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Does file sharing reduce music CD sales?: A case of Japan
version 0.1

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Abstract

File sharing systems such as Napster and KaZaA are accused by the recording industry of causing declines in sales of music CDs, and recently users of these systems are under lawsuit attack. However, there is not sufficient evidence that file sharing systems are responsible for the recent decline in music CD sales. Two previous studies examined micro data of sales and downloads and found mixed results regarding the connection between file sharing and CD sales (Blackburn, 2004; Oberholzer and Strumpf, 2004).

The current essay estimated the effect of file sharing systems on music CD sales using micro data from Japan in 2004. Japan's file sharing system ("Winny") is almost completely decentralized and highly anonymous compared with ones addressed in the two previous studies, thus Japanese users can download music files with less concern about lawsuits. The goal of this research is to examine the effect of file sharing on music CD sales in such an illegal-copy-friendly file sharing system.

Based on micro data of CD sales and numbers of downloads, we found that there was very little evidence that file sharing reduces music CD sales in Japan. We controlled simultaneous bias between sales and downloads by instrumental variables, but did not find correlation between CD sales and numbers of downloads. Although there were large differences in the numbers of downloads among CD titles, these differences did not affect CD sales. We also carried out a user survey on file sharing and CD purchases with consideration to the potential bias of respondents trying to understate their illegal copying activity. This survey also showed that file sharing had very limited influence on CD purchases.

JEL Classification: O34 Intellectual Property Rights, L82 Entertainment; Media
Keyword: Copyright, File sharing, P-to-P, Intellectual Property Rights, Music, Entertainment Industry

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1. Framework of optimal protection level

The goal of intellectual property rights is to give creators incentive for development of information goods. Information goods such as technologies, music and movies can be copied without additional cost. Thus it is optimal to price such goods at zero after the goods are developed. However, nobody will provide information goods if they know that the price is zero. To give incentive for development, intellectual property rights such as the patent system and copyright were introduced. Therefore we should adjust the strength of intellectual property rights to balance two factors--benefit of use and benefit of incentive for development.

Let x be the strength of intellectual property rights. X can be protection periods, scope of patents, strong law enforcement against piracy, etc. As x increases, revenue of creators increases and encourages the development of new information goods. We denote this benefit of new information goods as g(revenue(x)). Note that g is a function of intermediary variable *revenue*. On the other hand, larger x decreases users' benefit because users become less free to copy information goods. Note that users include creators (or inventors) who want to use information goods (e.g. patents) to develop their own new information goods. We represent users' benefit as f(x), which is a decreasing function of x. Total benefit is a sum of users' benefit and benefit of incentive for new development, that is, f(x) + g(revenue(x)).

Figure 1 shows these functions. Users' benefit f(x) is a decreasing function of x and benefit of incentive g(revenue(x) is an increasing function of x. When we assume that both curves are concave, the total benefit has an inverted-U form and there is a social optimum protection level x*. If we are under this level x* we should strengthen the protection level of property rights. But if we are beyond this level we should weaken protection. Perfect protection of intellectual property rights is not optimal.

Figure 1

This is well understood regarding the patent system because there are many studies that consider the function f(x) or g(revenue(x)) and argue against the too-strong patent system. For example, Merge and Nelson (1990), based on the history of innovation, insist that a wider scope of patents is harmful to next stage innovation. Heller and Eisenberg (1998) reported a "tragedy of anti-commons" in the biotechnology industry--that is, too many patent holders prevent efficient use of technology. These two studies indicate that stronger patent protection could lead to welfare loss, suggesting that f(x) has negative slope. On the other hand, Cohen, Nelson and Walsh (2000) reported that a patent is not primarily a tool to protect intellectual property; rather, lead time of development is more important. Lerner (2002) analyzed empirically whether stronger patent systems encouraged the number of patents, and obtained mixed results. These two studies are interpreted to examine whether or not g(revenue(x)) has positive slope. In summary, as far as the patent system is concerned, it is recognized that perfect protection is not optimal.

