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The Lure of Musical Comfort: An Analysis of How Consumer Preferences in Popular Music Change Depending on the State of the U.S. Economy using Billboard Hot 100, Spotify API, & Economic Data

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Abstract

This paper examines data from Spotify's Web API for all songs that have been on the Billboard Hot 100 chart from the first chart's release in August 1958 to May 2021 to determine the relationship between music misery and economic misery. Twelve dependent variables– duration, danceability, energy, key, acousticness, speechiness, mode, loudness, instrumentalness, liveness, valence, and tempo– are used to measure the impact of Arthur Okun's U.S. economic misery index on each characteristic. Using 12 individual linear regressions– one for each dependent variable– I find that during times of increased economic hardship, consumers are likely to choose to listen to longer, quieter, slower, happier songs that have a minor modality, higher levels of danceability, and lower levels of speechiness, liveness, and acousticness. Consistent with previous research, these results demonstrate how people seek comfort and an escape from a stressful reality when listening to music during uncertain economic times. Additionally, I propose a music misery index that puts a value to the regression results by dividing the statistically significant variables by their regression coefficients. The resulting music misery index has a positive correlation of 0.606 with economic misery, thus demonstrating a strong relationship between consumer preference in popular music and the state of the U.S. economy. Finally, given that 90% of the U.S. population listens to music regularly and that people regulate their emotions by listening to music, this paper argues that music misery can be utilized to estimate a real-time pulse of consumer confidence in the U.S. economy.

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I. Introduction

Music is everywhere. It is playing on the speakers of our supermarkets, elevators, car radios, gyms, shopping malls, movie theatres, smartphones, televisions, and personal headphones as we go about our days. Psychologists Jason Rentfrow and Samuel D. Gosling (2003) estimated that individuals in the United States spent 14% of their life listening to music in 2003. Today, people listen to music more than ever before, and music streaming services have substantially increased music accessibility for consumers across the United States.

The advent of Apple's iPod in October 2001, the founding of the first music streaming service Rhapsody in December 2001, and the launch of iTunes in 2003 transformed the industry by digitizing music access (see Appendix Figure A1 & Appendix Figure A2; Apple 2001; Evangelista 2001; Apple 2003). In 2017, the IFPI estimated that 90% of people listen to music regularly. Since then, the number of active Spotify users has grown from 160 million in Q4 2017 to 406 million in Q4 2021 (Spotify Technology, 2021). In 2019, a survey executed by the International Federation of the Phonographic Industry (IFPI) estimated that the average person spends 18 hours per week– or 2.56 hours per day– listening to music (IFPI, 2020). In 2020, that number increased to 18.4 hours per week– or 2.62 hours per day. (IFPI, 2021).

Amidst the chaos and uncertainty of the COVID-19 Pandemic, many Americans found solace and comfort in music. 8 in 10 IFPI survey respondents in January 2021 reported that "music helped with their emotional well-being during the pandemic" (IFPI 2021). 87% of respondents reported that music provided enjoyment and happiness, while 75% said that music provided them a sense of normalcy during the Pandemic (IFPI 2021). The survey's testimony of music's positive impact on well-being leads to questions about how attributes of popular music

changed during this time. Specifically, when consumers were looking for comfort in March 2020, when the U.S. unemployment rate skyrocketed from 4.4% to 14.7% (FRED 2022), what music were they drawn to?

When thinking of popular music during the original 2020 lockdowns, many think of earworm songs– i.e., Doja Cat's "Say So," Drake's "Toosie Slide," Meghan Thee Stallion and Beyoncé's "Savage Remix," and The Weeknd's "Blinding Lights"– that flooded many TikTok users' feeds and the Billboard Hot 100 charts (Yglesias, 2020). Others think of popular albums released around this time, such as Taylor Swift's *folklore,* Dua Lipa's *Future Nostalgia,* and The Weeknd's *After Hours* (Billboard Staff, 2020). While the latter two were recorded and released prior to the emotional and economic hardship felt worldwide in March 2020, Swift and her collaborators wrote, recorded, and released *folklore* during the first wave of nationwide lockdowns. *folklore* was heralded by critics and fans alike for its "soothing, soppy, pensive" lyrics, with– as New York Times music critic Jon Caramanica noted– only one song on the album that sounds hopeful (Caramanica, 2021). The album was number 1 on the Billboard 200 album chart for six straight weeks and went on to win Album of the Year at the 63rd GRAMMY Awards (Sisario, 2020).

Was the misery and reflection in *folklore*'s lyrics what contributed to its allure for music consumers and the Recording Academy alike? Or perhaps the album's many instrumentals, slower tempo, and low energy? Are song characteristics of popular music correlated with economic prosperity and hardship? In other times of economic hardship and recession, are consumers also drawn to miserable song lyrics with low happiness levels? These are the question this paper seeks to answer on a broader scale, beyond just that of the 2020 COVID-19 pandemic.

This paper seeks to gain a greater understanding of the relationship between the misery of the U.S. economy and the attributes of popular music. I propose a 'music misery index' that can help us generate a real-time understanding of nationwide consumer misery using top chart data. Using recently available metrics on musical attributes and economist Arthur Okun's Economic Discomfort Index, I show that economic misery is positively and negatively correlated with various statistics of hit songs through a series of twelve regressions for song attribute variables: acousticness, danceability, duration, energy, instrumentalness, key, liveness, loudness, mode, speechiness, tempo, and valence. I also conduct a second set of analyses that splits the dataset into two groups of Hot 100 songs before and after 1990. I conduct two robustness checks to verify the results using monthly and yearly averages of the Billboard Hot 100 song attributes.

I find that during times of greater economic misery, consumers are more likely to listen to longer, quieter, slower, and happier songs that have a minor modality, higher levels of danceability, and lower levels of speechiness, liveness, and acousticness. This paper's analysis demonstrates how people seek comfort in music during economic uncertainty– a sentiment consistent with prior literature (see Qiu et al. 2021; Pettijohn & Sacco 2009B; Pettijohn, Eastman, & Richard 2012; IFPI 2020).

Finally, based on these findings, I propose a 'music misery index' calculated by dividing the statistically significant variables by their respective coefficients from the regression results. Music misery has a positive correlation of 0.606 with Okun's economic misery index– as portrayed in Figure 1. This paper argues that a music misery index provides a real-time pulse of consumer opinion on the U.S. economy– something that Okun's economic misery index fails to do with a three-month lag in data availability.

The paper is organized as follows. Section II provides an overview of current literature determining music's impact on the psyche, exploring the relationship between music and the socioeconomic state of the U.S., and utilizing Spotify API data. Section III describes the datasets I use in my analyses. Section IV outlines the empirical strategy, presents the results, explains the results, and discusses robustness checks. In Section V, I propose a music misery index based on the findings presented in Section IV. Finally, section VI concludes the paper.

Figure 1: Music Misery & Economic Misery Correlation

Sources: Miller 2021; FRED Unemployment Rate 2022; FRED Consumer Price Index 2022

II. Literature

Economists, music industry professionals, and music lovers alike have been examining trends in popular music tastes and trends for decades. The Billboard Hot 100 is the standard chart used across the music industry and popular culture for determining the top songs in the United States. Billboard Publications Inc. publishes The Hot 100 chart every week. Song rankings are determined by physical music sales, digital music sales, audience impressions via radio airplay, and streams from music streaming services (Billboard, 2022). The release of the first Billboard Hot 100 chart in August 1958 gave way to accessible, objective data.

The Hot 100 chart matters not only because it provides valuable popularity information to executives in the music industry but also because it provides an insight into the music preferences of the United States to economists. Rentfrow and Gosling (2003) determined through analysis of two clusters of college students and 500 individuals across the U.S. that an individual's music preferences are influenced by a person's personality, self-view, emotional state, and cognitive ability. While personality and cognitive ability tend to be consistent throughout a lifetime, an individual's emotional state and self-view can vary daily depending on external influence. Since the economic, social, and political environment can significantly impact an individual's emotions and well-being (Dolan, Peasgood, & White, 2008), we can deduce that the economic, social, and political environment can lead to changes in music preferences across the United States.

Several studies have analyzed the relationship between popular songs' lyrical themes and socioeconomic conditions in the United States and globally, demonstrating that lyrical themes and trends within top songs may be associated with the socioeconomic conditions at a given time. For example, Qiu, Chan, Ito, and Sam (2021) analyzed the relationship between unemployment and

the lyrical content of the top 10 songs on the Billboard Charts in Germany and the United States between 1980 and 2017. They found that high unemployment rates in both countries were associated with higher levels of anger within each country's top 10 songs but were not associated with lyrical feelings of anxiety or sadness (Qiu et al., 2021).

Similarly, Pettijohn has demonstrated in a series of studies that analyzed the relationship between the lyrical content of the No. 1 songs in the United States and a General Hard Times Measure. Pettijohn has found that meaningful themes are more prevalent in the top No. 1 songs during socioeconomic hardship, while lyrical themes and elements related to fun and leisure are more prevalent during positive socioeconomic periods (Eastman & Pettijohn, 2019; Pettijohn & Sacco, 2009A).

Pettijohn and Sacco (2009B) surveyed 49 undergraduate students on the lyrical moods and content of the number 1 songs from 1955 to 2003. These student "raters" indicated the extent to which the top songs were romantic, were comforting, had a slow pace, and explored meaningful issues. They then analyzed these listener ratings of top-charting songs in the United States from 1955 to 2003 and related these ratings to the General Hard Times Measure- a standardized, global measure based upon the United States unemployment rate, change in CPI, change in disposable income, death rate, birth rate, marriage rate, divorce rate, suicide rate, and homicide rate. High GHTM values indicate more difficult socioeconomic times, while low GHTM values indicate easier, more positive socioeconomic times. They found that times of high GHTM values were significantly correlated with songs with meaningful themes, longer songs, more comforting songs, and slower songs (Pettijohn & Sacco, 2009B).

Pettijohn and Sacco (2009A) conducted a thematic lyrical assessment of the Billboard No. 1 songs in the United States for each year from 1955 to 2003 using the Linguistic Inquiry and

Word Count (LIWC) software package. They found that in more difficult GHTM times, the lyrical content of popular songs included more first-, second-, and third-person pronouns, referenced sports more often and discussed social processes– i.e., friendship and talking– more frequently (Pettijohn & Sacco, 2009A).

A similar study by Pettijohn, Williams, and Carter (2010) explored the musical preferences of 198 undergraduate college students during each of the four seasons, the corresponding moods associated with those seasons, and their respective weather patterns. After thinking about the fall and winter seasons, students preferred reflective and complex music, while students preferred energetic and rhythmic music after thinking about the spring and summer seasons (Pettijohn, Williams, & Carter, 2010). College students prefer blues, jazz, classical, and folk music during the fall and winter months, while they prefer rap/hip-hop, soul/funk, and electronica/dance music during the summer months (Pettijohn, Williams, & Carter, 2010). College students prefer pop, country, religious, and soundtrack music across all seasons (Pettijohn, Williams, & Carter, 2010).

Studies have found popular songs' musical characteristics to vary according to the song's genre. Pettijohn, Eastman, and Richard (2012) conducted a quantitative musical analysis of the No. 1 pop genre songs on the Billboard Charts from 1955 to 2008 and found that No. 1 pop songs with fewer beats per minute and songs with sharp and flat keys were most popular during difficult times on the GHTM scale while more upbeat songs in standard keys were most popular in relatively good times on the GHTM scale (Pettijohn, Eastman, & Richard, 2012).

Similarly, Eastman and Pettijohn (2019) conducted a quantitative analysis of the No. 1 R&B/Hip-Hop songs on the Billboard Charts from 1946 to 2010 and found that slower and longer No. 1 R&B/Hip-Hop songs are more prevalent during difficult socioeconomic times (Eastman & Pettijohn, 2019). Contrarily, Eastman and Pettijohn (2015) analyzed the No. 1 country genre

songs on the Billboard Charts from 1946 to 2008 and found that slower and sadder No. 1 country songs were more prevalent during relatively good socioeconomic times on the GHTM scale– the exact opposite result of the analysis of pop genre songs (Eastman & Pettijohn, 2015). The authors attribute these contrasting results to the different target audiences of pop and country music. Across both pop and country music, though, songs by more mature artists are more prevalent during difficult socioeconomic times (Eastman & Pettijohn 2015; Pettijohn & Sacci 2009B).

While much of the research discussed above utilizes lyrical analysis programs, tempo analysis programs, and survey data, a new and more precise source of data is transforming the field of music analysis. In 2014, Spotify acquired The Echo Nest– a company that specialized in sharing music intelligence and data with developers and media companies through its online database– and revamped the service to become Spotify API (Constine, 2014; The Echo Nest, 2014; Pérez, 2014). Today, Spotify API allows developers and data scientists alike to conduct track, artist, album, and playlist analyses with various song characteristic variables.

