The Effect of Music Piracy on CDs Purchases

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Abstract

This study attempts to measure the effect of music piracy on CDs purchases in Thailand by employing simultaneous tobit model. The econometric result shows that the pirated albums individual consumed substitutes the original CDs individual purchased. However, this variable is insignificant. We can state that pirated music does not affect the quantity purchased in the original music CDs. The most influential variable is the level of music interest determining music purchases positively. The qualitative questions are asked to explain the decline in music purchases. It can be concluded that the decline in music sales occurs because (1) there are no albums releasing from consumers' favorite artists, (2) consumers prefer to listen to only songs matched with their preferences and ignore the rest of the album, (3) songs are not melodious as the expectation, (4) law enforcement and quality difference between original and pirated music seem meaningless to consumers, and (5) the price of the original album is too high.

1. Introduction

The breakthrough of technologies changes the world to be digital. With the increasing in the number of users, computer and internet play the important role as never happened before. The fast penetration of the internet and the increased digitization of information have turned piracy of information goods, in particular music, movies and software, into a topic of intense debate (Belleflamme, 2002).

Since digital products can be compressed without losing much information or quality and the reproduction cost are negligible, it is easy to duplicate the products which almost similar to the original. This is why piracy substitutes the legitimate goods. However, piracy may stimulate demand for legitimate products in some senses. Since the characteristics of experience goods, to decide whether to purchase

the product or not, consumers have to inform by sampling or test the copies providing information on its characteristics. Besides, some kinds of information products such as music and movies have social interaction in which people would talk about with their friends (Peitz and Waelbroeck, 2003). This social interaction creates network externalities which might expand demand for the original. The conclusion of the effect of piracy on legitimate demand is ambiguous.

Music is the simplest kind of various information products and confronts the piracy problem, also in Thailand. This study attempts to analyze how music piracy by means of purchasing and downloading illegal music has affected on legitimate CDs by employing simultaneous tobit estimation. It is divided into 6 parts. The first part is introduction. Literature review is proposed in the second part. The third part discusses about theoretical model and the methodology. The forth part concerns sampling and questionnaire. The fifth part discusses the estimated result. Conclusion is stated in the last part.

2. Literature Review

The characteristics of digital products are appeared in Zhang (2002) and Peitz and Waelbroeck (2003). Although a copy is very similar to the original, the original product is always bundled with other non-digital components, such as a booklet for music CD or a printed manual for software. The non-digital contents make the original more precise than the copy. That is the copy cannot be perfectly substituted to the original.

The network externalities are concerned in digital products. The network externalities arise through the interactions between users. The requirement to exchange the information for software or the situation that people talk with their friends about music or movie they consumed are explained the externalities. By the way, many digital products are complex in the sense that the amount of information required to describe them is large. Many consumers need to test them before they decide whether to purchase them. The copy provides the information about the product to consumer.

Music is quite different from other digital products. In general, consumers are heterogeneous between their willingness to pay for the original and the copy. This value difference is not known for music consumers since music is an experience good, especially for new artists. Copy provides this information to consumers to help them decide whether to purchase the music or not. But in the computer software case, the value difference does depend on the decision of other consumers through network externality.

Many theoretical literatures attempt to capture the effect of piracy on the original demand, but the conclusions are ambiguous. These conclusions can be seen in Novos and Waldman (1984), Belleflamme (2002), Poddar (2003) and Duchene and Waelbroeck (2005).

Since there is no clear theoretical prediction, the effect of file sharing on sales is an empirical question. Liebowitz (2003) depicted the music industry in the age of file sharing and tried to explain whether MP3 downloads annihilate the record industry. He found that there are no factors that can fully explain the decline in music sales. Therefore he concluded that MP3 downloads are causing significant harm to the record industry. However, it is not clear that the harm will be fatal.

Nevertheless, the analysis of Liebowitz (2003) is disadvantage since it cannot fully explain the size of the effect. The econometric methods are applied to the study. Many literatures concern the two-stage least square method (2SLS) employing instrumental variables. The idea to use instrumental variables is that the presence of unobserved heterogeneity in music taste among individuals and pirated music is endogenous or, at least, that it is subject to unobserved heterogeneity. The instrumental variable technique is used to avoid the estimation bias from the correlation between pirate music and the unobserved heterogeneity. This method can be found in Hui and Png (2003), Zentner (2003), Rob and Waldfogel (2004) and Oberholzer and Strumpf (2004).

However, since the limitation of the study, the panel data or national-level data can not be provided. The individual data collected by field survey are the only way to work with the study. Another problem takes place when the data on quantities demand collected by survey contain many zero values, and it makes the two-stage least square method be inappropriate. Another method will be mentioned in the next part.

3. Theoretical Model and Methodology

Following Hui and Png (2003), the model considers the market for an information product by a single profit-maximizing producer. Copying is considered as an alternative to buying the legitimate item and there is no price. Potential end-users have three ways to choose; buying the legitimate item, copying the item or neither. The producer is aware of the possibility of illegal copying, so it may choose to invest effort to detect piracy and take enforcement action against piracy.

Assume a distribution $\Phi(v)$ of potential users who differ in their value, v, for the item. All potential users are risk neutral and make independent decision regarding buying, copying or not using. To simplify the model, we assume zero reproduction cost.

