

Alvisi et al. (2003) studied a firm's product differentiation strategy in the context of piracy. In their literature they have assumed a vertically differentiated market where the consumers are heterogeneous on the basis of two aspects. Firstly, they are assumed to have different preferences for quality and secondly, they vary across the cost of pirating where a high cost of pirating is associated with higher willingness to pay for quality. They have two interesting analysis which goes like the following. First, when the proportion of consumers with high cost of piracy is relatively low, product differentiation is shown to be a profitable solution by the monopolist to deter piracy. However when consumers are relatively homogeneous in the sense that the proportion of consumers with high cost of piracy is relatively high, product differentiation is found to be not as effective as the first case in deterring piracy. Thus the relative profitability of the product differentiation strategy depends upon the degree of consumer's heterogeneity.

Wu et al. (2003) observed that product versioning is an extremely effective measure to fight end-user piracy. For serving a heterogeneous market structure with high-end consumers and low-end consumers, the monopolist chooses to produce two version of the information good – with price - quality index $(P_1, 1)$ and (P_Q, Q). To restrict each of the segment of consumers from not buying the version designed for the other segment, two constraints are assumed. The high-end consumers will not choose to buy the low-end product if the net surplus from buying the former is higher than the latter or not purchasing at all. Similarly, the low-end consumers will also not choose to buy the high-end product if its net surplus from the former is higher. It shows that with zero marginal cost of production, it is optimal for the firm to produce a single version of product with the highest possible quality. It is further seen that the firm's optimal strategy will be to produce two versions of product if the proportion of high-end consumer is relatively high. Also, the optimal level of investment in piracy control is

seen to be inversely related to the proportion of high-end consumers. Another interesting result that is found from this theoretical study says that, when the common cost of piracy lies within the range of low-end consumers' valuation for the product and high-end consumers' valuation for the product, with proportion of high-end consumer relatively high, product versioning indeed enhances the profitability of the firm. The paper finally concludes that through product versioning a monopolist can increase its profit level by including two spectrum of consumers – firstly the ones with relatively lower valuation for the product, who would not buy without versioning and secondly the potential pirates. Further since versioning does not increase the cost of production of the firm, like legal enforcement or anti-piracy technical support does, it enhances the consumer surplus, hence the social welfare.

Cho and Ahn (2010) have worked on quality decision of the firm producing original good in the presence of piracy. In the literature they have assumed a heterogeneous continuum of consumers varying across their willingness to pay for the product. The development cost of quality has been assumed to be the only appreciable cost for the firm. In this scenario, it has been revealed that when there is no difference in quality between the original good and the pirated good and piracy cost is constant across all consumers, the H-type of consumer with relative higher willingness to pay for the product will be more inclined to pirate than to buy the original good. However when piracy cost is differentiated and defined by a range (d_H, d_L) the outcome is more interesting. When cost of pirating $d < d_L$, both types of consumers are seen to have an incentive to pirate. Again when $d > d_H$, none of the consumer group have any incentive to pirate. Finally, when, $d_L < d < d_H$, only the high type of consumer is found to have incentive to pirate. The interesting contribution of this paper includes that it reveals that in most cases the consumers with relatively higher willingness to pay for the product are more inclined towards piracy.

Wu and Chen (2014) tried to analyse whether versioning is an effective strategy for an information good producer to fight piracy. The paper assumes a monopolist which serves a market where consumers have reservation price for the product with quality index. The consumer base is therefore heterogeneous with high-type consumers with high reservation price and the low-type consumers with low reservation price. In this context, it is always optimal for the monopolist to produce single version of good at the highest quality level in the absence of piracy. However, in case of existence of piracy, when the cost of piracy lies between the low reservation (V_L) price and high reservation price (V_H) and also the proportion of high-type consumers is greater than or equal to the ration between low and high reservation price, the profitability of the monopolist is raised with versioning of the good.

2.1.2: Empirical Literature on end-user piracy

In this section the empirical literature on end-user piracy, their estimation, optimality of the monopolist in the given context, dominant socio-demographic and economic factors behind practising product piracy, deterrence techniques of product piracy, crowding out effect have been vividly discussed.

Peace et al. (2003) study software piracy behaviour by empirical research. A survey was conducted on a sample of working adults doing part-time MBA program of a mid- Atlantic U.S. University. The dominant factors affecting software piracy are individual's attitude towards software piracy, subjective norms of peers and perceived behavioural control. They further studied punishment severity as a tool to deter piracy and it has been noticed that certainty of punishment has a direct positive effect on the perceived behavioural control that deters piracy. It has also been found that higher software cost outweighs its benefits. When the

software cost is low, the gain from illegal copying is also low, acting as a deterrent to piracy. This supports the concept of transaction utility in the context of piracy where the price differential between the original and the pirated good seems to give an added utility to the consumer.

A further literature has been reviewed in context of piracy practised in music industry. ***Chiou et al.*** (2005) empirically studied a model to investigate the antecedents and factors ruling music piracy. The literature considered several hypothesis such as idolisation of singer, perceived prosecution risk, perceived social consensus affecting piracy attitude. Interestingly it has been observed that singer idolisation negatively affects illegal purchasing of music CDs while does not affect illegal downloading or copying of music files. This finding strengthens the prevalence of end-user piracy with respect to commercial piracy in the digital platform.

Pons and Garcia (2006) empirically analysed the effect of piracy on the legal demand of a good. The legal demand -

$$q_L^D = \alpha_0 + \alpha_1 y + \alpha_2 p + \alpha_3 z_1 + \alpha_4 z_2 + \alpha_5 q_I^D + x + u$$

is expressed as a function of income (y), price (p), cost of copying (z_1, z_2), illegal market demand (q_I^D) and other technological variables (x). On account of having two illegal markets for pirated goods – physical and online, cost of piracy is differentiated. The substitution effect of piracy across various forms for the original good has been shown to be significant, and relative prices shift legal demand. Furthermore, the literature does not support the viewpoint of piracy affecting legal demand positively. By applying 2SLS on data of music market, the paper concludes that the indirect effect of piracy on legal demand is known by substitution effect but the exact measure can only be approximated, since the data on volume of physical

piracy is known but not that on online mode of piracy. Thus, the result on crowding out effect of piracy becomes upwardly biased.

Borja et al. (2015) has considered music industry to study piracy among college students. They have considered socio-economic factors like peer pressure, annual income, demographic factors like age, gender, race and cognitive factors like perceived risk associated with piracy, risk-reward overconfidence and many more to study their impact on purchasing (pirating) decision of the consumers. Yet another booming trend of online music streaming has also been incorporated in the model to analyse the extent of music piracy. An empirical survey consisting of 197 subjects has been studied and it has been revealed that socio-economic and cognitive factors are important determinants of pirating decision of the consumer but demographic factors have been rendered to be inconsequential. The additional factor of music streaming which ensures legal availability of a large range of online music files against a nominal price being paid is absolutely of no relevance to reduce music piracy. Thus, social factors and cognitive factors of belief system are proved to be ruling the piracy decision of the consumers. An interesting finding of the literature suggests that subjects actively using music streaming heavily pirates music files. Thus the economic factor had been condensed to relative insignificance in the context of end-user piracy practised in music industry.

Arli and Tjipnoto (2016) study digital piracy behaviour and confirm that it needs to be explored from a combination of theories in order to address all its complexities. Internal factors like moral, attitude, perception of benefits are found to be more effective than external factors like punishment and legal consequences in reducing digital piracy. The study has been conducted in the context of Indonesian digital good market and the result gives that deterrence theory is less effective in exploring digital piracy in Indonesia. It has been further found that threat of legal

consequence and perceived likelihood of punishment are not significant antecedents of attitude towards digital piracy in Indonesia. The deterrent policy of the Indonesian government is found to be more focussed on supply side than on demand side. This insignificant effect of legal consequences and perceived likelihood of punishment have positively affected consumers' attitude towards digital piracy. Further factors like consumers' moral obligation, perceived benefits affects perceived behavioural control towards digital piracy.

Borja and Dieringer (2016) have done an empirical study to investigate the factors determining music piracy. Music streaming which is an online access to music files being provided to the consumers without actually downloading them is perceived to be complementing piracy in the music industry. In this context streaming serves the purpose of sampling before choosing the files to download illegally. Compatibility with technology and frequency of online activity are also found to be swelling incidence of piracy. Using a logit model on 1052 responses of the subjects from two universities in South Florida, they have revealed that streaming and piracy coexist in the context of music industry and in fact streaming service is an enabler of piracy, rather than being a buffer, as commonly perceived.

Phau et al. (2016) empirically examined factors behind digital movie piracy. Data collected from a large university in Western Australia shows that several demographic and economic factors are found to act as impetus to piracy while some social factors are found to not affect piracy decision at all. Factor like habitual conduct is seen to positively affect the rate of piracy among consumers committing serial offence of piracy. The act of piracy gives them a certain feeling of empowerment when they can evade punishment by committing a criminal act. This is a cognitive factor acting behind piracy. Poor moral judgement, lack of parental supervision are shown to affect piracy decisions among potential pirates positively. Self-efficacy is seen to be not significantly affecting piracy rate as act of piracy is easy and convenient to commit. Social factors like family and friends' influence are however found to

be not affecting a pirate's attitude significantly, thus supporting the neutralisation theory. Further it is seen that internet usage, internet time spent and internet speed do not act as moderators behind piracy.

The above reviewed literature made important contribution to the areas of optimisation of the original good producer's strategy in context of end-user piracy, comparative analysis of their profit, deterring techniques to prevent piracy, institutional enforcement to check piracy and to some extent the behavioural aspects behind practising end-user piracy in the information good market. However, the cognitive factor that arises from sheer price difference between the original product and the trivial copying cost associated with end-user piracy seems to give an additional utility to the potential pirates from the act of piracy, apart from acquisition utility. This concept can be compared to that of transaction utility which arises from the comparison of the price of a product with a reference price. The incorporation of transaction utility in the study of end-user piracy remains an unexplored area in the vast study of literature concerned, to the best of our knowledge. Thus, chapter 3 of the present dissertation aims to explore this novel concept of transaction utility in the context of end-user piracy and analyse its impact on the equilibrium price-quality of the original good manufacturer along with market share and profitability of the same. The consequent chapter 4 aims at validating this unique assumption of transaction utility in the context of end-user piracy through conducting a non-incentivised laboratory experiment with choices of purchase of either an original product or its pirated version.

2.2 : Studies on Commercial piracy

The following segment of the chapter discusses commercial piracy and issues related to it, both in forms of theoretical aspects and empirical research. Commercial piracy essentially represents a duopoly market where the incumbent firm produces the original version of the information good and the infringed firm illegally reproduces it and sells commercially in the market impeding the profit level of the former. The following literatures concern with discussion regarding the optimal strategy adopted by the incumbent firm in presence of commercial pirates and few of the literature deal with the empirical studies on them.

In his literature, ***Poddar*** (2005) attempts to reason out the difference in piracy rate across regions - underdeveloped and developed through a theoretical model. Both end-user piracy and commercial piracy are studied in the context of deterrence strategy adopted by the original good producer in terms of R&D. The premise of commercial piracy and end-user piracy differs on the ground of optimal strategic behaviour and deterrence activity of the monopolist firm. The paper focuses on the various aspects determining piracy rate, be it socio-economic factor like income gap or government's policy of deterring piracy or technological factor like quality of pirated good and concludes that piracy rate varies across these factors.

Banerjee & Mukherjee (2007) study entry-deterrence model in a duopoly market with an incumbent firm producing the original version of the good and a commercial pirate who infringes the market by illegally copying and selling the good. A positive development cost is assumed to be incurred by the incumbent while the pirate incurs a cost of reproduction in the form of purchasing devices that makes identical copies of the original product. In such a framework the incumbent can choose between two strategies – accommodating strategy and

entry deterring limit output strategy. There is existence of copyright protection in this model in the form of tariff imposed on the devices that illegally copies the product. The incumbent firm is seen to be choosing the accommodating strategy as the sub game perfect Nash Equilibrium (SPNE) when the copying cost incurred by the commercial pirate is relatively low. For relatively higher copying cost, the entry deterring limit output strategy is the SPNE. In the first case the incumbent firm produces a relative low quality good with low price in presence of copyright infringement. However in the second case, the relatively higher copying cost enhances the equilibrium product quality as well price of the product produced by the incumbent firm simultaneously negatively affecting the equilibrium quantity. However the threat of piracy is seen to be playing a crucial role in this model. In the absence of copyright infringement, the very threat of piracy induces the incumbent form (now monopolist) to produce the original product with a sub optimal level of quality. Naturally, the monopolist profit cannot be achieved even though the market is rendered monopolist solely due to the threat of piracy. Thus both the existence as well as the threat of piracy affects the equilibrium quality of the product produced by the incumbent firm negatively. It is further seen that the anti-copying measurement of tariff installed on the copying devices is effective only when the copying cost of the original product is relatively low and the tariff effectively increases the reproducing cost of the pirate. The effect of such anti-copying strategy on the consumer surplus and social welfare however remains ambiguous.

Banerjee et al. (2008) considers a duopoly market wherein an incumbent firm referred to as the monopolist produces the original good which the possible entrant firm copies illegally. The government is assumed to undertake monitoring activity and additionally the monopolist also chooses a level of protection in the form of anti-copying investment. The anti-copying investment when chosen above a critical level is found to deter piracy with certainty. In such

a context, the monopolist may adopt two strategy – either accommodating or aggressive. The monitoring rate of the government is shown to be endogenously determining the equilibrium level of output and anti-copying investment. When monitoring is socially optimal, the monopolist is seen to be choosing accommodating strategy by allowing a certain level of piracy. However when no monitoring is socially optimal, either of the no-copying strategy or accommodating strategy is chosen as the sub game perfect equilibrium by the monopolist. The literature asserts on a definite positive level of anti-copying investment is chosen by the monopolist in the equilibrium, in presence of an incumbent commercial pirate.

Sanchez (2010) considers a duopoly market with the incumbent firm producing the original good and the commercial pirate copying the good illegally and selling them in the market. There is a stringent monitoring government that penalises the pirate for copying the good illegally. The market is considered to be vertically differentiated by product quality and there is existence of price competition (Bertrand Model). In such a setup the paper attempted to analyse the role of the government and the incumbent firm in preventing the entry of the commercial pirate thus rendering the market monopolistic. The structure is assumed to be costless in the sense that the development cost of the incumbent firm is sunk cost and marginal cost of production and reproduction by the incumbent firm and commercial pirate respectively are zero. A sequential game is being played between the government, incumbent firm, commercial pirate and the consumers. At the very beginning the government announces the social maximising level of monitoring and the lump sum penalty rate. The commercial pirates observe the penalty rate and decide whether to act as a price leader or a price follower. If he decides to act as price leader the market remains duopolistic but if he decides to act as a price follower, he will decided whether or not to enter the market after observing the price set by the incumbent firm and there is a possibility that the market is rendered monopolistic.

Finally the consumers make their purchasing decision. With the help of backward induction method the game theoretic model is solved. The result shows that the entry decision of the commercial pirate depends upon the expenditure incurred by the government to carry out the monitoring activity. For a low level of government's expenditure, the pirate enters as a price follower and for a moderate level it enters as a price leader. However for a very high rate of 'g' the market becomes monopolistic as the pirate chooses to not enter. The optimum level of expenditure determined by the government depends upon the social welfare function which is instead a decreasing function of 'g'. The social welfare is diminished for government expending high on monitoring activity. Hence deterring the entry of commercial pirate entirely and rendering the market monopolistic is never the optimal strategy of the government as it reduces social welfare. Thus the government chooses the optimal monitoring rate depending upon the welfare maximising expenditure and that consequently decides the role of the commercial pirate as either the price leader or the price follower. The government may also choose the strategy of letting the incumbent firm set a low enough price to deter the entry of the pirate depending upon the technological for monitoring piracy.

Lu and Poddar (2012) worked reliability factor of pirated good working in favour or deterrence of piracy. It is a known fact that perceived quality and consequently price of pirated product varies across individuals on the basis of their heterogeneous demand. Hence, it is conventionally believed that more reliable the pirated good is, higher is the relative demand of pirated good and piracy rate is probable to increase. However, the actual relationship between these two factors has been revealed to ne non-monotonic and besides reliability, it depends on the nature of competition between the original good producer and the pirated good. Fascinatingly, the piracy rate is shown to be decreasing with an increase in the quality of the pirated good in case of commercial piracy. The role of IPR protection

strategy has also been revealed to be an important factor which plays a crucial determining role in determining the relationship between the two in the intermediate quality zone of the pirated product. Further the same relationship is studied in case of end-user piracy, where too it is revealed to be non-monotonic. When the nature of the competition between the commercial pirate and the original good producer is non-price, i.e. of quantity, the pirate enjoys the higher market share in relation to the scenario of price competition. In case of end-user piracy the survival possibility of the firm is found to be the least. The literature highlights the difference between the two regimes of piracy from a vital viewpoint of piracy rate in relation to quality of pirated good.

Kothari and Chowdhury (2015) developed a literature on quality differential between two firms in a duopoly market and its effect on the profitability of both the firms. It shows that with sufficiently large quality differential, monopoly profit for both the firma are relatively lesser than the duopoly profits. They reason out the same on the basis of reference dependence of quality. Reference quality refers to the perceived quality differential between a high quality product and a low quality product by the consumers. When the price differential between the two products exceeds the perceived quality differential between the products, a substantial rise in the price of the low quality product is seen to be increasing the profitability of the low quality product producing incumbent firm without any compromises in its market share due to polarization. Thus, reference dependence of quality is seen to be inflating the profit of both the incumbent and the entrant firm, thereby reducing the consumer welfare.

