

디지털 음악의 다운로드와 스트리밍 서비스 간에 보완성과 대체성 및 LTE 보급률의 조절효과에 관한 연구

A Study on Substitutability and Complementarity of Music Downloading and Streaming and the Moderating Role of LTE Penetration on Its Relationship

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요약

정보통신기술의 발달에 기반을 둔 디지털화의 급속한 기술 혁신은 디지털 콘텐츠 산업을 크게 변화시켰으며 스트리밍 서비스와 같은 새로운 형태의 서비스 출현으로 이어졌다. 그러나 스트리밍 서비스가 전통적인 다운로드 서비스에 대한 위협인지 여부는 여전히 논란의 여지가 있으며, 어떻게 관련되어 있는지는 중요한 문제이다. 따라서, 본 연구에서는 음악 스트리밍 서비스가 음악 다운로드 서비스에 대해서 보완관계인지, 대체관계인지 여부를 분석하였다. 또한, LTE의 보급률이 이러한 대체 보완 관계에 어떻게 영향을 미쳤는지 살펴보았다. 한국의 온라인 음악 시장에서 선두적인 플랫폼 자료를 사용하여 분석한 결과, 음악 다운로드 서비스가 음악 스트리밍 서비스를 보완한다는 것을 보였고, 이러한 보완 관계는 LTE 기술 도입으로 강화되고 있다.

■ **중심어** : | 대체성 | 보완성 | 온라인 음악 산업 | 음원 스트리밍 | 음원 다운로드 | 모바일 기술 |

Abstract

Rapid technological innovation led by digitization has significantly changed the business of digital content goods, and has led to the emergence of new forms of services, such as music streaming. However, whether the streaming service is a threat to the traditional downloading service is still under debate. In this study, we examine whether music downloading is a substitute for or a complement to music streaming by investigating the moderating effects of LTE technology penetration. Using a unique dataset on the online music market from a dominant music platform in Korea, we found that music downloading services are complementary to music streaming services, but this complementary relationship is significantly and positively moderated by the introduction of LTE technology.

■ **keyword** : | Complementarity | Substitutability | Online Music Industry | Streaming | Downloading | Mobile Technology |

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I. Introduction

Rapid technological innovation in digitization has significantly affected the music industry[1][2]. Digitization allows artists and labels to reduce the cost of production, distribution, and promotion[3][4]. It also gives birth to digital forms of a content instead of a physical album in forms of LPs, tapes, and CDs. Recently, revenues in music industry are predominantly generated from sales of digital contents, rather than sales of traditional physical albums[5].

The shift to the digitalized music industry has brought about two different types of services with which consumers can consume the same digital song: downloading and streaming. Downloading is similar to the traditional way of consuming music. A consumer needs to purchase individual songs, and they should be stored in a device to be played. On the contrary, streaming allows the real time consumption of a song without necessarily having to download the music file[6]. Consumers can access the streaming services by choosing between a membership which requires a certain level of subscription fee and a “freemium” model where consumers have to listen to ads between songs.

Due to the advantages of the fast mobile system, such as LTE, and the convenience from not having to store digital contents in a device, streaming service has become the norm when it comes to consuming music. However, whether this transformation of accessing music is beneficial to music creators and service providers is still under debate. Artists and labels are complaining about low payments for the streaming services and declining occurrences of downloads. For example, Taylor Swift is withholding her album ‘1989’ from free music streaming services, and Adele rejected streaming services for her album

‘25’ because they think that streaming has a negative impact on downloading. This belief is reflected on the fact that music downloading declined by 8 percent in 2014, while, at the same time, subscription streaming income accounts 23 percent of global digital revenues and inclined 39 percent, a significantly higher growth rate than the 16.6 percent increase in 2013[5].

Under this concurrent agenda, this paper asks the following questions: What is the relationship between streaming and downloading in the online music industry (substitutes or complements)? How does the increase in the usage of LTE affect the relationship between streaming and downloading in the online music industry? Although there are several prior studies on the various types of music consumption [7-9], and the relationship between the patterns of music consumption and sales[9-12], they do not provide a clear answer to these questions. Furthermore, there are only a few studies about the online streaming market, and some of their findings and intuitions are contradictory. Downloading a song may negatively affect streaming a song because consumers already have access to the song. On the flip side, purchasing a song implies that a consumer really values that song or music consumption. The more he values a song, the more likely he will explore songs to listen to and streaming services may make it easier for the consumers to sample the songs to test their quality. Our findings support the later; the positive relationship between downloading and streaming services. In particular, our analyses further show that downloading services positively influence streaming services when LTE penetration rate becomes high.