Suh (2019) utilized Spotify API data to estimate the effects of song attributes on the success of tracks on the Top 200 Chart on Spotify in the United States, Norway, Taiwan, Ecuador, and Costa Rica from 2017 to 2018. Yeung (2020) utilized Spotify API data to determine whether the Covid-19 Pandemic triggered nostalgia in music consumption (Yeung 2020). In addition, Ferwerda and Graus (2018) utilized Spotify API data from individual undergraduate study participants' music listening history to determine the relationship between music listening habits and personality traits (Ferwerda & Graus, 2018).

Current literature explores the relationship between song attributes and the economy by conducting lyrical analyses, looking at beats-per-minute, and surveying study participants on their opinions of songs' happiness. As discussed earlier, the lyrical analysis done by Qiu et al. (2021)

was limited to only the top 10 songs between 1980 and 2017. Pettijohn, Eastman, and Richard's (2012) quantitative analysis were limited to the beats-per-minute and keys of the No. 1 songs from 1955 to 2008. Pettijohn and Sacco's (2009B) survey of song mood was limited to only 49 undergraduates and only looked at the No. 1 songs from 1955 to 2003. Because of the limitations of sample sizes of songs, survey participants, and song characteristic variables, these studies do not allow for much generalizability.

While previous literature has focused on only No. 1 songs on the Billboard Hot 100, this paper analyzes the Spotify API data for every song that has ever been on the Billboard Hot 100 weekly chart to ensure generalizability across the United States, across genres, across decades, and throughout all popular music. Spotify API data provides a unique opportunity to expand upon and further generalize the analysis of the relationship between popular song characteristics and the social, political, and economic atmosphere at a given time. Since The Echo Nest's technology generates Spotify API song attributes, attribute values (i.e., valence/happiness, acousticness, instrumentalness) are standardized across all songs rather than up to the interpretation of study participants as in previous literature. This paper builds upon current literature using a new, standardized, and expansive dataset to determine and explain the relationship between popular music and the state of the U.S. economy.

III. Data

The purpose of this analysis is to gain a greater understanding of how American consumer taste in popular music differs during 'good' times– with relatively high economic, social, and political prosperity– versus 'bad' times– when morale is low and economic, social, and political atmosphere is relatively worse. Put simply, how does the social, political, and economic atmosphere of the United States impact consumer taste in popular music and the characteristics of top songs on the Billboard Hot 100?

I utilize data derived from Spotify's Developer Application Programming Interface (API)– a service that allows data scientists to fetch data from Spotify's music catalog, artist portfolio, user playlists, and tracks. Spotify API provides insight into a track's audio features across 12 variables: acousticness, danceability, duration, energy, instrumentalness, key, liveness, loudness, mode, speechiness, tempo, and valence. Detailed explanations for each of these 12 song attributes are available in Table 1. Given the ambiguity of the song attribute values and what separates high from low danceability, for example, Appendix Table A1 provides examples of songs with low, moderate, and high values of each numeric variable to contextualize these attributes.

I utilize two datasets compiled and published by data scientist Sean Miller.[1]. The first dataset includes every song on the Billboard Hot 100 on a weekly basis from the beginning of the chart in August 1958 until May 2021. The second dataset includes the Spotify API song characteristic statistics for every song in the Billboard Hot 100 charts available in Spotify's library. Appendix Table A2 outlines the variables in the Billboard Hot 100 dataset and their explanations.

[1] Sean Miller is a Lead Business Intelligence Developer and professional Data Scientist at the healthcare company Cerner. He web-scraped data from Billboard's Hot 100 charts and Spotify API to create two of the datasets utilized in this analysis.

Table 1: Definitions of Spotify API Audio Attributes

Variable	***Scale***	***Definition***
Acousticness	0 to 1	A confidence measure from 0 to 1 of whether the track is acoustic.
Danceability	0 to 1	How suitable a track is for dancing. Calculated using tempo, rhythm stability, beat strength, and overall regularity.
Duration (ms)	–	The duration of the track in milliseconds.
Energy	0 to 1	A perceptual measure of intensity and activity in a track calculated using the dynamic range, perceived loudness, timbre, onset rate, and general entropy.
Instrumentalness	0 to 1	Predicts whether a track contains no vocals. "Ooh" and "aah" sounds are treated as instrumental in this context. Rap or spoken word tracks are clearly "vocal."
Key	–1 to 11	Integers map to pitches using standard Pitch Class notation. E.g., 0 = C, 1 = C♯/D♭, 2 = D, and so on.
Liveness	0 to 1	Indicates the probability a track was performed live.
Loudness (dB)	–60 to 0	The overall average loudness of a track in decibels (dB).
Mode	0 or 1	Indicates the modality (major or minor) of a track, the type of scale from which its melodic content is derived. Major is represented by 1, and minor is 0.
Speechiness	0 to 1	Detects the presence of spoken words in a track. The more exclusively speech-like the recording, the closer to 1 the value.
Tempo (bpm)	–	The speed or pace of a given piece in beats per minute(bpm). Derived directly from the average beat duration.
Valence	0 to 1	Describes the musical positiveness conveyed by a track. High valence sounds more positive (e.g., happy, cheerful, euphoric). Low valence sounds more negative (e.g., sad, depressed, angry).

Note: Descriptions for audio feature variables were obtained from Spotify for Developers API website on the *"Get Tracks' Audio Features"* webpage. (https://developer.spotify.com/documentation/web-api/reference/#/operations/get-several-audio-features)

Data Source: Sean Miller, "Billboard Hot Weekly Charts - Dataset by KCMillerSean," Data.World, last modified June 2021, https://data.world/kcmillersean/billboard-hot-100-1958-2017.

Since both datasets include a SongID variable– a concatenation of song name and artist– I combined the two datasets to add the Spotify API song data to every row on the Billboard Hot 100 charts. Some songs are not in Spotify's catalog due to publishing and/or licensing rights, thus leading to missing song attribute values for these songs. Since it is imperative for this analysis that all songs in the dataset include song attribute data, I removed the rows in the combined dataset that were missing values for any of the Spotify API variables.

As an indicator of the social, political, and economic atmosphere in the United States, I utilize economist Arthur Okun's[2] Economic Discomfort Index (EDI) as a misery index to understand the state of the U.S. economy at the time of a song's popularity on the Billboard Hot 100 charts. Okun's EDI is a rough and ready estimate of misery in the United States, providing a reasonable approximation of how the economy impacts consumers (Lovell, 2000).

The misery index is calculated by adding the annual inflation rate and the seasonally adjusted unemployment rate. This data is acquired from the United States Department of Labor and the U.S. Bureau of Labor Statistics (BLS). To calculate inflation, we use the Consumer Price Index (CPI). The data from both government entities is published for public data use on the St. Louis Federal Reserve Bank's Federal Reserve Economic Database (FRED). The misery index utilizes the FRED's seasonally adjusted "Unemployment Rate (UNRATE)" and "Consumer Price Index for All Urban Consumers: All Items in U.S. City Average" datasets. Figure 2 shows the economic misery index over time from August 1958 to May 2021, while Figure 3 breaks down the index by Unemployment and Inflation.

[2] Arthur Okun was an American economist who served as the Chairman of the Council of Economic Advisors for President Lyndon B. Johnson. Prior to that role, Okun was a professor at Yale University, a fellow at the Brookings Institute, and a Fellow of the American Statistical Association. For more, see Brookings, 1980.

I created a Month-Year ID from the Billboard WeekID variable. Then, using MonthYearID as a key, I joined the misery index data with the combined Spotify and Billboard data so that each popular song had a corresponding misery index demonstrating the misery index at the week of the song's time on the chart. When accounting for Billboard Hot 100 songs not part of the Spotify catalog, the dataset was narrowed down from 301,600 to 284,200 song observations. Table 2 outlines the summary statistics for the final dataset of 284,200 hit songs from 1958 to 2021.

Table 2: Summary Statistics – All Hot 100 Songs in Sample

Variable	***n***	***Mean***	***Std. Dev.***	***Min.***	***Max.***
Acousticness	284,200	0.261	0.266	0.00000251	0.991
Danceability	284,200	0.613	0.150	0	0.988
Duration (ms)	284,200	228,850	64,898.03	29,688	3,079,157
Energy	284,200	0.631	0.194	0.0005	0.997
Instrumentalness	284,200	0.028	0.126	0	0.982
Key	284,200	5.258	3.565	0	11
Liveness	284,200	0.185	0.154	0.010	0.999
Loudness (dB)	284,200	-8.366	3.554	-28.03	2.291
Misery Index	284,200	9.613	3.410	5.06	21.98
Mode	284,200	0.717	0.451	0	1
Speechiness	284,200	0.071	0.078	0	0.951
Tempo (bpm)	284,200	120.075	27.759	0	241.009
Valence	284,200	0.600	0.236	0	0.991
Year	284,200	1990.385	17.982	1958	2021

Figure 2: United States Misery Index, 1958 to 2021

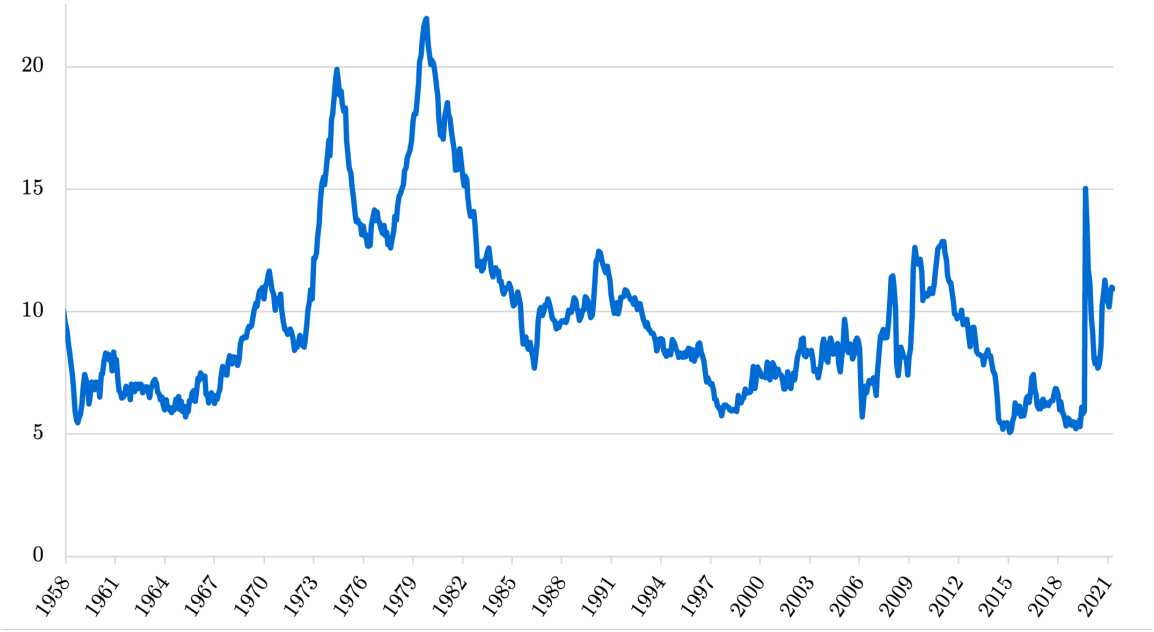
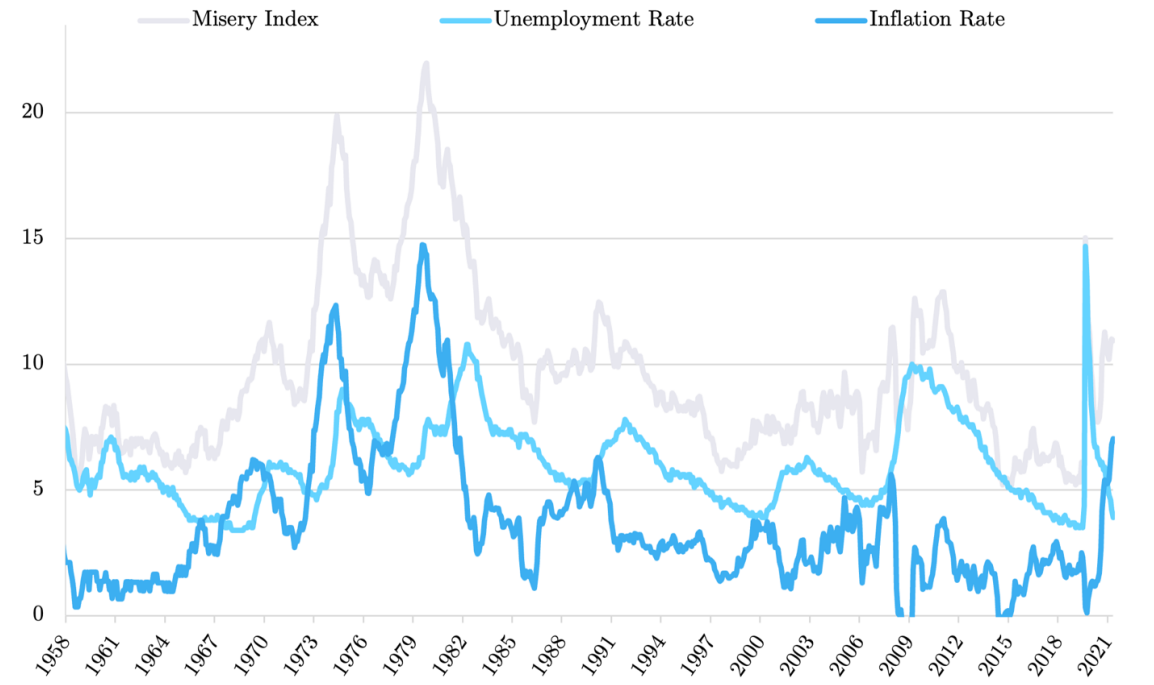


Figure 3: U.S. Unemployment, Inflation, & Misery Index, 1958 to 2021



Sources for Figures 2 & 3: FRED Federal Reserve Bank of St. Louis, "Unemployment Rate (UNRATE)," Federal Reserve Economic Data, last modified April 1, 2022, https://fred.stlouisfed.org/series/UNRATE.