Regarding copyrights, however, people tend to insist on perfect protection. For example, it is illegal to put one page of a book on a personal website or to write lyric lines on a BBS, although these acts are unlikely to decrease creator revenue. The European Union tried to pass a tough anti-piracy law and the Recording Industry Association of America began suing individual P2P software users as piracy criminals. In Japan some recording companies introduced copy-controlled compact discs that cannot be copied to any digital media. On top of this, a programmer of file sharing software was arrested by Japanese police. There seems to be no consideration given to users' benefit of copying and sharing information goods. [1]

But do these illegal copying activities reduce creator revenue? In other words, does copying reduce the sales of original information goods? If file sharing does not reduce sales of music CDs, we should say that file sharing improves economic welfare. Recently this is a hot topic in the music industry, especially focusing on peer to peer file sharing. For example, Oberholzer and Strumpf, (2004) estimated the effect of file sharing on music CD sales using individual music title data, and found no clear correlation between sales and downloads. Blackburn (2004) also estimated the effect of file sharing using micro data and reported that file sharing reduced the sales of big titles of famous artists but increased the sales of many other minor titles of ordinary artists.

This paper estimated the effect of file sharing systems on music CD sales using micro data from Japan in 2004. Japan's file sharing system ("Winny") is almost completely decentralized and highly anonymous compared with ones looked at in the two previous studies, thus Japanese users can download music files with less concern about lawsuits. The goal of this research is to examine the effect of file sharing on music CD sales in such an illegal copy-friendly file sharing system. Based on micro data of CD sales and numbers of downloads, we found that there was very little evidence that file sharing reduces music CD sales in Japan. We controlled simultaneous bias between sales and downloads by instrumental variables, but did not find correlation between CD sales and numbers of downloads.

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[1] Although a few scholars such as Lessig (2001) are against strong copyright protection, they are minorities in the business world.

2. File sharing and data collection

"Winny" is the most popular file sharing system in Japan. Winny is almost completely decentralized and does not have a central server. Since file names and locations are decoded, users do not know from where they are downloading. Winny also scatters intermediate files randomly in users' hard drives, thus it is difficult to identify the initial user who first put any particular file on the Winny network. These characteristics account for why police in Japan consider Winny to be illegal. It is said that this is a reason why Japanese police arrested the programmer of Winny rather than users.

Figure 3 shows the Winny user interface. Users input the file name keyword, which is usually a CD title or an artist's name. Then Winny searches the files in the Winny user network that include the keyword, and shows such files as candidates for download. Users choose the targeted file and download begins. Fortunately, Winny displays three useful pieces of file information: file size, referenced quantity, and hash. Hash is a unique file code that allows identification of the file without double counting. Referenced quantity is, approximately speaking, total downloaded quantity.[2] Thus we can estimate the number of downloads by dividing the referenced quantity by the file size.

Figure 2

Data collection was done every weekend from June 2004 to November 2004. The collection procedure was as follows:

(1) Obtained weekly, 30 best-selling music CD titles from Original Confidence (albums and singles separately)

(2) Four or five researchers searched titles in the Winny user network and obtained file data. This search was done usually on weekends.

(3) Files were identified the by the hash, and double counted ones were deleted.

(4) The number of downloads as (referenced quantity)/(file size) was calculated.

[2] Referenced quantity could increase not only by downloading, for example, but also by pure transfer triggered by Winny software or accidentally disconnected download.

Figure 3 shows the weekly pattern of CD sales and numbers of downloads for some CD titles (albums only). The horizontal line is the number of weeks passed after the CD release. The dotted line is CD sales, and the solid line is the number of downloads. Although CD sales decreased as time passed, the number of downloads tended to increase. But this negative correlation is possibly spurious because CD sales decrease with or without downloads, and it takes some time for a user to upload a music file in the Winny user network. We need to control this natural non-stationary tendency to correctly estimate the effect of file sharing, but this control is not easy because most CD titles continue in the top 30 sales ranking for a few weeks.

Figure 3

To avoid this difficulty, we used total sales in this study. Figure 4 shows the ratio of (total download)/(total sales) for each CD album title. We collected 261 titles. As easily seen, there is a large difference among titles. In the case of most downloaded titles, the number of downloads reached 35% of sales. On the other hand, we can see no downloads for 65 titles. Because the difference is large, if file sharing reduces CD sales we should observe sales decline for the frequently downloaded titles.

Figure 4

3. Effect of download to sales

Figure 5 shows the XY plot of sales and downloads. There is a positive correlation between sales and downloads. But we cannot say that downloads increase CD sales, because the causality is two-way: When CD sales increase because of popularity or quality of music, then downloads also increase. CD sales and number of downloads is simultaneously determined, thus an instrumental variable should be introduced.