Our study makes three distinct contributions to the literature. First, this is, to the best of our knowledge, the first study to empirically investigate the substitution relationship between online streaming

and downloading services covering almost all music content providers in a nation with a subscription fee. Second, we try to capture the effect of the penetration of new mobile technology, such as LTE service, in the online music industry. Third, this study contributes to make unique data set by data-mining the website (Gaon chart) and use the new and appropriate research context.

II. Literature Review

1. Streaming and Downloading in Online Music Market

Researchers are interested in to show how the characteristics of digital contents affects consumer behavior in a new digital age[6], and music contents in online music market has gained popularity[7][8]. What is the relationship between streaming and downloading in online music market? Are they substitutes or complements to each other? Prior studies have focused on how music consumption in online music market influences music sales in the offline music market, but their empirical results are not consistent[9-12]. On the one hand, Stevans and Sessions[10] examined whether downloading music files from the Internet influences consumer spending on physical albums. Using time-series model, the authors find that music downloading, since 2000, has positively affected consumer spending on tapes, LPs, and CDs. This implies that the downloading a song online is complementary to offline music consumption.

On the other hand, multiple studies have investigated the influence of the advent of peer-to-peer (P2P) music file-sharing influence on the sales of music products. According to Michel[9], using micro- and household-level survey data, found that music file sharing by Napster (P2P service) has

decreased the physical sales in the offline market. Moreover, Liebowitz[13] showed that the file-sharing caused the substantial decline in record sales even if generic Internet impact from the overall Internet impact was excluded. It implies that the online file-sharing negatively influences the offline music demand because people not only blunted the copyright infringement in the online P2P services but also people can easily get the music files through P2P. These studies showed that file-sharing plays a role as a substitute for the offline music market.

Nevertheless, several relevant studies refuted these claims and argued that sharing songs via P2P services for the music industry does not decrease the overall offline music sales. For example, Oberholzer-Gee and Strumpf[12] revealed that file sharing cannot be the reason for the decline in recorded album sales. With data on actual downloads of music files, they did not find any statistical evidence that downloads have an effect on recorded album sales. Bhattacharjee, Gopal, Lertwachara, Marsden and Telang[14] also found that sharing songs online does not negatively influence the survival of albums by looking the data combining the performance of music albums on the Billboard charts with music file sharing. Interestingly, using illegitimate digital piracy channel (e.g., BitTorrent) is not related to the demand for DVDs at Amazon[15]. It implies that either online music consumption through online-music-sharing has been entirely separate from the offline music consumption or the elasticity of the demand for the offline music consumption such as the sales of CDs and DVDs.

These studies focused excessively on the means of music consumption, and they seem to have overlooked an essential aspect of the dynamics of the online music industry. In fact, the global digital music revenues reached the same proportion to that of physical format music sales (46%) for the first time

in 2014[5]. This implies that there has recently been a massive shift from online to offline music consumption the world over[16]. We try to look at this phenomenon as the impact of mobile technology on the dynamics of online music market from streaming and downloading services.

Another strand of recent studies examined the impact of streaming service in the online music industry. For example, Nguyen, Dejean and Moreau [11] revealed that free music streaming services (e.g., Spotify or YouTube) do not decrease CD sales in the offline music market. It means that free music streaming service cannot be a substitute for the physical album sales. On the other hand, few studies have focused on the relationship between streaming and downloading service within the online music market. Using the clickstream sample of 16,500 European consumers, Aguiar and Martens[17] estimated the impact of different online music consumption channels and revealed that the use of licensed streaming websites is positively related to licensed websites selling digital music. Music is an experience good, so the quality of music cannot be known a priori[18-20]. Buying a product without knowing the quality of it is risky as a consumer may regret the purchase if a product turns out to be bad. To know the quality of it, a consumer should listen to it, and streaming is an option to verify and explore the quality of a song[19][20]. Therefore, consistent with the prior studies in this area, we postulate that downloading and streaming services have a complementary relationship.