FRED Federal Reserve Bank of St. Louis, "Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL)," Federal Reserve Economic Data, last modified April 12, 2022, https://fred.stlouisfed.org/series/CPIAUCSL.

The average monthly misery index from August 1958 to May 2021 is 9.613. Notably, the average misery index differs slightly with a value of 9.622 when limited to solely the 754-monthly values between August 1958 and May 2021. Since the dataset eliminated Billboard Hot 100 songs that were not in the Spotify catalog, the total observations in the dataset decreased from 301,600 entries to 284,200. The 17,400 missing rows of data likely contributed to the discrepancy between the sample average misery index and the actual average misery index from August 2, 1958, to May 29, 2021. The decrease in data also impacted the average year. While the average year would be 1989.50 had all songs been available in the Spotify library, the mean is somewhat skewed right with a value of 1990.4. An increase in the mean indicates that the songs unavailable in Spotify's music catalog were likely on the charts in the earlier years of the Hot 100's existence.

Since the mean year of my sample is 1990 and since the music industry was impacted significantly by the rise in music video popularity in the 1990s and the advents of digital music marketplaces and streaming services in the early 2000s, I conduct a second series of analyses that splits the dataset into two groups: (1) Hot 100 songs from Aug 1958 to Jan 1990 and (2) Hot 100 songs from Jan 1990 to May 2021.

Table 3 presents the summary statistics for these two groups. It is essential to note the difference in sample size between the two groups, resulting from the decreased availability of songs from the early years of the Hot 100 charts. Amongst the two groups, the greatest differences in means are for the variables acousticness, energy, and speechiness. These differences can be attributed to the rise in popularity of rap, R&B, and hip-hop genres in music after the 1990s– genres known for rhyming and rhythmic speech (Eastman & Pettijohn 2019).

Table 3: Summary Statistics – Billboard Hot 100 Songs by Timeframe

Variable	*Timeframe*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
Acousticness	1958-1990	0.365	0.289	0.00000567	0.991
	1990-2021	0.164	0.199	0.00000251	0.987
Danceability	1958-1990	0.580	0.151	0	0.988
	1990-2021	0.644	0.142	0.113	0.986
Duration (ms)	1958-1990	217,515.9	73,400.13	61,306	1,561,133
	1990-2021	239,423.5	53,695.74	29,688	3,079,157
Energy	1958-1990	0.580	0.205	0.000581	0.995
	1990-2021	0.679	0.170	0.022	0.997
Instrumentalness	1958-1990	0.044	0.158	0	0.982
	1990-2021	0.014	0.083	0	0.982
Key	1958-1990	5.188	3.552	0	11
	1990-2021	5.325	3.577	0	11
Liveness	1958-1990	0.193	0.167	0.00967	0.999
	1990-2021	0.178	0.140	0.13	0.991
Loudness (dB)	1958-1990	-10.240	3.444	-28.03	2.291
	1990-2021	-6.618	2.649	-23.023	0.175
Misery Index	1958-1990	9.686	3.447	5.06	21.98
	1990-2021	9.545	3.375	5.06	21.98
Mode	1958-1990	0.767	0.422	0	1
	1990-2021	0.669	0.470	0	1
Speechiness	1958-1990	0.049	0.044	0	0.924
	1990-2021	0.912	0.096	0.022	0.951
Tempo (bpm)	1958-1990	119.930	26.639	0	241.009
	1990-2021	120.209	28.765	36.71	213.737
Valence	1958-1990	0.663	0.232	0	0.991
	1990-2021	0.542	0.224	0.035	0.981
Year	1958-1990	1974.233	9.010	1958	1989
	1990-2021	2005.452	8.879	1990	2021

137,166 observations for years 1958-1990 | 147,034 observations for years 1990-2021

IV. Analysis

To understand the impact that the current economy has on consumer preferences in popular music, I estimate 12 regressions of the following form:

$$SongChar_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$$

where $SongChar_{i,t}$ is the song characteristic dependent variable for each song i at timeframe t, and $Misery_t$ is the independent variable– the economic misery index– for each monthly timeframe t. The 12 frames of song characteristics that serve as the dependent variable are acousticness, danceability, duration, energy, instrumentalness, key, liveness, loudness, mode, speechiness, tempo, and valence. The 12 regressions are thus:

(1) $Acousticness_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(2) $Danceability_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(3) $Duration_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(4) $Energy_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(5) $Instrumentalness_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(6) $Key_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(7) $Liveness_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(8) $Loudness_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(9) $Mode_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(10) $Speechiness_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(11) $Tempo_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

(12) $Valence_{i,t} = \alpha + \beta_1 Misery_t + \varepsilon_{i,t}$

The regression results are outlined in Table 4 below. Since most of the song attributes have an arbitrary scale of 0.0 to 1.0 (see Table 1), I will be primarily focusing on the sign change of the song attributes to understand how consumer taste in popular music changes as economic misery increases.

Table 4: Regression Results by Dependent Song Attribute

Variables	*Economic Misery*	*Correlation w/ Misery Index*	R^2
(1) Acousticness	–0.00138***	–0.018	0.000
	(0.000146)		
(2) Danceability	0.000696***	0.016	0.000
	(0.0000826)		
(3) Duration	885.9***	0.047	0.002
	(35.36)		
(4) Energy	0.000250**	0.004	0.000
	(0.000107)		
(5) Instrumentalness	0.000103	0.003	0.000
	(6.91e-05)		
(6) Key	–0.000701	–0.001	0.000
	(0.00196)		
(7) Liveness	–0.000182**	–0.004	0.000
	(8.46e-05)		
(8) Loudness	–0.0327***	–0.031	0.000
	(0.00195)		
(6) Mode	–0.00130***	–0.010	0.000
	(0.000248)		
(10) Speechiness	–0.000265***	–0.012	0.000
	(4.31e-05)		
(11) Tempo	–0.0476***	–0.006	0.000
	(0.0153)		
(12) Valence	0.00107***	0.015	0.000
	(0.000130)		

284,200 observations across all 12 variables
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As we can see in row 1, an increase in economic misery is associated with a decrease in the acousticness of a song. This finding is likewise statistically significant at the 1% level. An important distinction when evaluating this variable is understanding that acousticness refers to a confidence measure of whether the song is acoustic or not. For example, Justin Bieber's acoustic version of "As Long As You Love Me" has an acousticness rating of 0.798, while the original version has an acousticness rating of 0.0807. During worse economic times, people are more likely to listen to songs that are recorded acoustically. Again, it is important to note that the average acousticness rating among the sample is relatively low at 0.261 and that 238,281 songs– or 83.7%– of the sample are below the 0.1 threshold of acousticness, so the impact of economic misery on acousticness is minimal.

Row 2 indicates that an increase in economic misery is associated with an increase in song danceability. This finding is also statistically significant at the 1% level. Similarly, row 4 indicates that an increase in economic misery is associated with an increase in song energy. This finding is significant at the 5% level. People listen to music to help regulate and better their moods, often increasing moods with dancing. As a mode of regulation, people could be listening to songs with higher danceabilities and higher energy levels to help boost their moods during these times of nationwide distress. Since energy is contagious, a song like Green Day's 2009 hit 'Know Your Enemy' with its high energy level of 0.958 and moderate danceability of 0.56 could be an example of a song that can give an individual an escape from their present emotions by leading them to tap their foot and get engaged with the music instead.

Row 5 indicates that an increase in economic misery is associated with an 885.9-millisecond increase in song duration. During worse economic times, people are likely to listen to longer songs. This finding is statistically significant at the 1% level. Since people listen to music to find an

escape or comfort, it logically makes sense that individuals would choose to listen to longer songs for a longer-lasting escape from the reality of harsh economic conditions.

Row 7 indicates that an increase in economic misery is associated with a decrease in a song's liveness– or the confidence that a song was recorded live. This finding is statistically significant at the 5% level. Many songs prior to the 2000s were recorded live and published as recorded. Artists like Bruce Springsteen and the Beatles often published their music as recorded. That process is less common with improved recording abilities and the ease of post-recording sound editing using computer applications like GarageBand and Logic Pro. See Appendix Figure A9 for a greater understanding of how this result may result from time and more prosperous economic times that align with times of improved recording capabilities.

Row 8 provides the finding that an increase in economic misery is associated with a 0.0327 dB decrease in loudness. This finding is statistically significant at the 1% level. A few things could be contributing to this finding. First, we must consider the trends in song attribute variables over time. As recording equipment has improved, song quality and loudness have improved. Appendix Figure A10 conveys how loudness has changed in music over time. Simultaneously, though, perhaps quieter music is more desirable for consumers in times of high stress and economic hardship as loud music may only increase stress. As so, quieter music contributes to the desire to regulate an individual's emotions and find comfort.

Row 9 indicates that an increase in economic misery is associated with a decrease in mode amongst popular music. This finding is also significant at the 1% level. Mode indicates the modality (major or minor) of a track. Consumers are more likely to listen to tracks on a minor scale during increased economic discomfort.

Row 10 indicates that an increase in economic misery is associated with a decrease in the speechiness levels of a song. This finding is statistically significant at the 1% level. This is an interesting finding; however, it is worth noting that 238,404 songs– or 83%– of the songs in the sample have a speechiness rating of below 0.1. The change may be a decrease, but it is not a drastic shift. Regardless, during worse economic times, people turn more towards melodic music and away from songs with lots of spoken word.

Row 11 of Table 4 communicates that an increase in economic misery is associated with a decrease in song tempo. This finding is statistically significant at the 1% level. The tempo attribute records how many beats per minute a song has. People tend to listen to songs with fewer beats per minute in worse economic times. This finding also demonstrates how people seek comfort from music during economic discomfort. Slower songs likely are more attractive to seek calmness than their high tempo counterparts, which could raise heart rate and increase stress.

Lastly, row 12 indicates that an increase in economic misery is associated with a positive increase in song valence. Valence is an attribute that records the happiness level of a song. This finding is statistically significant at the 1% level. Essentially, during worse economic times, people listen to happier music. As we discussed earlier, music helps individuals regulate their moods. Therefore, people may prefer to listen to happier music during worse economic times as it helps them improve their mood.

Notably, the R-squared value for each regression analysis– except for duration's R-squared value of 0.002– is 0.000. Logically, this makes sense since the audio characteristics of 284,200 popular songs are not explanatory variables giving reason as to why the United States unemployment rate is high or why the inflation is increasing.

The second column of Table 2 communicates the correlation coefficient between each song attribute and the economic misery index. This column will be discussed in greater detail in the next section while discussing the music misery index.

As a robustness check, I created a monthly average dataset and a yearly average dataset that averaged the variables of the 284,200 songs that charted each month and each year from August 1958 to May 2021. The summary statistics for these monthly-average and yearly-average datasets are available in Appendix Table A3 and Appendix Table A4, respectively. Appendix Table A5 presents the regression results for the monthly-average dataset. Appendix Table A6 presents the regression results for the yearly-averaged dataset. When conducting the same regression analyses with the monthly and yearly averages, the signs and statistical significance determined by the regression results remain the same across the duration, danceability, loudness, mode, speechiness, acousticness, liveness, valence, and tempo. The only variable that loses statistical significance when utilizing the monthly and yearly averaged data for the regression analysis is energy, which was one of the variables to be less statistically significant than the other variables at the 5% level.