A net benefit is

$$U = \begin{cases} U_L = v - P & \text{if buy the legitimate item} \\ U_C = (1-K)v - C & \text{if copy the item} \\ 0 & \text{if not use the item} \end{cases}$$

where P is the price of legitimate item, $K \in (0,1)$ captures the quality difference between the legitimate and pirated items perceived by individual . C represents any other cost of copying rather than reproduction cost, such as the expected penalty if the user gets caught, or it could represent any other factors that have opposite effects on demands for legitimate and pirated item.

For users who buy the original, it is necessary that the value for the item has to be greater than its price, $v > P$, and utility from consuming the legitimate item has to be greater than utility from copying, $U_L > U_C$ and $U_L > 0$.

For users who copy the item, utility from copying is greater than utility from buying the legitimate item, $U_C > U_L$ and $U_C > 0$.

For users who do not use the item, utility from using the item is less than zero.

The users will be indifferent between buying the legitimate item and copying when $U_L = U_C$. That is

$$v_1 = \frac{P - C}{K} \tag{1}$$

v_1 defines a cut-off value. The users with value $v \geq v_1$ will buy the legitimate item while those with value $v < v_1$ will copy or not use.

The demand for the legitimate item is

$$Q_L = \int_{v_1}^{\infty} d\Phi(v) = 1 - \Phi(v_1) \tag{2}$$

where $\Phi(v_1)$ is the distribution of potential users whose value is not greater than v_1.

For users to copy the item, the net expected benefit must less than that from buying the legitimate but no less than that from not using. The users will be indifferent between copying and not using when $U_C = 0$. That is

$$v_2 = \frac{C}{1 - K} \tag{3}$$

The users with value $v_2 \leq v < v_1$ copy the item while those with value $v < v_2$ will not use the item.

The demand for copying is

$$Q_C = \int_{v_2}^{v_1} d\Phi(v) = \Phi(v_1) - \Phi(v_2) \tag{4}$$

where $\Phi(v_2)$ is the distribution of potential users whose value is not greater than v_2.

From (1) to (4), we derive the set of comparative static relationships as follow.

From (1) $\quad \dfrac{\partial v_1}{\partial P} = \dfrac{1}{K} > 0$, $\dfrac{\partial v_1}{\partial C} = -\dfrac{1}{K} < 0$ and $\dfrac{\partial v_1}{\partial K} = -\dfrac{(P - C)}{K^2} < 0$

From (3) $\quad \dfrac{\partial v_2}{\partial P} = 0$, $\quad \dfrac{\partial v_2}{\partial C} = \dfrac{1}{1 - K} > 0$ and $\dfrac{\partial v_2}{\partial K} = \dfrac{C}{(1 - K)^2} > 0$

Thus

$$\frac{\partial Q_L}{\partial P} = -\Phi'(v_1)(\frac{1}{K}) < 0 \tag{5}$$

$$\frac{\partial Q_L}{\partial C} = -\Phi'(v_1)(-\frac{1}{K}) > 0 \tag{6}$$

$$\frac{\partial Q_L}{\partial K} = -\Phi'(v_1)\left[-\frac{(P-C)}{K^2}\right] > 0 \tag{7}$$

$$\frac{\partial Q_C}{\partial P} = \Phi'(v_1)(\frac{1}{K}) > 0 \tag{8}$$

$$\frac{\partial Q_C}{\partial C} = \Phi'(v_1)(-\frac{1}{K}) - \Phi'(v_2)(\frac{1}{1-K}) < 0 \tag{9}$$

$$\frac{\partial Q_C}{\partial K} = \Phi'(v_1)\left[-\frac{(P-C)}{K^2}\right] - \Phi'(v_2)\left[\frac{C}{(1-K)^2}\right] < 0 \tag{10}$$

From (5) to (10), we see that piracy replaces the demand for the legitimate product.

Now we will extend the model to consider positive influences of piracy. Piracy may raise the demand for legitimate item through the exposure effect[1] and network externalities. The additive term, $e(Q_L, Q_C)$, presents the positive influences where function $e(.)$ is increasing in each of its arguments Q_L and Q_C. It implies that $\frac{\partial e(Q_L, Q_C)}{\partial Q_L} > 0$ and $\frac{\partial e(Q_L, Q_C)}{\partial Q_C} > 0$.

A net benefit is

$$U = \begin{cases} U_L = v + e(Q_L, Q_C) - P & \text{if user buys the legitimate item} \\ U_C = (1-K)\left[v + e(Q_L, Q_C)\right] - C & \text{if user copies the item} \\ 0 & \text{if user not use the item} \end{cases}$$

The condition that makes the user indifferent between buying and copying would be that with

$$\tilde{v}_1 = \frac{P-C}{K} - e(Q_L, Q_C) = v_1 - e(Q_L, Q_C) \tag{11}$$

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[1] Exposure effect is referred to the ability of consumers to know the quality of a product before purchasing (Blackburn, 2004).