Hypothesis 1: In the online music market, the downloading service is a complement to the streaming service.

2. The rate of LTE Penetration and Digital Music Consumption

Meisel and Sullivan[21] showed that the rise of internet usage made record labels and artist jump into the online distribution without traditional retails and it was the revolutionary change to existing revenue streams at that time. Today, we have already experienced the similar situation from the streaming service. Through a set of interviews with the experts in the online music industry, Wagner, Rose, Baccarella and Voigt[16] argued that the streaming service has a negative impact on the established downloading industry because of the development of mobile technology. In particular, the high-speed mobile environment is crucial because streaming service plays a song in the real time by transferring music data. Accordingly, the penetration of smartphone and advanced telecommunication technology are directly related to the rise of streaming services. In particular, LTE 4G service is the most advanced mobile telecommunication technology that is available today. As LTE service provides users with fast and convenient mobile environment, it is also capable of altering the pattern of music consumption. In particular, LTE service enhances streaming service through its high-speed technology, and a song can be played without any buffers, and music data can be transferred with higher sound quality. This implies that consumers could explore music more conveniently to examine the quality of the songs. So, the uncertainty associated with the purchase of the songs decreases with the convenience of the streaming service. Therefore the advantages of streaming services are the easy access in real time to all of the contents in music platform database, and the advantage of streaming services increases as the telecommunication technology improves. Accordingly, we propose that LTE service strengthens the positive relationship between downloading and streaming services.

Hypothesis 2: The rate of LTE penetration positively moderate the positive relationship between music downloading and music streaming.

III. Method

1. Research Context

To test our hypotheses, we try to form a database by collecting information on online music consumption. South Korea provides an appropriate research context to investigate the relationship between streaming and downloading services. Korea has the second-highest subscription income rate on total digital revenue after Sweden. In other words, South Korea is one of the leading countries with the highest pay-to-stream incidences[5]. Currently, a total of 17 online music platforms exist in Korea, and most online music platforms provide flat-rate subscription services[5]. In fact, pay-to-stream is very important in online music market because the market size of subscription stream income was twice more than that of ad-supported streams income in 2014[5]. Despite the importance, prior studies did not capture the subscription stream due to their research context.

On the other hand, Korea has the 4th highest smartphone penetration rate (83%) in the world after UAE, Singapore, Saudi Arabia while the world's average smartphone penetration rate is about 60 percent. Moreover, Korea already had one of the most developed 4G markets with 100 percent population coverage and over two-thirds of 4G adoption at the end of 2014[22]. In Korea, LTE services were started in July 2011. After then Korea has highest LTE coverage (97%) in the world and ranked 4th on LTE speed after New Zealand, Singapore, Romania[23]. Therefore, this research context gives us to the

appropriate effect of the LTE service.

2. Data Source and Sample

Using a web-crawling technique, we collected data from the Gaon chart website (<http://gaonchart.co.kr>). The Gaon chart was established by the Ministry of Culture, Sports, and Tourism of Korea and is managed by the Music Industry Association of Korea. It collects data on music sales from eight major digital music retailers in Korea, which comprise over 97% of digital music sales in the country. Covering most of music consumption patterns of consumers gives us the advantage over the prior studies, which mostly based on certain platforms or data sources. The Gaon chart consists of ranking streaming and download counts for the weekly top 100 songs. It also releases the chart for the physical album sales. As mentioned previously, LTE services were started in 2011. At the beginning of 2015, the LTE penetration rate reached 90% and it has marginally increased to about 95% at the end of 2015. This implies that the LTE services were almost fully penetrated by the end of 2015. Accordingly, our samples include all the streaming and downloading counts of each song listed on weekly top 100 from the first week in 2011 to the fifty-two week in 2015 with specific information for each song. Our final sample consisted of a total of 248 weeks of data from the period 2011–2015.

