The Diminishing Returns of Music in the Digital Era*

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This paper explores the dynamic between digital transformation and revenue models in the music industry, inspecting data from industry sales to dissect the economic consequences of the digital shift. It builds upon and broadens existing research, pinpointing a significant downturn in revenue per unit despite escalated consumption rates, with a focus on the pivotal years (early 2000s) marking the industry's digitalization. The paper reveals a nuanced relationship: the paradoxical increase in access to music paired with decreased monetary valuation. These findings underscore the profound influence of digital market forces on the music industry and highlight the critical need for adaptive economic strategies within the rapidly evolving digital landscape.

1 Introduction

In the digital dawn of the 21st century, the music industry has experienced an unprecedented transformation, ushered in by the proliferation of the internet and a resultant seismic shift in consumer behavior. Specifically, the introduction of file sharing services like Napster redefined the way music is distributed, valued, and consumed by effectively making music free to share, download, and listen to online. The Recording Industry Association of America (RIAA) sought to shut Napster down and it did within 2 years. RIAA may have won the battle against Napster but lost the war against the internet. Historically, the industry's financial success was predicated on physical sales, but the advent of the internet has catalyzed a pivot to digital formats — a pivot not without its economic consequences. While the democratization of music through digital platforms has expanded reach, it has also ushered in a complex debate about the monetary value of music, with implications for artists, producers, and the industry at large.

*Code and data are available at: https://github.com/libant/music-industry-analysis

This paper seeks to explain the economic narrative of the music industry's journey through the digital age. By analyzing a comprehensive dataset on music sales, we unravel how the industry's revenue per unit has been affected since the decline of physical media. Amidst the backdrop of booming digital consumption, we find an inverse trajectory in revenue, raising questions about the long-term sustainability of current digital revenue models.

We employed quantitative methods to scrutinize patterns in music sales, juxtaposing the eras of physical dominance with the digital revolution. Our findings present that while digital consumption has indeed skyrocketed, the economic value per unit of music has suffered a significant decline. The implications of this research are multifaceted — highlighting the critical need for innovation in monetization strategies for music in an increasingly digital world.

The structure of the paper is as follows: We commence with a detailed examination of the dataset, charting the industry's sales and revenue trends (Section 2). Subsequent sections present our analysis of the data (Section 4), revealing pivotal insights into the economic shifts within the industry. We then pivot to a discussion (Section 5), contextualizing our findings within the broader framework of digital economics and their relevance to stakeholders. Finally, we conclude by reflecting on the implications of our research, considering the broader paradigm of value creation and capture in the digital era, and proposing pathways for future research. The analysis was conducted using the statistical programming language R (R Core Team (2023)), utilizing packages such as rstanarm (Goodrich et al. (2022)), and additional papers such as " ".

2 Data

2.1 Source

The main data source is a dataset from the Recording Industry Association of America (RIAA) (Larxel and Bass (2019)), tracking recorded music revenues by format in the United States from 1973 to 2019. This dataset was generated by Matt Bass and has been adjusted for inflation, offering a standardized monetary comparison across five decades of music industry economics. Since the RIAA have yet to properly respond to requests for the use of their dataset, we made use of a Kaggle dataset from Kaggle user "Larxel" that cites the RIAA dataset. There could have been other datasets from Kaggle used but they weren't because they didn't cite the RIAA dataset.

Detailing yearly revenue across a spectrum of music formats, the RIAA dataset offers a comprehensive look at the industry's economic fluctuations, tracing the lineage from traditional mediums like LPs and cassettes to modern digital forms such as streams and downloads. This level of detail affords a nuanced understanding of changing consumer preferences and technological advancements that have influenced the music market in the United States.

The RIAA dataset was specifically chosen for its focus on the U.S. market and its longitudinal data, allowing for an in-depth analysis of market shifts over fifty years. Other global datasets did not offer the same level of historical depth or the focused granularity required to assess the U.S. market's unique journey through the digital transformation. The RIAA dataset is composed of multiple variables that encapsulate different facets of the music industry. Variables such as "Format", "Year", and "Value" have been carefully vetted to ensure consistent and accurate representations of the industry's financial landscape over time. This thorough examination guarantees that the paper rests on a solid empirical foundation, capable of yielding substantial insight into the evolution of the music industry.