The empirical researches on commercial piracy are fewer to find on account of unavailable data source of the illegal activity of commercial pirates. Moreover commercial pirates are relatively easier to monitor than the wide gamut of end-user pirates, hence the incidence of

piracy is relatively lower in the former case. However, some literatures related to this issue have been studied and discussed in the subsequent chapters.

Ridwan et al. (2013) study the trend, pattern, dynamics and effects of piracy in video industry in Nigeria. A qualitative research model has been studied for this study where 42 respondents were interviewed and several relevant documents have been analysed as complementary sources of the research.

Few other literature like *Haque et al.* (2009), *Gunter* (2009), *Sudler* (2013), *Choi et al.* (2014) have notable contribution in the empirical researches done on piracy. However, in the present chapter, all the literatures that have been reviewed did not discuss the issue of product versioning strategy in the context of commercial piracy and as a way to deter it. Product versioning has proved to an important deterrent strategy in case of end-user piracy as discussed in the array of reviewed literature. But none of them discussed the same strategy in context of commercial piracy and its efficacy in deterring it. This seems to be an unexplored area in the context of study of commercial piracy.

Summarising the above literature review, the following points were noted

- None of the theoretical literature on end-user piracy contributed to the cognitive motivation behind practising piracy that streams from the price difference between two products – original and pirated. The concept is similar to the concept of transaction utility (***Thaler,*** 1985) which has not been incorporated in the study of end-user piracy. Chapter 3 of the present dissertation takes care of this issue and frames a theoretical model wherein a monopolist firm operates in a market that is infringed by end-user pirates who receives a transaction utility from piracy besides acquisition

utility. The optimal price-quality decision of the monopolist and impact on it when the degree of transaction utility derived from piracy increases, when the incidence of piracy increases and finally when the copying technique of the end-user pirates improves. All these have been theoretically analysed in this chapter.

- Since the assumption of transaction utility in context of end-user piracy is a new concept, the present dissertation attempted to validate the assumption with the help of a laboratory experiment in chapter 4. This chapter bridges the gap in literature on consumer behaviour related to product piracy by incorporating the concept of transaction utility in the piracy decision made by the consumers in a non-incentivised laboratory environment setup with no threat of punishment and similar technological facility for all participants.
- Finally chapter 5 of the present dissertation deals with the issue of practising product versioning in context of commercial piracy which has not been studied so far in any of the literature that has been reviewed. The chapter discusses policies adopted by the incumbent firm in the presence of commercial pirates to enhance its profit. The strategy of product versioning has been theoretically discussed as the factor determining the price-quality level of the original good (incumbent) firm. The profit level of the incumbent firm is analysed in both product versioning regime and no versioning regime. Following the comparison between the two regimes optimises the strategy of the firm to maximise its profit in the context of commercial piracy. The final chapter gives concluding remarks of the present dissertation.

Chapter 3 : Transaction utility of end-user pirates – An analysis

3.1 : Introduction

Product piracy is practiced in an exponential scale nowadays. With the rapid digitalization of technology and easy availability of technology friendly devices like tablets, smartphones, product piracy has reached its crest. These digitalized supports make end-user piracy (copying an information good from any media platform) very lucid. Piracy allows the consumers to avail the good at a relatively lower cost than the original good. This however can generate a psychological satisfaction for the consumer to involve in the act of piracy, which adversely affects the interest of the original producers. This psychological satisfaction may be similar to the concept of transaction utility, that "represents pleasure (or displeasure) associated with the financial terms of the deal per se" (*Thaler* 1983, *Thaler*, 1980). In the present study, we incorporate consumers' satisfaction or 'transaction utility' from end-user piracy in a theoretical model to see its impact on the price-quality decision of the original producer.

Thaler (2008) specified two types of utility attached to the consumption decision of a good – acquisition utility and transaction utility. While the former is the simple utility derived by the consumer from purchasing a unit of the good, the latter is derived by the consumer from the difference between selling price of the good and a reference price. In our paper we introduced the concept of transaction utility for the end-user pirates. The consumers of an information-good have two choices of consumption. He can either buy the good from the market or can copy the good from any media platform at a minimal cost. For the first choice of consumption, he will have merely the acquisition utility, amounting to his consumer surplus. But for the second choice of consumption, he will have an added transaction utility along

with acquisition utility. Transaction utility is defined as the additional satisfaction of the consumer derived from the difference between observed (selling) price of the original good and his reference price (cost of copying).

Sajeesh et al. (2017) studied the impact of the transaction utility on the price-quality decision of a firm in a vertically differentiated market with the result that high-quality firm provides more discount to the consumers than low-quality firms. We hypothesized a model and studied the price-quality decision of the monopolist producing the original information good with respect to the transaction utility parameter. Not strictly a vertically differentiated market, but our paper assumed a proportion of the market not receiving transaction utility from practising piracy. Some interesting results have also been deduced for price-quality and profit choices of the monopolist with regard to the variation in the proportion of non-transaction utility consumers.

Muehlbacher, Kirchler and Kunz (2011) led experiment studying the impact of transaction utility on purchase decisions of the consumer. It shows that negative transaction utility (perceived loss) has greater impact on purchase decisions of consumers relative to its positive counterpart. This is based on the prospect theory of *Kahneman and Tversky* (1979).

Urbany et al. (1997) worked on the role of quality on the purchase decision of the consumers with transaction utility. It is revealed that uncertainty about quality plays an insignificant role contrary to identified quality which plays a dominant role in the purchase decision of the consumer. Our model endogenises the quality level of the original good and studies carefully the role of transaction utility on the quality decision of the producer.

There exists literature on piracy that covers a humongous array of topics like quality differentiation, price discrimination and product versioning, effect of network externality,

policy instruments of government to control piracy and so on. We discussed some of those papers in the following paragraphs.

Banerjee et al. (2008) studied the effectiveness of the trade-off between anti-copying investment of the incumbent firm and monitoring and penalising the pirates to combat piracy. The paper concludes when monitoring is socially optimal, anti-copying measure doesn't guarantee to deter piracy. The paper basically discusses piracy control policies of the incumbent firm.

Alvisi et al. (2003) studied product differentiation as a measure to fight piracy. It concludes that in presence of piracy the incumbent firm will always have an incentive to produce a low quality version of the product for serving the pirates, but when copyright protection law is stringent, it loses the incentive to differentiate product. This paper gives us an insight regarding quality choice of the incumbent firm in presence of piracy.

Lu et al. (2012) compares two regimes of piracy – end-user and commercial piracy. The paper reveals that in a commercial piracy background, when the incumbent firm competes with pirate in quantities, the degree of reliability of pirated product affects piracy rate positively. But in an end-user piracy background, when the competition is based on price, this result may not hold. In our paper, we tried to incorporate the idea of studying the impact of the pirated product's quality on the price-quality of original product and the rate of piracy under end-user piracy.

Cho et al. (2010) discussed the quality choices of the incumbent firm across consumers with heterogeneous parameter of willingness to pay. The paper highlights that the quality choices of the incumbent firm will reverse in situation with and without piracy. We incorporated this concept heterogeneity among consumers in terms degree of transaction utility received by them along with heterogeneity with respect to willingness to pay for quality.

Cremer et al. (2007) suggested three different levels of piracy control for three different types of producers. The highest level of piracy control is that chosen by the profit maximising monopolist, the second highest is chosen by welfare maximising monopolist and the least is chosen by a public authority. The paper gives an interesting insight regarding the idea of piracy being a social optimal choice.

Further we studied few empirical literatures to assert the reason behind piracy. *Borja et al.* (2015) has written distinctly on music industry piracy. They used a model with logistic regression to show that frequent music streamers are potential pirates of music industry[1]. *Chiou et al.* (2005) also worked on music industry, studying the antecedents of consumers attitude and intention behind pirating music files. Factors like attributive satisfaction, perceived prosecution risk are some of the major reasons affecting attitude of the consumers. *Pons et al.*(2006) ; *Haque et al.* (2009) ; *Haque et al.* (2011) ; *Ridwan et al.* (2013) are some other relevant studies reviewed in this context.

However, none of the studies we came across have incorporated the t of transaction utility in the context of piracy. It seemed like an interesting idea to us to analyse this unexplored area of studying the impact of transaction utility on price-quality decision of the original producer in the presence of piracy. The main contribution of the present study is that, it amalgamates two threads of literature namely the issues related to end-user piracy and the concepts of transaction utility. We incorporate the concept of transaction utility in the context of end-user piracy of an information good, which to best of our knowledge has not been studied so far in any of the literature. We find the background of transaction utility to be quite relevant to pirates who have an absolute psychological satisfaction by availing information good at a

[1]Borja, Dieringer and Daw (2015) conducted an empirical survey among college students of University of South Florida, St. Petersburg campus. Using a logistic model they showed that students who are frequent users of music streaming, pirates music files more often. In fact, their result showed that music streaming increases the likelihood in engaging in music piracy by 20%. A plausible explanation for this, given by the authors is that the reasons are peer and social acceptance of music piracy knowledge about computer technology and software downloading, low apprehension of risk and penalty, viewpoint about artist's success and so on.

trivial cost compared to that of the original counterpart. The transaction utility parameter is expected to play a dominating role in the purchase decision of the consumers which in turn affects the price-quality decision of the monopolist producing original good. The contribution of this paper is to analyse the role of transaction utility behind practising piracy.

In our model, we hypothesized that transaction utility could be a dominant factor behind end-user piracy. The pirates are able to get hold of the same good with (maybe) slight quality degradation at a much lower price. The pirates are assumed to derive transaction utility from piracy, besides, acquisition utility. This can be a ruling reason behind piracy. Hence, in our present paper we developed a theoretical model assuming a utility function that includes transaction utility (a certain psychological satisfaction) which is expressed as a function of the price difference between the original and the cost of acquiring pirated product (copying cost). In this respect we must mention the study by Kothari et al. (2016) that uses the impact of reference quality dependence on price decision of an incumbent firm[2]. We consider a monopolist producing an original information good in the presence of end–user piracy, where the pirates receive an acquisition utility as well as transaction utility from consumption of the pirated goods. Here, the transaction utility is positively affected by the difference between the price of the original product and the cost of acquiring the pirated good. Then we check the impact of this transaction utility on the price – quality decision of the monopolist. Further, the movement in the piracy rate is also checked with respect to this psychological satisfaction measure (transaction utility parameter).

The rest of the paper is arranged in the following manner. The second segment of the paper explains the theoretical model followed by the comparative static analysis. The final segment concludes the study.

[2]Kothari and Chowdhury (2016) used the concept of reference quality dependence in their paper. Reference dependence revealed that in a duopoly market, consumers with an identical willingness to pay for the product, experience an additional loss of utility, expressed as a function of quality difference between two products, if they consume the low quality product. Furthermore, they showed that greater reference dependence worsen off consumer's welfare and increases price and profit of the producers.

3.2 : Theoretical Model

The present study considers the monopoly market of an information-good that is infringed by end-user piracy. The monopolist firm produces the original version of the information good by incurring a cost of quality. But the market is invaded by the end-user pirates where the individual pirates copy an inferior quality of the same good at a negligible cost. The end–user pirates enjoy a certain satisfaction over the fact of availing the pirated good at a minimum cost with trivial quality degradation. In this paper we try to analyse the impact of this psychological satisfaction of the consumers on the price – quality decision of the original producer. The model assumes that the monopolist produces an original information good with quality – price (q, p) by incurring a quadratic cost of quality $\frac{\gamma q^2}{2}$. There exists a continuum of consumers distributed according to their 'willingness to pay' parameter value in the interval $[0, \overline{\theta}]$. We assume that not all consumers receive transaction utility from product piracy.[3] We assume μ proportion of the consumers do not receive transaction utility from piracy and (1-μ) do. The lower fringe of the consumer spectrum with relatively lower willingness to pay for the product is assumed to involve in the act of piracy and they copy the product illegally at a negligible cost at online platform. Obviously, the quality of the pirated product is inferior to that of its original counterpart. The quality – price/cost of the pirated product is assumed to be $(\alpha q, c)$, where $0 < \alpha < 1$. Next, we assume that if the consumer uses the pirated good, his utility is the sum of two components. The first component is his consumer surplus ($\theta \alpha q -$

[3] We are thankful to the referee for pointing out to this assumption. This assumption is in line with the findings of a primary survey conducted among students in the age group of 18 years to 24 years from Kolkata where they were asked if they receive any psychological satisfaction from the mere act of piracy or if they receive transaction utility from piracy. We observed that a subsection of the sample gave affirmative answer. We observed that out of these 261 respondents who are involved in act of piracy 56.6% revealed that they receive some form of psychological satisfaction (transaction utility) from piracy in any of the mediums. A group says that they consume pirated good but do not receive any psychological satisfaction from the mere act of piracy.

c)which can be considered equivalent to acquisition utility (*Thaler* 2008). The second component measures his satisfaction from getting the pirated good at low cost relative to the price of the original product, which is considered as the reference price following Thaler (2008). It is measured as $\lambda(p-c)$. Here λ $(\lambda > 0)$, is the rate at which his satisfaction increases with the difference between price of the original good and the cost of acquiring the pirated good. In the subsequent analysis λ is referred to as transaction utility parameter.

Following *Mussa and Rosen* (1978), the utility of a representative consumer who does not receive transaction utility from piracy, from consuming one unit of the product is shown in (1) –

$$\begin{aligned} U(\theta) &= \theta q - p && when\ he\ purchases\ one\ unit\ of\ original\ product. \\ &= \theta\alpha q - c && when\ he\ pirates. \\ &= 0 && when\ he\ purchases\ nothing. \end{aligned} \tag{1}$$

θ_1 is the 'willingness to pay' parameter value of the marginal consumer indifferent between purchasing the original good and copying for the group of consumers who do not receive the transaction utility from product piracy

$$\therefore U(\theta_1) = \theta_1 q - p = \theta_1 \alpha q - c \Rightarrow \theta_1 = \frac{(p-c)}{q(1-\alpha)} \tag{2}$$

Therefore when $p \to c$, the entire market is served by the monopolist.

${\theta_1}^l$ represents the 'willingness to pay' parameter of the marginal consumer indifferent between copying and not consuming the product for this group of consumer.

$$\therefore U({\theta_1}^l) = {\theta_1}^l \alpha q - c = 0 \Rightarrow {\theta_1}^l = \frac{c}{\alpha q} \tag{3}$$

The demand function of the monopolist from this group of consumer is shown in (4) –

$$D_1 = \int_{\theta_1}^{\overline{\theta}} d\theta = \left(\overline{\theta} - \theta_1\right) = \left[\overline{\theta} - \frac{(p-c)}{q(1-\alpha)}\right] \tag{4}$$

The utility of a representative consumer who receives transaction utility from piracy, is shown in (5) –

$$\begin{aligned} U(\theta) &= \theta q - p_m && when\ he\ purchases\ one\ unit\ of\ original\ product. \\ &= \theta\alpha q - c + \lambda(p-c) && when\ he\ pirates. \\ &= 0 && when\ he\ buys\ nothing. \end{aligned} \tag{5}$$

θ_2 is the 'willingness to pay' parameter value of the marginal consumer indifferent between purchasing the original good and copying for the group who receives transaction utility.

$$\therefore U(\theta_2) = \theta_2 q - p = \theta_2\alpha q - c + \lambda(p-c) \Rightarrow \theta_2 = \frac{(1+\lambda)(p-c)}{q(1-\alpha)} \tag{6}$$

${\theta_2}^l$ represents the 'willingness to pay' parameter of the marginal consumer indifferent between copying and not consuming the product.

$$\therefore U({\theta_2}^l) = {\theta_2}^l\alpha q - c + \lambda(p-c) = 0 \Rightarrow {\theta_2}^l = \frac{1}{\alpha q}[c - \lambda\,(p-c)] \tag{7}$$

For a given *c*, as transaction utility parameter from piracy $'\lambda'$ increases, market coverage will increase.

The market will be fully covered only when -

$${\theta_2}^l \leq 0 \Rightarrow c \leq \lambda\,(p-c) \Rightarrow p \geq \frac{c(1+\lambda)}{\lambda}$$

The monopolist's demand function from the group receiving transaction utility is shown in (8) –

$$D_2 = \int_{\theta_2}^{\overline{\theta}} d\theta = \left(\overline{\theta} - \theta_2\right) = \left[\overline{\theta} - \frac{(1+\lambda)(p-c)}{q(1-\alpha)}\right] \tag{8}$$

The expected demand of the monopolist from this heterogeneous market is given in (9)-

$$D_m = \left[\left\{\mu(\overline{\theta} - \frac{(p-c)}{q(1-\alpha)}\right\} + \left\{(1-\mu)\left(\overline{\theta} - \frac{(1+\lambda)(p-c)}{q(1-\alpha)}\right)\right\}\right] \tag{9}$$

The profit of the monopolist is thus –

$$\pi = pD_m - \frac{\gamma q^2}{2} \tag{10}$$

First the monopolist chooses his quality level and given the quality level the price level is determined. Using backward induction method first the pricing decision of the monopolist is analysed. The monopolist takes cost of copying 'c' as given and chooses his equilibrium price p^* for a given level of quality.

$$p^* = \frac{\overline{\theta} q(1-\alpha)}{2\{1+\lambda(1-\mu)\}} + \frac{c}{2} \tag{11}$$

It is observed that $\frac{\partial p^*}{\partial \lambda} < 0$, for a given value for q. The value of transaction utility parameter has a positive impact on the market share of pirated good. This affects the original firm's demand and market share, thus putting a downward pressure on its price.