Figure5

Note that there are 65 titles that were not downloaded. To cope with this heterogeneity, we carried the estimation for the two cases: only downloaded titles and all titles.

(1) Primary variables (endogenous variables)

Ln (sale): Natural logarithm of the sale of CDs. CD titles were collected from weekly, 30 best sellers from June 2004 to November 2004.[3] Thus our sample covers CD titles that have reached the best 30 sales at least once. Sample size is 261 for albums and 289 for single CDs. In this paper we show the estimation result for album case. Since sales data are cumulative sales just before the titles disappear from the best 30 lists, there is small negative bias to long-selling songs.

Ln(down): Natural logarithm of the number of downloads of CDs. Since the search corresponds to the top 30 sales in CD titles each week, there is also small negative bias for long-time downloaded songs. We can see no downloads for 65 of 261 titles.

(2) Explanatory variables (exogenous variables) for CD sales

Ln(psale): Natural logarithm of the artists' previous CD sales. It is well known that music listeners tend to continue buying the same artists' CDs. Thus an artist's previous CD sales are a good predictor of current sales. The expected sign is positive. Unfortunately, previous CD sales are available for only 149 of all CD titles. Thus we introduce the dummy variable Npresale, which describes a case in which previous CD sales are not available.

Npresale: dummy equal to 1 if there are no previous sales.

CCCD: Dummy variable for copy-controlled CDs. If the CD is copy-controlled, variable CCCD is one. Whether the CD is copy-controlled or not is determined by CD catalog data on the web site. If the CCCD prevents the casual copying of CD discs, CCCD will increase CD sales. If users do not like CCCD because of quality loss, CCCD may decrease CD sales. Therefore, the expected sign is unknown.

(2) Explanatory variables (exogenous variables) for number of downloads

EFK: dummy for Enka (Japanese traditional songs), family songs (such as kids exercise records) and Korean TV songs. Listeners of these genres are middle-age and not main users of file sharing software. Therefore, CDs of these genres are downloaded less frequently. The expected sign is negative.

Anime: dummy for anime and video game songs. File sharing users are intensive computer users, and tend to be anime fun or video gamers, so called *otaku*. If this

[3] Data source is Original Confidence which is a major Japanese research company about CD sales

connection is large, the expected sign is positive. On the other hand, main users of anime or game songs are children. If this connection is dominant, the expected sign is negative.

West: dummy for western origin music. We classify the CD title as western origin music if the language is not Japanese (or Korean). For example, a CD of Utada Hikaru is classified as of western origin when she sings in English. We expect that listeners of western origin music tend not to be computer intensive (otaku) users. Thus the expected sign is negative.

D3: dummy when the title continues on the top ten list for more than three weeks and the initial week's sale is over 50% of total sales within the top 30 listings. Because the download is slow-started as shown in figure 1, higher sales concentration during the initial week may reduce the harm of downloading. The expected sign is negative.

Table 1 shows the estimation result. Case 0 is the case of simple ordinary least squares, showing that the signs of the coefficients are as expected.

Table 1

Case 1-2 is the estimation result using the instrumental variable method to cope with simultaneous bias. In case 1 we omit 65 non-downloaded titles and use downloaded titles only. Adding to this we omit CD titles without previous sales for case 2. Case 3 includes all CD titles.

Coefficients of ln (down) is always positive and significant. Thus downloads do not reduce CD sales. To check the robustness of this result we tried all combinations of explanatory variables for case 1. Since there are three combinations of explanatory variables for ln(sale) regression and 15 combinations for ln(down) regression, we have 45 combinations of explanatory variables. Figure 6 is the distribution of estimated coefficients of ln(down) and its t-values. T-values never reach the negatively significant level. Therefore, this result is robust as far as these explanatory variables are concerned.

Figure 6

This regression lacks some natural explanatory variables such as a price or advertising. But I suppose it is not likely that the coefficient of ln(down) changes inversely; that is, becomes significantly negative even if we include other explanatory variables, because there are large differences in download/sale ratio as shown in figure 4, and the instrument variables in the ln(down) regression seem to work well.