Similarity, the user indifferent between copying and not using would be that with

$$\tilde{v}_2 = \frac{C}{(1-K)} - e(Q_L, Q_C) = v_2 - e(Q_L, Q_C) \tag{12}$$

Since function $e(.)$ is increasing in each of its arguments Q_L and Q_C, we then differentiate the demand function with respect to Q_C as follow.

$$\frac{\partial Q_L}{\partial Q_C} = \Phi'(\frac{P - Ke(Q_L, Q_C) - C}{K})\left[\frac{\partial e(Q_L, Q_C)}{\partial Q_C}\right] > 0 \tag{13}$$

In the same way, we differentiate demand for piracy with respect to demand for the original item as follow.

$$\frac{\partial Q_C}{\partial Q_L} = -\Phi'\left(\frac{P - Ke(Q_L, Q_C) - C}{K}\right)\left[\frac{\partial e(Q_L, Q_C)}{\partial Q_L}\right] + \Phi'\left(\frac{C - (1-K)e(Q_L, Q_C)}{(1-K)}\right)\left[\frac{\partial e(Q_L, Q_C)}{\partial Q_L}\right] \tag{14}$$

From (13), it is obviously to see that demand for the legitimate product increases with the increase in the extent of piracy. By the way, we do not predict the sign of $\dfrac{\partial Q_C}{\partial Q_L}$ because it depends on the distribution Φ and externality $e(Q_L, Q_C)$. It can be positive or negative.

Thus, from (5) to (10), and (13), we can state that

1. When price of the legitimate product increases, the demand for the legitimate item will be decreased while the demand for the pirated item will be increased. On the other hand, the demand for the legitimate item will be increased while the demand for the pirated item will be decreased, when the expected penalty or the quality difference arises. That means piracy substitutes the demand for the legitimate item. This is substitution effect.

2. The demand for the legitimate item is increasing in the extent of piracy. In other words, piracy stimulates the demand for the legitimate item. This is network effect.

The model is established by introducing equation (2) and (4) and they are nonlinear. To simplify, the Taylor series approximation will be applied. The equations are linearized by using the first order Taylor series approximation.

Previously, recall from equation (2) and (4) that $Q_L = 1 - \Phi(\tilde{v}_1)$ where $\tilde{v}_1 = \dfrac{P - Ke(Q_L, Q_C) - C}{K}$ and $Q_C = \Phi(\tilde{v}_1) - \Phi(\tilde{v}_2)$ where $\tilde{v}_2 = \dfrac{C - (1 - K)e(Q_L, Q_C)}{(1 - K)}$.

These equations are rearranged in the form of implicit function, respectively, as

$$F_1\left(Q_L, Q_C, P, K, C\right) = Q_L - 1 + \Phi(\tilde{v}_1) = 0 \tag{15}$$

$$F_2\left(Q_L, Q_C, P, K, C\right) = Q_C - \Phi(\tilde{v}_1) + \Phi(\tilde{v}_2) = 0 \tag{16}$$

where $\tilde{v}_1 = f_{1i}(Q_L, Q_C, P, K, C)$, $\tilde{v}_2 = f_{2i}(Q_L, Q_C, P, K, C)$ and i represents the individual characteristics. If the determinant of the matrix

$$\begin{pmatrix} \dfrac{\partial F_1}{\partial Q_L} & \dfrac{\partial F_1}{\partial Q_C} \\ \dfrac{\partial F_2}{\partial Q_L} & \dfrac{\partial F_2}{\partial Q_C} \end{pmatrix} \equiv \dfrac{\partial\left(F_1, F_2\right)}{\partial\left(Q_L, Q_C\right)}$$

evaluated at particular value, Q_L^0, Q_C^0, P^0, K^0 and C^0, is nonzero. Then, by the implicit function theorem, there exists functions $Q_L = g_1(P, K, C)$ and $Q_C = g_2(P, K, C)$ such that

$$F_1\left(g_1(P, K, C), g_2(P, K, C), P, K, C\right) = 0 \tag{17}$$

$$F_2\left(g_1(P, K, C), g_2(P, K, C), P, K, C\right) = 0 \tag{18}$$

$$Q_L^0 = g_1(P^0, K^0, C^0) \tag{19}$$

$$Q_C^0 = g_2(P^0, K^0, C^0) \tag{20}$$

The first order Taylor series approximation is applied to expand $\Phi(v_1)$ at the particular value, v_1^0, as follow.

$$\Phi(v_1) = \Phi(v_1^0) - \Phi'(v_1^0)\frac{\partial e}{\partial Q_L}(Q_L - Q_L^0) - \Phi'(v_1^0)\frac{\partial e}{\partial Q_C}(Q_C - Q_C^0)$$

$$+ \Phi'(v_1^0)\left(\frac{1}{K^0}\right)(P - P^0) + \Phi'(v_1^0)\left(\frac{C^0 - P^0}{(K^0)^2}\right)(K - K^0) \qquad (21)$$