V. Music Misery Index

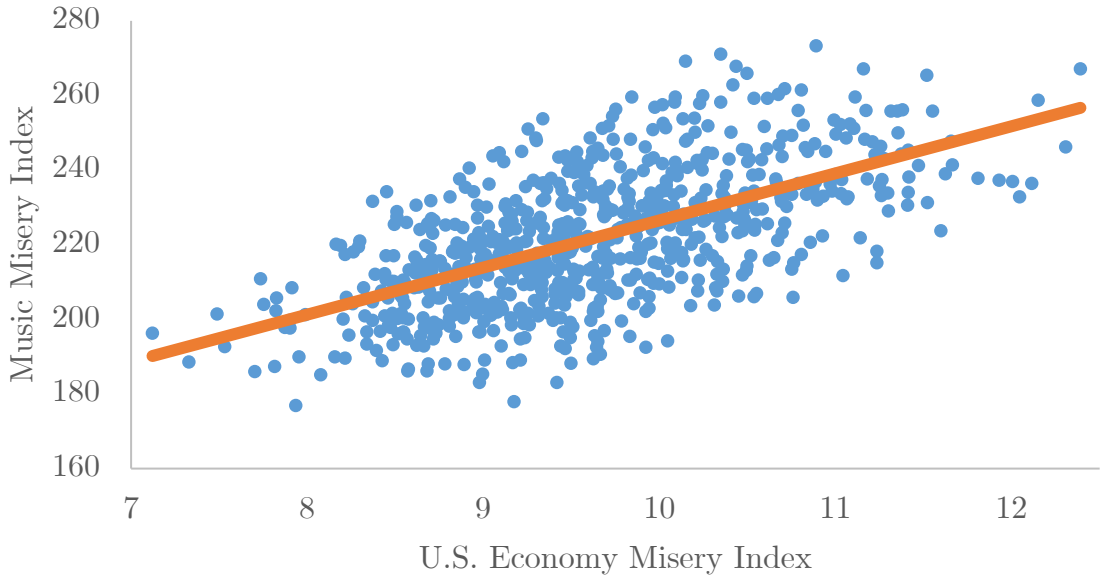
The final part of my analysis builds upon the first twelve regressions I conducted. Using the statistically significant variables, I propose a music misery index variable by dividing the values for each of the statistically significant variables–acousticness, danceability, duration, energy, liveness, loudness, mode, speechiness, tempo, and valence– by their respective coefficients listed in the regression results in Table 2. The exact equation for this music misery is below:

$$musicMisery = \frac{acousticness}{-0.00138} + \frac{danceability}{0.0000826} + \frac{duration}{885.9} + \frac{energy}{0.000250} + \frac{liveness}{-0.000182} + \frac{loudness}{-0.0327} + \frac{mode}{-0.00130} + \frac{speechiness}{-0.000265} + \frac{tempo}{-0.0476} + \frac{valence}{0.00107}$$

My proposed music misery index is important as it provides insight into how we can utilize music data going forward to understand the relationship between consumer taste in popular music and the world's economic state. To visualize the relationship between the music misery index and the economic misery index, see Figure 4. The resulting correlation coefficient between these two indexes is 0.606. For a visual representation of how the music misery and economic miseries track overtime from August 1958 to May 2021, see Figure 5.

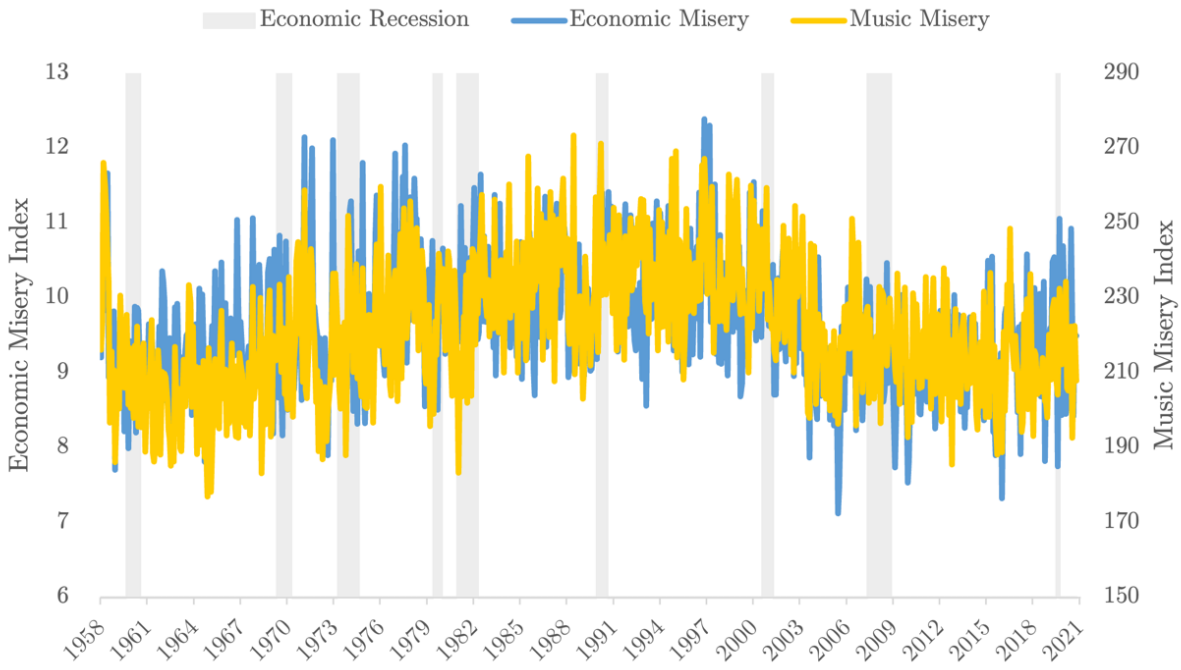
Column 2 of Table 2 presents the correlations between each of the 284,200 song's attributes and the economic misery index. The attribute with the highest correlation is duration, with a correlation coefficient of 0.047, while the other attributes have correlation coefficients that range from –0.032 to 0.020. When averaging the song attributes for all Hot 100 songs during a given month, the correlation between each attribute and the misery index increases (see Appendix Table A6). When averaging song attributes for all Hot 100 songs during a given year, the correlation

Figure 4: Music Misery & Economic Misery Correlation



Sources: Miller 2021; FRED Unemployment Rate 2022; FRED Consumer Price Index 2022

Figure 5: Music Misery & Economic Misery Tracking, from Aug 1958 to May 2021



between each attribute and the economic misery index decreases. Table 5 outlines the correlations between each attribute and the economic misery index for the entire dataset, the monthly average dataset, and the yearly average dataset.

For each year, up to 5,200 songs are in both the Billboard Hot 100 and Spotify's library. Therefore, the yearly-averaged dataset is particularly sensitive to outliers that substantially impact the average value for each song attribute. As a result, the yearly-averaged correlations are not as accurate as the monthly-average correlation. Since the economic misery index is a monthly index, the monthly correlations in column 2 of Table 5 are likely the most accurate– as some economic recessions (i.e., February to April 2020) only last a few months and not the entire year.

Table 5: Correlation with Economic Misery Index for Each Dataset Type

Variable	***Entire Dataset***	***Monthly Avg.***	***Yearly Avg.***
Acousticness	–0.018	–0.014	-0.097
Danceability	0.016	0.202	-0.028
Duration	0.047	0.342	0.384
Energy	0.004	0.045	–0.004
Instrumentalness	0.003	0.087	0.119
Key	–0.001	0.047	–0.073
Liveness	–0.004	–0.213	–0.087
Loudness (dB)	–0.031	–0.186	–0.359
Mode	–0.010	-0.210	0.100
Speechiness	–0.012	–0.170	–0.427
Tempo (bpm)	–0.006	–0.196	0.131
Valence	0.015	0.143	0.374

Table 5 demonstrates how individual song attributes are not strongly correlated with economic misery under the weekly, monthly-average, or yearly average datasets. When these individual song attributes are combined in the music misery index, though, collectively, the attributes are strongly correlated with the misery index.

As discussed in the introduction, the music industry has changed substantially since 1990 due to the popularization of music videos on MTV in the 90s and the advent of digital music marketplaces and music streaming services. As so, I conduct a fourth set of regressions that assess the impact of the economic misery index on acousticness, danceability, duration, energy, instrumentalness, key, liveness, loudness, mode, speechiness, tempo, and valence in two different time frames: (1) August 1958 to December 1990 and (2) January 1991 to May 2021. Table 6 outlines the regression results from these timeframe-grouped regressions. As outlined in Table 6, the results from the two timeframes differ in statistical significance across liveness, speechiness, tempo, and valence. In addition, the regression results differ in sign change across acousticness, energy, instrumentalness, key, loudness, and tempo. From 1990 to 2021, in times of increased economic misery, consumers were more likely to listen to happier, quieter, longer, slower, less-energetic songs in the minor modality that had higher levels of acousticness, danceability, instrumentalness and lower levels of speechiness. Contrarily, in times of increased economic misery from 1958 to 1989, consumers were more likely to listen to louder, longer, more-energetic songs in the major modality that had lower instrumentalness, liveness, and acousticness higher levels of danceability. These differences in popular music tastes among the two timeframes could be due to several reasons. First, music attributes, in general, have changed over the years due to changes in consumer taste, improvements in technology, and overall evolvement in the music industry.

Table 6: Regression Results by Dependent Attribute & Before/After 1990

Variables	*1958 - 1990* *Economic Misery*	R^2	*1991 - 2022* *Economic Misery*	R^2
(1) Acousticness	–0.00438***	0.003	0.000335***	0.000
	(0.000226)		(0.000154)	
(2) Danceability	0.00132***	0.001	0.000464***	0.000
	(0.000118)		(0.000110)	
(3) Duration	1,252***	0.003	651.6***	0.002
	(57.41)		(41.45)	
(4) Energy	0.00167***	0.001	–0.000538***	0.000
	(0.000160)		(0.000132)	
(5) Instrumentalness	–0.000420***	0.000	0.000433***	0.000
	(0.000124)		(0.0000642)	
(6) Key	–0.000909	0.000	0.000324	0.000
	(0.00278)		(0.00276)	
(7) Liveness	–0.000444***	0.000	–0.0000196	0.000
	(0.000131)		(0.000108)	
(8) Loudness	0.00690**	0.000	–0.0496***	0.004
	(0.00270)		(0.00204)	
(6) Mode	–0.00213***	0.000	–0.00108***	0.000
	(0.000331)		(0.000363)	
(10) Speechiness	–0.0000171	0.000	–0.000253***	0.000
	(0.0000346)		(0.0000741)	
(11) Tempo	0.0190	0.000	–0.111***	0.000
	(0.0209)		(0.0222)	
(12) Valence	0.00000807	0.000	0.00138***	0.000
	(0.000182)		(0.000173)	

137,166 total observations across all 12 variables for Panel 1: 1958-1990
147,034 total observations across all 12 variables for Panel 2: 1991-2021

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 6: Music Misery & Economic Misery Tracking, from 1958 to 1989