2.2 Measurement

2.2.1 Variables and Their Measurement

The key variables included in the Kaggle dataset and their respective measures are as follows:

1. Year: The year of the data entry, serving as a marker for trend analysis.
2. Format: The music distribution format, categorized into variaous phyiscal formats such as Vinyl, CD, and various digital formats like Streaming and Downloads.
3. Revenue: Measured in millions and adjusted for inflation to present a uniform value metric over time.

The inflation adjustment applied to the revenue figures is particularly noteworthy, as it allows for an equitable comparison of the industry's financial status year-over-year, accounting for the changing value of money. Bias should be taken into consideration as the method of revenue tracking has evolved with technology and industry standards.

2.2.2 Revenue by Format

Revenue, the central variable in the RIAA dataset cited in the Kaggle dataset, is measured in millions of U.S. dollars and has been adjusted for inflation to 2019 values. The RIAA has segmented revenue into various categories, each corresponding to a different format:

1. LP/EP
2. Vinyl Single
3. 8-Track
4. Cassette
5. Cassette Single
6. Other Tapes
7. CD
8. CD Single
9. SACD

10. DVD Audio
11. Music Video (Physical)
12. Download Album
13. Download Single
14. Ringtones & Ringbacks
15. Download Music Video
16. Other Digital
17. Kiosk
18. Paid Subscription
19. On-Demand Streaming (Ad-Supported)
20. Other Ad-Supported Streaming
21. SoundExchange Distributions
22. Synchronization

Each category represents a particular mode of music consumption, and the revenue figures associated with these formats are used to track shifts in consumer preferences and technological advancements.

2.3 Data Characteristics

The RIAA dataset published by Larxel and Bass (2019) was cleaned to account for the irrelevence of the "number_of_records" and "metric" columns. Using the dataset, we were able to replicate all of the means and standard deviations of the music formats, as shown in Table 1. The summary statistics illustrate how the high standard deviations across the board reflect a wide variation in yearly revenue, which could be attributed to a certain format's lifecycle or other market changes over time. For example, 8-Track tapes, despite their irrelevance, have an intriguingly high mean revenue.

However, newer formats like digital downloads present lower mean revenues and relatively lower standard deviations, indicating a more consistent performance year-over-year but at a lower profitability scale. This could reflect market saturation (which is growing exponentially in the age of the internet), pricing strategies, or the competition from streaming services. The disparity between these formats highlights the evolution of music consumption, with digital formats overtaking physical mediums and reflecting changing consumer preferences and the influence of technological advancements such as social media and streaming services on the music industry's revenue streams.

Table 1: Summary Statistics of the Music Formats

format	mean_revenue	sd_revenue
8 - Track	511.177232	984.411165
CD	4733.432620	5645.536764
CD Single	45.346843	85.966719
Cassette	1403.643775	1919.217701
Cassette Single	126.793441	158.928097
DVD Audio	2.699241	3.632631
Download Album	523.063861	454.588843
Download Music Video	16.108696	14.523113
Download Single	956.128235	471.170965
Kiosk	2.843023	1.782577
LP/EP	905.310691	1966.291355
Limited Tier Paid Subscription	614.897193	228.885536
Music Video (Physical)	198.247984	213.153230
On-Demand Streaming (Ad-Supported)	452.028121	270.051745
Other Ad-Supported Streaming	214.019553	80.656749
Other Digital	19.121265	1.893653
Other Tapes	5.971933	17.806481
Paid Subscription	1417.139072	1827.921687
Paid Subscriptions	12.118509	17.023962
Ringtones & Ringbacks	299.985818	359.027230
SACD	3.602776	7.206144
SoundExchange Distributions	447.869189	359.379065
Synchronization	224.290481	32.118650
Vinyl Single	156.419683	268.091990

Figure 1 presents a vivid picture of how music format revenues have shifted over approximately four decades and the rise and fall of various music formats, echoing the technological and cultural shifts over time. Notably, the graph illustrates the dominance of CDs in the 90s through early 2000s, highlighting the era's preference for physical media. The subsequent decline of CDs and rise of digital formats reflect the impact of the internet and mobile technology on music consumption. The recent surge in streaming services, visible in the graph, represents the latest phase in music distribution, where conveniency takes precedence over physical ownership. This shift not only marks a change in consumer habits but also has broad implications for revenue models in the music industry, affecting everything from artist compensation to the survival of traditional record stores. The data in this graph tells the story of an industry that has had to continuously adapt to the rapid evolution of technology and consumer preferences.