$$+ \Phi'(v_1^0)\left(-\frac{1}{K^0}\right)(C - C^0) + \psi_1$$

Replace (21) into equation (2) and rearrange, we will obtain

$$Q_L = \left[\begin{array}{l} 1 - \Phi(v_1^0) - \Phi'(v_1^0)\frac{\partial e}{\partial Q_L}(Q_L^0) - \Phi'(v_1^0)\frac{\partial e}{\partial Q_C}(Q_C^0) + \Phi'(v_1^0)\left(\frac{1}{K^0}\right)(P^0) \\[3mm] + \Phi'(v_1^0)\left(\frac{C^0 - P^0}{(K^0)^2}\right)(K^0) + \Phi'(v_1^0)\left(-\frac{1}{K^0}\right)(C^0) \end{array}\right]$$

$$+ \left[\Phi'(v_1^0)\frac{\partial e}{\partial Q_L}\right]Q_L + \left[\Phi'(v_1^0)\frac{\partial e}{\partial Q_C}\right]Q_C - \left[\Phi'(v_1^0)\left(\frac{1}{K^0}\right)\right]P$$

$$- \left[\Phi'(v_1^0)\left(\frac{C^0 - P^0}{(K^0)^2}\right)\right]K - \left[\Phi'(v_1^0)\left(-\frac{1}{K^0}\right)\right]C - \psi_1$$

$$\qquad (22)$$

where ψ_1 is the error in the first order Taylor series approximation. The parameters in equation (22) can be estimated by linear least squares.

In the same way, we approximate $\Phi(v_2)$ at particular value, v_2^0, as follow.

$$\Phi(v_2) = \Phi(v_2^0) - \Phi'(v_2^0)\frac{\partial e}{\partial Q_L}(Q_L - Q_L^0) - \Phi'(v_2^0)\frac{\partial e}{\partial Q_C}(Q_C - Q_C^0)$$

$$+ \Phi'(v_2^0)\left(\frac{1}{1 - K^0}\right)(C - C^0) + \Phi'(v_2^0)\left(\frac{C^0}{(1 - K^0)^2}\right)(K - K^0) + \psi_2 \qquad (23)$$

Replace (21) and (23) into equation (4) and rearrange, we will obtain

$$Q_C = \left\{ \begin{array}{l} \Phi(v_1^0) - \Phi(v_2^0) + \left[\Phi'(v_1^0) - \Phi'(v_2^0) \right] \dfrac{\partial e}{\partial Q_L}(Q_L^0) \\[2mm] + \left[\Phi'(v_1^0) - \Phi'(v_2^0) \right] \dfrac{\partial e}{\partial Q_C}(Q_C^0) - \Phi'(v_1^0)\left(\dfrac{1}{K^0}\right)(P^0) \\[2mm] - \left[\Phi'(v_1^0)\left(\dfrac{C^0 - P^0}{(K^0)^2}\right) - \Phi'(v_2^0)\left(\dfrac{C^0}{(1-K^0)^2}\right) \right](K^0) \\[2mm] + \left[\Phi'(v_1^0)\left(\dfrac{1}{K^0}\right) + \Phi'(v_2^0)\left(\dfrac{1}{1-K^0}\right) \right](C^0) \end{array} \right\}$$

$$- \left[\left[\Phi'(v_1^0) - \Phi'(v_2^0) \right] \dfrac{\partial e}{\partial Q_L} \right] Q_L$$

$$- \left[\left[\Phi'(v_1^0) - \Phi'(v_2^0) \right] \dfrac{\partial e}{\partial Q_C} \right] Q_C + \left[\Phi'(v_1^0)\left(\dfrac{1}{K^0}\right) \right] P \qquad (24)$$

$$- \left[\Phi'(v_1^0)\left(\dfrac{1}{K^0}\right) + \Phi'(v_2^0)\left(\dfrac{1}{1-K^0}\right) \right] C$$

$$+ \left[\Phi'(v_1^0)\left(\dfrac{C^0 - P^0}{(K^0)^2}\right) - \Phi'(v_2^0)\left(\dfrac{C^0}{(1-K^0)^2}\right) \right] K + (\psi_1 - \psi_2)$$

where $\psi_1 - \psi_2$ is the error from the first order Taylor series approximation. The parameters in equation (24) can be also estimated by linear least squares.

To establish the model, it is necessary to consider the variables that affect the demand for both legitimate and pirated item. From the theoretical background above, price of legitimate item, the expected penalty and the quality difference as shown in (5) to (10) are determining variables. The extent of piracy is considered as an endogenous variable which is also shown in (5) to (10). Moreover, any other variables that can be observed and should influence the demand for the legitimate item are introduced in the form of the vector.

Accordingly, based on (5) to (10) and (13), the approximated equations (22) and (24) and adding the individual characteristics, I, the structural demand equations are constructed as:

$$Q_L = \alpha_0 + \alpha_1 P + \alpha_2 C + \alpha_3 K + \alpha_4 I + \alpha_5 Q_C + \varepsilon \qquad (25)$$

$$Q_C = \beta_0 + \beta_1 P + \beta_2 C + \beta_3 K + \beta_4 I + \beta_5 Q_L + u \qquad (26)$$

where K represents the quality difference between the original and the copy perceived by individual, I represents the vector of the observed individual characteristics which are exogenous variables. ε and u denote random errors with zero means. The sign of the coefficients is considered as follows. By (5) to (10), α_1 β_2 and β_3 are negative while α_2, α_3 and β_1 are positive. By (13), α_5 is positive while β_5 is not predicted the sign.