4 Students survey on copied CDs

We conducted a student survey about illegal copying activity and CD sales. Students were asked to profile their history of music CD purchases and file sharing and copied CD activity from the first grade of high school to the current university grade. Students have 5 to 8 school years, so data is unbalanced panel data. Time t is measured by school years; that is, H1, H2, H3 (for high school grades 1, 2 and 3), and U1, U2, U3 (for university grades 1, 2 and 3). Sample size was 501, and the number of total observations was 2,165. Recall that students were asked to remember their CD purchase history and file sharing and copied CD activity. Thus the reliability of this data depends on the accuracy of students' memories. Sample students were chosen from an undergraduate course at Keio University in 2003 and 2004.

(1) Explained variable

$CDpurchase_{it}$: number of music CDs that survey participant purchased per year at school year t.

(2) Primary explanatory variable

$PtoP_{it}$: dummy variable equal to one after survey participant started using PtoP software. If file sharing reduces CD purchases as the recoding industry insists, the sign of this variable would be negative.

(3) Other explanatory variables: control variables

$CopyCD_{it}$: dummy variable equal to one after survey participant started using copied CDs. If use of copied CDs reduces CD purchases, the sign would be negative.

$Mphone_{it}$: mobile phone expenditure per month. Unit is 1000 yen. Expenditure on mobile phones has increased rapidly during the past five years, along with the decline in CD sales. The expected sign is negative.

CDR_{it}: dummy variable equal to one after survey participant bought a CDR drive. Since a CDR drive is used to make copied CDs, the sign of this variable could be negative if copied CDs reduces CD purchases.

$U3_{it}$: dummy variable equal to one when time t is the third grade of university. Share of data of third grade university students is only a few percent, but their CD purchase activity is unexpectedly low. This is caused by sampling bias. This dummy variable is introduced to cope with this outlier effect. Omitting this variable does not change the major conclusion of this paper, it only reduces the fitting (R square) slightly.

The panel regression result is shown in table 2. Cases (1) (2) and (3) are the fixed effect model, and case (4) is the random effect model. Coefficient of PtoP is 1.747 in the fixed effect model and 2.065 in the random effect model, and significant at 10% and 5% respectively. To check the robustness of this result we omitted control variables, COPY CDR and U3 respectively and found that the result is the same.

This result indicates that use of file sharing software increases CD purchases. This may be surprising, but we have several explanations for this result. First, this positive correlation is caused by students' changing demand for music. If a student suddenly gets interested in music, he or she starts to buy more CDs, but at the same time he or she may start using file sharing to listen to much music at no charge. In this case, the positive correlation between purchase and the use of file sharing is spurious and there still can be negative correlation between file sharing and CD purchases if we control this simultaneous bias. Second, users can use file sharing as a search tool to find favorite music. This is a kind of effect network discussed by Takeyama (1994). If this effect is large, illegal file sharing could raise CD purchases. In this case, file sharing truly has a positive effect on CD purchases.

5. Conclusion

This research is very preliminary because we have not yet tried sufficient instrumental variables. Therefore, we cannot commit to a decisive conclusion. However, it is worth reporting that we did not find any negative effect of file sharing on CD sales. Specifically, according to micro download data, downloads do not reduce CD sales and student surveys show that use of file sharing does not reduce CD purchases.

Let us assume that we accept this result and go back to Figure 1. What is the policy implication? Let the change from x_1 to x_2 in figure 1 be an introduction of file sharing software. Then as far as this change in concerned, g(revenu(x)) does not decrease. Since users’ benefit f(x) surely increases by the use of file sharing software, total benefit f(x)+g(revenue(x)) increases by file sharing software. Therefore, bans on file sharing software should be blocked from the perspective of economic welfare.

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Table 1 Result of regression of CD sales and downloads

	case0 Ordinary least square downloaded titles only				case1 Instrumental variable downloaded titles only			
	ln(sale)		ln(down)		ln(sale)		ln(down)	
Const	5.394		−3.070		5.278		−5.369	
	(8.82)		−(4.32)		(8.14)		−(3.03)	
ln(down)	0.539	***			0.714	***		
	(12.38)				(4.20)			
ln(sale)			0.923	***			1.136	***
			(14.26)				(6.99)	
Ln(PSALE)	0.170	**			0.070			
	(2.77)				(0.62)			
NPRESALE	1.770	**			0.714			
	(2.63)				(0.59)			
CCCD	−0.027				−0.089			
	−(0.16)				−(0.49)			
EFK			−1.49	***			−1.200	
			−(2.85)				−(1.39)	
ANIME			−0.071				0.237	
			−(0.15)				(0.40)	
WEST			−0.589	***			−0.496	**
			−(3.13)				−(2.47)	
D3			0.432				−0.104	
			(1.05)				−(0.18)	
R2	0.571		0.575		0.562		0.574	
adjusted R2	0.561		0.564		0.552		0.561	
n	177		196		177		177	