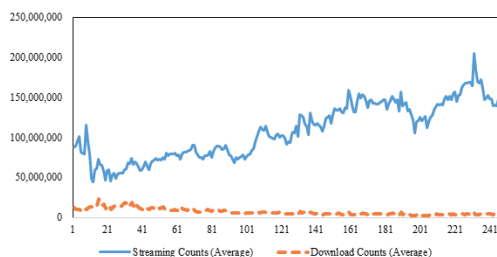


Fig. 1. Streaming and Downloading Counts per Week in Online Music Industry

[Fig. 1] shows the trend in streaming and downloading counts. The trend in total streaming counts continuously rises over time while that of total downloading counts seems to be relatively stable. To control for the effect of other factors influencing services, such as production, distributor, and genre, we further collected song information from Melon, which is the most popular online music platform in Korea. The streaming chart includes a total of 554 productions, 46 distributors, and 18 genres, and the downloading chart comprises 763 productions, 61 distributors, and 30 genres.

We utilize top 100 weekly chart counts, following prior studies. Aguiar and Waldfoegel[24] used the Spotify weekly top 50 streams, and they empirically show that the top 50 songs can accurately represent the entire population (corr. = 0.99) by comparing the top 50 songs and the top 200 songs. They also insist that the top 50 chart is valid and suffices to capture the total effect of Spotify. Asai[25] used the top 10 selling songs to analyze the sales pattern of hit music in Japan. She compares the top 10 selling songs to songs ranked from 990 to 1,000 in 2005. The results show a similar pattern, and the top 10 songs can represent the entire population. We interviewed with the data specialist of the Gaon chart to verify that top 100 songs well represent the online music industry. According to this interview, the top 100 songs account for more than 40% of total sales, and it could well capture the current pattern of the online music industry in South Korea. Based on prior studies and the interview, our sample is appropriate to the empirical tests.

We collected information on the LTE penetration rate from the Korea Communication Commission (KCC). Although LTE service started in July 2011, the KCC provided the LTE distribution data from November 2011. Therefore, this study uses LTE

distribution data from November 2011 to December 2015. However, the penetration rate of 4G LTE in November 2011 was only 3%. Thus, the impact of missing information earlier than November 2011 may not be significant.

3. Variables

By utilizing aforementioned data, we construct the variables used in this study as follows.

Streaming counts: We constructed this variable by averaging the total streaming counts of weekly top 100 songs. For normality, we used logged streaming counts.

Downloading counts: We constructed this variable by averaging the total downloading counts of the weekly top 100 songs. For normality, we used logged downloading counts.

LTE penetration rate: For any given month, this was defined as the proportion of LTE users in mobile phone users at the establishment in that month.

Album sales counts: We constructed this variable by averaging the total number of physical album sales of the weekly top 100 songs. For normality, we used the log value of it.

Major production ratio: This variable was defined as the ratio of songs produced by major music production firms. In Korean music industry, there are only two listed firms (SM Entertainment and YG Entertainment) on KOSDAQ (Korea Securities Dealers Automated Quotations) leading K-pop.

Major distributors ratio: This variable was defined as the ratio of songs distributed by Loen Entertainment and KT music. Two distributors have their own online music platforms, Loen manages Melon which has most subscribers in Korea, KT manages Olleh music. Two platforms are connected with telecommunication companies; Melon is connected with SK Telecom which has half of the

Table 1. Descriptive Statistics and Correlation Matrix

Variables		Obs.	Mean	S.D.	Min.	Max.								
Streaming	counts (log value)	248	18,45	0,34	17,61	19,14	1							
Download	counts (log value)	248	15,63	0,52	14,71	16,97	-0,79	1						
LTE penetration	(%)	248	57	34,1	0	96	0,90	-0,92	1					
Album	sales counts (log value)	248	13,31	0,32	12,49	13,92	0,12	-0,11	0,15	1				
Major	Production ratio (Streaming)	248	11,13	4,89	3	25	0,50	-0,38	0,47	0,13	1			
Major	Distributors ratio (Streaming)	248	57,40	6,32	41	77	0,39	-0,38	0,42	0,19	0,33	1		
Broadcasting	ratio (Streaming)	248	6,80	5,74	0	32	-0,35	0,39	-0,40	-0,13	-0,13	0,10	1	
Minor	Genre (Streaming)	248	84,68	4,73	70	96	-0,34	0,38	-0,35	-0,11	-0,11	-0,28	0,17	1

market share in Korea and Olleh music is connected with KT. When consumers use online music platform connected with their telecommunication company, they used to execute use various promotional events. To capture this, we constructed major distributors as the ratio of songs by distributed major distributors.