Since the expected penalty cannot be observed. Though it can be observed, it is difficult to transform the data into a common operational scale. We avoid this problem by substitute C from (25) into (26). We will get the following equation.

$$Q_L = \gamma_0 + \gamma_1 P + \gamma_2 K + \gamma_3 I + \gamma_4 Q_C + \psi \tag{27}$$

where $\gamma_0 = \eta\left(\alpha_0 - \dfrac{\alpha_2\beta_0}{\beta_2}\right)$ $\qquad$ $\gamma_4 = \eta\left(\dfrac{\alpha_5\beta_2 + \alpha_2}{\beta_2}\right)$

$\gamma_1 = \eta\left(\dfrac{\alpha_1\beta_2 - \alpha_2\beta_1}{\beta_2}\right)$ $\qquad$ $\psi = \eta\left(\varepsilon - \dfrac{\alpha_2}{\beta_2}u\right)$

$\gamma_2 = \eta\left(\dfrac{\alpha_3\beta_2 - \alpha_2\beta_3}{\beta_2}\right)$ $\qquad$ $\eta = \left(\dfrac{\beta_2}{\beta_2 + \alpha_2\beta_5}\right)$

$\gamma_3 = \eta\left(\dfrac{\alpha_4\beta_2 - \alpha_2\beta_4}{\beta_2}\right)$

Consider $\gamma_4 = \eta\left(\dfrac{\alpha_5\beta_2 + \alpha_2}{\beta_2}\right)$ which contains parameters from the demand for both legitimate and piracy item, it consists of two parts. The first part is $\alpha_5 > 0$, showing that demand for the legitimate item is increasing in the extent of piracy. Another part is $\dfrac{\alpha_2}{\beta_2} < 0$, showing the substitution between legitimate and pirated item. Equation (27) depicts that we could not separately test these two effects, but we can measure the net effect of piracy on legitimate demand.

By the way, the theoretical model is constructed by considering the market demand. The model is assumed that each consumer purchases only one unit of the

product. But in practical, there is lack of this aggregate data in Thailand. So the individual data, collected by field survey, is applied instead. Zentner (2003) and Rob and Waldfogel (2004) emphasized this idea by proposing that the ideal data for studying the effect of music piracy would be volumes of sales and pirated music consumption by individual. Surveys are the only way to obtain this information. Moreover, collecting data by surveys allows working with high number of observation and more controls. However, surveys are not representative for the whole country since it can capture only the sample available to the study, but it is useful in order to understand whether substitution by pirated music operates at all.

Though pirated music consumption is endogenous, unfortunately, the data on quantities demand collected by field survey contain many zero values[2]. The traditional two-stage least square method may be inappropriate. Thus tobit estimation is applied in the study.

Simultaneous tobit model is constructed by the idea of tobit model and simultaneous equations. In this study, there are two simultaneous equations. One equation is conventional linear regression (equation (26)) while another is formed as tobit model (equation (25)). The problem arises since the endogenous variable appears as the independent variable in the model. Hence, the instruments used instead the endogenous variable are needed. To do so, we regress the pirated consumption with other explanatory variables and other instruments which are correlated with pirate music consumption but not with CDs purchases. Then the estimated consumption on music piracy is used as the instruments and is replaced into equation (25). Equation (25) can be estimated by tobit estimation.

We consider whether music piracy substitute CDs purchased through cross sectional regression of the number of albums legally purchased on the number of albums illegally consumed and other control variables.

In the individual level, price of pirated music should determine demand for legal music CDs. But it is obvious that the cost of downloaded music is zero. Though there is price for illegal CDs containing various albums in MP3 format, but price per each album is very low. So price of music piracy is negligible. The pirated quantities as the proxy for price of pirated music are used instead.

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[2] Field survey and sampling are explained in part 4.

The independent variables affecting the quantity demand for music CD can be divided into 3 groups. The first group concerns the theoretical variables including:

Q_C is the number of pirated music accounted in albums. As noted before, to deal with the individual data, price of pirated music should be considered. But it is almost zero and negligible. The number of pirated quantities is used as the proxy for price of pirated music instead. Since we are interested in both type of pirated consumption; purchasing illegal CDs and downloading from the internet, the numbers of quantities on both type of piracy are required. Pirated music CD is defined as pirated music, generally in MP3 format, contained in compact disc[3], and pirated music downloading is defined as pirated music downloaded from the internet[4]. So music piracy is defined as the pirated music CD plus pirated music downloading. The effect of piracy can be either positive or negative on music purchases.

WTP is willingness to pay for a legal music CD. Since, on average, price of legal music CDs is mostly the same in Thailand. To avoid this, WTP is used instead price. Consumers are asked to show their willingness to pay for one music album. Willingness to pay should be positively correlated with demand for original music CDs.

K is the consumer's concern about quality difference between legal and pirated music. The quality difference, besides the sound quality[5], includes any other digital contents such as special feature enhanced with music CD, and non-digital contents such as CD case, booklet and lyrics. Consumer may value special features or non-digital contents which reflect higher quality in product rather than the copy. If the perception of consumers who aware the product differentiation increases, demand for the legal music should be increased.

