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 (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, I made use of a Kaggle dataset from Kaggle user "Larxel" that cites 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. All physical formats and digital formats were cleaned and grouped together.

2.3 Data Characteristics

The RIAA dataset published by Larxel (2019) did not require any further data cleaning. Table 1 shows how in this sample, the most valuable format of music consumption 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 is the music video. This may be in part due to the fact that music videos are immensely costly and they are slowly losing traction due to the rise in social media.

Table 1: 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
Synchronization	224.29
Other Ad-Supported Streaming	214.02

format	average_revenue
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

Some of our data is of penguins (Figure 1), from Horst, Hill, and Gorman (2020).

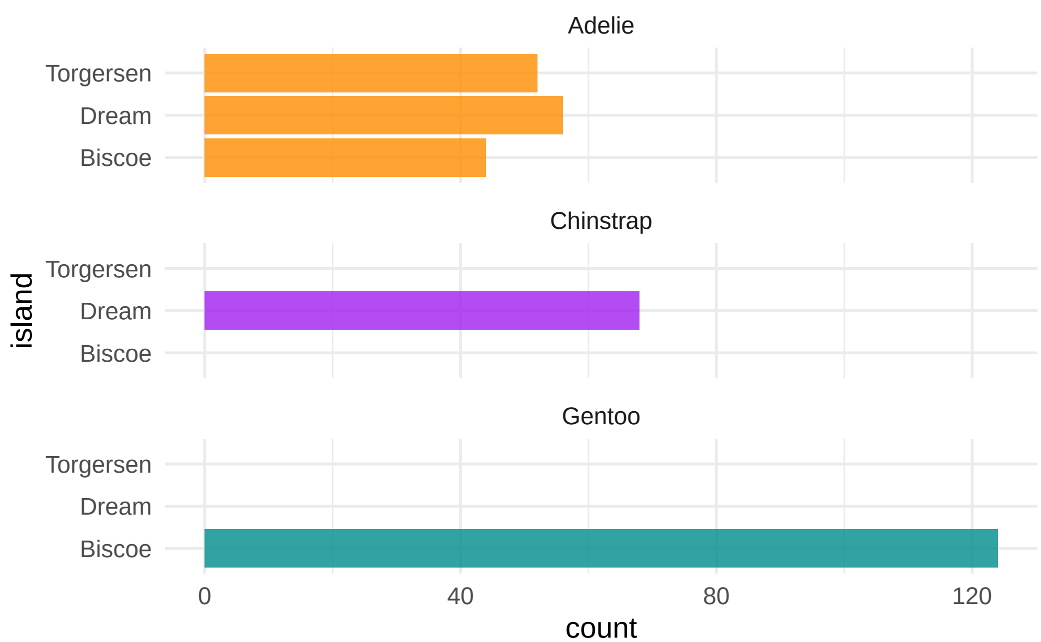


Figure 1: Bills of penguins

Talk more about it.

And also planes (Figure 2). (You can change the height and width, but don't worry about doing that until you have finished every other aspect of the paper - Quarto will try to make it look nice and the defaults usually work well once you have enough text.)

Talk way more about it.

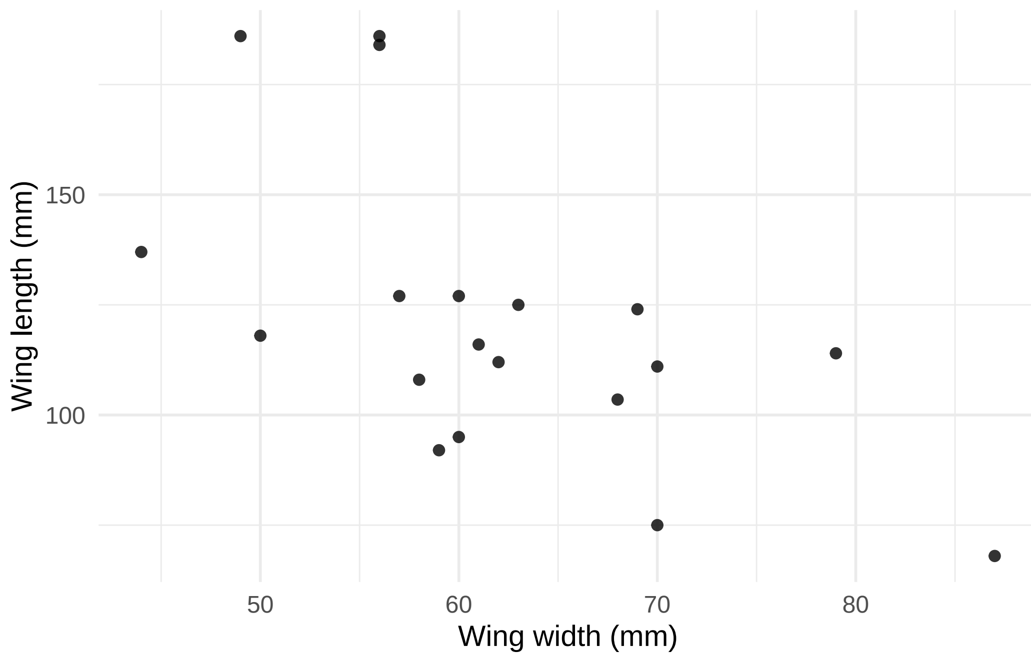


Figure 2: Relationship between wing length and width

3 Model

The goal of our modelling strategy is twofold. Firstly,...