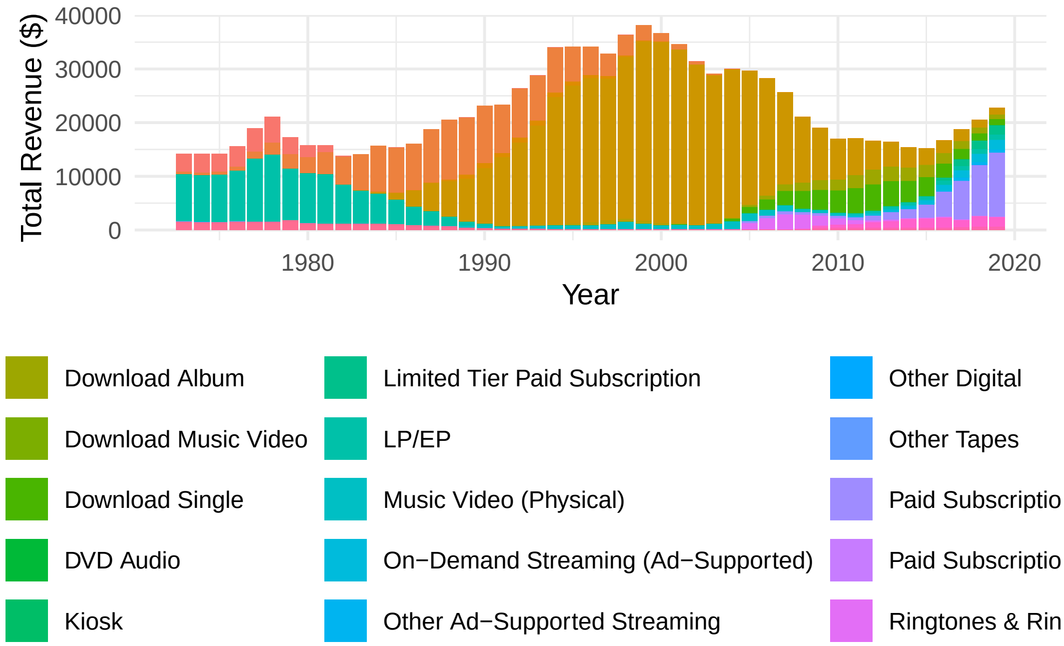

Figure 1: Revenue Distribution by Year and Format

Table 2 shows how in this sample, the most valuable format of music consumption in North America is the CD. This is because CDs are cheap to produce and there is a larger return on investment because they are physical format which have a larger cost than digital formats to the consumer. The least valuable format of music consumption in North America is the music video. This may be in part due to the fact that music videos are immensely costly and they have been slowly losing traction due to the rise in social media and streaming services.

Table 2: Music Industry Average Revenue per Format

format	average_revenue
CD	4733.43
Cassette	1455.63
Paid Subscription	1417.14
8 - Track	1005.32
Download Single	956.13
LP/EP	905.31
Limited Tier Paid Subscription	614.90
Download Album	523.06
On-Demand Streaming (Ad-Supported)	452.03
SoundExchange Distributions	447.87
Ringtones & Ringbacks	299.99

format	average_revenue
Synchronization	224.29
Other Ad-Supported Streaming	214.02
Music Video (Physical)	198.25
Cassette Single	172.53
Vinyl Single	156.42
CD Single	46.83
Other Tapes	23.39
Other Digital	19.12
Download Music Video	16.11

3 Model

The goal of our modelling strategy is twofold. Firstly, we seek to evaluate how different music formats contribute to overall industry revenue over time. This involves analyzing the changes in revenue streams from physical sales such as CDs and vinyl to digital formats like streaming and downloads. Secondly, we seek to use these insights to forecast future revenue trends for these formats.

In the section below, we outline the Bayesian analysis model utilized to examine the linear regression model of revenue generation per music format.