The expected demand of the monopolist is shown in (12) –

$$D_m = \frac{\overline{\theta}}{2} + \frac{c\{1+\lambda(1-\mu)\}}{2q(1-\alpha)} \tag{12}$$

It is observed that $\frac{\partial D_m}{\partial \lambda} > 0$, for a given value of q. A high value for transaction utility from piracy induces the original firm to charge a low price for the original product for a given level of quality. As a result, demand for original product also goes up for a rise in λ, when quality level is given.

The profit of the monopolist for a given level of quality is shown in (13) –

$$\pi^* = \frac{[\overline{\theta} q(1-\alpha) + c\{1+\lambda(1-\mu)\}]^2}{4q(1-\alpha)\{1+\lambda(1-\mu)\}} - \frac{\gamma q^2}{2} \tag{13}$$

Next we consider the choice of quality by the monopolist. The monopolist maximises profit given in (13). The first order condition is -

$$\frac{\partial \pi^*}{\partial q} = \left[\frac{\overline{\theta}^2(1-\alpha)}{4\{1+\lambda(1-\mu)\}} - \frac{c^2\{1+\lambda(1-\mu)\}}{4q^2(1-\alpha)}\right] - \gamma q = 0 \tag{14}$$

$$\Rightarrow A(q) = \gamma q, \ where\ A(q) = \left[\frac{\overline{\theta}^2(1-\alpha)}{4\{1+\lambda(1-\mu)\}} - \frac{c^2\{1+\lambda(1-\mu)\}}{4q^2(1-\alpha)}\right] \tag{14a}$$

We further observe that –

$$A'(q) = \frac{c^2\{1+\lambda(1-\mu)\}}{2q^3(1-\alpha)} > 0 \; and \; A^{"}(q) = -\frac{3c^2\{1+\lambda(1-\mu)\}}{2q^4(1-\alpha)} < 0 \qquad (15)$$

Thus the curve of A(q) is upward sloping and concave. The sufficient condition for profit maximisation w.r.t. quality requires –

$$A'(q) - \gamma < 0 \; \Rightarrow A'(q) < \gamma \Rightarrow \frac{c^2\{1+\lambda(1-\mu)\}}{2q^3(1-\alpha)} < \gamma \qquad (16)$$

The determination of the equilibrium quality is shown diagrammatically in Figure 1, when $A(q)$ is increasing but concave in quality level q. Further, $A(q) \geq 0$ for $q \geq \frac{c\{1+\lambda(1-\mu)\}}{\overline{\theta}(1-\alpha)} = \overline{q}$.

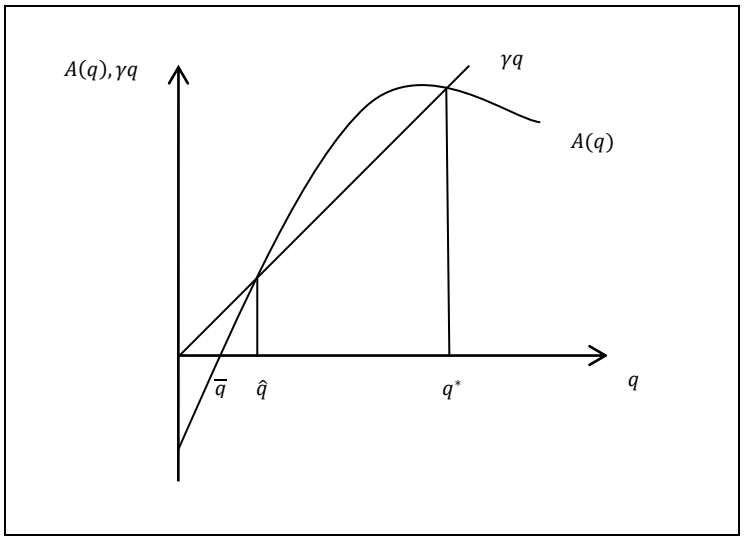

Figure 3.1: Endogenising Quality

In figure 3.1, $A(q)$curve intersects the linear γq curve at $q = \hat{q} \; and \; q = q^*$, $\left[where \; \overline{q} = \frac{c\{1+\lambda(1-\mu)\}}{\overline{\theta}(1-\alpha)}, i.e. when \; A(q) = 0 \Longrightarrow q = \frac{c\{1+\lambda(1-\mu)\}}{\overline{\theta}(1-\alpha)}\right]$. However at $q = \hat{q}$, we have $A'(q) > \gamma$, i.e. the slope of $A(q)$ curve is steeper than the slope of γq curve. So, the second order condition is not satisfied. The equilibrium is thus found at $q = q^*$.

From profit maximising condition, we get proposition 1.

Proposition 1: An increase in transaction utility parameter from piracy affects the price and quality of the original good negatively.

Proof: Differentiating (14) with respect to λ, and given the second order condition of profit maximisation in (16), we have,

$$\frac{\partial q^*}{\partial \lambda} = \frac{-1}{\left[\gamma - \frac{c^2\{1+\lambda(1-\mu)\}}{2q^{*3}(1-\alpha)}\right]}\left[\frac{\overline{\theta}^2(1-\alpha)(1-\mu)}{4\{1+\lambda(1-\mu)\}^2} + \frac{c^2(1-\mu)}{4q^{*2}(1-\alpha)}\right] < 0 \tag{17}$$

Putting q^* in (11), we get the equilibrium price p^*.

$$\frac{\partial p^*}{\partial \lambda} = \frac{\overline{\theta}(1-\alpha)}{2)}\left[\frac{1}{\{1+\lambda(1-\mu)\}}\frac{\partial q}{\partial \lambda} - \frac{q^*(1-\mu)}{\{1+\lambda(1-\mu)\}^2}\right] < 0 \quad \text{(Hence proved)} \tag{18}$$

Thus, for a rise in λ, in order to compete with pirated good, the firm has to lower its price. This in turn tends to reduce the profitability of the firm. As a result, the firm further reduces its quality level as provision of quality is costly. This in turn reduces the price of the original good. So a rise in λ, induces the firm to take a low quality – low price strategy. Low price strategy actually raises the demand for original product. Further, a reduction in quality additionally dampens the price of the product and raises the overall demand for original good. Thus, if a transaction utility is attached to consuming pirated product at negligible price relative to original product increases, it induces the original good producer to adopt a low quality – low price strategy, thereby raising its market share. The equilibrium profit is defined as -

$$\pi^* = \frac{[\overline{\theta}q^*(1-\alpha)+c\{1+\lambda(1-\mu)\}]^2}{4q^*(1-\alpha)\{1+\lambda(1-\mu)\}} - \frac{\gamma q^{*2}}{2} \tag{19}$$

$$\frac{d\pi^*}{d\lambda} = \frac{\partial \pi^*}{\partial \lambda} + \frac{\partial \pi^*}{\partial q}\frac{\partial q}{\partial \lambda} = -\frac{\overline{\theta}^2 q^*(1-\alpha)}{4(1+\lambda)^2} + \frac{c^2}{4q^*(1-\alpha)} = -\frac{\left[\overline{\theta}^2 q^{*2}(1-\alpha)^2 - c^2(1+\lambda)^2\right]}{4q^*(1+\lambda)^2(1-\alpha)} < 0 \qquad \left[\text{as} \quad \frac{\partial \pi^*}{\partial q} = 0 \; and \right.$$

$$\left. q^* > \frac{c\{1+\lambda(1-\mu)\}}{\overline{\theta}(1-\alpha)}\right] \tag{20}$$

It is observed that $\frac{d\pi^*}{d\lambda} < 0$. As transaction utility from piracy increases, it shrinks the market for the original good, and from (11) we find that the monopolist will reduce its price and quality to keep its demand intact. These two effects jointly reduce the profit of the monopolist, thereby affecting the monopolist's profit negatively. Along with the mathematical proof, we also used a numerical example to validate the above findings using parameter values $\alpha = 0.8, \gamma = 1, \overline{\theta} = 3,\ \lambda \in [0.01, 0.999]$ and $\mu = 0$.

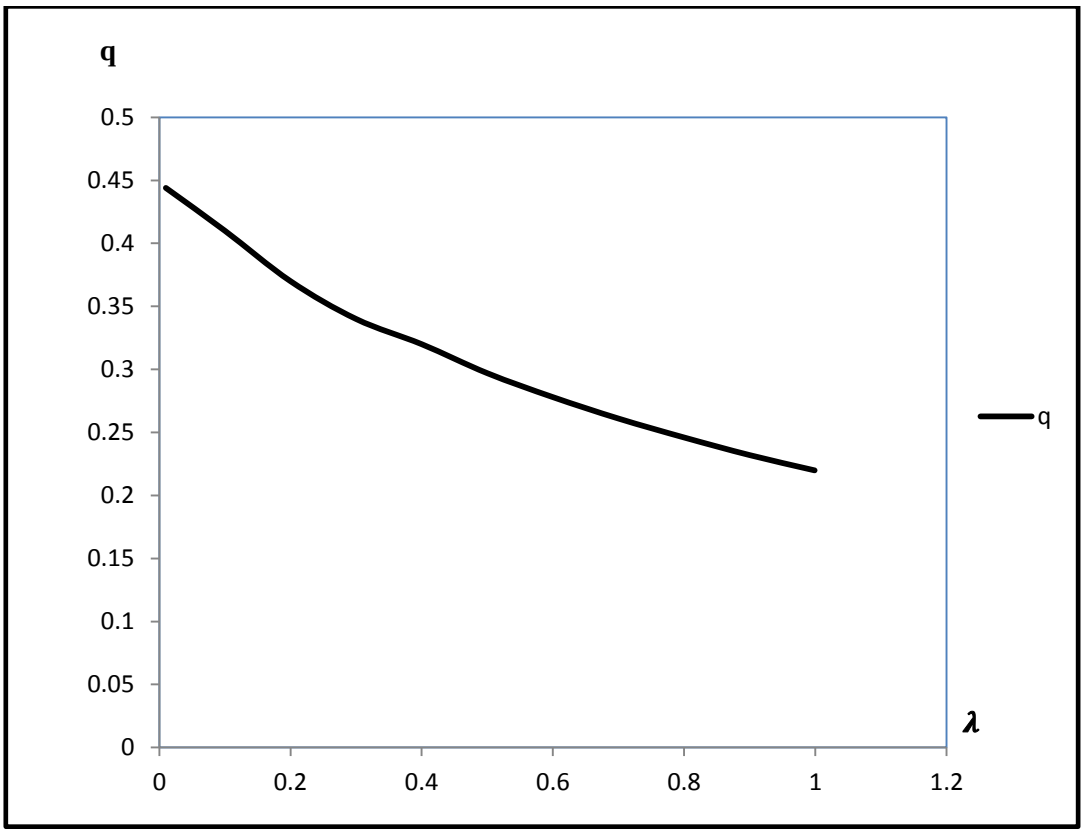

Figure 3.2 : Quality as a decreasing function of transaction utility parameter

It is checked numerically, how the transaction utility parameter affects quality of the original good, assuming $\alpha = 0.8, \gamma = 1, \overline{\theta} = 3,\ \lambda \in [0.01, 0.999]$ and $\mu = 0$; the results showed that indeed quality of the original good is decreasing in transaction utility parameter. The result is graphically shown in figure 2.

Next, we observe the impact of the change in quality parameter of pirated good (α) and the proportion of consumers not enjoying transaction utility (μ) on the price, quality and profit level of the monopolist.

Proposition 2: An increase in the quality of pirated good will affect price - quality of the original good negatively.

$$\text{Proof}: \frac{\partial q^*}{\partial \alpha} = \frac{-1}{\left[\gamma - \frac{c^2\{1+\lambda(1-\mu)\}}{2q^{*3}(1-\alpha)}\right]}\left[\frac{\overline{\theta}^2}{4\{1+\lambda(1-\mu)\}} + \frac{c^2\{1+\lambda(1-\mu)\}}{4q^{*2}(1-\alpha)^2}\right] < 0 \qquad (21)$$

This follows from the condition $\gamma > \frac{c^2\{1+\lambda(1-\mu)\}}{2q^{*3}(1-\alpha)}$ from the second order condition of profit maximisation with respect to quality.

$$\frac{\partial p^*}{\partial \alpha} = \frac{\overline{\theta}}{2\{1+\lambda(1-\mu)\}}\left[-q^* + (1-\alpha)\frac{\partial q^*}{\partial \alpha}\right] < 0 \quad \text{as } \frac{\partial q^*}{\partial \alpha} < 0. \text{ (Hence Proved)} \qquad (22)$$

The pirated good is an imperfect substitute of the original good. A rise in quality of the pirated good might increase level of piracy and might affect the interest of the monopolist negatively. As the monopolist has to incur a cost for quality, it will produce a relatively lower quality good for its consumers. The pirated good, being the copied version of the original good will degrade in its quality simultaneously. This might affect the level of piracy negatively and improve the market condition of the monopolist. In addition, when the pirated good's quality rises, the market served by the monopolist shrinks. Consequently the monopolist will choose a low price strategy to fight the situation and to hold on to its market share.

It can be added that the profit of the monopolist is also affected negatively by an increase in the pirated good's quality level.

$$\frac{d\pi^*}{d\alpha} = \frac{\partial\pi^*}{\partial\alpha} + \frac{\partial\pi^*}{\partial q}\frac{\partial q}{\partial\alpha} = -\left[\overline{\theta}q^*(1-\alpha) + c\{1+\lambda(1-\mu)\}\right]\left[\frac{\overline{\theta}}{2} - \frac{c\{1+\lambda(1-\mu)\}^2}{2q^*(1-\alpha)}\right] < 0 \text{ [as } \frac{\partial\pi^*}{\partial q} = 0 \text{]}$$

(23)

The rise in quality of the pirated good puts a downward pressure on the price-quality of the original good. The monopolist is forced to adopt a low price – low quality product strategy to fight piracy. Naturally as a consequence of this, the profit of the monopolist is also affected negatively.

Proposition 3: An increase in the proportion of consumers not receiving transaction utility from piracy will affect the price and quality of the original good positively.

$$\text{Proof : } \frac{\partial q^*}{\partial\mu} = \frac{1}{\left[\gamma - \frac{c^2\{1+\lambda(1-\mu)\}}{2q^{*3}(1-\alpha)}\right]}\left[\frac{\lambda\overline{\theta}^2(1-\alpha)}{4\{1+\lambda(1-\mu)\}^2} + \frac{\lambda c^2}{4q^{*2}(1-\alpha)}\right] > 0 \qquad (24)$$

$$\cdot\ \frac{\partial p^*}{\partial\mu} = \frac{\overline{\theta}(1-\alpha)}{2}\left[\frac{1}{\{1+\lambda(1-\mu)\}}\frac{\partial q^*}{\partial\mu} + \frac{\lambda q^*}{\{1+\lambda(1-\mu)\}^2}\right] > 0 \quad \text{(Hence Proved)} \qquad (25)$$

As the proportion of consumers not receiving transaction utility from piracy increases, the incidence of piracy is expected to decline. This situation will incentivise the monopolist to produce a superior quality of good to serve the market. When the monopolist produces higher quality product with an increasing proportion of consumers not receiving transaction utility from piracy, the price of the original good increases on account of the quality cost.

$$\frac{d\pi^*}{d\mu} = \frac{\partial\pi^*}{\partial\mu} + \frac{\partial\pi^*}{\partial q}\frac{\partial q}{\partial\mu} = \frac{\lambda[\overline{\theta}q^*(1-\alpha)+c\{1+\lambda(1-\mu)\}]}{4q^{*2}(1-\alpha)\{1+\lambda(1-\mu)\}}\left[\frac{\overline{\theta}^2q^*(1-\alpha)}{\{1+\lambda(1-\mu)\}} - c\right] > 0 \ \left(\text{As } \frac{\partial\pi^*}{\partial q} = 0\right) \qquad (26)$$

As stated earlier, the monopolist enjoying better market position with higher μ will also enjoy higher level of profit.

In the next subsection, we consider the effect of any change in transaction utility parameter on piracy rate.

3.2.1 : Piracy rate Analysis

This sub-section analyses the impact of change in the transaction utility parameter λ on the piracy rate. Piracy rate is defined to be the market share of pirated good with respect to the total market size. The following results will show that transaction utility has some interesting impact on piracy rate for both the cases of market coverage.

Firstly, we analyse the market share of original and pirated good for both the groups of consumers – one not enjoying transaction utility from piracy i.e. μ proportion of total consumers and other enjoying transaction utility from piracy i.e. $(1-\mu)$ proportion of the entire consumer spectrum.