estimationperiods 2004:6−2004:11, t−values in the parenthsis、

Table 1 (continued) Result of regression of CD sales and downloads

case2
Instrumental variable
titles downloaded and with previous sale

case3
Instrumental variable
all titles

	case2 ln(sale)		case2 ln(down)		case3 ln(sale)		case3 ln(down)	
Const	5.325		−4.933		6.676		−10.708	
	(9.58)		−(3.15)		(7.46)		−(3.13)	
log(down)	0.661	***			0.465	***		
	(3.57)				(3.20)			
log(sale)			1.097	***			1.507	***
			(7.71)				(4.69)	
Log(PSALE)	0.101				0.152			
	(0.86)				(1.17)			
NPRESALE					1.625			
					(1.22)			
CCCD	−0.151				−0.202			
	−(0.84)				−(0.79)			
EFK			−0.453				−2.790	*
			−(0.43)				−(1.67)	
ANIME			NA				−0.309	
							−(0.27)	
WEST			−0.606	**			−0.626	
			−(2.69)				−(1.58)	
D3			−0.014				0.645	
			−(0.03)				(0.48)	
R2	0.674		0.682		0.370		0.354	
adjusted R2	0.664		0.669		0.359		0.340	
n	106		106		236		236	

estimationperiods 2004:6−2004:11, t−values in the parenthsis、

Table 2 Student survey: Panel regression

	pooled		between		within		random	
C	7.158	***	6.431	***			7.995	***
	(13.01)		(4.89)				(11.38)	
MP	0.104		0.177		0.036		0.042	
	(1.22)		(0.87)		(0.44)		(0.56)	
COPY	0.683		1.733		−0.188		0.069	
	(0.80)		(0.88)		−(0.23)		(0.07)	
RW	0.434		1.256		0.199		0.222	
	(0.50)		(0.59)		(0.25)		(0.30)	
NY	3.300	**	4.261		1.747	*	2.065	**
	(3.03)		(1.63)		(1.76)		(2.24)	
UNIV3	−4.221	*	−13.514		−1.894		−2.248	
	−(1.83)		−(1.07)		−(1.26)		−(1.51)	
R2	0.0096		0.0166		0.7288		0.0092	
adjustedR2	0.0073		0.0067		0.6463		0.0069	
n	501		501		501		501	
# of obs	2156		2156		2156		2156	

Hausman test: Chi(5)=5.014 (P−value=0.4141)