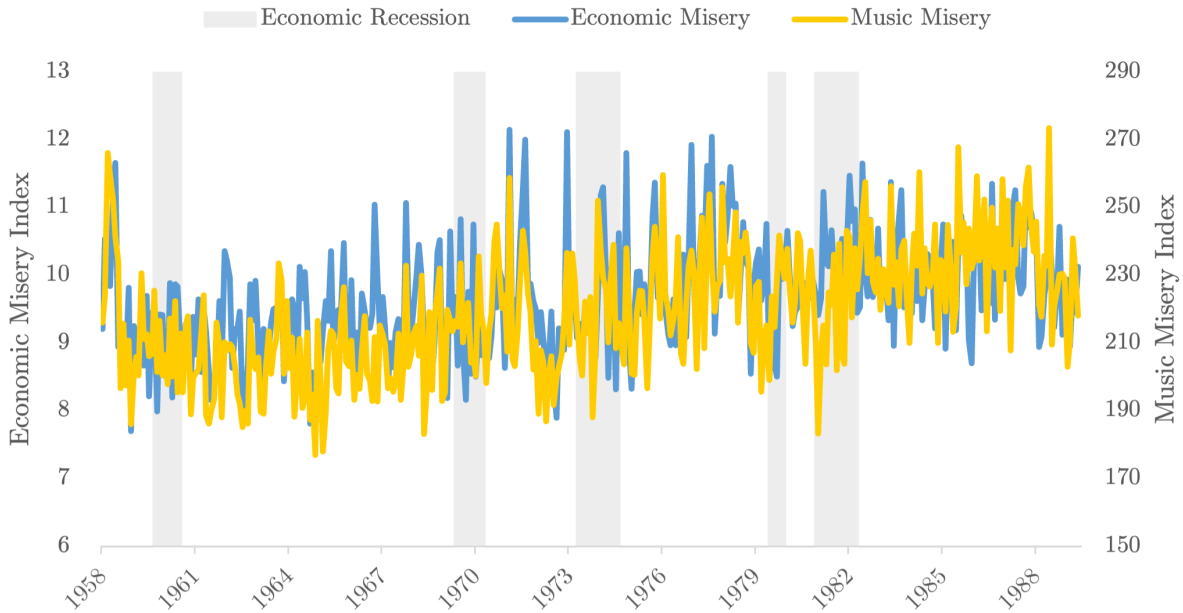


Figure 7: Music Misery & Economic Misery Tracking, from Jan 1990 to May 2021

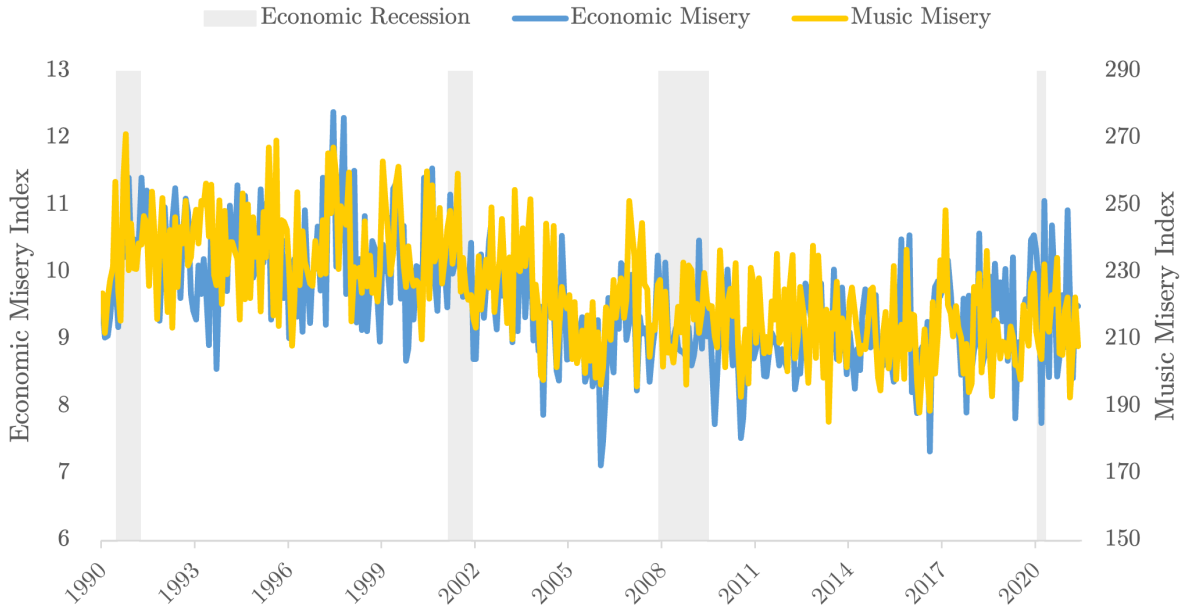
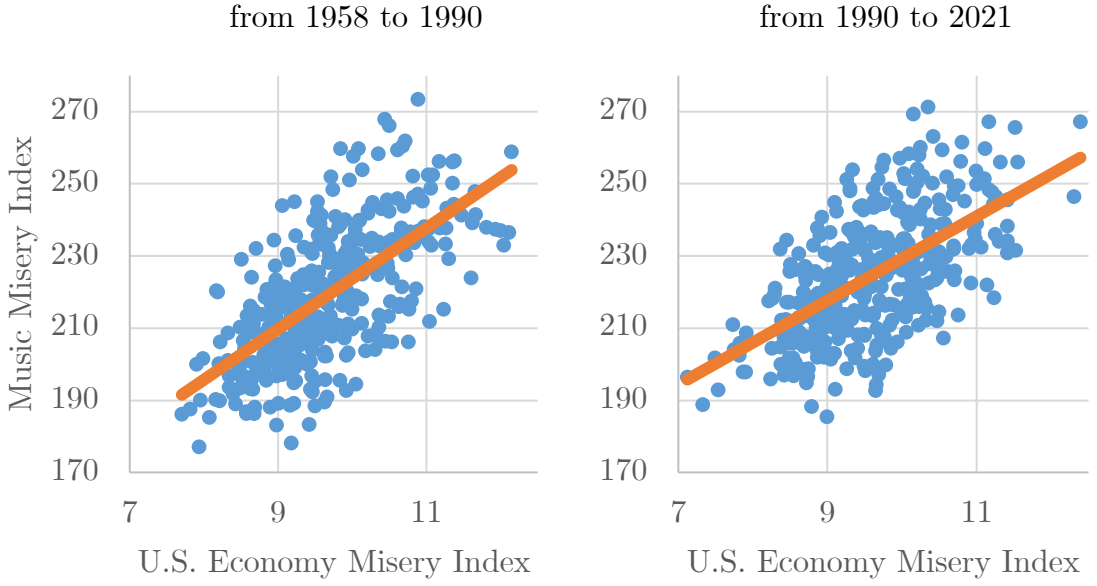


Figure 8: Music Misery & Economic Misery Correlation, from 1958 to 2021



Appendix Figures A3 through A14 portray the trends in acousticness, danceability, duration, energy, instrumentalness, key, liveness, loudness, mode, speechiness, tempo, and valence, respectively, in the Hot 100 chart from August 1958 to May 2021. Figures A6, A10, and A12 portray increasing trends in energy, loudness, and speechiness over time, while Appendix Figures A3, A7, and A14 portray a decrease in acousticness, instrumentalness, and valence over time. Figures A4, A8, A9, and A13 portray how danceability, key, liveness, and tempo have remained relatively constant in popular music on the Hot 100 charts since 1958.

Another reason for these discrepancies could be due to the differences in economic misery over each period. As seen in Figure 6 and Figure 7, there were more years of economic recession from 1958 to 1990 than from 1990 to 2021. While there were five recessions lasting a total of 64 months in the U.S. between 1958 and 1990, there were only four recessions lasting 40 months after 1990 until May 2021. The first timeframe experienced two additional years of economic recession than the second timeframe after 1990. Simultaneously, looking at Figure 6, we can see an upward

trend in both economic misery and music misery prior to 1990, while Figure 7 demonstrates a downward trend in both economic misery and music misery. These metrics, along with the trends in musical attributes over the years, likely explain the discrepancies in the impact of economic misery on song attributes over the years. Figure 8 portrays the correlation between music misery and economic misery amongst these timeframes. From 1958 to 1990, the correlation between the two misery indices is 0.647. From 1990 to 2021, the correlation between the two misery indices is 0.597. Across both periods, the correlation is 0.606.

As previously discussed in this paper, research has established that the economic, social, and political environment negatively impacts our moods and people regulate their moods using music (Dolan, Peasgood, & White, 2008; Rentfrow & Gosling 2003). Since 90% of the U.S. population listens to music regularly (IFPI 2017) and since 80% of that music listening takes place on streaming services (RIAA 2022) that offer users on-demand song choices, the Billboard Hot 100 chart communicates accurate data about what type of music people are gravitating towards every week. Assuming that previous literature is correct in establishing that an individual's music preferences are not only a factor of that person's stagnant personality, self-view, and cognitive ability but also a person's ever-changing emotional state, songs on the Billboard Hot 100 chart can provide insight into the emotional state of the general U.S. population. Furthermore, by attributing a music misery index to each song using Spotify API's song attribute values, we can gain a pulse on consumer confidence in the socioeconomic state of the U.S.

A problem economists face today is the issue of a lack of real-time data due to the 3-month lag in CPI data availability and the month-long lag in unemployment data availability. By utilizing this new music misery index, policymakers and the economists have access to an almost real-time metric provided by the public data from Billboard's weekly Hot 100 chart and Spotify's

powerful Web API song attribute data. While utilizing music data may not be a perfect metric to obtain a real-time understanding of consumer opinion of the state of the U.S. economy, it at least provides some insight into consumer confidence in the U.S. economy by assessing and utilizing data on listening habits and popular music habits music across the nation. Overall, this music misery index fills in the gap of a significant data problem we face in the U.S. today and offers a rough and ready estimate of how consumers are feeling at any given moment.

VI. Conclusion

This paper seeks to understand the relationship between the attributes of popular songs on the Billboard Hot 100 and the country's economic state at the time of those songs' appearances on the chart. By conducting a series of linear regressions with the economic misery index serving as the independent variable, this paper estimates the impact of an increase in economic misery. Increased economic misery is associated with increases in song duration, danceability, energy, instrumentalness, and valence and decreases in song key, loudness, mode, speechiness, acousticness, liveness, and tempo. In other words, during times of greater economic misery, American music consumers are likely to listen to longer, quieter, slower, and happier songs with a minor modality, higher levels of danceability, and lower levels of speechiness, liveness, and acousticness. This paper's analysis indicates that people tend to seek comfort through music during times of economic uncertainty.

Previous research has established that economic stress negatively impacts our moods and that people regulate their moods using music (Dolan, Peasgood, & White, 2008; Rentfrow & Gosling 2003). My analysis demonstrates how Americans' listening habits alter depending on the state of the U.S. economy. The findings in this paper are consistent with prior research done by Pettijohn and Sacco in their 2009 paper "Tough Times, Meaningful Music, Mature Performers: Popular Billboard Songs and Performer Preferences across Social and Economic Conditions in the USA." These results are also consistent with Qiu, Chan, Ito, and Sam's 2021 paper "Unemployment Rate Predicts Anger in Popular Music Lyrics: Evidence from Top 10 Songs in the United States and Germany from 1980 to 2017" and with survey research published by the

International Federation of the Phonographic Industry in their 2021 report "Engaging with Music 2021."

Based on these findings and regression results, I propose a new music misery index that can be used to provide a real-time pulse or index of consumer opinion on the U.S. economy. The music misery index is generated by dividing each statistically significant attribute by its corresponding regression coefficient and adding each resulting product. From August 1958 to May 2021, the music misery index has a correlation of 0.606 with Arthur Okun's Economic Discomfort Index. My proposed music misery index has the potential to provide a real-time pulse of consumer confidence in the U.S. economy at any given week by utilizing the Billboard Hot 100 weekly chart and Spotify's API database.

There is much room for future opportunities to expand upon this analysis, including utilizing Spotify's Daily Top Charts or Apple Music's Daily Top 100 charts for an even more real-time understanding of consumer confidence in the U.S. economy as that playlist is updated daily. In addition, research can be done to apply this metric to other countries that have significant portions of their populations that listen to music regularly. Further, a more in-depth misery index could be utilized to replace Okun's Economic Discomfort Index. While Okun's index provides a reasonable, rough estimate of the state of the U.S. economy, it does not directly account for the political or social upheaval that could likewise bring great stress upon the U.S. population. A more detailed misery index could be a great opportunity to expand upon the findings of this paper.

In summary, this paper broadens the understanding of how consumer taste in popular music and how song attributes of popular songs alter depending on the socioeconomic state of the U.S. The results support previous literature's assertion that people seek comfort in music during times of increased economic hardship. My proposed music misery index can be utilized in the

future to build upon previous literature and the findings presented in this paper to apply the research to practical use as it can provide a pulse of the state of consumer confidence in the U.S. economy at any given moment.

VII. References

Apple Newsroom. "Apple Launches the iTunes Music Store." News release. April 28, 2003. https://www.apple.com/newsroom/2003/04/28Apple-Launches-the-iTunes-Music-Store/.

———. "Apple Presents iPod." News release. October 23, 2001. https://www.apple.com/newsroom/2001/10/23Apple-Presents-iPod/.

Billboard Media. "The Hot 100." Billboard. Last modified February 19, 2022. https://www.billboard.com/charts/hot-100/.

Billboard Staff. "The 50 Best Albums of 2020: Staff Picks." Billboard. Last modified December 7, 2020. https://www.billboard.com/media/lists/best-albums-2020-top-50-9494859/.

Brookings. "Arthur Okun (1928-1980)." Brookings. Last modified January 1980. https://www.brookings.edu/wp-content/uploads/1980/01/1980a_bpea_gordon_hall.pdf.

Caramanica, Jon. "Taylor Swift, a Pop Star Done With Pop." *The New York Times* (New York, NY), July 26, 2021. https://www.nytimes.com/2020/07/26/arts/music/taylor-swift-folklore-review.html?smid=url-share.

Constine, Josh. "Inside the Spotify – Echo Nest Skunkworks." TechCrunch. Last modified October 19, 2014. https://techcrunch.com/2014/10/19/the-sonic-mad-scientists/.

Data.World. "About Us." https://data.world/company/about-us/. Last modified April 3, 2022. https://data.world/company/about-us/.