For the first group, replacing values for $q^*$and p^* in (2) and (3) and, we observe in equilibrium,

$$\theta_1{}^* = \frac{\overline{\theta}}{2\{1+\lambda(1-\mu)\}} - \frac{c}{2q^*(1-\alpha)} > 0 \quad \text{as p*>c} \tag{27}$$

$$\theta_1{}^{l^*} = \frac{c}{\alpha q^*} > 0 \tag{28}$$

The piracy rate as defined for group 1 is thus –

$$R_1 = \frac{\theta_1^* - \theta_1^{l^*}}{\overline{\theta} - \theta_1^{l^*}} = \frac{\left[\frac{\overline{\theta}}{2\{1+\lambda(1-\mu)\}} - \frac{c}{q^*}\left\{\frac{1}{2(1-\alpha)} + \frac{1}{\alpha}\right\}\right]}{\overline{\theta} - \frac{c}{\alpha q^*}} \tag{29}$$

For the second group, replacing values for $q^*$and p^* in (6) and (7), we observe in equilibrium,

$$\theta_2{}^* = \frac{\overline{\theta}(1+\lambda)}{2\{1+\lambda(1-\mu)\}} - \frac{c(1+\lambda)}{2q^*(1-\alpha)} \tag{30}$$

Further,

$$\theta_2{}^{l^*} = \frac{1}{2\alpha}\left[\frac{c(2+\lambda)}{q^*} - \frac{\overline{\theta}\lambda(1-\alpha)}{\{1+\lambda(1-\mu)\}}\right] \tag{31}$$

For this group, there can be two different piracy rate depending upon the market coverage. For incomplete market coverage, when ${\theta_2}^{l^*} > 0$, the piracy rate for group 2 is given as

$R_{2_i} = \frac{\theta_2^* - \theta_2^{l^*}}{\overline{\theta} - \theta_2^{l^*}}$ and for complete market coverage, i.e. when ${\theta_2}^{l^*} \leq 0$, the piracy rate is reduced to $R_{2_c} = \frac{\theta_2^*}{\overline{\theta}}$.

Proposition 4 : The transaction utility parameter has a negative impact on the rate of piracy for consumers not receiving transaction utility from piracy but its impact on the rate of piracy for consumers enjoying transaction utility from piracy is ambiguous.

Proof :

$$\frac{\partial R_1}{\partial \lambda} = \left(\overline{\theta} - {\theta_1}^{l^*}\right)\left[\frac{-\overline{\theta}(1-\mu)}{2\{1+\lambda(1-\mu)\}^2} + \frac{c}{2{q^*}^2(1-\alpha)}\frac{\partial q^*}{\partial \lambda}\right] + \left(\overline{\theta} - {\theta_1}^{*}\right)\frac{c}{\alpha q^*}\frac{\partial q^*}{\partial \lambda} < 0 \text{ as } \frac{\partial q^*}{\partial \lambda} < 0 \qquad (32)$$

In case of incomplete market coverage, piracy rate for group 2 of consumers receiving transaction utility from piracy is -

$$\frac{\partial R_{2i}}{\partial \lambda} = \frac{\left(\overline{\theta} - \theta_2^{l^*}\right)\left(\frac{\partial {\theta_2}^*}{\partial \lambda} - \frac{\partial {\theta_2}^{l^*}}{\partial \lambda}\right) - (\theta_2^* - \theta_2^{l^*})(-\frac{\partial {\theta_2}^{l^*}}{\partial \lambda})}{\left(\overline{\theta} - \theta_2^{l^*}\right)^2} \gtreqless 0 \qquad (33)$$

Since,

$$\frac{\partial {\theta_2}^*}{\partial \lambda} = \left\{\frac{\overline{\theta}}{\{1+\lambda(1-\mu)\}}\right\}\left\{\frac{1}{2} + \frac{\mu(1+\lambda)}{\{1+\lambda(1-\mu)\}}\right\} - \frac{c}{2q^*(1-\alpha)} + \frac{c(1+\lambda)}{2{q^*}^2(1-\alpha)}\frac{\partial q^*}{\partial \lambda} \gtreqless 0 \qquad (34)$$

And, $\frac{\partial {\theta_2}^{l^*}}{\partial \lambda} = \frac{-\overline{\theta}(1-\alpha)}{2\alpha\{1+\lambda(1-\mu)\}^2} - \frac{c(2+\lambda)}{2\alpha {q^*}^2}\frac{\partial q^*}{\partial \lambda}\frac{c}{2\alpha q^*} \gtreqless 0$ (35)

The piracy rate for complete market coverage regime for group 2 of consumers is given as –

$$\frac{\partial R_{2_c}}{\partial \lambda} = \frac{1}{\overline{\theta}}\left[\frac{\partial {\theta_2}^*}{\partial \lambda}\right] = \frac{1}{\overline{\theta}}\left[\frac{1}{2\alpha}\left\{\frac{c}{q^*} - \frac{\overline{\theta}(1-\alpha)}{\{1+\lambda(1-\mu)\}^2} - \frac{c(2+\lambda)}{{q^*}^2}\frac{\partial q^*}{\partial \lambda}\right\}\right] \gtreqless 0 \text{ (Hence Proved)} \qquad (36)$$

For the first group of consumers not receiving transaction utility from piracy, an increase in the transaction utility parameter λ has a positive direct effect on the market share of original good. When λ increases, it induces the monopolist to reduce its price for the original product, which in turn expands the market share of the monopolist. The market share of pirated good with respect to the total market, which is defined as the piracy rate will eventually fall as a consequence.

For the second group, however, as transaction utility from piracy increases, the consumers receiving it will tend to indulge more in piracy. This will definitely increase the market share of the pirated good. This is the direct positive effect of transaction utility parameter λ on piracy rate. However, when λ increases, the monopolist reduces the price of their product which in turn expands their market. This creates a negative effect on the market share of the pirate. This is the indirect negative effect of λ on piracy rate. Hence, the final impact of it on the rate of piracy is ambiguous irrespective of the level of the market coverage.

The expected piracy rate is given as –

$$R = \mu\left(\frac{\partial R_1}{\partial \lambda}\right) + (1-\mu)\left\{\frac{\partial R_{2_i}}{\partial \lambda} + \frac{\partial R_{2_c}}{\partial \lambda}\right\} \gtrless 0 \qquad (37)$$

The expected piracy rate is also found to be ambiguous on account of the ambiguity in piracy rate for the second group of consumers receiving transaction utility from piracy.

3.3 : Conclusion

We studied a theoretical model which incorporates transaction utility from end-user piracy due to price gap between original and pirated good. The model assumes that a group of consumers receive transaction utility from consuming pirated good because of the price difference between the original and pirated good. In the model, the original good producer

acts as the monopolist and produces the original information good. The results from the theoretical model show that the price, quality and profit of the monopolist are decreasing in transaction utility parameter. The reason can be explained that as satisfaction (utility) over piracy increases, the original good producer adopts a low quality – low price strategy to fight with end–user piracy for market coverage. This strategy however expands the market share of the original firm but diminishes its profit.

Next, we observe that for a change in quality parameter of the pirated good the monopolist will reduce price and deteriorates the quality level. In addition, the profit will fall. If the pirated product becomes very close substitute of the original good, the consumers are inclined towards pirated good. As a result, the monopolist faces a decline in its market share. To recapture the market the monopolist chooses low price and low quality strategy which in turn affects the profit negatively.

The effect of a decline in the proportion of consumers enjoying transaction utility has positive impact on price, quality and profit level of the monopolist. In our model, the existence of transaction utility motivates the consumers to indulge in the act of piracy. As the proportion of consumers who receive transaction utility from product piracy falls, the incidence of piracy is likely to reduce. This in turn, induces the monopolist to produce a better quality good at higher price and the profit of the monopolist improves.

An increase in the transaction utility parameter will diminish the rate of piracy for the first group of consumers who does not receive transaction utility from piracy. A rise in transaction utility parameter induces the monopolist to lower the price of the original product. This increases the market share of the monopolist as the consumers are incentivised to purchase the original good at a much lower price. This explains the indirect positive effect of transaction utility parameter on the market share of the monopolist for the first group of

consumers. On the contrary, for the second group of consumers, as the transaction utility parameter increases, its effect on the rate of piracy is found to be ambiguous. This is on account of the fact that the increase in transaction utility parameter has both direct and indirect effect on the market share of the monopolist. The direct effect will increase piracy level as the consumers will receive more utility from piracy than before. However, the low price – low quality strategy of the monopolist will increase the market share of the original good. Hence the net result is ambiguous.

Thus, in this study we focussed on the original idea of incorporating the concept of transaction utility in the context of end-user piracy. In this context, we found that an increase in the transaction utility parameter induces the original good producer to adopt a low quality-low price strategy even at the cost of its profit. A possible future avenue for this study can be an extension of this model in the context of commercial piracy.

Chapter 4 : An Experimental Understanding of Transaction Utility in End-User Piracy

4.1: Introduction

Thaler (2008) defines two types of utility attached with the consumption of a product, the first being acquisition utility which refers to the net consumer surplus the consumer enjoys, and the other being an additional utility that he receives by availing a good with a price lower than a reference price to him. This second type of utility is referred to as transaction utility by *Thaler* (2008). The reference price serves as a yardstick of comparison to the consumer, and the price differential gives him an added utility over his consumer surplus. The concept of transaction utility has been further studied in numerous contexts, including firm's behaviour in a competitive market, their price-quality decision and so on. However, the concept of transaction utility has not been experimentally validated in the analysis of end-user piracy.

Product piracy is done in two forms - end-user piracy and commercial piracy. The former refers to piracy at individual level and the latter defines piracy at the firm level. However, end-user piracy is predominant because of its degree of convenience to pirate any media file across any online platform. Piracy seems to give a certain psychological satisfaction to the pirates on account of availing a good at a much lower cost than the market version. The quality of the pirated product may be degenerated across various degrees, for example, downloading software or movie files or e-books from an illegal online platform often involves moderate to high degree of quality degradation. However, the sheer ability to avail a pirated copy of a good at a negligible price seems to give the pirate a feeling of contentment. In this paper we try to study this psychological satisfaction factor behind end-user piracy through a laboratory experiment.

Basu and Banerjee (2019) theorises the existence of transaction utility in context of end-user piracy and studies its impact on the price – quality decision of the original good producer using a theoretical model. The present paper attempts to validate the same concept through a laboratory experiment. The theoretical model in *Basu and Banerjee* (2019) assumes that the end-user pirate along with acquisition utility derives an additional utility from availing a pirated product at a much lower cost than the original version. The present paper attempts to experimentally analyse and validate the theoretical concept of existence and extent of transaction utility in context of end-user piracy.

The circumstance of transaction utility in end-user piracy is distinctive. While studying transaction utility of any other general good, the reference price that acts as a comparative index to the consumer does not really exist in the market in the same period. It refers to the price of the good in some previous period or that of a close substitute existing in the market. In case of end – user piracy however, both the original good and the copied version exist together in the same period in the market. The price differential between the reference price (original good) and the price of the product (pirated good) is a real parameter and not a perceived situation that impacts the purchasing decision of a potential consumer (pirate). Often the price differential between the original version of product and its copied version is stupendously high. Contrarily for most of the time there is trifling quality degradation in case of pirated version on account of highly efficient copying technology. This situation serves as the perfect platform for generation of transaction utility for the end-user pirates.

Muehlbacher et al. (2011) conduct two experimental studies to demonstrate the role of transaction utility in consumers' purchase decision. The experiments reveal negative transaction utility has greater impact on consumers' purchase decision than positive transaction utility. The experimental designs of their paper contribute significantly to this paper regarding nature of conducting experiments related to transaction utility. *Grewal et al.*

(1998) experimental paper too supports the hypothesis of the impact of buyer's internal reference price in his consumption decision.

Lichtenstein et al. (1990) study consumer behaviour in terms of coupon proneness (transaction utility) and value consciousness (acquisition utility). The literature reveals that coupon proneness which is similar to the concept of transaction utility is not isomorphic rather has a conceptual definition. The various factors, mostly socio-economic along with measure of value consciousness play part in deciding the degree of coupon prone behaviour of a consumer. *Urbany et al.* (1997) notice both the utilities in consumer behaviour and conclude that price differential is not the only significant cause behind transaction utility of a consumer, but the quality of the product plays a major role too. An experimental study shows that acquisition utility is in fact dominating over transaction utility, the latter being significant only when there is certainty of quality. *Dodonova et al.* (2004) empirically study consumer behaviour in an online website and found that products with more 'buy now' tag posted are sold more, even when prices are higher than the final price. This somehow amplifies the theory of a certain psychological satisfaction (transaction utility) attached to the deal. *McNeill et al.* (2013) demonstrate the degree of transaction utility varying over parameters like sales promotion and cultural differences. *Chiang et al.* (2013) study transaction utility in a market with mobile coupon and show that mobile users with higher degree of coupon proneness have higher understanding and positive attitude towards mobile coupons. Thus, in a way, transaction utility improvises consumer consciousness. *Goh and Bockstedt* (2009) use multipart pricing as an interesting tool to understand transaction utility. The literature shows that bundling and different pricing schemes affect the consumer behaviour through the route of transaction utility. These literatures provide a clear insight regarding transaction utility and conditions behind its working.

The theoretical literature on end user piracy contribute to clarify the idea of end-user piracy and its various facets are *Banerjee et al.* (2008), *Alvisi et al.* (2003), *Cho et al.* (2010) and *Cremer et al.* (2007). The empirical literature on piracy investigates various factors that contribute to the individual's decision on piracy.

Borja et al. (2015) observe in music industry, frequent music streamers are potential music pirates. Logistic regression analysis of a sample of 197 college students reveal that a potential music pirate is a heavily peer-influenced, young, low-income and overconfident about risk and reward. Socio-demographic aspects are thus observed to be significant factors behind piracy. In another study *Borja and Dieringer* (2016) conduct a survey of 1052 college students to investigate the factors determining music piracy, and the role of music streaming in the behavior of the individuals illegally downloading music. Using logistic regression analysis they observe that music streaming complements piracy, providing evidence that these two modes of music consumption coexist in the market. Further, social and peer behavior, risk perceptions, and online consumption time are elements contributing to music piracy. *Phau et al.* (2016) probe the factors impelling digital movie piracy and observe that habitual conduct, positive feeling towards acquiring the movie and facilitating conditions have significant influence upon attitudes toward downloading pirated movies. However, social factors are not found to have a significant relationship on attitudes toward downloading pirated movies from the internet. *Arli and Tjiptono* (2016), using a structural equation modeling approach in the context of Indonesia, observe that consumers' attitude toward digital piracy and perceived behavioral control significantly affect their intention to pirate digital products, while perceived benefits, moral obligation, and perceived behavioral control are predictors of consumers' attitude toward digital piracy.Interestingly, fear of legal

consequences and perceived likelihood of punishment are not significant predictors of consumers' attitude towards digital piracy causing piracy deterrent policies ineffectual. *Pop et al.* (2017), using data from Romania observe thatwhen consumers have the opportunity, they will always find ways of cheating in terms of piracy. Also, attitude and perceived behavioural control act as influencing factors for digital piracy in the context of Romanian consumers. Consumers may be inclined to be opportunistic when they feel that piracy behaviour can be performed effortlessly. *Dilmperi et al.* (2017) also observe intention to acquire music via an illegal channel is influenced by the perceived benefits of piracy. The above papers mostly consider the attitude/intention and perceived behavioral control based explanation of digital piracy based on primary survey. Thus, none of the studies we come across use a controlled laboratory environment to determine the probability of choosing a pirated good by an agent. Our study fills these gaps in the existing literature.

In our study, we measure the effect of transaction utility and the relative trade-off between acquisition utility and transaction utility on decision of acquiring a pirated product with the help of an experiment with 209 subjects in a laboratory setup. The first treatment intends to comprehend the existence of transaction utility among consumers at the very pretext. The next two treatments examine the effect of transaction utility when the quality of the pirated goods and as well as original good varies. The fourth treatment however, incorporates a trade-off between acquisition utility and transaction utility of possessing a pirated good. The laboratory set up provides an equal access to technology in the same environment to all subjects while taking the piracy decision. Thus, under this circumstance, our study helps us to identify the behavioural motive in terms of enjoying transaction and acquisition utility behind the act of digital piracy among the group of students with various socio-economic and demographic parameters.

Intriguingly, for all the treatments, transaction utility proves to be a significant factor behind pirating information good while we are controlling other socio demographic variables. To the best of our knowledge, we have not come across any literature that has dealt with this issue in context of end – user piracy. Thus, our paper uniquely contributes to the existing literature by analysing the effect of transaction utility in the piracy decision of end-user pirates using an experimental set up.

The rest of the paper is arranged in the following manner. Section 2 gives the theoretical foundation of the paper, followed by Section 3with the detailed experiment with treatment designs and methodology. Subsequently section 4 gives the result of the experiment and discusses the same. The final section 5 concludes the study.

4.2 : Theoretical Foundation

Thaler (1983) defines transaction utility that "represents pleasure (or displeasure) associated with the financial terms of the deal per se". This concept has been incorporated in the utility function of the consumer in our model who has been given a choice between purchasing an original version of a good and its pirated version. We assume there is a continuum of heterogeneous consumers, varying across their net valuation (acquisition utility) for the product. There are two versions of a good in the market – the original and the copied or pirated one. The goods generally represent information good or media files like software, book, movie files, music files, e-books and so on. The original version of the good is naturally of superior quality, say q, and the pirated version is a degraded copy of the same with quality level $\alpha q, \alpha \in [0,1]$. The price paid by the consumer to acquire one unit of the

original good is denoted by p, and the copied version of the same good is availed at a trivial cost c. The utility function of a representative consumer following Basu and Banerjee (2019) can thus be given as –

$$\begin{aligned} U(\theta) \quad &= \theta q - p \qquad \textit{when purchases one unit of original product.} \\ &= \theta \alpha q - c + \lambda(p - c) \;\; \textit{when pirates.} \\ &= 0 \qquad\qquad \textit{when purchases nothing.} \end{aligned} \tag{1}$$

θ represents the valuation of the product to the consumer or simply 'willingness to pay' for a product. When a consumer decides to buy an original good, he enjoys only acquisition utility or in other words, only the net valuation from the product ($\theta q - p$). However when he chooses to copy the same product by incurring copying cost c, along with acquisition utility, he is assumed to enjoy an additional utility, the transaction utility or a certain psychological satisfaction from the deal itself. The transaction utility is thus represented by $\lambda(p - c)$, where λ represents the transaction utility parameter. Assuming the hypothesis that a consumer enjoys transaction utility along with acquisition utility when he chooses to pirate; we conduct an experiment with four distinct treatments to perceive the existence and impact of transaction utility. The subsequent section gives the detail of the experiment.