3.1 Model set-up

Define y_i as the annual revenue from a given music format. Then β_i is the effect of physical sales, γ_i is the effect of digital downloads, θ_i is the effect of streaming subscriptions, and ϕ_i is the effect of ad-supported streaming. Let x_i be a vector containing the presence of each format in a given year.This is all measured in USD.

$$
\begin{aligned}
y_i|\mu_i,\sigma &\sim \text{Normal}(\mu_i,\sigma) && (1)\\
\mu_i &= \alpha + \beta_i x_{i1} + \gamma_i x_{i2} + \theta_i x_{i3} && (2)\\
\alpha &\sim \text{Normal}(0, 2.5) && (3)\\
\beta &\sim \text{Normal}(0, 2.5) && (4)\\
\gamma &\sim \text{Normal}(0, 2.5) && (5)\\
\theta &\sim \text{Normal}(0, 2.5) && (6)\\
\phi &\sim \text{Normal}(0, 2.5) && (7)\\
\sigma &\sim \text{Exponential}(1) && (8)
\end{aligned}
$$

We run the model in R (R Core Team 2023) using the `rstanarm` package of Goodrich et al. (2022). We use the default priors from `rstanarm`.

3.1.1 Model justification

We expect a positive relationship between physical formats like CDs and vinyl records and revenue in the earlier years, reflecting the technology and consumer habits of those times. As we move into the digital age, we anticipate seeing a shift with digital downloads and streaming services gaining prominence and thus a positive relationship with revenue in the later years of the dataset.

Particularly, we predict that the rise of streaming services will correlate with a decrease in revenue from physical formats due to the convenience and accessibility of music online. Additionally, the advent of certain ad-supported streaming platforms might introduce a more complex relationship with revenue, potentially showing growth in consumer numbers but a slower rate of revenue increase due to its reliance on ad sales rather than direct consumer purchases.

Interactions between different formats are also of interest. For example, the coexistence of digital downloads and streaming services may reveal competitive or complementary dynamics. A competitive interaction might exhibit a negative relationship between the revenue of one format as the other rises, while a complementary interaction may not show a significant negative impact. These dynamics are crucial for understanding the evolution of music consumption and the financial viability of different formats in the music industry.

4 Results

4.1 Revenue Percent Change in the Digital Age

Figure 2 illustrates the year-over-year percentage change in revenue for various music formats, demonstrating the music industry's dynamic nature over time. For example, the gradual rise and later steep decline observed in the cassette format's line is indicative of its rise and fall in popularity, reflective of technological obsolescence and subsequent market shifts. CDs exhibit a general decline in recent years, which correlates with the proliferation of digital music. The download single format and LP/EP show resurgence possibly due to niche market appeal and the revival of vinyl records among collectors and other enthusiasts. These revivals can be traced to social media trends as well, further propagating the internet's immense influence on the music industry. The paid subscription format presents a growing trend, emphasizing the industry's shift towards streaming services as the primary source of music consumption. This graph not only highlights broader trends in the industry, but it also lines up the death of physical media with the rise of the internet, which have reshaped the way music is distributed and monetized.