Figure 1 Optimum protection level of Intellectual property rights

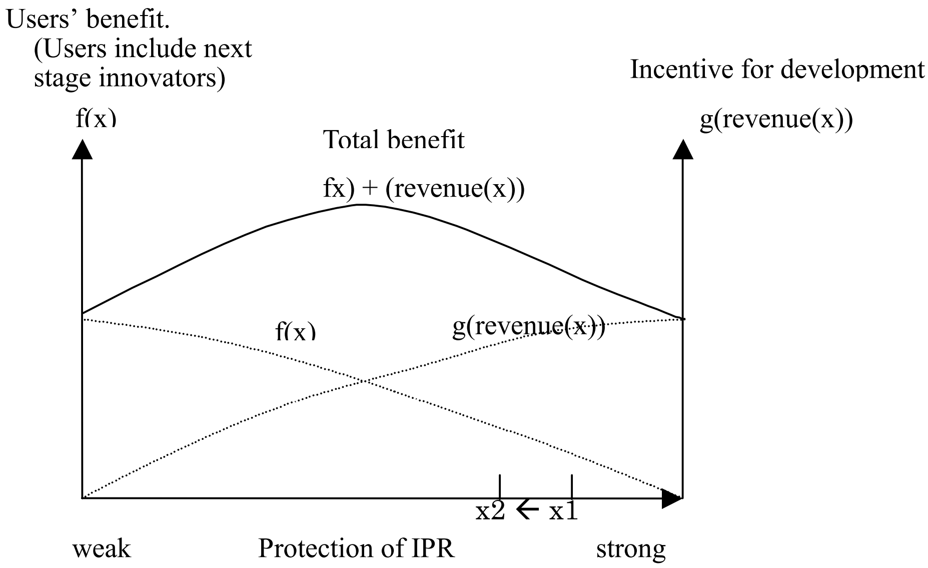