If the quality of a pirated good is identical or very close to the original good ($\alpha \cong 1$), then the value of the pirated good is also very close to that of the original good. Now if the price of the pirated good is significantly lower than the price of the original good (p > c), then the acquisition utility ($\theta \alpha q - c$) from the pirated good will be higher than the acquisition utility ($\theta q - p$) derived from the original good. In addition, there is the component of higher transaction utility [$\lambda(p - c)$] as the price of the pirated good is lower than that of the original good, assuming that the quality of the pirated version is as good as the original.

4.3 : The Experiment

To segregate the impact of higher acquisition utility from transaction utility, the material or nominal payoff has not been distributed to the subjects. Consequently, the motivation of obtaining higher acquisition utility has been blocked and what remains is only transaction utility, that is, the perceived or psychological value of the transaction. This has been done by non-incentivising the experiment and paying the subjects their show-up fees.

A total number of 210 students have participated in the experiment with 15 participants in 14 sessions. However, owing to incomplete information, we have to drop one subject data and perform the analysis with remaining data of 209 subjects. The participants are all students of Jadavpur University, Kolkata, India and have been selected in equal proportion from humanities, science and engineering courses, 60% of them being male and the remaining 40% female. The participants have been initially asked to fill up an anonymous socio-economic information questionnaire to explore the relationship between piracy decision and socio-demographic factors like sex, stream of education, annual income etc. Subsequently, they have been given a sheet of paper consisting of general instruction, experiment protocol which has also been read out to them. After the instructions have been given, the participants have been asked to play the treatments in their respective personal computers, without any mutual consultation. The responses of the participants have been retrieved by us with the assistance of Z-Tree software instantaneously. The course of experimental sessions got over in a span of 45 days in the period of July to September, 2019. Each session has lasted between 25 and 30 minutes during which communication between subjects has not been allowed. Each session has four treatments and in each treatment, the subjects have been asked to make four non-incentivised choices and have been paid a show up fee of Rs. 200 each. The details of the choices are being given below in the next sub-section.

4.3.1: Design & Treatments

The participants have been asked to play the role of a buyer and make their respective purchase decisions. They have been provided with two purchase options – one for an original version of a good and the other for the pirated version. The actual valuation or 'willingness to pay' for both the versions have been given to them along with the prices that they have to pay for each of them. Additional information of reference price has also been provided, wherein the reference price is nothing but the price of the original version of the good. When the buyer chooses to buy the original good, his reference price and market price (price that he pays) coincide. However, if he chooses to buy the pirated version, the price of the original version acts as a point of reference or comparison to him. The idea of net valuation or acquisition utility has been clearly demonstrated to them as the total valuation less the market price they pay for the product. The decision to non-incentivise the experiment has been made to segregate the impacts of higher monetary pay-offs with transaction utility of the choices made. Each option has the following information in the form - (actual worth, reference value, selling price).

If the participants had been given the assurance of a reward equal to the net valuation of their purchase choices, the very concept of transaction utility would have been overlooked, as all the participants would have calculated only the net valuation or acquisition utility expecting higher monetary reward. This would have resulted in biased responses from the participants' end. In order to evade this obvious error, we plan to pay them equally, as show-up fee and the responses are thus, non-incentivised.

Treatment 1: This treatment aims to check the existence of transaction utility irrespective of pirated good or not. The participants have been given four different purchasing choices. For each of the choices, they have been given two options to choose from. The first option always

comes with an unknown reference price X, whereas the second option has a known reference price. The participants have been asked to choose between the two options for each choice. Further, it may be noted that it has been emphatically mentioned to the participants that the unknown reference price (X) can be either higher or lower than the price they are paying for the product. This has been intended to observe the impact of declining difference between the reference price and the price paid.

The four different choices with two options for each choice, given to the purchasers are specified in Table 1, where the first value in all the options reveals the valuation for the product to the purchaser, the second value represents the reference price and the third value represents the price that the purchasers pay to acquire the product.

It has been mentioned to the participants that their monetary gain from all of their transaction would be amounting to net valuation (i.e. valuation less the market price) and that reference price has given only as a point of comparison while they purchase the good.

Table 4.1 : Details of Treatment 1

Choices	Option A	Option B	% of subjects choosing Option B with known reference price
1	(100, X, 25)	(100, 75, 25)	76.67%
2	(100, X, 25)	(100, 50, 25)	77.03%
3	(100, X, 25)	(100, 30, 25)	52.63%
4	(100, X, 25)	(100, 10, 25)	24.88%

#Source: Lab experiment conducted by the authors

We observe that revelation of reference price has actually been influencing the choice of the subjects. This treatment proves the existence of transaction utility irrespective of pirating or

not. It is revealed that a majority of the participants has significantly chosen options with known transaction utility over an unknown transaction utility. It must be noted that in both the cases, the acquisition utility has been held constant. As expected, in choice 4 where reference price is lower than the actual price of the product, most of the subjects choose option A with unknown reference price. We have also performed Cochran's Q[1] test with test statistic equals to 162.76 with df=3 and p value = 0.[2]

Treatment 2: This treatment has been designed to capture the impact of transaction utility on purchase decision when quality of only the copied product and its respective market price (copying cost) decline steadily for hypothetical pirated good. This treatment too consists of four choices. For each choice the participants have been given two options to choose from. The first option (Option A) represents the hypothetical original version of product while the second option (Option B) represents the pirated version. If the participant chooses to buy Option A, which remains unchanged at (100, 75, 75) for all four choices, he receives only acquisition utility with no reference price to obtain transaction utility from. However, for Option B, the participant receives both acquisition utility (=25 for all cases) and transaction utility that improves gradually (25, 35, 45, 50) for the four respective choices. The valuation of the pirated product however decreases over the choices (75, 65, 55, 50), as well their market prices from choice 1 to choice 4. The treatment has been designed to arrest the effect

[1]Cochran's Q Test is a non-parametric test that finds differences in matched samples of three or more frequencies or proportions. It is used to check the effects of different treatments on same set of respondents.
[2]We have also conducted pair wise McNemar's test taking choice 1 as control and choice 2,3,4 as treatment.The McNemar test is a non-parametric test to compare a change in proportion for the paired data after a treatment is being given. Results show that there is insignificant difference between Choice 1 and 2 (McNemar'schi2(1) = 0.02 Prob> chi2 = 0.8886). However Choice 3 and choice 4 are significantly different from choice 1.
McNemar'schi2(1) = 27.17 Prob> chi2 = 0.0000 between choice 1 and 3. And
McNemar'schi2(1) = 77.76 Prob> chi2 = 0.000 for choice 1 and 4 where in choice 4 reference price is lower than the market price.

of transaction utility, for gradual degradation of quality of pirated products. The detail of the treatment is depicted in Table 2.

Table 4.2 : Details of Treatment 2

Choices	Option A (Original Good)	Option B (Pirated Good)	% of subjects choosing Option B
1	(100, 75, 75)	(75, 75, 50)	43.06%
2	(100, 75, 75)	(65, 75, 40)	52.63%
3	(100, 75, 75)	(55, 75, 30)	58.37%
4	(100, 75, 75)	(50, 75, 25)	53.58%

#Source: Lab experiment conducted by the authors

We observe that there is a trade-off between product quality (valuation of the good) and transaction utility enjoyed by the subjects. In choice 1, when the quality difference between pirated and original good is small as well as transaction utility is also low, only 43.33% of the subjects opts for pirated good. However, with deteriorating quality of pirated good relative to the original good, the price differential which amounts to transaction utility keeps rising. We observe, in Choice 2, 52.63% of respondents opts for pirated good and in Choice 3, 58.37% of same opts for pirated good. However in Choice 4 when the quality difference between pirated and original good is the highest, around 53.58% of subjects opts for pirated product, lower than that in Choice-3. In this case test statistic for Cochran's Q is13.3913 with df = 3 and p value= 0.[3] Thus, it is observed that when transaction utility is increasing, the quality of the pirated good is declining and the acquisition utility remaining unchanged, the percentage

[3]We have also performed McNemar's pairwise test taking choice 1 as control. In this case, it shows that there is significant differences in proportion of respondents choosing pirated product between choice 1 and Choices 2, 3 and 4.
McNemar'schi2(1) = 5.26 Prob> chi2 = 0.0218 for comparison between choice 1 and 2.
McNemar'schi2(1) = 8.98 Prob> chi2 = 0.0027 for comparison between choice 1 and 3.
McNemar'schi2(1) = 4.40 Prob> chi2 = 0.0359 for comparison between choice 1 and 4.

of people choosing pirated good (Option B) increases despite quality degradation till a certain level, then reverses.

Treatment 3 : This treatment is designed to comprehend the influence of transaction utility when quality of both the original and its copied version improve gradually along with their respective market prices on the purchase decision of the subjects. This treatment too has a set of four choices. For each of the choices, the participants have been given two hypothetical options where the first option represents the original version and the second option represents the pirated version. If the participant decides to purchase the original good, he receives only a constant acquisition utility (=25) with no transaction utilitywith gradual increase in valuation (quality) of the good (100, 125, 150, 175) for subsequent choices . For the pirated version being chosen, the participant receives both acquisition utility and transaction utility. For pirated good, the acquisition utility has been kept unchanged for all the choices at 25 while the quality of the pirated version improves for subsequent choices (75, 94, 113, 131) thereby increasing transaction utility (25, 31, 37, 44). The treatment is showed in Table 3.

Table 4.3 : Details of Treatment 3

Choices	Option A (Original Good)	Option B (Pirated Good)	% of subjects choosing Option B
1	(100, 75, 75)	(75, 75, 50)	33.49%
2	(125, 100, 100)	(94, 100, 69)	55.50%
3	(150, 125, 125)	(113, 125, 88)	63.64%
4	(175, 150, 150)	(131, 150, 106)	63.64%

#Source: Lab experiment conducted by the authors.

The first choice of option 1, where transaction utility is low, only 33.49% of the subjects opts for the pirated good. We observe that as the quality level of both the original and the pirated

goods gradually improve along with a rise in the transaction utility from purchase of pirated good, majority of the sample opts for the pirated good. In this case Cochran's Q test statistic is 69.0390 with df = 3 and pvalue=0.[4] Here again we observe that as transaction utility (TU) increases along with quality differential between pirated and original good with unchanged acquisition utility (=25), percentage of consumers likely to pirate increases steadily.

Treatment 4 : The design mechanism aims at checking the relative trade-off between acquisition utility and transaction utility of the consumers on the product piracy decision. The first option (Option A) of all the choices represents the hypothetical original version of the good with constant acquisition utility 25 and no transaction utility. The second option (Option B) represents the hypothetical pirated version of the good, similar to the previous treatments, but the four choices in this treatment have been designed such that a reduction in acquisition utility is paired with an upsurge in transaction utility. In option B, the first and the third choices of the treatment have same acquisition utility (24) with respective increasing transaction utility equal to 25 and 50 respectively. Alternatively the second and fourth choices (pirated good) have same acquisition utility (22) with rising transaction utility of 45 and 90 respectively. The treatment has been intentionally designed in such a manner to check random responses from the participants with the incentive to compare the relative weights of the two utilities associated with a purchasing decision of a given consumer. The acquisition utility provides the consumer with monetary gain (value consciousness) in terms of enhanced consumer surplus. Alternatively, transaction utility gives the buyer a psychological satisfaction from the deal itself (Thaler, 1983). It seems a motivating idea to us to compare these two, to get some profound result.

[4]In this case taking Choice 1 as control we observe that McNemar's pairwise test statics is always significant when Choice 2, Choice 3 and Choice 4 are considered as treatments with Choice 1 as the control.
McNemar'schi2(1) = 25.80 Prob> chi2 = 0.0000 for comparison between choice 1 and 2.
McNemar'schi2(1) = 40.92 Prob> chi2 = 0.0000 for comparison between choice 1 and 3.
McNemar'schi2(1) = 36.41 Prob> chi2 = 0.0000 for comparison between choice 1 and 4.

Table 4.4 : Details of Treatment 4

Choices	Option A (Original Good)	Option B (Pirated Good)	% of subjects choosing Option B
1	(200, 175, 175)	(174, 175, 150)	36.84%
2	(200, 175, 175)	(152, 175, 130)	42.58%
3	(200, 175, 175)	(149, 175, 125)	55.02%
4	(200, 175, 175)	(107, 175, 85)	61.24%

#Source: Lab experiment conducted by the authors.

A comparison between the first and the third option shows that, more number of subjects choose to pirate in option 3 vis-à-vis option 1 where McNemar'schi2(1) = 16.79, Prob> chi2 = 0.0000.

The same result has been obtained by comparing option 2 and option 4 where McNemar'schi2(1) = 17.48 Prob> chi2 = 0.0000. Thus, we observe, as the transaction utility level increases from option 1 to option 4, more subjects opt for pirated product.

4.3.2: Econometric methodology and data

The methodology that is being followed to obtain the determinants of probability of choosing pirated good is standard logistic regression model with clustered standard error at the individual level. Suppose, we have *m* individuals who have given their responses for *k* number of times, for a particular treatment in the experiment. Let y_{ij}be the binary variable showing the response of *i*th individual's *j*th response in a representative treatment. In our case i=1, 2 ……..209 and j= 1,2,3,4 for each treatment. Thus, for a particular treatment we have a

total of 836 binary responses. Let $y_{ij} = 1$, if the subject chose pirated good over original good. Let p_{ij} be the conditional probability, that$y_{ij} = 1$. We define our model in this way:

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_o + \beta_1 transaction\ utilty\ level_{ij} + \quad \vec{\zeta}\vec{X}_{controls_{ij}}$$

Here, we introduce transaction utility level of *i*th individual for *j*th response in each treatment to observe the effect of this variable on the purchase decision of pirated product. $\vec{X}_{controls_{ij}}$gives the vector of other control variables.Since in this case, each individual has taken purchase decision four times for a treatment, it could have led to correlation among the responses of an individual. To take account of correlated binary choices, we estimate the model under the assumption of clustered standard error at the individual level. We have used STATA 15 for the estimation process.

Following *Dilmperi et al.* (2011), *Borja et al.* (2015) and *Borja and Dieringer* (2016), we have included various demographic variables like sex, annual family income and education stream in the model. We have not included age of the respondent in the analysis as all of them are students and have little variation in age. It is generally argued that it is the males rather than females who are more habitual to piracy. We also include monthly data pack used in GB as a variable to take account of the intensity of online activity of the respondent. *Rochelandet and Le Guel* (2005), *Borja and Dieringer* (2016) argue that prolonged online activity increases the probability of piracy of digital product. Table 5 gives the detail description of the explanatory variables for 209 individuals.[5]

[5]Association between the explanatory variables are in Appendix 4A.

Table 4.5 : Description of the Demographic Characteristics of the Subjects

Variable Name	% in case of Dummy/ Category Variables	Mean	Std. Dev.	Min	Max
Sex Dummy		0.37	0.48	0.00	1.00
Male=0	63.16%				
Female=1	36.84%				
Edu stream **Humanities**	32.54%	.325	0.47	0.00	1.00
Science	33.01%	0.33	0.47	0.00	1.00
Engineering	34.45%	0.34	0.48	0.00	1.00
Annual Family income (in Lakhs of Rs.)	---	5.47	8.37	0.30	100.00
Monthly internet data pack used in GB	---	42.62	83.06	0.75	1000.00

4.4 : Results & Discussions

4.4.1 : Results

This section gives the econometric analysis of our experimental study to determine the factors affecting the probability of piracy by the subjects for each of the respective treatments in a controlled laboratory environment with same facilitating technological conditions with no threat of punishment for piracy. The results are summarised in Table 6 for Treatment 2, Treatment 3 and Treatment 4.