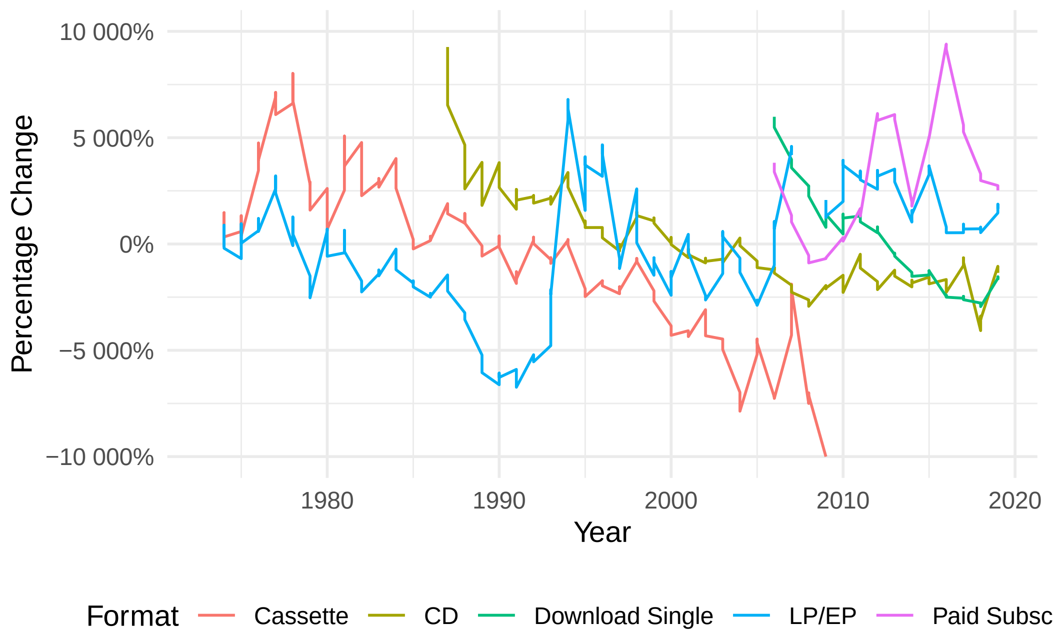

Figure 2: Revenue Change for the Top Music Formats

4.2 Volatile Revenue Trends

Figure 3 illustrates the revenue trends over time for various music formats, demonstrating the music industry's sharp volatility regarding revenue over time. The graph generally indicates that the more volatile the revenue for a given music format, the more revenue it will generate. However, the more consistent the revenue for a given music format, the less revenue it will generate. This also demonstrates the revenue trend between physical and digital sales. Physical sales generate more revenue but are less consistent whereas digital sales generate less revenue but are more consistent. This could be due to the convenience that the internet and the ever-increasingly connected world provide in regards to music consumption. Additionally, the graph shows a general decline in recent years for physical music formats such as CDs, which further correlates with the proliferation of digital music and the internet. This is the best illustration of the main concern of the contemporary music industry where the most prominent format of music (paid subscriptions) is failing to generate as much revenue as it seemingly should.

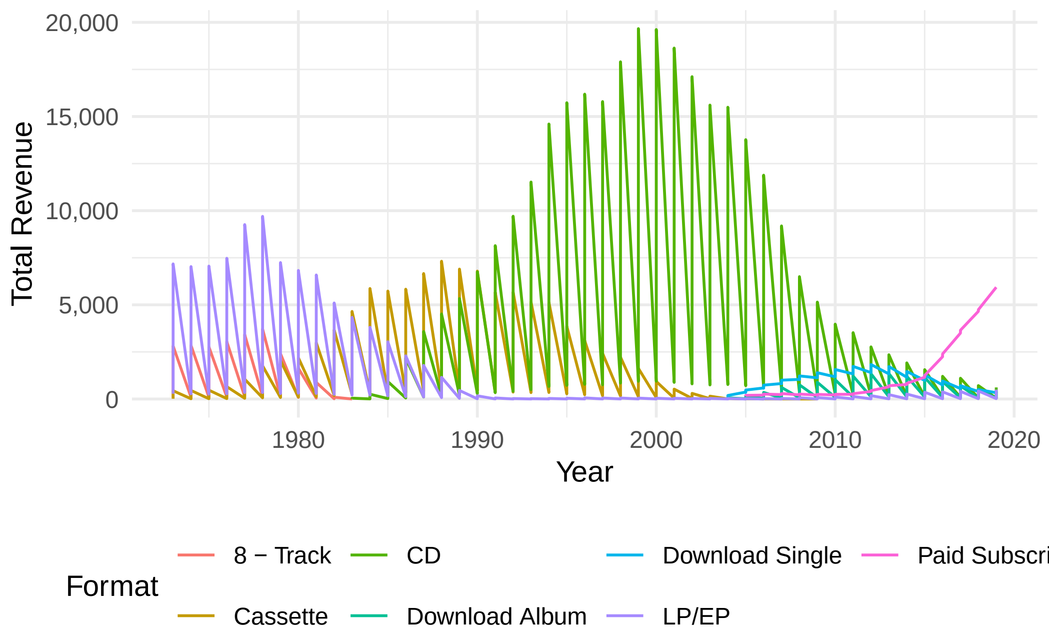

Figure 3: Revenue Trends per Music Format

4.3 Model Results

Our results are summarized in Table 3.

Table 3: Explanatory models of flight time based on wing width and wing length

	Bayesian Linear Regression
b_Intercept	761.60
b_formatCassette	1.30
b_formatCassetteSingle	-0.72
b_formatCD	8.60
b_formatCDSingle	-1.60
b_formatDownloadAlbum	-0.21
b_formatDownloadMusicVideo	-0.64
b_formatDownloadSingle	0.05
b_formatDVDAudio	-0.91
b_formatKiosk	-0.62
b_formatLimitedTierPaidSubscription	-0.18
b_formatLPDEP	0.21
b_formatMusicVideoPhysical	-0.98
b_formatOnMDemandStreamingAdMSupported	-0.03