Dolan, Paul, Tessa Peasgood, and Mathew White. "Do We Really Know What Makes Us Happy? A Review of the Economic Literature on the Factors Associated with Subjective Well-being." *Journal of Economic Psychology* 29, no. 1 (February 2008): 94-122. https://doi.org/10.1016/j.joep.2007.09.001.

Eastman, Jason T., and Terry F. Pettijohn. "Gone Country: An Investigation of Billboard Country Songs of the Year across Social and Economic Conditions in the United States." *Psychology of Popular Media Culture* 4, no. 2 (April 2015): 155-71. https://doi.org/10.1037/ppm0000019.

———. "Good Times and Endless Love: Billboard R&B/Hip Hop Songs of the Year across Social and Economic Conditions." *Psychology of Popular Media Culture* 8, no. 3 (July 2019): 243-50. http://dx.doi.org/10.1037/ppm0000176.

The Echo Nest. "The Echo Nest Joins Spotify!" *The Echo Nest Blog*. Entry posted March 6, 2014. https://blog.echonest.com/post/78749300941/the-echo-nest-joins-spotify.

Evangelista, Betty. "Music Firms Open Online Services, but Will Fans Pay?" San Francisco Gate. Last modified December 3, 2001. http://www.sfgate.com/business/article/Music-firms-open-online-services-but-will-fans-2845907.php.

Ferwerda, Bruce, and Mark Graus. "Predicting Musical Sophistication from Music Listening Behaviors: A Preliminary Study." Cornell University: arXiv. Last modified 2018. https://doi.org/10.48550/arxiv.1808.07314.

FRED Federal Reserve Bank of St. Louis. "Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL)." Federal Reserve Economic Data. Last modified April 12, 2022. https://fred.stlouisfed.org/series/CPIAUCSL.

———. "Unemployment Rate (UNRATE)." Federal Reserve Economic Data. Last modified April 1, 2022. https://fred.stlouisfed.org/series/UNRATE.

Götting, Marie Charlotte. "Music Streaming Market Share." Statista. Last modified November 16, 2021. https://www.statista.com/statistics/653926/music-streaming-service-subscriber-share/.

IFPI: International Federation of the Phonographic Industry. "Engaging with Music 2021." IFPI: Representing the Music Industry Worldwide. Last modified October 2021. https://www.ifpi.org/wp-content/uploads/2021/10/IFPI-Engaging-with-Music-report.pdf.

———. "Music Listening 2019: A Look at How Recorded Music Is Enjoyed around the World." IFPI: Representing the Music Industry Worldwide. Last modified July 2020. https://www.ifpi.org/wp-content/uploads/2020/07/Music-Listening-2019-1.pdf.

Lovell, Michael C., and Pao-lin Tien. "Economic Discomfort and Consumer Sentiment." *Eastern Economic Journal* 26, no. 1 (2000): 1-8. http://www.jstor.org/stable/40325964.

Miller, Sean. "Billboard Hot Weekly Charts - Dataset by KCMillerSean." Data.World. Last modified June 2021. https://data.world/kcmillersean/billboard-hot-100-1958-2017.

Monroy Yglesias, Ana. "From Drake's 'Toosie Slide' To Doja Cat's 'Say So,' What TikTok Dance Have You Been Practicing During Quarantine?" Grammy Awards. Last modified May 14, 2020. https://www.grammy.com/news/drakes-toosie-slide-doja-cats-say-so-what-tiktok-dance-have-you-been-practicing-during.

National Bureau of Economic Research (NBER). "U.S. Business Cycle Expansions and Contractions." NBER: National Bureau of Economic Research. Last modified July 19, 2021. https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions.

Pérez, José M. "Say Hello to Our New Web API." *Spotify for Developers: Community Announcements* (blog). Entry posted June 14, 2014. https://developer.spotify.com/community/news/2014/06/17/say-hello-new-web-api/.

Pettijohn, Terry F., and Donald F. Sacco (2009A). "The Language of Lyrics." *Journal of Language and Social Psychology* 28, no. 3 (May 13, 2009): 297-311. https://doi.org/10.1177/0261927X09335259.

Pettijohn, Terry F., and Donald F. Sacco (2009B). "Tough Times, Meaningful Music, Mature Performers: Popular Billboard Songs and Performer Preferences across Social and Economic Conditions in the USA." *Psychology of Music* 37, no. 2 (April 2009): 155-79. https://doi.org/10.1177/0305735608094512.

Pettijohn, Terry F., Jason T. Eastman, and Keith G. Richard. "And the Beat Goes On: Popular Billboard Song Beats per Minute and Key Signatures Vary with Social and Economic Conditions." *Current Psychology* 31, no. 3 (July 25, 2012): 313-17. https://doi.org/10.1007/s12144-012-9149-y.

Pettijohn, Terry F., Greg M. Williams, and Tiffany C. Carter. "Music for the Seasons: Seasonal Music Preferences in College Students." *Current Psychology* 29, no. 4 (November 26, 2010): 328-45. https://doi.org/10.1007/s12144-010-9092-8.

Qiu, Lin, Sarah Hian may Chan, Kenichi Ito, and Joyce Yan ting Sam. "Unemployment Rate Predicts Anger in Popular Music Lyrics: Evidence from Top 10 Songs in the United States and Germany from 1980 to 2017." *Psychology of Popular Media* 10, no. 2 (April 2021): 256-66. https://doi.org/10.1037/ppm0000282.

Recording Industry Association of America (RIAA). "U.S. Sales Database." RIAA. Last modified 2022. https://www.riaa.com/u-s-sales-database/.

Rentfrow, Peter J., and Samuel D. Gosling. "The Do Re Mi's of Everyday Life: The Structure and Personality Correlates of Music Preferences." *Journal of Personality and Social Psychology* 84, no. 6 (2003): 1236-56. https://doi.org/10.1037/0022-3514.84.6.1236.

Sisario, Ben. "Taylor Swift's 'Folklore' Returns to No. 1 for a Seventh Week." *The New York Times* (New York, NY), September 28, 2020, The Charts. https://www.nytimes.com/2020/09/28/arts/music/taylor-swift-folklore-billboard-chart.html?smid=url-share.

Spotify. Spotify for Developers: Community Announcements. Last modified June 14, 2014. https://developer.spotify.com/community/news/2014/06/17/say-hello-new-web-api/.

Spotify Technology S.A. (NYSE: SPOT). "Spotify Technology S.A. Announces Financial Results for Second Quarter 2021." News release. July 27, 2021.

https://investors.spotify.com/financials/press-release-details/2021/Spotify-Technology-S.A.-Announces-Financial-Results-for-Second-Quarter-2021/default.aspx.

Suh, Brendan Joseph, "International Music Preferences: An Analysis of the Determinants of Song Popularity on Spotify for the U.S., Norway, Taiwan, Ecuador, and Costa Rica" (2019). CMC Senior Theses. 2271. https://scholarship.claremont.edu/cmc_theses/2271

Yeung, Timothy Yu-Cheong. "Did the COVID-19 Pandemic Trigger Nostalgia? Evidence of Music Consumption on Spotify." *SSRN Electronic Journal*, 2020. http://dx.doi.org/10.2139/ssrn.3678606.

VIII. Appendix

Figure A1: Music Sales by Format Market Share, 1973 to 2021

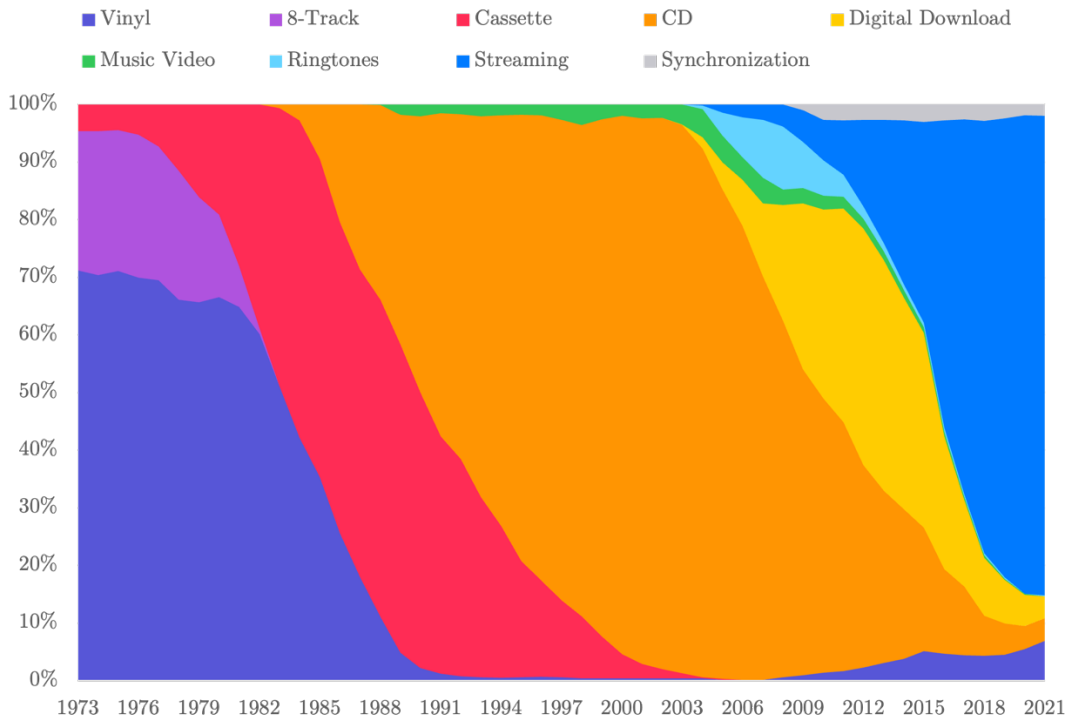
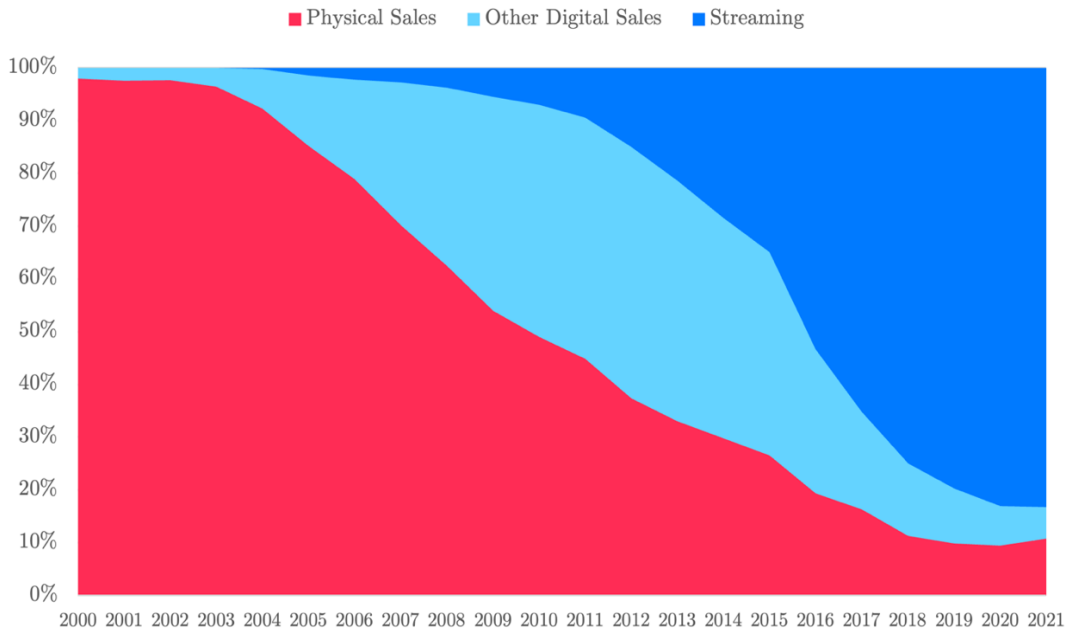


Figure A2: Music Sales by Format Market Share, 2000 to 2021



Sources for Figure A1 & Figure A2: Recording Industry Association of America, "U.S. Sales Database," RIAA, 2022; Marie Charlotte Götting, "Music Streaming Market Share," Statista, last modified November 16, 2021

Table A1: Example Tracks of Spotify API Audio Features

Variable	*Low Value*	*Moderate Value*	*High Value*
Acousticness	"Smells Like Teen Spirit" by Nirvana (0.0000286)	"Thinking Out Loud" by Ed Sheeran (0.445)	"When The Party's Over" by Billie Eilish (0.978)
Danceability	"Silent Night" by Billy Crystal (0.11)	"Waiting on the World to Change" by John Mayer (0.577)	"Ice Ice Baby" by Vanilla Ice (0.978)
Energy	"Say Something" by A Great Big World & Christina Aguilera (0.147)	"She Will Be Loved" by Maroon 5 (0.667)	"We Got The Beat" by the Go-Go's (0.994)
Instrumentalness	"Pump Up The Jam" by Technotronic (0.00000115)	'Lady" by Lenny Kravitz (0.504)	"James Bond Theme" by Billy Strange (0.869)
Liveness	"Hollaback Girl" by Gwen Stefani (0.0243)	"God's Plan" by Drake (0.552)	"Born in the USA" by Bruce Springsteen (0.959)
Loudness (dB)	"Landslide" by Fleetwood Mac (-22.32 dB)	"The River of Dreams" by Billy Joel (-8.15 dB)	"Not Afraid" by Eminem (-1.19 dB)
Speechiness	"No One" by Alicia Keys (0.0286)	"Caroline" by Aminè (0.505)	"Take Off" by Bob & Dog McKenzie (0.728)
Tempo (bpm)	"Tennessee Whiskey" by Chris Stapleton (48.718)	"Welcome to the Jungle" by Guns N' Roses (123.544)	"Buttons" by The Pussycat Dolls (211.261)
Valence	"My Heart Will Go On" by Celine Dion (0.0382)	"Blank Space" by Taylor Swift (0.57)	"Happy" by Pharrell Williams (0.963)

Data Source: Sean Miller, "Billboard Hot Weekly Charts - Dataset by KCMillerSean," Data.World, last modified June 2021, https://data.world/kcmillersean/billboard-hot-100-1958-2017.