Table 4.6 : Results of Logistic Regression on Experiment Data

	Treatment 2		Treatment 3		Treatment 4	
Outcome variable : Probability of Choosing pirated good	Coef. (Robust Std. Err.#)	Marginal Effect (Delta-method Std.Error)	Coef. (Robust Std. Err #)	Marginal Effect (Delta-method Std.Error)	Coef. (Robust Std. Err#)	Marginal Effect (Delta-method Std.Error)
Explanatory Variables						
Sex dummy Male=0 Female=1	-0.30* (0.18)	-0.072* (.044)	-0.121 (0.218)	-0.028 (0.051)	0.33 (0.20)	0.078 (0.048)
Education Stream *Reference Category Humanities* **Science Stream**	-0.67*** (0.23)	-0.165*** (.05)	-0.456* (0.260)	-0.106* (.060)	-0.29 (.23)	-0.068 (.056)
Engineering Stream	-0.57** (0.23)	-0.142** (.05)	-0.428* (0.258)	-0.100* (.059)	-0.01 (.24)	-0.003 (.059)
Annual family income in lakhs of Rs.	0.02 (0.01)	0.005 (.003)	0.012 (0.011)	0.003 (.003)	0.0036 (0.13)	0.001 (0.003)
Average Monthly Data Consumed in GB	-0.0001 (0.0005)	0.00002 (.0001)	0.001 (0.001)	0.0002 (.0001)	-0.0001 (0.001)	-0.00003 (0.00014)
Transaction Utility	0.02*** (0.01)	0.005** (.002)	0.06*** (0.011)	0.015*** (.002)	0.0201*** (.0038)	0.005*** (0.001)
Acquisition Utility	-------	------	--------	------	0.18** (0.08)	0.042** (0.019)
Constant	-0.27 (.37)	------	-1.790 (0.427)	------	-5.21 (1.96)	------
Number of observation	836		836		836	
`Wald chi2(7)	20.79		43.78		35.00	
Prob> chi2	0.002		0.00		0.00	
Log pseudo likelihood	-564.92322		-551.433		-559.38275	
Pseudo R2	0.0241		0.0438		0.0343	
Hosmer-Lemeshow chi2(8)	6.34		12.33		4.24	
Prob> chi 2	0.61		.1369		0.8349	
AIC	1143.846		1116.867		1134.766	
BIC	1176.947		1149.968		1172.595	

Standard errors are corrected for 209 clusters at individual level. **** significant at 1% level; ** significant at 5% level;* significant at 10% level.* Source: Estimation based on experiment data.

4.4.2: Discussion of Results

The Effect of Transaction Utility and Acquisition Utility on Piracy Decision:

The results of the logistic regressions show that under all three treatments as discussed in section 3.1, transaction utility positively and significantly affects the probability of choosing pirated good by the consumer. Thus, the mental accounting of transaction utility enjoyed by the subjects under various treatments affects their decision to choose pirated good in laboratory environment.

In Treatment 2, we have gradually declined the quality and price of the hypothetical pirated good relative to the hypothetical original good, thereby raising the level of transaction utility. We observe that the probability of purchasing pirated good goes up by 0.5 percentage point for a unit increase in transaction utility while controlling for other explanatory variables.

In case of Treatment 3, an amelioration of quality coupled with a rise in price of the hypothetical original good improves the quality of the hypothetical copied version while the copying cost remains trivial as before. As a result, the subjects of our experiment mentally account an increase in transaction utility and for a unit increase in transaction utility the probability of purchase of pirated good increases by 1.5 percentage points.

Finally, we come to Treatment 4 where both the acquisition utility and transaction utility from purchasing of the hypothetical pirated product vary. In this case, for a unit increase in transaction utility, the purchase probability of pirated good goes up by 0.5 percentage points. In Treatment 4, the change in acquisition utility has been included as an explanatory variable. We observe that for a unit increase in acquisition utility the probability of piracy goes up by 4.2 percentage point. This clearly indicates the importance of value consciousness of the consumers (measured by valuation of product per unit of quality net off price, as shown in

equation 1) on the purchase decision of the pirated good while controlling for different explanatory variables, and differences in technological access and possibility of punishment in the laboratory set up. Thus, high quality copy at low cost will always induce consumers to go for product piracy.

The empirical studies on piracy by *Gopal and Sanders* (1997, 2000), *Peace et al.* (2003), *Kariithi* (2011), *Borja et al.* (2015), *Borja and Dieringer* (2016), *Bhattacharjee et al.*(2003), *Arli and Tjiptono* (2016) noted that high price of the original information good is an important factor behind product piracy. Our experiment also ascertains that, existence of transaction utility, defined as the difference between price of original good (reference price) and copying cost of pirated good significantly impacts the piracy decision. However, the sheer chance of enjoying almost unadulterated quality good at a negligible price (acquisition utility) also have strong impact on piracy decision.

Effects of Socio Demographic Variables on the piracy Decision

We observe in case of Treatment 2, probability of doing piracy is 7.2 percentage points lower for female subjects visà vis male at 10% level of significant. This result is in line with the standard literature that females are less likely to practice piracy compared to their male counterparts (*Chiang and Assane*, 2008). Next, we observe that in case of Treatment 2 and Treatment 3, probability of piracy is significantly higher for students from Humanities compared to Science and Engineering streams. The study by *Borja et al.* (2015) and *Borja and Dieringer* (2016) observe that educational stream is insignificant in explaining piracy probability. However, our study observe that even though students from science and technology background are expected to have superior knowledge about computer languages and other techniques, still they are less likely to indulge in piracy decision in a laboratory

environment compared to students from Humanities.[6] Rests of the variables are found to be insignificant.

4.5 : Conclusion

Our paper bridges a gap in literature on consumer behaviour related to product piracy by incorporating the concept of transaction utility in the piracy decision made by the consumers in a laboratory environment setup with no threat of punishment and similar technological facility for all participants. The paper treats the price of the original good as reference price and assumes that a consumers receives transaction utility form piracy from the difference between the price of the original good and a much lower copying cost in case of end user piracy. In a non-incentivised laboratory experiment with 209 voluntary participants from Jadavpur University, Kolkata, India, across various streams of education in the age group of 18-23, the result shows that transaction utility positively and significantly affects the likelihood of product piracy across various treatments applied in the experiment. The experiment was decisively made non-incentivised to segregate the impact of transaction utility from that of acquisition utility on the likelihood of choosing pirated good by the consumers. In one treatment we also vary the acquisition utility or net valuation of the pirated good and observe that it too affects the piracy decision positively. Also, we observe that the male subjects and students belonging to Humanities are more prone to product piracy.

The result of this experimental study is in line with the theoretical result in *Basu and Banerjee* (2019), in which transaction utility has been considered to be a vital factor in the

[6]The reason may be as follows : the students from Humanities consist of students from Literature, Language, History, Sociology, Philosophy, Economics and Political Science Departments. They require different books, copies of old books ,media files like movie files, music files for their studies which they are eager to pirate when available.

context of end-user piracy and its impact has been studied regarding price-quality decision of the original good producer.

Given the findings of our paper we have few interesting policy prescription. The organisations facing the problem of extensive end-user piracy can opt for two different tactics: in one hand deterrent techniques (or preventive controls as conceptualised by *Gopal and Sanders*, 1997) can be used to make the process of copying technologically more difficult, thereby raising the copying cost. This in turn will reduce the extent of transaction utility or psychological satisfaction from the act of piracy. Alternatively, the price of original good can be decreased to reduce the price differential between the original and the pirated good. A possible way out for it can be the implementation of product versioning policy and produce a lower quality version of the product for the masses with relevant lower prices to keep the price differential between the original and the pirated product in check (thus checking the associated transaction utility). Literatures on product versioning as a tool to enhance profit in piracy infested market (*Slive and Bernhardt*, 1998 ; *Wu et al.*, 2003 ; *Basu and Banerjee*, 2018) can contribute to modify the pricing policies of the organisations.

Our study has some limitations as well. The study includes only the young students form one academic institution due to paucity of fund. The result will be more generalised if other academic institutions from other parts of the country are included in the study. Also, the above findings may change if we have aged working people of higher age group included in the study. Further, the actual behaviour of the subjects may change outside the laboratory environment with different technological parameters and legal framework.

Appendix 4A

Table 4A : Table of Association between the Variables

Biserial Correlation between Binary Variables and Continuous Variables			
		Annual Family income in Lakhs of Rs.	Monthly internet data pack used in GB
Education Stream	Sex	0.2188	-0.1199
	Humanities	0.1941	-0.0922
	Science	-0.0522	0.1531
	Engineering	-0.1397	-0.0606
Pearsonian Correlation Between Annual Family income in Lakhs of Rs. and Monthly internet data pack used in GB is .1076			
Cramer'V between Sex Dummy and Education Stream is .42			

Chapter 5 : A Theoretical Analysis of Product Versioning in the context of Commercial Piracy

5.1 : Introduction

Intellectual property rights (IPR) ensures legal justice to innovations. It is particularly important in the context of incentivizing the producers to innovate new products and invest on their R&D sector. However, firms face serious threats to their profit and market share due to the problem of product piracy. Product piracy in any form is a violation of IPR and despite of the legal backing, the original producer suffers from the activities of pirates. This problem is specifically relevant in case of information good industry because of their vulnerability to the threat of piracy. Piracy is generally of two types – End-user piracy and commercial piracy. End-user piracy refers to the act of piracy done by private individuals for their personal use, whereas commercial piracy refers to the form of piracy where a firm makes illegal copies of the original information good and sells them commercially in the market. After digitalization of the economy, the rate of piracy has increased exponentially. Apart from software's, books, journals, music and video cd's are equally or even more susceptible to digital piracy. The incidence of piracy becomes severe as we move to developing economies. The developing economies that are characterised by low per capita income and high income gap between rich and poor, piracy finds itself easier to be practiced. In these areas, the legal enforcement or the IPR protection is not severe and therefore not as effective as in the case of the developed economies. This is backed by the logic that piracy instils competition in the market and thereby enhances the consumer surplus. In the developing economies with low per capita income the consumers usually have lower willingness to pay, consequently they cannot keep up with the dynamic global digitalisation. This constricts their exposure and knowledge, further aggravating the problem of underdevelopment. These

sometimes initiate the government to relax IPR regime and allow a tolerated level of piracy. In such situations the welfare maximising target somehow dominates the provision of protecting the interests of the original information good producer, who are generally large multinational corporations. Thus, in an environment where commercial piracy prevails, the original good producers seek for alternative strategies for maximising their profit.

The producers of original product also adopt various strategies to combat piracy. Sometimes they invest in installing anti-piracy measure within their product, or they can adopt the policy of limit pricing to restrict the entry of pirate. In the present paper, we try to find whether the practise of product versioning can be observed as an effective measure of the original good producers to maximise profit and combat piracy. In an economy with relaxed IPR regime and a large proportion of consumers with lower willingness to pay for the product (depicting a developing economy), the original good producers find it optimal to design different versions for different spectrums of consumers with varying willingness to pay. This ensures some or most of the lower fringes of consumers buy the original information good of lower version at relatively lower price. Since this policy does not interfere with the welfare maximizing objective of the government (by keeping the consumer surplus unchanged), versioning is growing to be an important tool to fight the threat of piracy.

Literatures on commercial piracy and related government policy (*Banerjee* 2003,2005) have been reviewed in the context of this paper. *Banerjee* (2003) addressed the aspects of anti-piracy investment by the incumbent firm and the trade-off between government monitoring of piracy and the same. *Banerjee* (2005) discussed the effect of lobbying in the context of commercial piracy. Basically these papers were reviewed to get a broad outline of the area of commercial piracy and the functioning of the pirates.

There exists a gamut of literature that discusses various issues related to product versioning under end-user piracy. *Alvisi et al.*, (2002), *Wu et al.*, (2003), *Cremer et al.*, (2008), *Cho et al.*, (2010). *Alvisi, et al.* (2002) asserted that end-user piracy incentivises the original good producer to produce different qualities of the same product to deter piracy. *Wu et al.* (2003) positively asserted that product versioning in a much more effective tool that the anti-piracy technological tools or penalty to the pirates to deter end-user piracy. They showed that product versioning strategy is also the welfare maximising strategy. *Cremer and Pestieau* (2008) worked on the pricing policy of product versions produced by a monopolist in presence of end-user piracy and identified three different equilibriums of piracy control based on the nature of original good producing monopolist has been discussed. The highest piracy control is charged by the profit-maximising monopolist followed by the welfare maximising monopolist and public authority respectively. *Cho and Ahn* (2010) discussed quality choices of original good producer practising product versioning in a vertically differentiated market in presence of end-user piracy. This paper contributes to our study by lending idea of addressing issue of a vertically differentiated market based on willingness to pay parameter of the consumers. This paper too concludes that product versioning is optimal in presence of end-user piracy and that the producer will choose a relatively lower quality product for high end consumers and higher quality product for low end consumers in comparison to a situation without piracy. The existing literatures either addressed the issue of product versioning by the original good producer in the context of end-user piracy and a tool to deter it or the monitoring or technological instruments to fight commercial piracy. Amalgamating these two ideas, our paper tries to gauge the issue of product versioning in the presence of commercial piracy, decide the quality level of the original producer and compares the profit of the original good producer in the context of product versioning and no-versioning to optimise the strategy. The rest of the paper is arranged in the following manner. Section 2

illustrates the model explaining product versioning regime and no product versioning regime followed by section 3 that deals with comparison between the versioning and no versioning regime, in order to optimise the strategy of the original firm. Section 4 concludes the study.

5.2 : The Model

The theoretical model studies the profitability of a firm producing original good (herein referred to as original firm) while practicing product versioning in a duopoly market with heterogeneous consumers in the presence of commercial piracy. The heterogeneity among the consumers is based on their willingness to pay for the good. The first group is the business group with a relative higher willingness to pay for quality and is indexed by $\beta \in \left[\underline{\beta}, \overline{\beta}\right]$, β denotes the valuation of product for a representative consumer in the group. This group is assumed to never involve in the act of purchasing a pirated product. For example, the consumers like academic institutions and corporate houses usually never involve in the act of purchasing pirated product. The second group is that of home group of consumers, with a relative lower willingness to pay for the product and is indexed by $\theta \in \left[0, \overline{\theta}\right]$, θ denotes the valuation of the product of a representative consumer. This group usually represents individual consumers who might be inclined to buy pirated product at a lower price. It is further assumed that the business group will strictly not buy the product designed for the home group on account of absence of certain technical facilities like LAN in case of software and others. The original firm serves a linear consumer spectrum such that $\overline{\theta} \gtrless \underline{\beta}$, with the assumption that the business consumers will neither buy home product nor will it involve in the act of piracy. The original firm produces two distinct versions of an information good of two different qualities for catering the two groups of consumers. For simplicity, we assume that the original firm is an installed firm; hence the development cost can be avoided. The

quality cost of both the versions of original good are assumed to be quadratic with production of business version being relatively costlier. The commercial pirate, competes with the original firm by reproducing unauthorized copies of the information good and selling them in the market. The quality of the pirated product is inferior to that of the home version of original good, in fact it is an imperfect substitute of the home version. The quality loss can be attributed to aspects such as regressive copying technique of the pirate or the loss of support-services that come with the original product or the probability of the copy to be defective. The pirate's cost associated with copying from the original good is negligible, hence assumed to be zero. Thus, in this model when the commercial pirate operates it competes with the original firm to capture the home group market. The qualities of the original product are denoted by $q_i,\ i = h, l$ and that of the pirated product is denoted by α. For simplicity of analysis, we assume that $\alpha = \mu q_l$ $[\mu \in (0,1)]$. The model assumes a stringent monitoring of commercial piracy by the government such that the monitoring activity raises the unit cost of production for the pirate. The original firm takes into account the monitoring rate g and acts as the price leader and the pirate acts as the price follower. The game is solved using backward induction method.

5.2.1 : Versioning of Product Regime

This section discusses the versioning strategy of the original firm. Under versioning the firm first chooses the price and quality for both its version. The pirate observes them and imitates the home version of product where the government monitoring imposes a unit cost on the pirate. The pirate thus acts as a price follower. After this, the consumers make their purchase decision. The price – quality for two versions of original good are assumed to be : (p_h, q_h) for the business group and (p_l, q_l) for the home group. We further assume $q_h > q_l$and $p_h > p_l$. The commercial pirate reproduces the good with quality α $[\alpha = \mu q_l\ ; 0 < \mu < 1]$ and

sells at price p_c. The utility function of the business consumer purchasing one unit of product is :

$$U(\beta) = \begin{cases} \beta q_h - p_h, & if\ he\ buys\ the\ original\ good \\ 0, & if\ he\ buys\ nothing. \end{cases} \tag{1}$$

The utility function of the home consumer purchasing one unit of product is :

$$U(\theta) = \begin{cases} \theta q_l - p_l, & if\ he\ buys\ original\ good \\ \theta \mu q_l - p_c, & if\ he\ buys\ pirated\ good \\ 0, & if\ he\ buys\ nothing. \end{cases} \tag{2}$$

We suppose β_1 be the marginal business consumer who is indifferent between purchasing the good and not purchasing,θ_1 be the marginal home consumer who is indifferent between purchasing the original good and the pirated good and $\theta_2$be the marginal home consumer who is indifferent between purchasing the pirated good and nothing.[1]

The original firm faces the demand from the business group of consumers as well as from the home group. The demand faced by the original firm from the business market is given in (3).

$$D_m^{\beta}(p_h) = \int_{\beta_1}^{\overline{\beta}} dq = \left[\overline{\beta} - \frac{p_h}{q_h}\right] \tag{3}$$

The demand faced by the original firm from the home market is given in (4).

$$D_m^{\theta}(p_l, p_c) = \int_{\theta_1}^{\overline{\theta}} dq = \left[\overline{\theta} - \frac{p_l - p_c}{q_l(1-\mu)}\right] \tag{4}$$

[1] $\beta_1 = \frac{p_h}{q_h}$; $\theta_1 = \frac{p_l - p_c}{q_l(1-\mu)}$; $\theta_2 = \frac{p_c}{\mu q_l}$

The pirate faces the demand from only the home group of consumers:

$$D_c^{\theta}(p_l, p_c) = \int_{\theta_2}^{\theta_1} dq = \frac{p_l - p_c}{q_l(1-\mu)} - \frac{p_c}{\mu q_l} \quad (5)$$

The profit of the pirate is :

$$\pi_c = (p_c - g)\left[\frac{p_l - p_c}{q_l(1-\mu)} - \frac{p_c}{\mu q_l}\right] \quad (6)$$

The pirate is assumed to incur zero marginal cost, but the monitoring rate 'g' of the government is a kind of unit cost to it. Using the back-ward induction method, first the price game is solved. The original firm decides to play the pricing game sequentially and acts as a price leader. The reaction function of the pirate is derived to be :

$$p_c = \frac{\mu p_l + g}{2} \quad (7)$$

The joint profit function of the firm from the two spectrums of consumer assuming lump sum quadratic cost of quality for both the versions of original good, incorporating the reaction function of the pirate is :

$$\pi_v = p_h\left[\overline{\beta} - \frac{p_h}{q_h}\right] - \frac{{q_h}^2}{2} + p_l\left[\left(\overline{\theta} + \frac{g}{2q_l(1-\mu)}\right) - \frac{p_l(2-\mu)}{2q_l(1-\mu)}\right] - \frac{\tau {q_l}^2}{2} \quad (8)$$

where $\tau < 1$ implies home quality is relatively cheaper to produce than business quality.