	Bayesian Linear Regression
b_formatOtherAdMSupportedStreaming	-0.22
b_formatOtherDigital	-0.04
b_formatOtherTapes	-0.88
b_formatPaidSubscription	0.28
b_formatPaidSubscriptions	-0.52
b_formatRingtones&Ringbacks	-0.23
b_formatSACD	-0.91
b_formatSoundExchangeDistributions	-0.18
b_formatSynchronization	-0.39
b_formatVinylSingle	-1.48
sigma	2245.34
Num.Obs.	1351
R2	0.000
R2 Adj.	0.001
ELPD	-12350.9
ELPD s.e.	103.2
LOOIC	24701.7
LOOIC s.e.	206.5
WAIC	24701.5
RMSE	2245.30

Table 3 present the results of the Bayesian linear regression analysis, examining the relationship between music formats and revenue generation. The model's coefficients (b) for various formats—such as cassette, CD, and different digital formats—are listed alongside their numerical estimates, which represent the expected change in revenue generation associated with each format, holding all else equal.

The coefficient for the intercept indicates the baseline revenue when all other predictors are at zero. The significant figure of 761.20 is the baseline revenue for the reference category of music formats. Negative coefficients, like those for paid subscriptions and downloads, suggest that these formats are associated with a decrease in revenue relative to the reference category. In contrast, positive values, like the one for vinyls, imply a potential increase in revenue.

Overall, this table provides a comprehensive overview of how different music formats are estimated to impact revenue generation within the scope of the data analyzed, offering valuable insights for stakeholders in the music industry regarding which formats may be more financially viable or are declining in terms of revenue contribution.

5 Discussion

5.1 Diminishing Returns in the Music Industry

Our analysis revealed a shift in the music industry from a reliance on physical sales, like CDs and vinyl, to digital formats, especially streaming services. Additionally, we discovered that the revenue from streaming services and digital sales has been more consistent than physical format sales (indicating that more people are listening to music) but have failed to compensate for the revenue from physical format sales. The physical to digital sales transition highlights the industry's capacity to innovate but failure to adapt to technological advancements and changing consumer preferences. This finding is crucial for several reasons. Primarily, it suggests that the music industry has yet to find a pathway to sustain itself and grow in the digital age. Embracing the digital landscape rather than resisting it was the right thing to do. However, more must be done to bring more sizable returns. Keintz (2008) suggests that the next step for the recording industry is to develop a recorded digital music strategy for each country in an effort to restore revenue growth by offering consumers a compelling digital music value proposition. Wilde and Schwerzmann (2004) further suggests that the current strategy of the music industry is centered around protecting their traditional business model through technical measures and the search for new business models is the better way to go, even though it may take some time and effort to identify these business models.

What I believe to be the solution to the music industry's diminishing returns lies with both sentiments. To succeed, there must be a new, convenient business model that offers a compelling value for digital music consumption and an extensive library of music to boot. From the artist perspective, touring has become prohibitively expensive and revenue models tied to streaming services fail to properly compensate them for their work. Due to social media engagement and streaming services, artists are also incentivized to release more music at a faster rate to satisfy each respective algorithm and model. Drake, one of the biggest artists of the 21st century, has arguably benefited the most from a mastery of social media algorithms and streaming service models, as he leveraged his pre-streaming era success to release lengthy projects at an annual rate to maximize streams and increase his social media engagement. In 2013, Thom Yorke from Radiohead pulled all of his own (not counting Radiohead) songs from Spotify in protest at how much it pays artists. In 2007, Radiohead released their album "In Rainbows" independently as a "pay-what-you-want" download, meaning that fans could set their own price. The band's reasoning for this was that it "liberated them from conventional promotional formats and removed barriers to audiences". Services like Bandcamp offer the same thing for smaller artists. If this business model was adopted by larger artists and properly integrated with smartphones and computers, it would offer enough convenience to the consumer to be a reliable alternative that would also generate revenue for artists and the industry as a whole, as it challenges old models and finds new ways to connect with fans.