Table A2: Billboard Chart Variable Explanation

Variable	***Explanation***
Billboard Chart URL	The link to the corresponding URL on Billboard's website for the Hot 100 Chart week
WeekID	The week each track is on the chart– structured as YYYY-MM-DD
Song	The title of the track
Performer	The artist of the track
SongID	A concatenation of the `*Song Name*` and `*Performer Name.*`
Current Week on Chart	The position of the track on the Hot 100 chart for the corresponding week as noted in WeekID
Instance	The number of times that the track has appeared on the chart. For example, an instance of 6 indicates that this is the sixth time the track has appeared on the chart
Previous Week Position	The position of the track on the chart in the week before the chart's corresponding publishing week
Peak Position	The highest position on the chart that the track has held, as of the corresponding week
Weeks on Chart	The number of weeks that the songs have appeared on the Hot 100 chart, as of the corresponding week

Table A3: Summary Statistics, Monthly Average of Song Attributes

Variable	*n*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
Acousticness	754	0.269	0.156	0.054	0.735
Danceability	754	0.611	0.049	0.496	0.713
Duration (ms)	754	227,651.3	36,578.98	145,754.6	304,948.4
Energy	754	0.627	0.075	0.419	0.752
Instrumentalness	754	0.029	0.024	0.0001	0.130
Key	754	5.255	0.373	4.148	6.492
Liveness	754	0.186	0.022	0.135	0.262
Loudness (dB)	754	-8.472	2.081	-11.943	-4.976
Misery Index	754	9.619	0.856	7.122	12.391
Mode	754	0.719	0.083	0.512	0.929
Speechiness	754	0.071	0.026	0.039	0.146
Tempo (bpm)	754	119.971	3.408	107.845	130.180
Valence	754	0.603	0.070	0.430	0.752
Year	754	1989.5	18.155	1958	2021

Data Sources: Sean Miller, "Billboard Hot Weekly Charts - Dataset by KCMillerSean," Data.World, last modified June 2021, https://data.world/kcmillersean/billboard-hot-100-1958-2017;

FRED Federal Reserve Bank of St. Louis, "Unemployment Rate (UNRATE)," Federal Reserve Economic Data, last modified April 1, 2022, https://fred.stlouisfed.org/series/UNRATE;

FRED Federal Reserve Bank of St. Louis, "Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL)," Federal Reserve Economic Data, last modified April 12, 2022, https://fred.stlouisfed.org/series/CPIAUCSL.

Table A4: Summary Statistics, Yearly Average of Song Attributes

Variable	*n*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
Acousticness	64	0.273	0.159	0.120	0.674
Danceability	64	0.611	0.048	0.516	0.691
Duration (ms)	64	226,595.3	37,090.57	148,839.4	275,240.6
Energy	64	0.625	0.075	0.457	0.739
Instrumentalness	64	0.030	0.021	0.003	0.088
Key	64	5.256	0.214	4.813	5.985
Liveness	64	0.186	0.018	0.146	0.236
Loudness (dB)	64	-8.481	2.082	-10.940	-5.256
Misery Index	64	9.626	0.502	8.824	10.777
Mode	64	0.720	0.077	0.581	0.881
Speechiness	64	0.071	0.025	0.043	0.130
Tempo (bpm)	64	119.909	2.697	113.887	125.874
Valence	64	0.602	0.068	0.454	0.709
Year	64	1989.5	18.619	1958	2021

Data Sources: Sean Miller, "Billboard Hot Weekly Charts - Dataset by KCMillerSean," Data.World, last modified June 2021, https://data.world/kcmillersean/billboard-hot-100-1958-2017;

FRED Federal Reserve Bank of St. Louis, "Unemployment Rate (UNRATE)," Federal Reserve Economic Data, last modified April 1, 2022, https://fred.stlouisfed.org/series/UNRATE;

FRED Federal Reserve Bank of St. Louis, "Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL)," Federal Reserve Economic Data, last modified April 12, 2022, https://fred.stlouisfed.org/series/CPIAUCSL.

Table A5: Regression Results by Monthly-Average Dependent Song Attribute

Variable	*Economic Misery*	*Correl. w/ Economic Misery*	R^2
(1) Acousticness	–0.0261***	–0.143	0.020
	(0.0066)		
(2) Danceability	0.0116***	0.202	0.041
	(0.0021)		
(3) Duration	14,625***	0.342	0.117
	(1,465)		
(4) Energy	0.00392	0.045	0.002
	(0.0032)		
(5) Instrumentalness	– 0.0024**	0.087	0.008
	(0.0010)		
(6) Key	0.0205	0.470	0.002
	(0.0159)		
(7) Liveness	– 0.0055***	–0.213	0.045
	(0.0009)		
(8) Loudness	– 0.452***	–0.186	0.035
	(0.0872)		
(9) Mode	–0.0202***	–0.210	0.044
	(0.0034)		
(10) Speechiness	– 0.0051***	–0.170	0.029
	(0.0011)		
(11) Tempo	–0.779***	–0.196	0.038
	(0.142)		
(12) Valence	0.0117***	0.143	0.020
	(0.0029)		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6: Regression Results by Yearly Average Dependent Song Attribute

Variable	*Economic Misery*	*Correlation w/ Economic Misery*	R^2
(1) Acousticness	– 0.0668*	–0.097	0.044
	(0.0393)		
(2) Danceability	0.0324***	–0.028	0.113
	(0.0115)		
(3) Duration	41,021***	0.384	0.308
	(7,803)		
(4) Energy	– 0.00564	–0.004	0.001
	(0.00190)		
(5) Instrumentalness	0.00481	0.119	0.013
	(0.00537)		
(6) Key	– 0.0922*	–0.073	0.047
	(0.0529)		
(7) Liveness	– 0.0148***	–0.087	0.170
	(0.00415)		
(8) Loudness	– 1.387***	–0.359	0.113
	(0.496)		
(9) Mode	– 0.0516***	0.100	0.113
	(0.0183)		
(10) Speechiness	– 0.0155**	–0.427	0.094
	(0.00611)		
(11) Tempo	– 2.196***	0.131	0.167
	(0.623)		
(12) Valence	0.0361**	0.374	0.072
	(0.0165)		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure A3: Average Acousticness in Billboard Hot 100 Songs Over Time

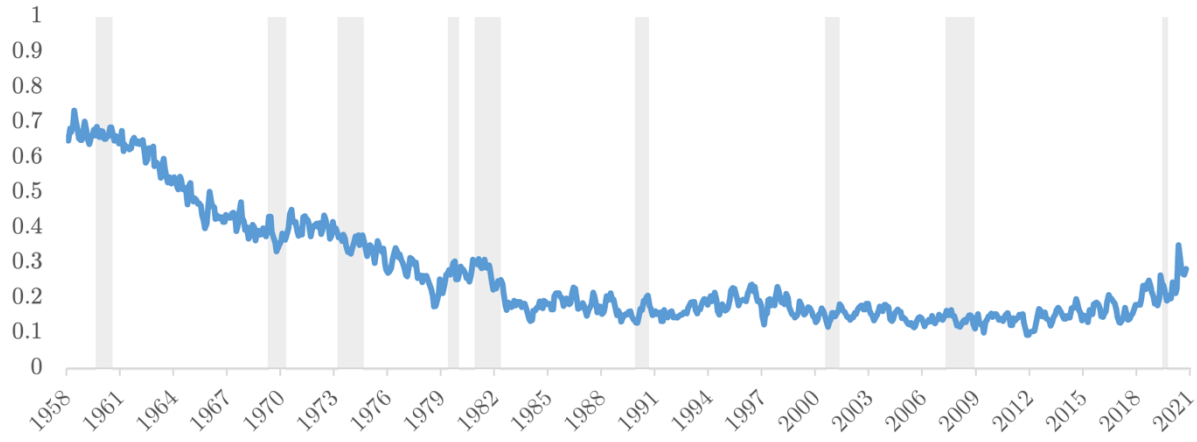


Figure A4: Average Danceability in Billboard Hot 100 Songs Over Time

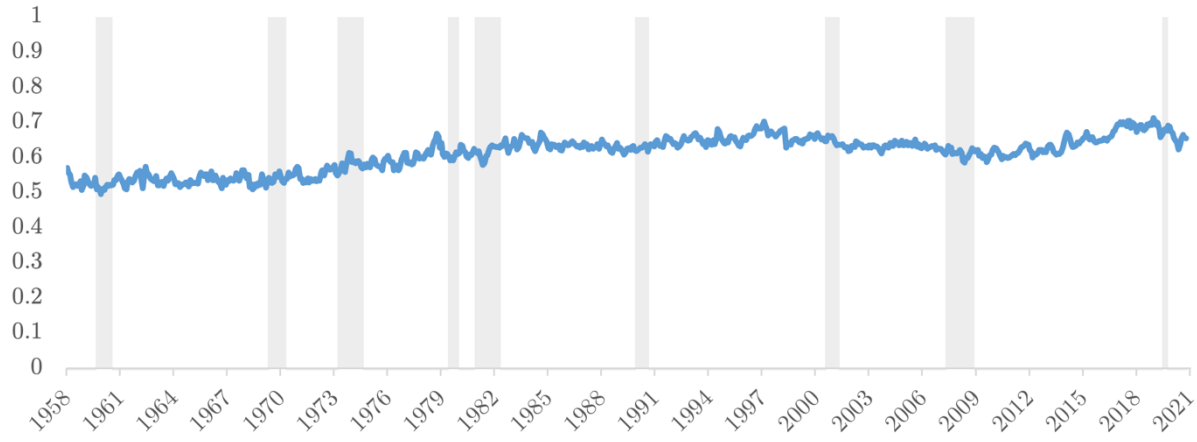


Figure A5: Average Duration (in milliseconds) of Billboard Hot 100 Songs Over Time