5.2.2 : Perfect discrimination of consumers

Assuming that the firm can perfectly discriminate among the home group and the business group, the equilibrium prices are:

$${p_h}^* = \frac{\overline{\beta} q_h}{2} \quad (9)$$

$${p_l}^* = \frac{\overline{\theta} q_l(1-\mu)}{(2-\mu)} + \frac{g}{2(2-\mu)} \quad (10)$$

Since the business consumers have no incentive to buy pirated product, stricter IPR regime will have no effect on them. So price of business version is unaffected by a rise in 'g'. As 'g' rises the price of pirated product rises and consequently price of its substitute home version rises too. The increase of the demand parameters $\overline{\beta}$ and $\overline{\theta}$ will increase the equilibrium prices.

The profit of the firm is :

$$\pi_v{}^* = \left[\frac{\overline{\beta}^2 q_h}{4} - \frac{{q_h}^2}{2}\right] + \left[\frac{\overline{\theta}^2 q_l(1-\mu)}{2\,(2-\mu)} + \frac{\overline{\theta} g}{2(2-\mu)} + \frac{g^2}{8q_l(1-\mu)(2-\mu)} - \frac{\tau {q_l}^2}{2}\right] \quad (11)$$

We observe profit of the original firm is increasing in g, as stricter monitoring regime allows the it to charge higher price for its home version product which is a close substitute of the pirated product. This enhances the profit. An increase in the demand parameters $\overline{\beta}$ and $\overline{\theta}$ also enhances profit of the original firm by increasing the prices for both the versions.

The pirate is the price follower in the game and chooses its equilibrium price:

$$p_c{}^* = \frac{\overline{\theta}\,\mu q_l\,(1-\mu)}{2\,(2-\mu)} + \frac{g\,(4-\mu)}{4(2-\mu)} \quad (12)$$

The price of the pirated good increases with 'g'. A rise in 'g' induces the pirate to raise its price for profitable production.

Quaility choice : Next we consider the choice of quality by the firm. Under versioning regime, the original firm chooses $q_h \in \left[\underline{q_h}, \overline{q_h}\right]$ and $q_l = \left[\underline{q_l}, \overline{q_l}\right]$, where $\overline{q_l} < \underline{q_h}$. The endogenised quality of the business version at equilibrium is $q_h = \frac{\overline{\beta}^2}{4}$, since the individual profit of the business version is maximum for this level of quality. We checked the S.O.C. of the profit maximisation problem and derived $\frac{\partial^2 \pi_v}{\partial {q_h}^2} < 0$. But for home version, the first order condition for profit maximisation with respect to q_l is given as –

$$\frac{\partial \pi_v}{\partial q_l} = 0 \Rightarrow \left[\frac{\overline{\theta}^2(1-\mu)}{2(2-\mu)} - \frac{g^2}{8{q_l}^2(1-\mu)(2-\mu)}\right] = \tau q_l \qquad (13)$$

The S.O.C. for profit maximisation in case on home version requires –

$$\frac{\partial^2 \pi_v}{\partial {q_l}^2} < 0 \Rightarrow \frac{g^2}{4{q_l}^3(1-\mu)(2-\mu)} < \tau \qquad (14)$$

(13) can be simplified as $A(q_l) = \tau q_l$, where

$$A(q_l) = \left[\frac{\overline{\theta}^2(1-\mu)}{2(2-\mu)} - \frac{g^2}{8{q_l}^2(1-\mu)(2-\mu)}\right] \qquad (15)$$

Here, $A'(q_l) > 0$ and $A''(q_l) < 0$. $A(q_l) = 0$ for $q_l = \overline{q_l} = \frac{g}{2\overline{\theta}(1-\mu)}$

Thus, $A(q_l)$ can be represented by the concave upward sloping curve. Figure 5.1 diagrammatically determines the equilibrium value for q_l.

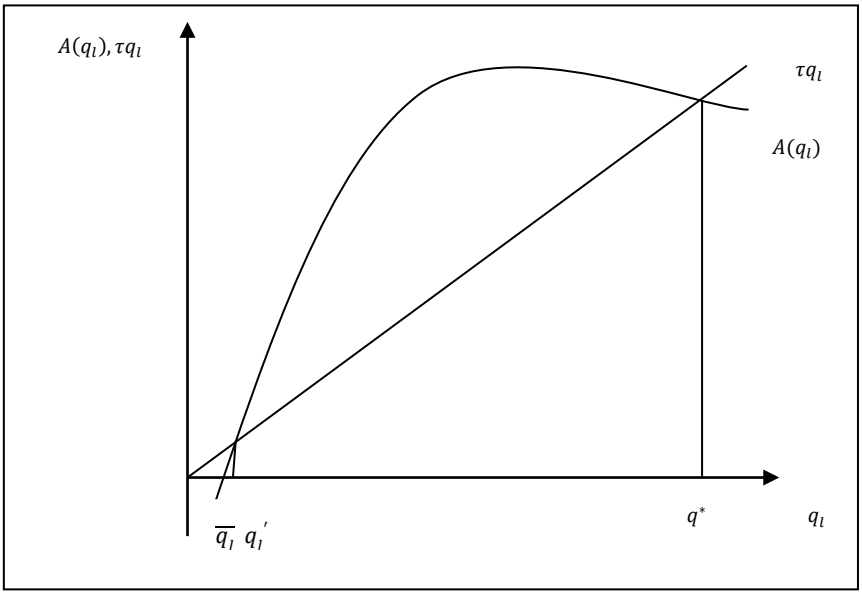

Figure 5.1: Determination of Quality of home group product under Perfect discrimination

In the Figure 5.1 τq_l is represented by the linear curve passing through the origin. $A(q_l)$ and τq_l intersect at $q_l'$and $q_l{}^*$. But the sufficient condition for profit maximisation is satisfied at $q = q_l{}^*$, where $\tau > A'(q_l) = \left[\frac{g^2}{4{q_l}^3(1-\mu)(2-\mu)}\right]$. Hence, the endogenised quality is determined at $q_l = q_l{}^*$

5.2.3 : Imperfect discrimination of consumers

In this section we consider the situation when the original good producer cannot perfectly discriminate between the business group and the home group and it is possible for the home group to imitate as the business group and purchase the product designed for the business group. However, we have already assumed that the business group will strictly not buy the version of product designed for the home group. Therefore, to restrict the home group of consumers to purchase the business version of the product, the original firm chooses its price for business version in such a way that even the consumer with highest willingness to pay in the home group cannot afford to purchase that, i.e. $\overline{\theta} q_h \leq p_h$. Hence, we get the following constraint:

$$p_h \geq \overline{\theta} q_h \qquad (16)$$

The firm will thus maximise its profit given in (8) subject to the above constraints and the pirate maximises the profit given in (6). Depending upon the parameter values two different equilibrium configurations can be identified.

Case 1 :

This particular case happens for parametric condition $\overline{\beta} > 2\overline{\theta}$. Under this condition, the unconstrained optimum solution as shown in (9) and (10) will be chosen by the original firm. The joint profit of the firm in this case is identical to the profit of the perfect discrimination as given in (11)[2].

Under the condition $\overline{\beta} > 2\overline{\theta}$, it is observed that, when the highest willingness to pay parameter of the business group is sufficiently higher than that of the home group, the firm earns the unconstraint monopoly profit even under imperfect discrimination. Since this case

[2]Proof in Appendix.

coincides with the perfect discrimination regime, the qualities provided by the original firm for both the business group as well as the home group will be the same as shown in last sub-section.

Case 2 : For parametric restriction $\overline{\beta} < 2\overline{\theta}$, the firm reaches its equilibrium prices at [3]:

$$p_{h_2} = \overline{\theta} q_h \qquad (17)$$

$$p_l^* = \frac{\overline{\theta} q_l (1-\mu)}{(2-\mu)} + \frac{g}{2(2-\mu)} \qquad (10)$$

In this case, the highest willingness to pay parameter value for the business consumer is relatively small with respect to that of the home group. Therefore, though the firm charges unconstrained maximising price for the home group market, it cannot do the same for the business group. Basically, when $\overline{\theta} > \frac{\overline{\beta}}{2}$, the consumer at the upper end of the home spectrum may deviate to the business group product. To restrict such deviation, the firm charges $p_{h_2} > p_h^*$.

It is observed again that only the price of home version increases with 'g'. The price of business version is not affected. For this reason, corresponding price of the pirate is same as (12). It is also observed that prices for the both the versions of original good is increasing in the demand parameter θ. Finally, the profit of the original firm is :

$$\pi_{v_2} = \left[\overline{\beta}\overline{\theta} q_h - \overline{\theta}^2 q_h - \frac{{q_h}^2}{2}\right] + \left[\frac{\overline{\theta}^2 q_l (1-\mu)}{2\,(2-\mu)} + \frac{\overline{\theta} g}{2(2-\mu)} + \frac{g^2}{8 q_l (1-\mu)(2-\mu)} - \frac{{q_l}^2}{2}\right] \qquad (18)$$

Quality choice: The optimum qualities provided by the original firm for business version of product is $q_h = (\overline{\beta} - \overline{\theta})\overline{\theta}$. The optimum quality of the home version however remains the same as that in case 1 which is in turn same as perfect discrimination case. The S.O.C. of

[3] Proof in Appendix.

profit maximisation is also checked to be satisfying. Thus in the case, when $\overline{\theta} > \frac{\overline{\beta}}{2}$, implying the highest willing ness to pay for the product for the home group consumer is sufficiently high, the original good producer deteriorates the quality of business group product to deter the home group consumers to purchase the product for the business group.

In both Case I and Case 2, the pirate's price increases with the monitoring rate 'g', since with an increase in 'g', the unit cost of pirate increases, thereby raising its price.

5.2.4 : No-Versioning of Product Regime

The following section discusses the 'no versioning' regime of the model. The original firm produces a single version of good with quality q and sells at price p_{nv}, incurring a quality cost of $\frac{\tau q^2}{2}$. The commercial pirate reproduces the good with quality α [$\alpha = \mu q$; $0 < \mu < 1$] and sells at price p_c. When $p_h = p_l = p$ and $q_h = q_l = q$, the profit of the original firm as given in (8) reduces to :

$$\pi_{nv} = p_{nv}\left[\overline{\beta} - \frac{p_{nv}}{q}\right] + p_{nv}\left[\overline{\theta} - \frac{p_{nv}(2-\mu)-g}{2q(1-\mu)}\right] - \frac{\tau q^2}{2} \qquad (19)$$

The original firm chooses its equilibrium price[4] :

$$p_{nv} = \frac{2q\,(\overline{\beta}+\overline{\theta})(1-\mu)+g}{2(4-3\mu)} \qquad (20)$$

The price of the firm increases with stringent monitoring. It is further observed that $\frac{\partial p_{nv}}{\partial \overline{\beta}} > 0$ and $\frac{\partial p_{nv}}{\partial \overline{\theta}} > 0$,i.e. an increase in either $\overline{\beta}$ or $\overline{\theta}$ also increase the equilibrium price.

The profit of the original firm is :

[4] Proof in Appendix 5A.

$$\pi_{nv} = \frac{[2q(\overline{\beta}+\overline{\theta})(1-\mu)+g]^2}{8q\,(1-\mu)(4-3\mu)} - \frac{\tau q^2}{2} \quad (21)$$

In this regime too, $\frac{\partial \pi_{nv}}{\partial \overline{\beta}} > 0$ and $\frac{\partial \pi_{nv}}{\partial \overline{\theta}} > 0$, i.e. the profit of the original firm is increasing in demand parameters $\overline{\beta}$ and $\overline{\theta}$. An increase in either of the demand parameters $\overline{\beta}$ or $\overline{\theta}$, increases the demand base and the average willingness to pay for the product for both the consumer spectrums of the original firm, resulting in an enhancement of profit.

Given the price of the original firm, the pirate's price is :

$$p_{c_{nv}} = \frac{(\overline{\beta}+\overline{\theta})\mu q\,(1-\mu)}{2(4-3\mu)} + \frac{g(8-5\mu)}{4(4-3\mu)} \quad (22)$$

The price of the pirated good increases with 'g'. A rise in 'g' induces the pirate to raise its price for profitable production.

Quality choice : The first order condition for profit maximisation is given as-

$$\frac{\partial \pi_{nv}}{\partial q} = 0 \Rightarrow \left[\frac{4(\overline{\beta}+\overline{\theta})^2(1-\mu)^2}{8(1-\mu)(4-3\mu)} - \frac{g^2}{8q^2(1-\mu)(4-3\mu)}\right] = \tau q \quad (23)$$

The S.O.C. for profit maximisation in case of single version (the "nv" case) is given by –

$$\frac{\partial^2 \pi_{nv}}{\partial q^2} = \frac{g^2}{8q^3(1-\mu)(4-3\mu)} - \tau < 0 \quad (24)$$

It can be simplified as $V(q) = \tau q$, where

$$V(q) = \left[\frac{4(\overline{\beta}+\overline{\theta})^2(1-\mu)^2}{8(1-\mu)(4-3\mu)} - \frac{g^2}{8q^2(1-\mu)(4-3\mu)}\right] \text{ with } V(q)' > 0 \text{ and } V''(q) < 0 \quad (25)$$

The quality of the no-versioning regime can be determined diagrammatically similarly as that in case of the home version in versioning regime.

5.3 : Comparison between Versioning and No Versioning

The original firm is a profit maximising entity and it will choose a strategy that will maximise its profit in the presence of commercial piracy. To analyse the situation, we compared the profit of the original firm under versioning and no versioning regime. The profit comparison between (11) and (21) (for $\overline{\beta} > 2\overline{\theta}$) and the comparison between (11) and (21) (for $\overline{\beta} < 2\overline{\theta}$) yield no conclusive result. Thus, we conclude Versioning may or may not be the optimal strategy of the original good producer in the presence of commercial piracy.

Therefore, we attempted to solve this problem by applying simulation method.

In all the existing literatures concerning product versioning used as a strategy to fight end-user piracy, the results unambiguously showed that versioning enhance the profit of the original good firm. However, in our study, we observed a counter-intuitive result. Assuming the values of the demand parameters and the government monitoring rate, we numerically deduced the profit of the original firm for a set of values of μ (parameter measuring the degree of substitutability of the pirated good). It is observed that as the pirated version of the good becomes close substitute to the home version of the original good, it is feasible for the original firm to produce a single version of product, rather than two. Simultaneously, it is also observed that the no-versioning profit always exceeds the versioning profit of the original firm for all feasible cases. The numerical table for profit comparison between versioning and no versioning regimes for both the cases are given below for feasible range of :

Table 5.1: (Case 1 : $\overline{\beta} > 2\overline{\theta}, assuming\ \tau = 1$)

$\overline{\beta}$	$\overline{\theta}$	g	α	μ	q_h	q_l	q	${\pi_m}^{\beta}$	${\pi_m}^{\theta}$	π_v	π_{nv}
4.5	2	0.5	0.5	0.1	5.0625	1.8844	10.2768	12.8144	1.1703	13.9847	26.8444
4.5	2	0.5	0.5	0.2	5.0625	1.7638	9.9409	12.8144	1.0801	13.8946	25.1858
4.5	2	0.5	0.5	0.3	5.0625	1.6272	9.54	12.8144	0.9883	13.8028	23.2801
4.5	2	0.5	0.5	0.4	5.0625	1.4698	9.0531	12.8144	0.8969	13.7113	21.0742
4.5	2	0.5	0.5	0.5	5.0625	1.2826	8.4492	12.8144	0.8096	13.6240	18.5035
4.5	2	0.5	0.5	0.6	5.0625	1.0395	7.6806	12.8144	0.7346	13.5491	15.4958

Table 5.2: (Case 2 : $\overline{\beta} < 2\overline{\theta}, assuming\ \tau = 1$)

$\overline{\beta}$	$\overline{\theta}$	g	α	μ	q_h	q_l	q	${\pi_m}^{\beta}$	${\pi_m}^{\theta}$	π_v	π_{nv}
3.75	2	0.5	0.5	0.1	3.5	1.8844	8.0419	6.125	1.1703	7.2953	16.5590
3.75	2	0.5	0.5	0.2	3.5	1.7638	7.7790	6.125	1.0801	7.2051	15.5540
3.75	2	0.5	0.5	0.3	3.5	1.6272	7.9652	6.125	0.9883	7.1133	14.3374
3.75	2	0.5	0.5	0.4	3.5	1.4698	7.0840	6.125	0.8969	7.0219	13.0646
3.75	2	0.5	0.5	0.5	3.5	1.2826	6.6113	6.125	0.8096	6.9346	11.5100
3.75	2	0.5	0.5	0.6	3.5	1.0395	6.0093	6.125	0.7346	6.8596	9.6934

Thus, our model shows that in a market with commercial piracy, with lump sum cost of quality development original good producer may not chose product versioning strategy. This result is attributable to the fact that the quality provision is costly and endogenous. Since production of business version of product entails higher quality cost, the firms may not find it profitable to diversify the product spectrum when it is competing with the profit maximising commercial pirate.