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[3] In general, a pirated music CD contains 15-30 albums, or 150-300 songs per disc. To account for the number of pirated albums, I assume that a pirated music CD is equals to 20 music albums.

[4] Almost music files provided in the internet are in the form of single file rather than in the form of an album. To account for the number of pirated albums, ten music files are counted as one album. This is because, generally, one album contains ten songs.

[5] Sound quality is considered from bit rate which is the number of bits that are conveyed or processed per unit of time. Bit is a unit of measurement, the information capacity of one binary digit. Binary digit is a basic unit of information storage and communication in digital computing and digital information theory. High bit rate determines high sound quality. Generally, music files above 160 Kbps generated from MP3 compression have quality comparable to CDs.

The second group of variables is related to the individual characteristics. The proxies used instead the variables are shown as follow.

SEX is dummy variable for gender. We set 1 if consumer report man and 0 if consumer report woman.

AGE is age of consumer. It can be either positive or negative impact on music purchases.

EDU is the numbers of years in school. From literatures reviewed, *EDU* has negative effect on music demand.

INC is consumer's income. From literatures reviewed, there is no obvious effect of income on music purchases.

HOU is the number of hours on music listening per day. It should be positively correlated with music demand.

MUS is the consumer's level of interest in music. It should be positively correlated with demand for legal music CDs.

The last group of variables concerns the instruments determining demand for pirated music, not for legal demand in music CDs. Since we are interested in both illegal CDs and illegal downloaded music files, we have two sets of variables instrumented for piracy. These variables in this group are shown as follow.

MPP is dummy variable for using the devices that can play any formats of music files. We set 1 for using and 0 for not using. Using the devices that can play any formats should be positively correlated with demand for music piracy.

BRO is dummy variable for accessing broadband internet. We set 1 for accessing hi-speed internet and 0 if not. Using broadband connection should induce increasing in downloading music.

IT is the consumer's level of interest in computer. It should be positively correlated with demand for music piracy.

IS is the consumer's level of interest in internet. It should be positively correlated with demand for music piracy.

To make equation (27) correspond with the study, the characteristic variables described above are put instead *I* , and the following equation is obtained.

$$Q_L^* = \gamma_0 + \gamma_1 WTP + \gamma_2 K + \gamma_{3,1} SEX + \gamma_{3,2} AGE + \gamma_{3,3} EDU$$
$$+ \gamma_{3,4} INC + \gamma_{3,5} HOU + \gamma_{3,6} MUS + \gamma_4 Q_C + \psi \tag{28}$$

$$Q_L = \begin{cases} Q_L^* & \text{if } Q_L^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

In the first stage regression, we regress piracy consumption with instrumental variables and other explanatory variables. Thus the first stage equation is

$$Q_C = \lambda_0 + \lambda_1 WTP + \lambda_2 K + \lambda_{3,1} SEX + \lambda_{3,2} AGE + \lambda_{3,3} EDU + \lambda_{3,4} INC$$
$$+ \lambda_{3,5} HOU + \lambda_{3,6} MUS + \lambda_4 MPP + \lambda_5 IT + \lambda_6 BRO + \lambda_7 IS + r \tag{29}$$

where r is the error term which has zero mean and is uncorrelated with each right-hand-side variable. By least square method, $\hat{Q}_C$ is obtained from equation (29) and is replaced as the instrument into equation (28). The second stage equation is

$$Q_L^* = \gamma_0 + \gamma_1 WTP + \gamma_2 K + \gamma_{3,1} SEX + \gamma_{3,2} AGE + \gamma_{3,3} EDU$$
$$+ \gamma_{3,4} INC + \gamma_{3,5} HOU + \gamma_{3,6} MUS + \gamma_4 \hat{Q}_C + \psi \tag{30}$$

$$Q_L = \begin{cases} Q_L^* & \text{if } Q_L^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

As noted before, equation (30) constructs as tobit model. Thus we estimate equation (30) with tobit estimation by maximizing the log likelihood function and obtain $\hat{\gamma}$ as the maximum likelihood estimators of γ.

Though $\hat{\gamma}$ estimated from the equation is not the marginal effect we interest because Q_L^* is latent variable. The marginal effect for the observed data, Q_L, used to analyze should be $\hat{\gamma}$ times the proportion of non-limit observations, $Q_L^* > 0$, in the sample. That is $\dfrac{\partial E\left[Q_L | X\right]}{\partial X} = \hat{\gamma} \times \Phi\left(\dfrac{X\gamma}{\sigma}\right)$.

4. Sampling and Questionnaire

Music in the study is focused only on Thai popular music. Popular music is defined as music that has a wide following, is produced by contemporary artists and does not required public subsidy to survive (Connolly and Krueger, 2005). It includes rock, pop, jazz, hip-hop and any other genres, except classical music and publicly supported orchestras. Thai traditional songs and Thai country songs (Louk Toung) are also excluded from Thai popular music. This is because music listeners in popular music group, generally, are interested in different music compared to the latter group.

Music consumer is defined as the people who listen to the music whether legally or not and focus music consumer who live in Bangkok only. We assume that every people who live in Bangkok have an ability to pay for music. Accidental sampling is applied to collect 524 samples. The survey is conducted in the populated places, e.g. department stores or parks. The period of the field survey is in February, 2007.