Figure 2 User interface of Winny

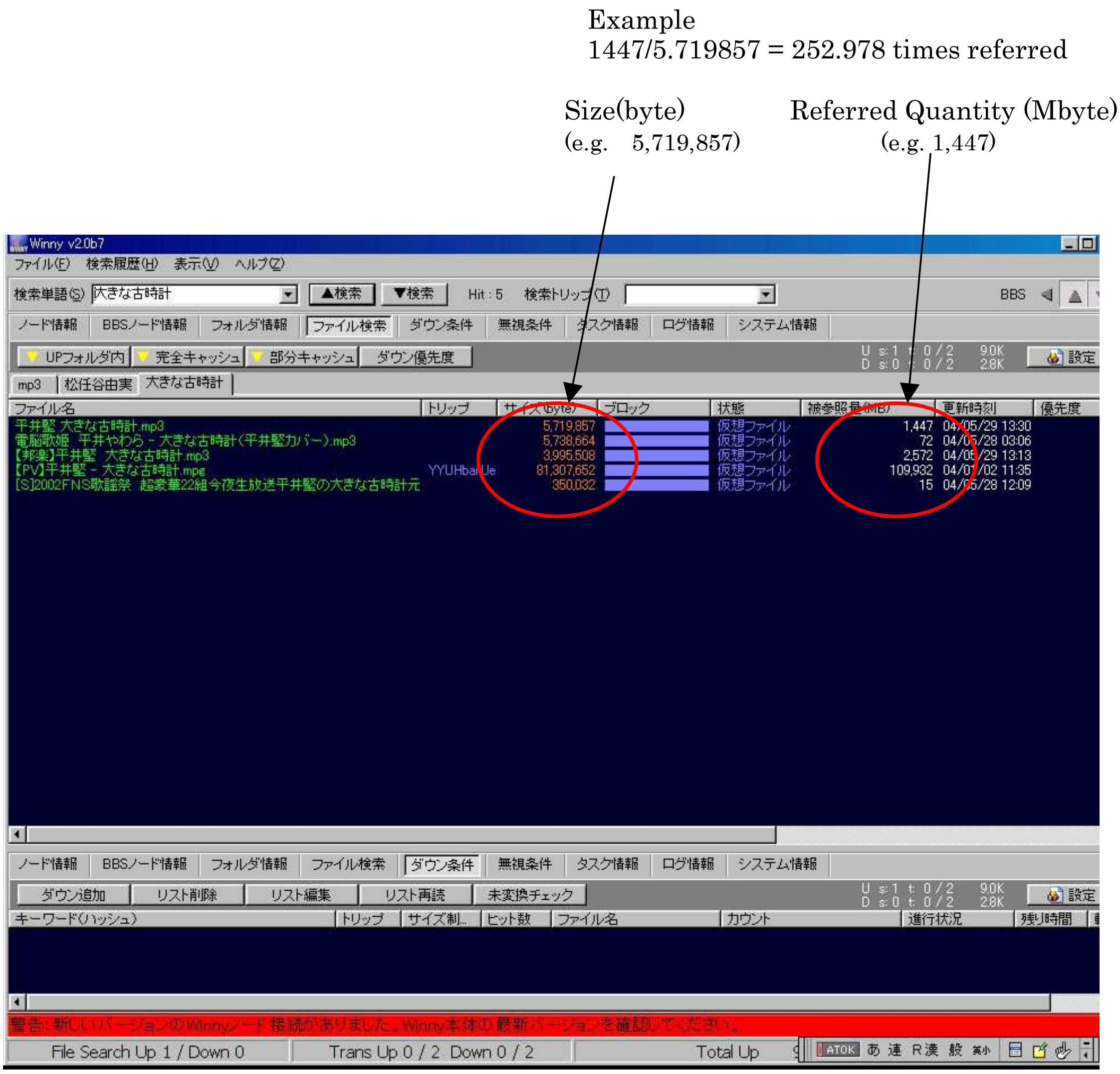
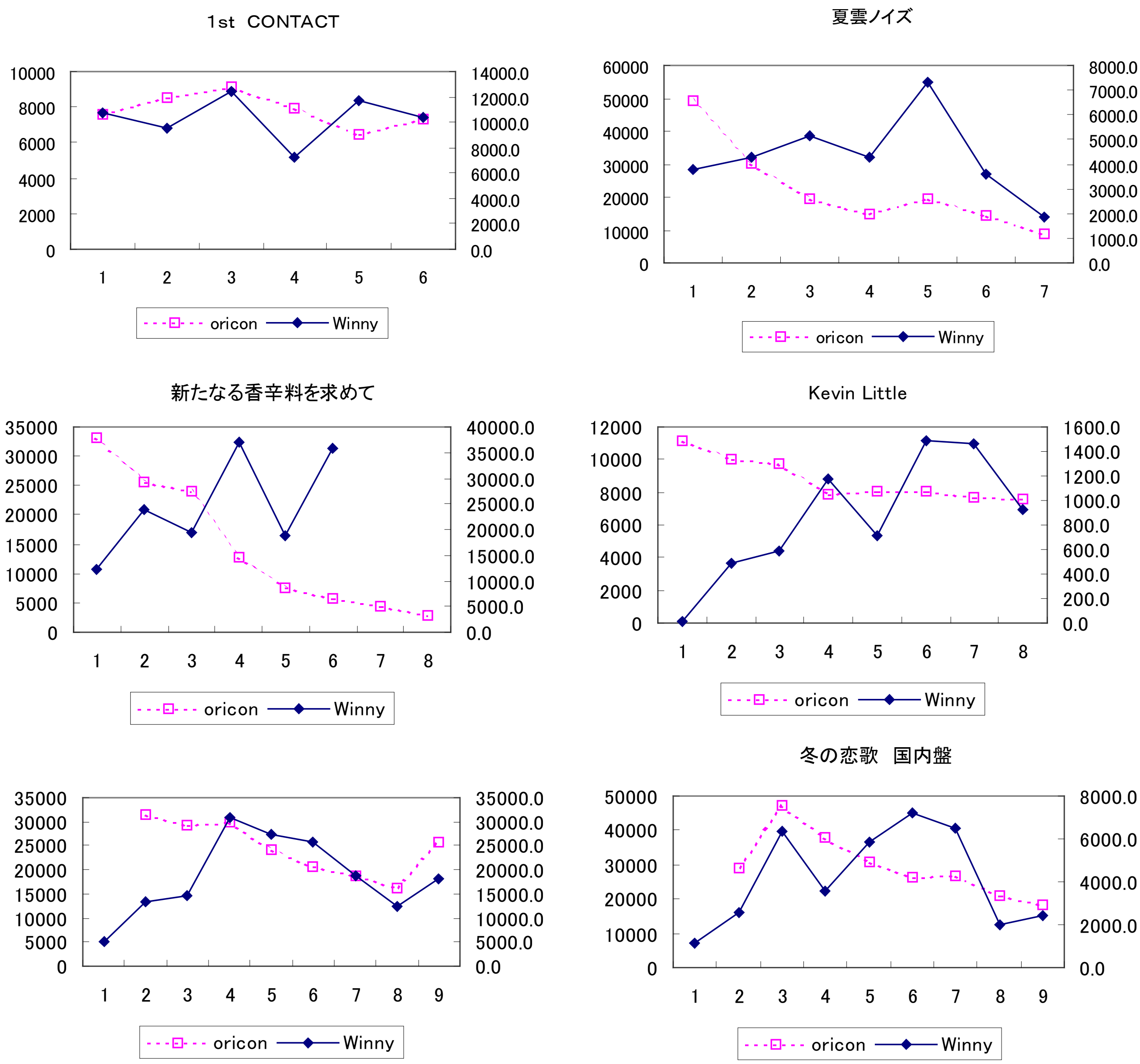