Broadcasting ratio: This variable was defined as the ratio of songs introduced by the broadcasting program such as American Idols, Voice UK, and others. In Korean music industry, the impact of the broadcasting program is also tremendous because it is efficiently exposed to consumers through the media and ranked on the chart. To capture this, we constructed broadcasting effect as the ratio of songs released by broadcasting firms.

Minor genre: This variable was defined as the ratio of genre diversity. Ballad, Hip-hop, Rock, R&B, Electronica, Dance are popular genres in South Korea. We constructed the genre diversity through the ratio of songs with non-popular genres in a week.

4. Model and Estimation

The main purpose of this study is to examine the relationship between downloading and streaming services as well as the role of mobile technology on this relationship, and the corresponding conceptual

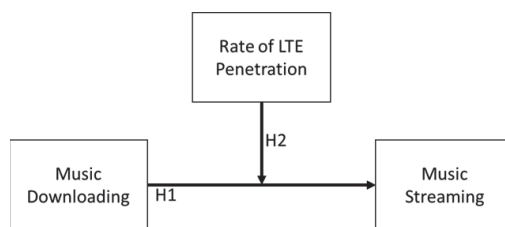


Fig. 2. Conceptual Framework

framework is shown in [Fig. 2]. With this framework, we propose the following empirical model.

$$\begin{aligned} \text{Log (Streaming counts)}_{t+1} = & b_0 + b_1 \times \text{Log (Download} \\ & \text{counts)}_t + b_2 \times (\text{LTE penetration})_t + b_3 \times \text{Log} \\ & (\text{Download counts})_t \times (\text{LTE penetration})_t + b_4 \times X_t + \varepsilon_t \end{aligned} \quad (1)$$

where Streaming counts_{t+1} and Download counts_t are weekly average counts for the top 100 songs. (LTE penetration)_t is the penetration of users for LTE mobile services in South Korea and Log (Download counts)_t × (LTE penetration)_t is the interaction term between Download counts and (LTE penetration). This term is to capture the moderating role of the penetration ratio of high-speed telecommunication technology. X_t is a vector of control variables that are expected to be related to streaming counts, and ε_t is an error term. For the

control variables, we include offline album sales, and ratios of major production, distributor, broadcasting system and genre following Asai[25] and Summers and Popp[26]. We further include season, and year in the model. We lag all independent and control variables by one year to deal with possible simultaneity between streaming counts and other variables of interest[27].

[Table 1] lists the descriptive statistics and the correlation matrix for the relevant variables. Because we use time-series data, the error terms in our model have potential problems of autocorrelation and heteroskedasticity. Thus, we use the Newey-West estimator to overcome these issues[28].

Table 2. Estimates of the Impact of Mobile Technology on the Relationship between Streaming and Downloading

Estimator:	Newey-West correction with two lags		OLS	
	(1)	(2)	(3)	(4)
Dep. var.:	Log (Streaming counts)			
Log (Downloading counts)	0,152** (0,055)	-0,004 (0,058)	0,152** (0,044)	-0,004 (0,042)
LTE penetration	0,006** (0,002)	-0,176*** (0,026)	0,006** (0,002)	-0,176*** (0,021)
LTE penetration x Log (Downloading counts)		0,010*** (0,001)		0,010*** (0,001)
Full set of controls	Yes	Yes	Yes	Yes
Observations	247	247	247	247
Adjusted R-squared			0,8951	0,9198
DF	14	15	14	15

Note: Standard errors in parentheses. All control variables included but not reported, as described in Section 2. DF stands for degree of freedom, AR(1) and AR(3) cases as well as AR(2) cases also show the consistent results.

***p<0.001; **p<0.01; *p<0.05; +p<0.1 (two-tailed tests)

IV. Results

1. Main Findings

[Table 2] reports the estimated results. Model 1 shows that download counts have a significant and

positive relationship with streaming counts ($p < 0.01$). This implies that downloading service stimulates streaming services, suggesting that streaming and downloading services are complementary to each other in the online music market (Hypothesis 1 is supported). It can also mean that when consumers more listen to music, they use both downloading and streaming services.