The questionnaire is divided into 5 parts. The first part asks music consumers about their socio-economic variables which are age, gender, education and income. The second part concerns belief and perception variables which are the interest and the attitude for music. The third and forth part is related to the knowledge in internet and computer, and music demand, respectively. The last part concerns about the willingness to pay.

5. The Estimated Result

To select the suitable model, Akaike Information Criterion (AIC) and Baysian Information Criterion (BIC) are employed as the criteria. They are computed by $AIC = 2M - 2\ln L$ and $BIC = \dfrac{-2\ln L + M \ln N}{N}$ where L is the maximized value of likelihood function with M parameters estimated using N observations. The model with the lowest value of AIC and BIC should be selected. First all variables are put in the model and then one variable is removed from the equation. Do this for all variables, except Q_C. The suitable equation considered by AIC and BIC should be

$$Q_L^* = \gamma_0 + \gamma_1 WTP + \gamma_2 K + \gamma_{3,1} SEX + \gamma_{3,2} AGE + \gamma_{3,5} HOU + \gamma_{3,6} MUS + \gamma_4 \hat{Q}_C + \psi \qquad (31)$$

$$Q_L = \begin{cases} Q_L^* & \text{if } Q_L^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

Equation (31) is estimated by simultaneous tobit estimation. The estimated result is

$$\begin{aligned} Q_L = &-13.784 + 0.008 WTP^* + 0.070K + 1.722 SEX^{***} \\ &+ 0.063 AGE^* + 0.193 HOU + 0.491 MUS^{***} - 0.004 Q_C \end{aligned} \qquad (32)$$

where *** is significant at 99% level of confidence, ** is significant at 95% level of confidence and * is significant at 90% level of confidence.

By considering the significant variables, we see that the expected signs are correct with the assumption. The coefficient of Q_C is negative. This means pirated music substitutes the original music CDs. However, it is insignificant. It will be explained later

We have known that there are differences between coefficients and the marginal effects since the dependent variable is latent. The marginal effect can be calculated by multiplying the estimated coefficient by the proportion of non-limit observations in the sample.

Table 1

Marginal Effects

Variable	Coefficient	Marginal Effect
Q_C	-0.004	-0.001
WTP	0.008	0.003
SEX	1.722	0.656
AGE	0.063	0.023
HOU	0.193	0.071
MUS	0.491	0.181
K	0.070	0.026

Source: Author

The marginal effect of simultaneous tobit model can be interpreted as changing in the conditional expected value of dependent variable that can be observed when the independent variable changes by one unit. This interpretation is different from OLS which interprets the marginal effect as changing in dependent variable when the independent variable changes by one unit. In our case, the quantity of music CDs purchased is dependent variable censored at zero. We can state that the marginal effect in this study explains the change in the conditional expected value of CDs quantity in purchasing group when the explanatory variable changes by one unit. The interpretation is described below.

The result shows that the pirated albums individual consumed substitutes the original CDs individual purchased. Nevertheless, this variable is insignificant. One of the reasons is that the study assumes that each consumer purchases only one unit of the product. But, in reality, instead of buying a unit of product, a consumer can either buy the original music CDs or consume the pirated music. Besides, consumer who uses the pirated album may purchase that original album if he likes the music, while consumer who purchases the original album will buy neither that illegal CD nor download music files which are exactly the purchased album. This may lead to the insignificant estimated result. However, at least in our samples, we can state that pirated music does not affect the quantity purchased in the original music CDs. In other words, it can be implied that pirated music does not cause the decline in music purchases significantly as always mentioned.

Consumer with high willingness to pay for a legal music CD purchases more original albums. However, the difficulty is how we can measure the album value into nominal term of willingness to pay. Consumers' preferences are absolutely not the same, and we cannot specify which variables are valued equally that nominal term. By the way, the result convinces us that consumer with high willingness to pay for music tends to purchase the original music CDs more than consumer with low willingness to pay does.

It is difficult to claim that consumer concerns the quality difference because this variable is insignificant. Consumers cannot detect the sound quality difference, or if consumers can observe it, they do not care about it. Observing the sound quality may need the audio equipments that can present sound dimension, and these

equipments are quite expensive. Moreover, the quality difference defined in the study covers non-digital contents and digital enhancements rather than sound quality determined by bit rate. The insignificant result shows that consumer is not worried about the packaging, the artwork, lyrics and booklet. Besides, the new technology can replicate music CDs almost the same as the original. These may be the reasons why consumers are not aware of the quality difference as they should be.

The positive sign of consumer's age supports that teenagers are more technophile and more likely to download and share files on the internet or bright in computer than adult are. If adult are also technophile, the positive sign implies that pirated music boosts CDs purchases for adult, it substitutes for younger.

Hour on listening to the music is insignificant variable. However, there are some notices. Consumer listening to the music many hours per day has chance to explore new music. The probability that consumer will purchase music CDs should increases because listening to the music many hours per day improves consumer's preference matching with the decision whether to purchase or not. But the insignificant result may imply that consumers listen to the music on the radio or online station only and do not purchase CDs.