5.2 The Music Industry Adoption of the Internet

The data indicates that the internet's role in the music industry signifies a pivotal shift towards a more interconnected and user-centric experience, altering the landscape of the music business and cultural consumption fundamentally. The shift from physical formats to digital formats has revolutionized how music is distributed, accessed, and enjoyed by audiences worldwide. With the advent of the internet, traditional barriers to entry were dismantled, allowing for an unprecedented democratization of music production and consumption in addition to piracy. Artists gained the ability to bypass traditional gatekeepers, reaching listeners directly through online platforms. Consumers embraced this new era of conveniency, where a vast library of music became available at the click of a button. However, this also brought challenges, such as the devaluation of individual tracks in the face of streaming economies and the difficulties for artists to monetize their work effectively. Mundorf and Bryant (2002) additionally proposes that although interactivity has become linked to the Internet, other communication technologies provide interactive options, too. Many of these alternative technologies are complementary to Internet usage in that their reach includes populations that lack regular PC-based Internet access. The challenge facing revenue generation in services like streaming services is finding ideal combinations of entertainment and information features that can be applied to the service in a sufficiently attractive manner to justify the consumer investment in software. This suggests that the essence of increasing revenue in the music industry hinges on the caliber of the user experience — a seamless, enriching, and engaging interaction that makes the digital shift in the music industry not just a convenience but a superior choice for content consumption, a choice that properly connects artists and their fans.

The effect of Tiktok on the music industry can't have been explicitly applied to the present data in this paper because this data cuts off at 2019 and Tiktok started to gain prominence in 2018. However, I think Tiktok perfectly illustrates the quality of the user experience and it's subsequent effect on the music industry. The user-generated content that Tiktok is made up of has opened new doors for revenue through advertising partnerships and virality in addition to some content monetization. Mainly, the platform serves as a marketing tool, enabling artists to build their brand and engage with fans directly. Collectively, these digital alternatives complement streaming by diversifying the revenue portfolio of the industry, showcasing the multifaceted nature of music consumption in the digital age. However, the issue with this is that the complementation of streaming with Tiktok has led to additional conveniency for the consumer. This duo of streaming and Tiktok leads to people consuming music as if it were free, as described by musician James Blake. He specifically argued that Tiktok has negatively affected songwriting by encouraging artists to write differently to appeal to the Tiktok algorithm and the attention deficit of the consumer by presenting a vast library of quick user-generated content tailor made for the consumer.

5.3 How Does AI Come Into Play?

The integration of artificial intelligence (AI) into the music industry holds immense potential, signaling a significant shift in how music is created, distributed, and consumed. Nowadays, AI algorithms can compose music, personalize listening experiences, and even (attempt to) predict future hits by analyzing vast datasets of listener preferences and music compositions. AI in the music industry could additionally redefine the role of artists, reshape business models, and introduce new legal and ethical dimensions regarding intellectual property. Generally, AI's impact on the music industry is likely to be as disruptive as it is innovative, fostering new art forms while challenging existing paradigms. Shang and Sun (2020) further explores the broader transformation of the music industry's business model, driven by AI and blockchain technology. It additionally suggests that AI has the potential to significantly impact revenue in the music industry, particularly through its influence on technology, creativity, and business models. Since it has been incentivized in the digital age to create faster, synthetic music to release on streaming services at a consistently quick rate, one could argue that AI would act as a complement to streaming services as Tiktok already does. With that comes new revenue streams. However, AI music in theory would pay artists little to nothing. It is too soon to say if AI offers more conveniency for the consumer on a mass scale but the implications of it don't justify it's small revenue boost for the music industry to champion it.

5.4 Weaknesses and Next Steps

The analysis within this paper, while thorough, is not without limitations that should be acknowledged. Firstly, the dataset's restriction to revenue figures may overlook the nuanced consumer behaviors and preferences that drive the market. Future research could benefit from integrating qualitative data, such as consumer surveys or artist interviews, to complement the quantitative revenue analysis. Additionally, the rapid pace of technological change means that the dataset may quickly become outdated; continuous data collection and analysis will be crucial to maintain relevance. The dataset only includes information on North America. Incorporating worldwide data with Keintz (2008) suggestions could lead to additional substantial observations.

Furthermore, the current dataset does not capture the entire scope of the music industry, such as live performances, merchandise sales, and licensing deals, which are significant revenue streams. Future iterations of this research should aim to include these aspects for a more comprehensive view of the industry's economic landscape.

The industry is also moving towards more immersive and interactive experiences, such as virtual concerts or music NFTs, areas not covered by the present dataset. Including these emerging trends could provide valuable insights into future revenue potentials and shifts in consumer engagement.

In response to these weaknesses, subsequent steps should involve expanding the dataset to account for these additional dimensions and exploring predictive models to forecast industry trends. Engaging with the latest advancements in technology, like AI and blockchain, and understanding their impact on music consumption and distribution could also offer valuable contributions to the literature. By addressing these gaps, future research can provide a more holistic understanding of the industry and its trajectory in the digital age.

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