5.6 : Conclusion

In a duopoly structure with a firm producing original information good and a commercial pirate illegaly imitating that, with quality cost for two groups of consumers with heterogenous valuation for the product, we tried to analyse the efficacy of product versioning strategy of the original firm to combat commercial piracy in a developing economy. We assume the existence of a government that monitors piracy and a stringerent monitoring activity raises the unit cost of production of the pirate. We have studied majorly two regimes, 'versioning' and 'no versioning' and compared the reults. In this structure it is shown that depending on the demand parameters, there are two possible equilibria for the original firm in the versioning regime. The mathematical comparison between profit of the original firm for versioning regime and no versioning regime is however coming ambiguos in our study. Then applying simulation, it is observed that firstly, it is not feasible for the original firm to adopt product versioning as the degree of substitutability of the pirated product increases. It is further observed that no-versioning can be an optimal strategy of the original firm in presence of a commercial pirate catering to the spectrum of consumers having realatively low ability to pay for the product. The quality cost of the original products are responsible for diminishing the profit of the original producer. Since the cost of production of the business version of good is considerably costly, it puts a downward pressure on the profit margin of the original producer, irrespective of the size of the business consumer spectrum. Hence the original producer will find it more profitable to produce a single version of product with realtively lower quality cost (same as that of home version)for the entire consumer spectrum rather than to diversify its production when it is facing a competition from a profit maximising commercial pirate. The findings of our paper counters the results of the study of *Alvisi, Argentesi and Carbonara* (2002) which has assumed costless quality provision under end-user piracy. *Cremer and Pestieau* (2008) and *Cho and Ahn* (2010) have concluded that

product versioning is unambiguously the optimal strategy for the original producer in the presence of end-user piracy with positive cost for quality provision. In case of end-user piracy, the profit earned by the original producer is entirely monopoly profit which is naturally more than the duopoly profit earned by the producer from the lower spectrum of consumers where it has to compete with a profit maximising commercial pirate. *Wu, Chen, Anandalingam* (2003) studied a model of end-user piracy with heterogeneous consumers. They showed that if the piracy cost faced by the consumers is asymmetric, it is profitable to produce a single version of good under certain condition. This goes in line with our study that develops a model in the presence of commercial piracy and posits that the efficacy of product versioning strategy by the original firm in presence of commercial piracy is ambiguous.

Appendix 5A

Versioning with Imperfect Discrimination

Incorporating the reaction function of the pirate, the Lagrange expression associated with the joint profit of the original firm is given by :

$$L = p_h\left[\overline{\beta} - \frac{p_h}{q_h}\right] - \frac{{q_h}^2}{2} + p_l\left[\overline{\theta} - \frac{p_l(2-\mu)-g}{2q_l(1-\mu)}\right] - \frac{{q_l}^2}{2} + +\lambda\left[p_h - \overline{\theta}q_h\right] \quad \text{(A1)}$$

λ is the shadow price.

In view of the FOCs the expression for equilibrium prices of the original firm are :

$$p_h = \frac{q_h(\overline{\beta}+\lambda)}{2} \quad \text{(A2)}$$

$$p_l = \frac{\overline{\theta}q_l(1-\mu)}{(2-\mu)} + \frac{g}{2(2-\mu)} \quad \text{(A3)}$$

Applying Kuhn-Tucker theorem for the profit maximisation problem. The FOC's of the profit maximisation problem are :

$$\frac{\partial L}{\partial p_h} = \overline{\beta} - \frac{2p_h}{q_h} + \lambda = 0 \qquad \text{(A4)}$$

$$\frac{\partial L}{\partial p_l} = \overline{\theta} - \frac{p_l(2-\mu)}{q_l(1-\mu)} + \frac{g}{2q_l(1-\mu)} \qquad \text{(A5)}$$

$$\frac{\partial L}{\partial \lambda} = p_h - \overline{\theta} q_h \geq 0 \; ; \qquad \lambda > 0 \qquad \text{(A6)}$$

Case 1 : $\overline{\beta} > 2\overline{\theta}$

Here, $\lambda = 0$. Constraint is non-binding implying $p_h > \overline{\theta} q_h$

The equilibrium prices are same as the unconstrained monopoly prices.

$$p_h = \frac{\overline{\beta} q_h}{2} \qquad (7)$$

$$p_l = \frac{\overline{\theta} q_l(1-\mu)}{(2-\mu)} + \frac{g}{2(2-\mu)} \qquad (8)$$

Putting the equilibrium prices in the constraint –

$$\frac{\overline{\beta} q_h}{2} > \overline{\theta} q_h \Rightarrow \overline{\beta} > 2\overline{\theta}$$

Thus, this case is feasible when $\overline{\beta} > 2\overline{\theta}$.

<u>Endogenised quality</u>

Profit of original firm from the business group :

$$\pi_m{}^{\beta} = \left[\frac{\overline{\beta}^2 q_h}{4} - \frac{{q_h}^2}{2} \right] \Rightarrow \frac{\partial \pi_m{}^{\beta}}{\partial q_h} = \frac{\overline{\beta}^2}{4} - q_h = 0 \Rightarrow q_h = \frac{\overline{\beta}^2}{4}$$

Profit of the original firm from the home group :

$$\pi_m{}^{\theta} = \left[\frac{\overline{\theta}^2 q_l(1-\mu)}{2\,(2-\mu)} + \frac{\overline{\theta} g}{2(2-\mu)} + \frac{g^2}{8q_l(1-\mu)(2-\mu)} - \frac{{q_l}^2}{2}\right] \Rightarrow \frac{\partial \pi_m{}^{\theta}}{\partial q_l} = \frac{\overline{\theta}^2(1-\mu)}{2(2-\mu)} - q_l - \frac{g^2}{8{q_l}^2(1-\mu)(2-\mu)} =$$

0

$$\Rightarrow 8{q_l}^3(2-\mu)(1-\mu) - 4\overline{\theta}^2{q_l}^2(1-\mu)^2 + g^2 = 0$$

Case 2 : $\overline{\beta} < 2\overline{\theta}$

In this case where $\lambda > 0$,(constraint non-binding) we observe $\lambda = 2\overline{\theta} - \overline{\beta} > 0, i.e.\ \overline{\beta} < 2\overline{\theta}$

The equilibrium prices are :

$$p_{h_2} = \overline{\theta} q_h \qquad (20)$$

$$p_{l_2} = p_l{}^* = \frac{\overline{\theta} q_l(1-\mu)}{(2-\mu)} + \frac{g}{2(2-\mu)} \qquad (8)$$

Putting the equilibrium price of the business version, we observe that,

$$\lambda > 0 \Rightarrow p_{h_3} = \overline{\theta} q_h \Rightarrow \frac{(\overline{\beta}+\lambda) q_h}{2} = \overline{\theta} q_h \Rightarrow \left(\overline{\beta} + \lambda\right) = 2\overline{\theta} \Rightarrow \overline{\beta} < 2\overline{\theta}$$

Thus this case is feasible when $\overline{\beta} < 2\overline{\theta}$.

<u>Endogenised Quality</u>

Profit of original firm from the business group :

$$\pi_m{}^{\beta} = \left[\overline{\beta}\overline{\theta} q_h - \overline{\theta}^2 q_h - \frac{{q_h}^2}{2}\right] \Rightarrow \frac{\partial \pi_m{}^{\beta}}{\partial q_h} = \overline{\beta\theta} - \overline{\theta}^2 - q_h = 0 \Rightarrow q_h = \left(\overline{\beta} - \overline{\theta}\right).\overline{\theta}$$

<u>No versioning Case :</u>

Profit of the original firm :

$$\pi_m = p_m\left[\overline{\beta} - \frac{p_m}{q}\right] + p_m\left[\overline{\theta} - \frac{p_m(2-\mu)-g}{2q(1-\mu)}\right] - \frac{q^2}{2} \Rightarrow \frac{\partial \pi_m}{\partial p_m} = \overline{\beta} - \frac{2p_m}{q} + \overline{\theta} - \frac{p_m(2-\mu)}{q(1-\mu)} +$$

$$\frac{g}{2q(1-\mu)} = \left(\overline{\beta} + \overline{\theta}\right) + \frac{g}{2q(1-\mu)} - \frac{p_m}{q}\frac{(4-3\mu)}{(1-\mu)}$$

$$\Rightarrow p_{nv} = \frac{2q\left(\overline{\beta}+\overline{\theta}\right)(1-\mu)+g}{2(4-3\mu)}$$

Price of pirated goods :

$$p_c = \frac{\mu p_m + g}{2} = \frac{\mu}{2}\left[\frac{q\left(\overline{\beta}+\overline{\theta}\right)(1-\mu)}{(4-3\mu)} + \frac{g}{2(4-3\mu)}\right] + \frac{g}{2} = \frac{\mu q\left(\overline{\beta}+\overline{\theta}\right)(1-\mu)}{2(4-3\mu)} + \frac{\mu g + 2g(4-3\mu)}{4(4-3\mu)} = \frac{\left(\overline{\beta}+\overline{\theta}\right)\mu q\,(1-\mu)}{2(4-3\mu)} +$$

$$\frac{g(8-5\mu)}{4(4-3\mu)}$$

Endogenised quality

Profit of the original firm :

$$\pi_{nv} = \frac{[2q\left(\overline{\beta}+\overline{\theta}\right)(1-\mu)+g]^2}{8q\,(1-\mu)(4-3\mu)} = \frac{4q^2\left(\overline{\beta}+\overline{\theta}\right)^2(1-\mu)^2}{8q\,(1-\mu)(4-3\mu)} + \frac{4qg\left(\overline{\beta}+\overline{\theta}\right)(1-\mu)}{8q\,(1-\mu)(4-3\mu)} + \frac{g^2}{8q\,(1-\mu)(4-3\mu)}$$

$$\Rightarrow \frac{\partial \pi_{nv}}{\partial q} = \frac{4\left(\overline{\beta}+\overline{\theta}\right)^2(1-\mu)^2}{8(4-3\mu)} - \frac{g^2}{8q^2\,(1-\mu)(4-3\mu)} = 0 \Rightarrow q = \frac{g}{2\left(\overline{\beta}+\overline{\theta}\right)(1-\mu)}$$

Chapter 6: Conclusion

The present chapter provides a general conclusion of the dissertation. The chapters that present theoretical models discuss the optimal price-quality strategy of an incumbent firm in the presence of either end-user pirates or commercial pirates. The price quality provision of a monopolist firm is discussed under the assumption that transaction utility works as a motivation behind end-user piracy. Alternatively, another theoretical model in a duopoly framework discusses the efficacy of the strategy of product versioning to fight commercial piracy. The fourth chapter is unique as it shows the result of a laboratory experiment that identifies the issue of transaction utility as a motivation behind it, in order to validate the theoretical assumption of transaction utility in case of end-use pirates.

The first chapter of the present dissertation gives a general introduction to the study with the chronological evolution of Intellectual Property Right and effects of infringement of such rights. The second chapter gives a detailed review of existing literatures related to the study where infringement of IPR at both individual level (end-user) and commercial level have been vividly reviewed. This chapter also concerns with identifying the gaps in the existing literature which act as the motivation behind the three consequent chapters' modelling.

In chapter three, an infringed monopoly market has been considered where the monopolist produces an original information product for differentiated consumers who might or might not obtain transaction utility from the price differential between the original product and the pirated product. The practise of end-user piracy has been the focus in this chapter. Transaction utility has been assumed to be an additional utility other than simple acquisition utility that the consumer acquires from the price differential between the two products. In such a theoretical structure, it has been shown that an increase in the transaction utility

parameter compels the monopolist to reduce the price – quality of its product that in turn increases its market share but reduces its profitability. In the differentiated spectrum of consumers, when the proportion of consumers not acquiring transaction utility from piracy increases, the incidence of piracy is seen to be diminishing and the monopolist gets an incentive to produce a relatively higher quality good with a higher price. This strategy is seen to have a positive impact on the profitability of the firm. The increase in transaction utility parameter has been found to have an interesting impact on the market share of piracy (piracy rate) on both the groups of consumers. As the transaction utility increases, it has a direct negative effect on piracy rate for the first group of consumers that does not enjoy transaction utility, on account of the monopolist's increased market share with their low price – low quality strategy. However the very same stimulus has an ambiguous effect on the piracy rate of the second group of consumers that enjoy transaction utility from piracy. The direct positive effect streams from the logic that increased transaction utility gives increased motivation to the potential pirates thereby increasing the incidence of piracy. Simultaneously with increased transaction utility, the monopolist adopts a low price – low quality strategy that has an indirect negative effect on the piracy rate of this group. Hence the final effect is ambiguous.

The next chapter aims to validate the existence of transaction utility among the end-user pirates with the aid of a non-incentivised laboratory experiment. Since the assumption of transaction utility among end-user pirates is a novel concept that to the best of our knowledge has been incorporated in piracy study for the first time, an attempt to experimentally validate the idea has driven to construct this chapter of the present dissertation. A monopoly market has been assumed which is infringed with end-user piracy practised at individual level. The potential pirates are assumed to enjoy transaction utility from the act of piracy due to the price difference between the original product and the trivial copying cost. Assuming this

theoretical framework, a laboratory experiment with various treatments has been conducted with a total number of 209 students ranging between 18 to 23 years from streams of Humanities, Science and Engineering in Jadavpur University, Kolkata, West Bengal, India. The survey consists of 60% of male respondents and 40% of female respondents. The participants have been asked to play the role of a purchaser who has two options to purchase from – the original good and the pirated good. The price of the original good has acted as a reference price to the subjects who compare it with the much less copying cost of the pirated version of the good. Four different treatments validate the result that transaction utility indeed increases the likelihood of end-user piracy among consumers. Further it has also been noticed that acquisition utility when varied, has a positive impact on the likelihood to pirate among consumers. Standard logistic regression model with clustered standard error at individual level has ascertained the result that both transaction utility as well as acquisition utility have certain and positive impact on the piracy decision of the consumers. The proneness to pirate has been noticed to be higher among male respondents and students of Humanities.

In the fifth chapter a duopoly market has been assumed with the incumbent firm producing the original version of the good and the commercial pirate producing copied version of the same good and sells them illegally in the market. The consumer spectrum is assumed to be heterogeneous with business group and home group who vary across their valuation for the product. In the presence of a stringent monitoring government that increases the unit cost of reproduction of the pirated product by the commercial pirate, two regimes of product versioning and no versioning have been studied and compared. Depending upon the demand parameters the versioning regime has been further categorised into two regimes – one where the incumbent firm can perfectly discriminate between the business group and the home group and the other where it cannot. Two different equilibriums have been determined for these two regimes and one for the no versioning regime. Comparison of incumbent's profit

between the versioning regimes and the no versioning regime has resulted ambiguous. Hence, simulation method has been applied and it is being noticed that product versioning strategy becomes redundant when the degree of substitutability of the pirated product increases. Further it is also being noticed that when the commercial pirate caters to the lower fringe of consumers, it is optimal for the incumbent firm to produce a single version of the product with incurring relatively lower cost for quality provision. Thus, this chapter theoretically establishes the result that product versioning is not always the optimal strategy of the incumbent firm to fight commercial piracy. In presence of heterogeneous consumer base with costly quality provision, non-diversifying product can be a tool to enhance the profit. This result is counterintuitive to the results of the existing literature which positively ascertain that product versioning is an optimal strategy to fight piracy, however end-user.

The present dissertation contributes an important analysis regarding behavioural motivation towards product piracy and its consequence on the monopolist firm's price - quality decision. The impact of the cognitive factor behind end-user piracy in the form of transaction utility has been explored both theoretically and empirically. Further the dissertation has studied policy prescription to fight piracy in the form of detailed discussion on product versioning strategy that can be adopted by the incumbent firm. There can be various other policies that can be adopted to reduce the incidence of piracy and enhance the profit of the incumbent firm. In presence of strong network externality, it is evident that piracy does not demean the profit of the original good manufacturer, rather accelerate it in a way. Hence, it is profitable to allow piracy at a limited rate in presence of strong network externality. Mounting anti-piracy installations is however a long-standing method of curbing piracy, though costly. Therefore in this highly digitalised time, where piracy is practised widespread, facilities like providing open access to digitalised version of the original information good at a minimal price appears like an effective method of checking piracy. The measure is similar to that of

music streaming facility where the subscriber has to pay a minimum subscription charge to get full access to the digital versions of the music files without actually downloading them. This minimises the difference in price of the original version of the good and its copied counterpart, thus reducing the psychological satisfaction derived from the act of piracy which might check the incidence of piracy.

The present dissertation wishes to contribute on important aspects of product piracy both end-user and commercial in the form of behavioural motivation, pricing strategy, quality choices and comparative analysis of profitability of the incumbent firm.

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