The level of music interest is the most influential variable determining music purchases. The word "level of music interest" is very broadly, depending on researchers. I define level of music interest not only following music information, but also the value consumer weighing to the music. Consumer with high level of music interest should consume both legal and illegal music. He collects music CDs and, simultaneously, uses downloading and file-sharing as the channels to improve the preference, i.e. consumer with high level of music interest purchases the music matching with his preference, while consumer with low level of music interest uses piracy as the substitution. Moreover, consumer with high level of music interest values the music as the first priority. It is considered from their expenses spent on music. In conclusion, the level of music interest causes CDs purchases positively.

It is very interesting that constant term is negative and significant. It implies that there are other variables influencing the decline in the conditional expected quantity of music purchases. Since music preferences are different in each consumer, it is difficult to define and measure all relevant determinants. So some qualitative

questions are added in the questionnaire, focusing on music demand. The questions ask respondents whether they purchase music CDs or not and why.

Up to 45.80 percents of consumers purchasing music CDs say that they buy CDs because they are albums releasing from their favorite artists. Collecting CDs and be the popular music are also the reasons to purchase CDs, which are 16.03 and 14.50 percents respectively. Only 8.59 percents think that CD price is acceptable and 6.11 percents purchase CDs because of other reasons.

Most consumer not purchasing music CDs said that there is no album released from their favorite artists. The proportion is 22.14 percents. 17.75 percents pay their money to other entertainment goods and 11.64 percents think that CD price is too expensive. 10.31 percents do not purchase CDs because of other reasons (see table 5.3). It is obvious that albums released by consumers' favorite artists are the main concern of whether to purchase music CDs or not. Thus, the decline in music purchases can be concluded from the reason that there is no album from the respondents' favorite artists.

For the questions why they consume or not consume pirated music, consumers use pirated music because they can choose songs matching with their preference, pirated music is cheap, and it is easy to obtain. The percentages calculated in the group of pirated users, respectively, are 37.40, 30.53 and 27.29. Only 12.98 percents think that pirated music does not have lower quality than the original and 9.16 percents consume pirated music because of other reasons.

From the group of consumers not using pirate music, 17.18 percents of this group do not consume pirated music because they avoid the probability to reach incomplete files. 13.36 percents said that pirated music has lower quality than the original. 10.11 percents want to support albums of artists they like. Only 8.78 percents do not use pirated music since it is illegal. Up to 16.41 percents do not consume pirated music because of other variables.

The advantages of pirated music that consumers can select songs, instead of buying the whole album, with low price and easily obtained may cause the decline in music purchases. If this statement is true, it can be implied that consumers prefer listening to only songs matched with their preferences and ignore the rest of the album. Besides, law enforcement and quality difference between original and pirated

music seem meaningless to consumers. These also cause the decline in music purchases.

The questions also ask the respondents what are the most three influential factors determining the decision on music purchases, almost half of consumers (49.43 percents) purchase music CDs released from their favorite artists first. 31.11 percents decide whether to purchase music CDs or not by first considering melodiousness, while 14.69 percents first consider CD price. Again, it can be stated that the decline in music purchases occur since there is no album released from consumer's favorite artists, songs are not melodious as the expectation and the price of the original album is too high.

Only 2.86 percents buy original CDs because of laws. Package is almost negligible first priority consumers decide for purchasing. There is only 0.95 percents value packaging first (see table 5.5). For a second time, these convince us that laws and packaging defined as quality difference are insignificant determinants.

6. Conclusion

This study attempts to measure the effect of music piracy on CDs purchases in Thailand. The individual data collected by field survey are used instead since the lack of aggregated data in Thailand. Simultaneous tobit model is employed to the study since the data on music purchases are zero for a significant fraction, and the pirated music consumption appearing as independent variable is endogenous.

The econometric result shows that the pirated albums individual consumed substitutes the original CDs individual purchased.. Nevertheless, this variable is insignificant. One of the reasons is that the study assumes that each consumer purchases only one unit of the product. But, in reality, instead of buying a unit of product, a consumer can either buy the original music CDs or consume the pirated music. Besides, consumer who uses the pirated album may purchase that original album if he likes the music, while consumer who purchases the original album will buy neither that illegal CD nor download music files which are exactly the purchased album. This may lead to the insignificant estimated result. However, at least in our samples, we can state that pirated music does not affect the quantity purchased in the

original music CDs. In other words, it can be implied that pirated music does not cause the decline in music purchases significantly as always mentioned.

The level of music interest is the most influential variable determining music purchases positively. Willingness to pay and ages of consumers also have influences on music purchases in the positive way. Gender represented as dummy variable is positive. It is interpreted that males purchase more music CDs than females do. While the level of consumer's concern in quality difference and the number of hours on listening to the music positively determine music purchases, they are insignificant.

To explain the decline in music purchases, the qualitative questions are added to ask the respondents. It can be concluded that the decline in music sales occurs because (1) there are no albums releasing from consumers' favorite artists, (2) consumers prefer to listen to only songs matched with their preferences and ignore the rest of the album, (3) songs are not melodious as the expectation, (4) law enforcement and quality difference between original and pirated music seem meaningless to consumers, and (5) the price of the original album is too high.

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