Model 2 shows that the interaction terms of downloading counts and LTE penetration have a significant and positive effect on streaming counts ($p < 0.001$). This indicates that LTE distribution strengthens the complementarity between streaming and downloading services. We obtain similar results with OLS (see Models 3 and 4). Therefore, we obtain consistent results in both cases by showing that the rate of LTE penetration positively moderates the positive relationship between music downloading and music streaming (Hypothesis 2 is supported).

2. Robustness Check

To ensure the stability of our findings, we ran a series of robustness checks. First, we used a one-week time lag ($t-1$) in our all models between the dependent and independent, and control variable. Second, we have assumed autoregressive (1) model in our main analysis, but we also tested ar(1) or ar(3) process. Although we only note the estimated results with lag two, we also test lag one and lag three for robustness. The results from the robustness checks were similar with our reported findings.

V. Discussion and Conclusion

This study examines the relationship between downloading and streaming services in the online music industry and how the increase in mobile

technology penetration alters this relationship. By focusing on the amount of weekly music consumption in the streaming and downloading market, we reveal that downloading a song is positively related to streaming a song. Although the music consumption environment is in the process of transforming toward more streaming friendly environment, streaming and downloading services are complementary to each other rather than substitutive. In addition, our paper finds that the penetration of mobile technology significantly strengthens the relationship in online music consumption.

As the mode of music consumption has changed by new technologies, for example, from LPs to tapes, tapes to CDs, CDs to MP3, the current mode of music consumption has changed from downloading to streaming services. With these emerging patterns, practitioners in the online music industry are complaining that the two different music services are the substitute for each other, and the profits in the online music industry will be lower with the rise of music streaming services. However, the founder of Spotify, Dainel Ek, claimed that even digital piracy deprived artists of reasonable rewards, Spotify has paid more than two billion dollars to labels, publishers and organized communities for songwriters and recording artists. Actually, the US music industry's total revenue increased in 2015, and Friedlander[29] reported that the continuing growth of revenue from streaming services offset the decrease of downloading. As mentioned above, ad-supported streaming services brought consumers to the legal music market.

Furthermore, unlike practitioners' concern, our results show that online music downloading and streaming services are complementary to each other. It means that the market can grow with two different services and music downloading can even increase

the overall revenue from music streaming. Our finding on the moderating role of the rate of LTE penetration on the positive relationship between downloading and streaming services also shows that the positive revenue effects from complimentary even further increases with the advance of mobile technology. If practitioners utilize this finding by facilitating consumers to utilize more advanced mobile technology to enjoy digital songs, they can be more profitable. Likewise, Liebowitz[30] noted that copyright owners once regarded the new technology as a threat to the music industry, but the new technology was a fortunate of the music industry, not a threat.

This study contributes to our deeper understanding of the recent changes in digital goods markets, in which one product can be consumed in different ways, such as downloading and streaming services. As the technological environment of this market rapidly changes, successful management of different types of digital goods is becoming more important in these markets regarding producers' welfare. Thus, by shedding light on this issue, our study contributes to a timely discussion on the relationship among different consumption types of digital goods. In addition, our findings about the online music industry can be a good proxy for the future of the online music market in other countries because Korea has the fastest telecommunication environment in the world[5].

However, there are several limitations to our study. First, although Gaon chart covers a substantial amount of the platforms, we still need to integrate the data for aggregate music consumption from various platforms. In these days, consumers listen to music from video-streaming services, such as YouTube. We believe that it would be interesting to extend our study by gathering data on different segments of the

online music consumers from other platforms. Second, we analyzed an aggregate data to investigate the effect of downloading and streaming services on sales. Future research could benefit by gathering and analyzing individual-level data on music consumption. Third, future study can examine whether the relationship between downloading and streaming services differs based on the different types of streaming business models, such as subscription streaming and ad-supported streaming services. We hope that future study should more carefully consider these issues.

Despite these limitations, our study is important because we find music downloading has been complimentary to music streaming, and LTE penetration stimulates the relationship. It means music consumption is simultaneously utilizing from downloading to streaming. The stakeholders in the music industry should concern about these issues. Artists and labels still complain about streaming services because they do not receive proper royalty compare to downloading and physical music sales. We hope this study motivates to find a way to satisfy artists, labels, distributors, and consumers.

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