Here we briefly describe the Bayesian analysis model used to investigate... Background details and diagnostics are included in Appendix B.

3.1 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

$$
\begin{aligned}
y_i|\mu_i, \sigma &\sim \text{Normal}(\mu_i, \sigma) && (1)\\
\mu_i &= \alpha + \beta_i + \gamma_i && (2)\\
\alpha &\sim \text{Normal}(0, 2.5) && (3)\\
\beta &\sim \text{Normal}(0, 2.5) && (4)\\
\gamma &\sim \text{Normal}(0, 2.5) && (5)\\
\sigma &\sim \text{Exponential}(1) && (6)
\end{aligned}
$$

Table 2: Explanatory models of flight time based on wing width and wing length

	First model
(Intercept)	1.12
	(1.70)
length	0.01
	(0.01)
width	−0.01
	(0.02)
Num.Obs.	19
R2	0.320
R2 Adj.	0.019
Log.Lik.	−18.128
ELPD	−21.6
ELPD s.e.	2.1
LOOIC	43.2
LOOIC s.e.	4.3
WAIC	42.7
RMSE	0.60

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 the size of the wings and time spent aloft. In particular…

We can use maths by including latex between dollar signs, for instance θ.

4 Results

Our results are summarized in Table 2.

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

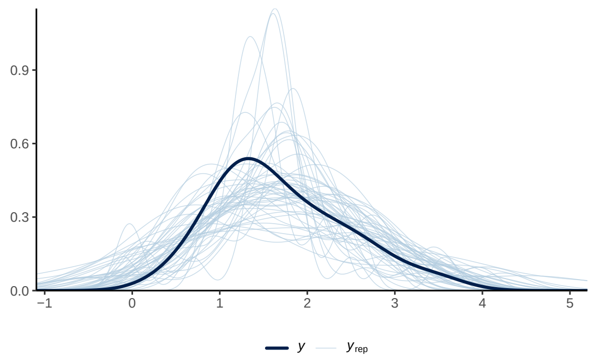
A Additional data details

B Model details

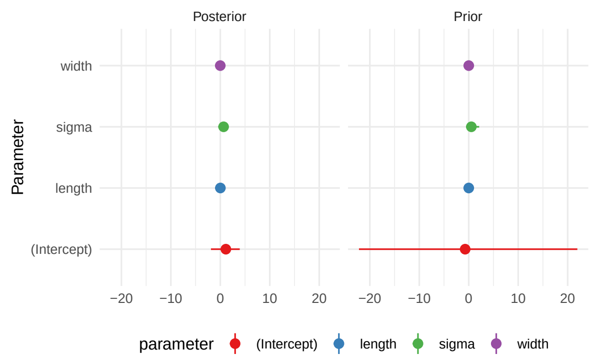
B.1 Posterior predictive check

In Figure 3a we implement a posterior predictive check. This shows...

In Figure 3b we compare the posterior with the prior. This shows...



(a) Posterior prediction check



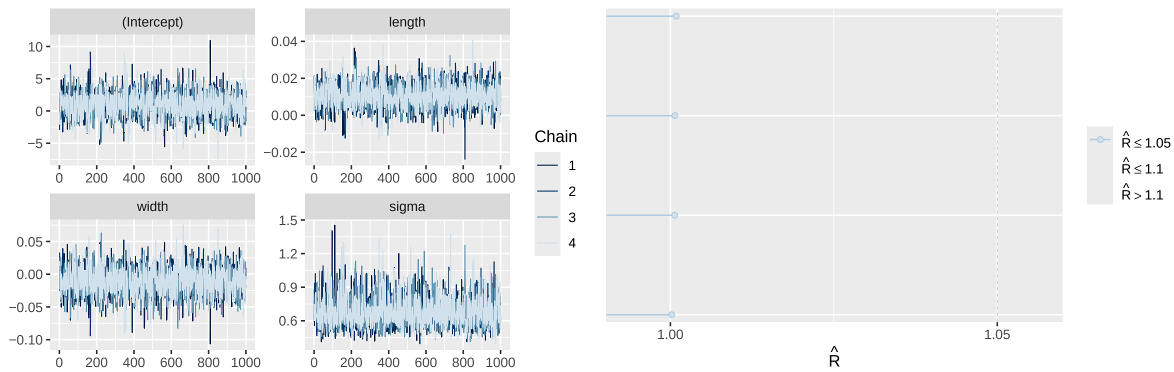
(b) Comparing the posterior with the prior

Figure 3: Examining how the model fits, and is affected by, the data

B.2 Diagnostics

Figure 4a is a trace plot. It shows... This suggests...

Figure 4b is a Rhat plot. It shows... This suggests...



(a) Trace plot

(b) Rhat plot

Figure 4: Checking the convergence of the MCMC algorithm

References

Goodrich, Ben, Jonah Gabry, Imad Ali, and Sam Brilleman. 2022. "Rstanarm: Bayesian Applied Regression Modeling via Stan." https://mc-stan.org/rstanarm/.

Horst, Allison Marie, Alison Presmanes Hill, and Kristen B Gorman. 2020. *Palmerpenguins: Palmer Archipelago (Antarctica) Penguin Data*. https://doi.org/10.5281/zenodo.3960218.

Larxel, Matt Bass. 2019. "Music Industry Sales (1973 - 2019)." https://www.kaggle.com/datasets/andrewmvd/music-sales/data.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.