Figure 3　CD sales and number of downloads in every week after CD release



Horizontal line is number of weeks after CD release.

Figure 4 Downloads/sales ratio

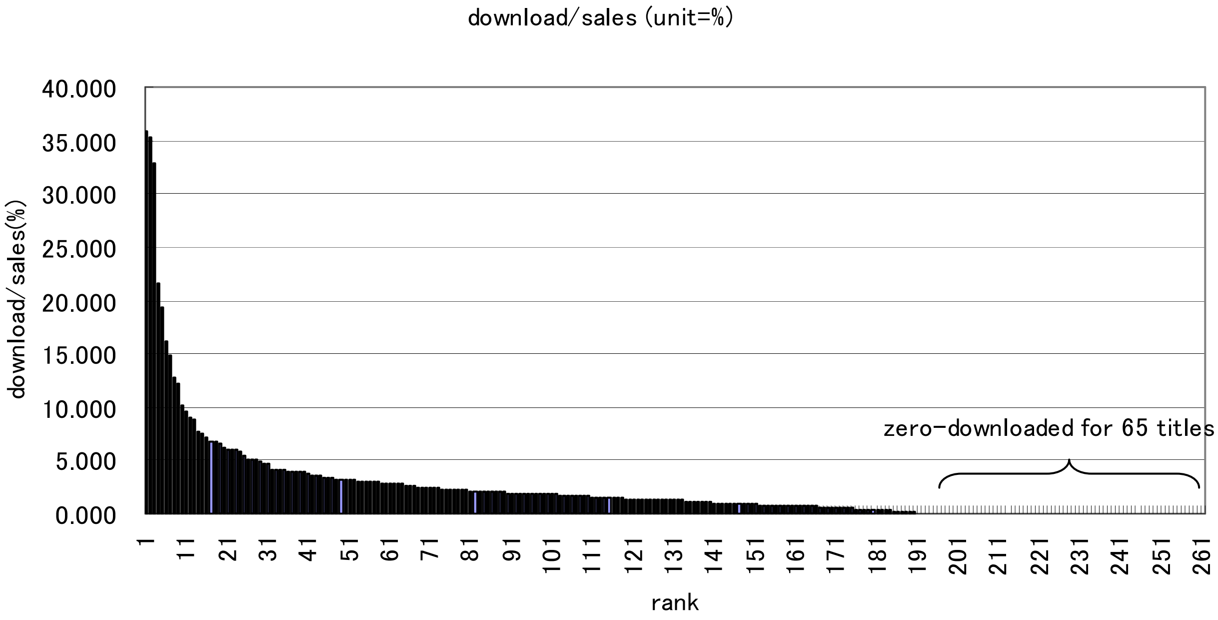


Figure 5 Sales vs Downloads

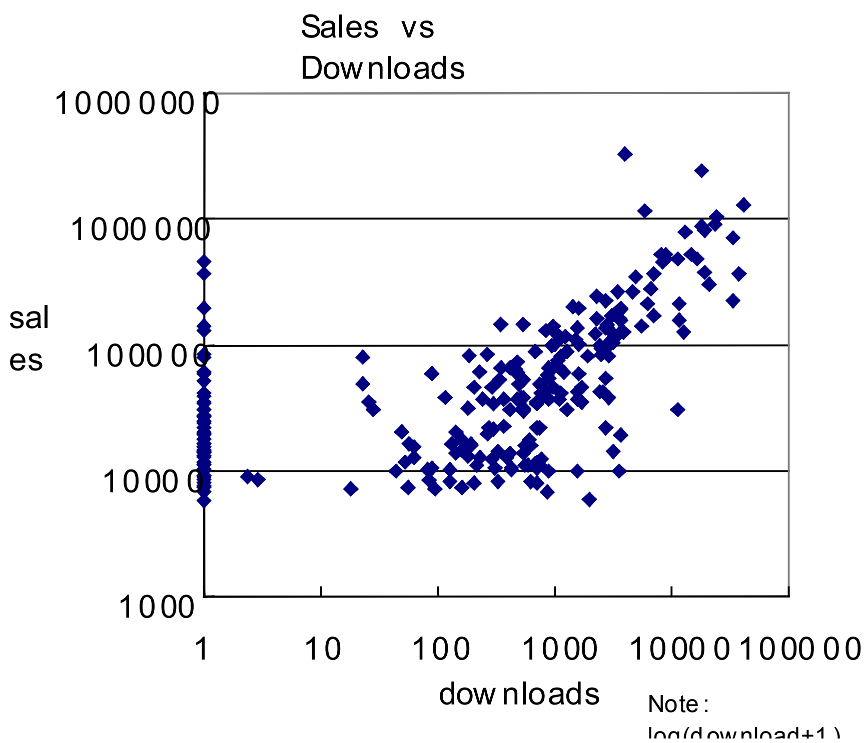


Figure 6 Distribution of coefficient and t-values :
For all combinations of explanatory variables