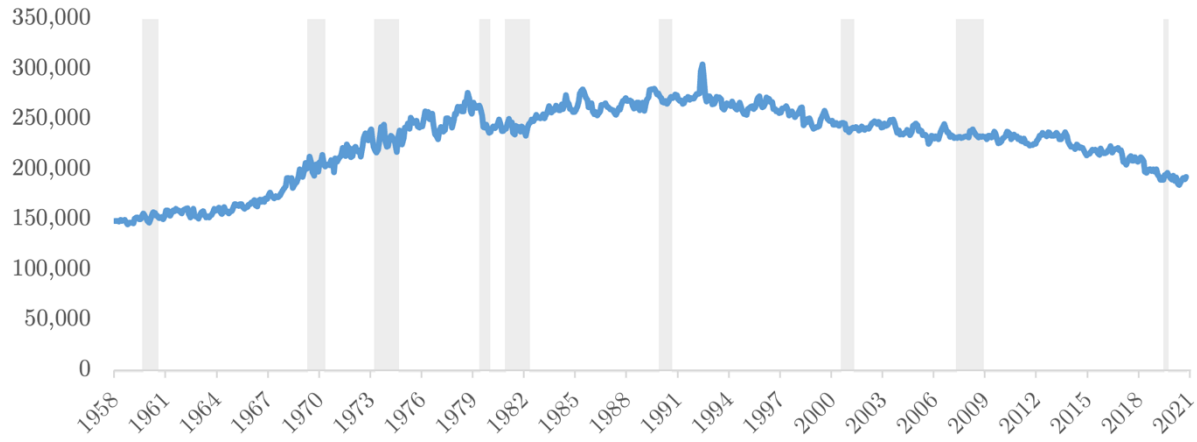


Figure A6: Average Energy of Billboard Hot 100 Songs Over Time

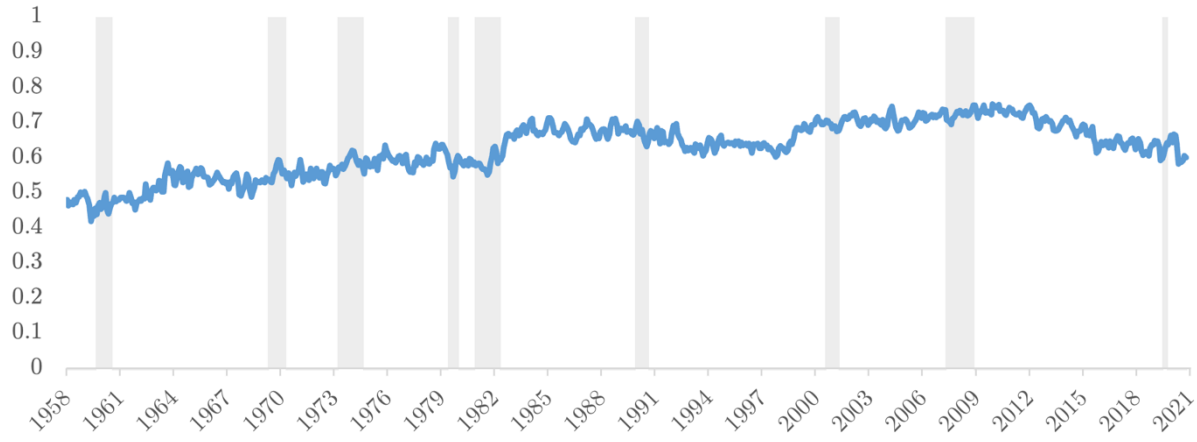


Figure A7: Average Instrumentalness of Billboard Hot 100 Songs Over Time

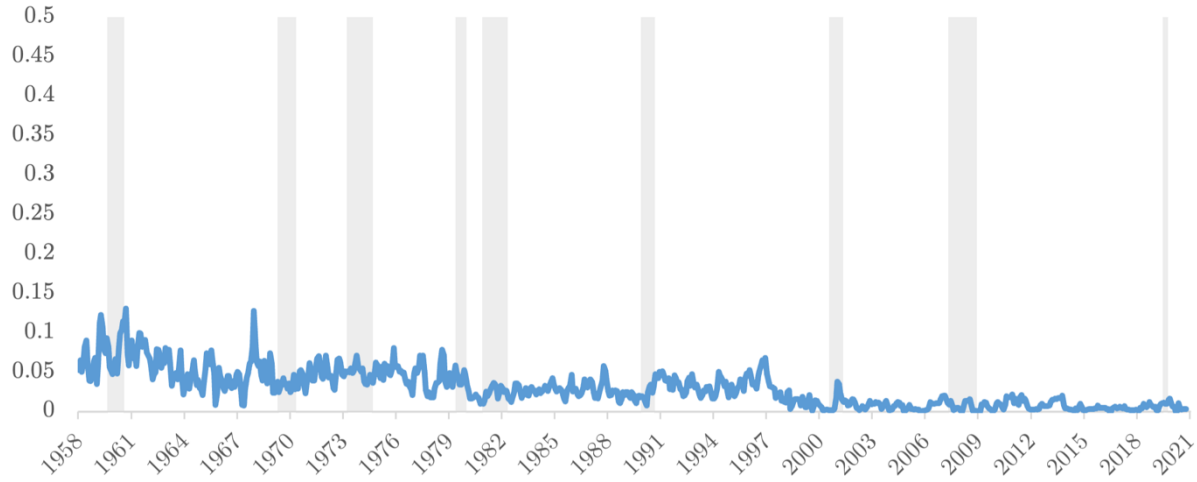


Table A8: Average Key of Billboard Hot 100 Songs Over Time

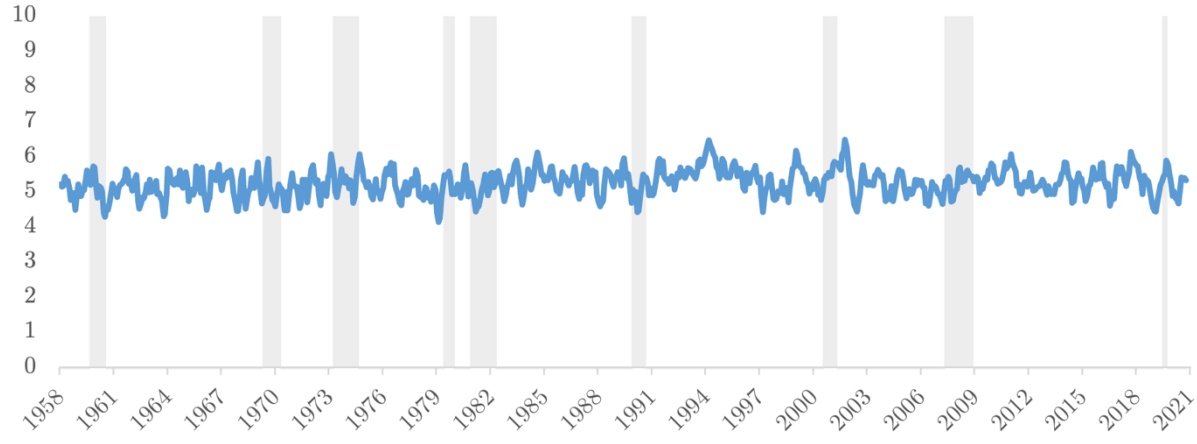


Figure A9: Average Liveness of Billboard Hot 100 Songs Over Time

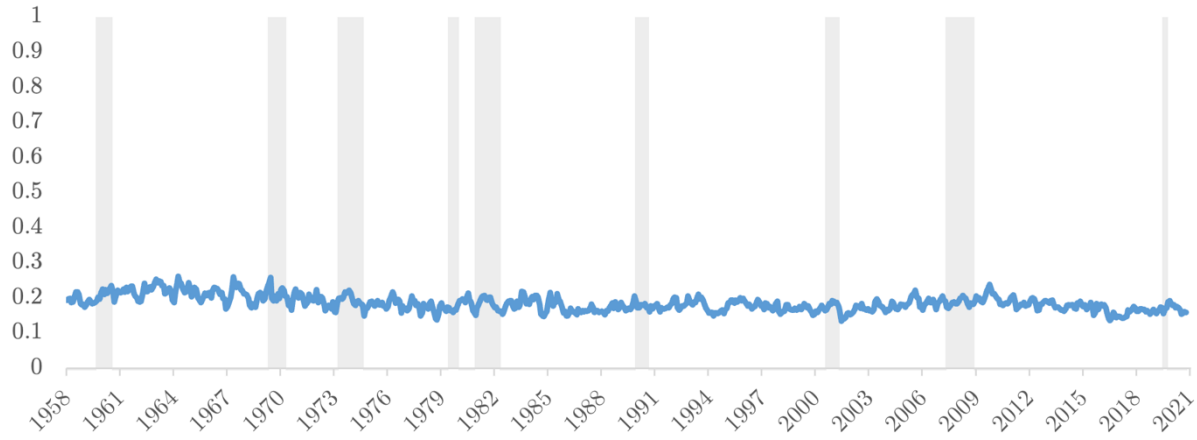


Figure A10: Average Loudness (dB) of Billboard Hot 100 Songs Over Time

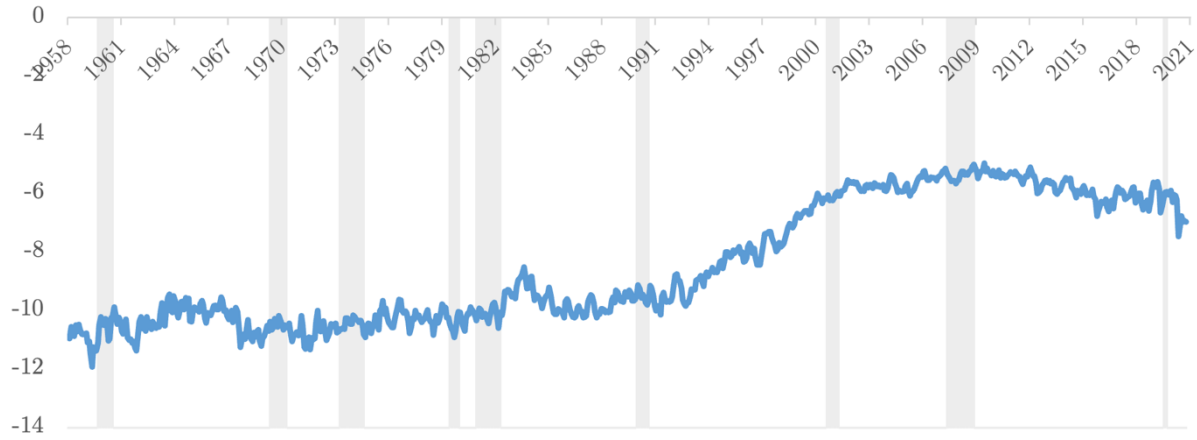


Figure A11: Average Mode of Billboard Hot 100 Songs Over Time

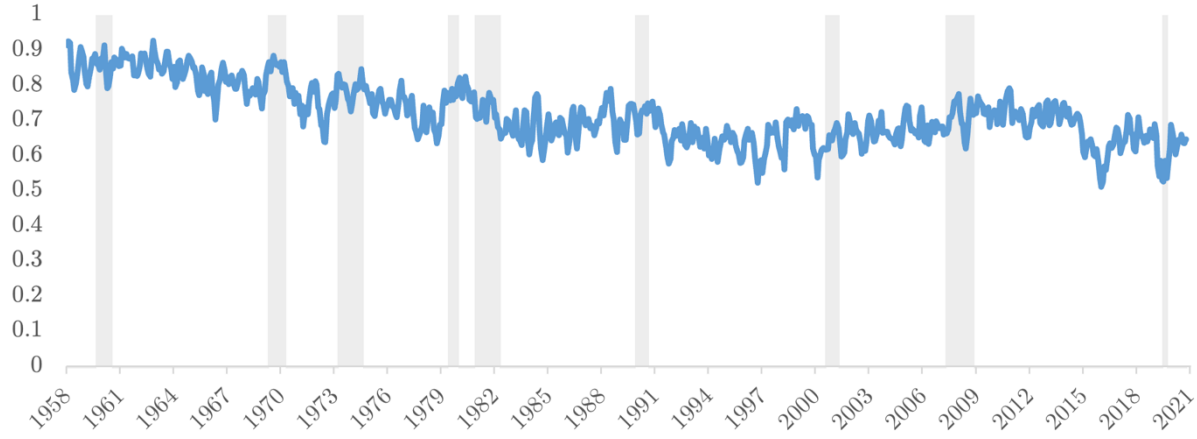


Figure A12: Average Speechiness of Billboard Hot 100 Songs Over Time

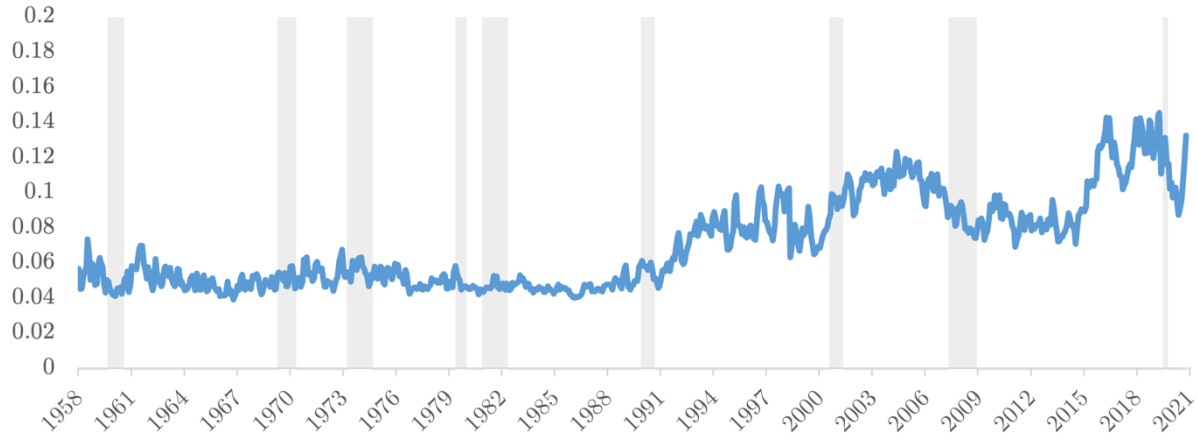


Figure A13: Average Tempo (BPM) of Billboard Hot 100 Songs Over Time

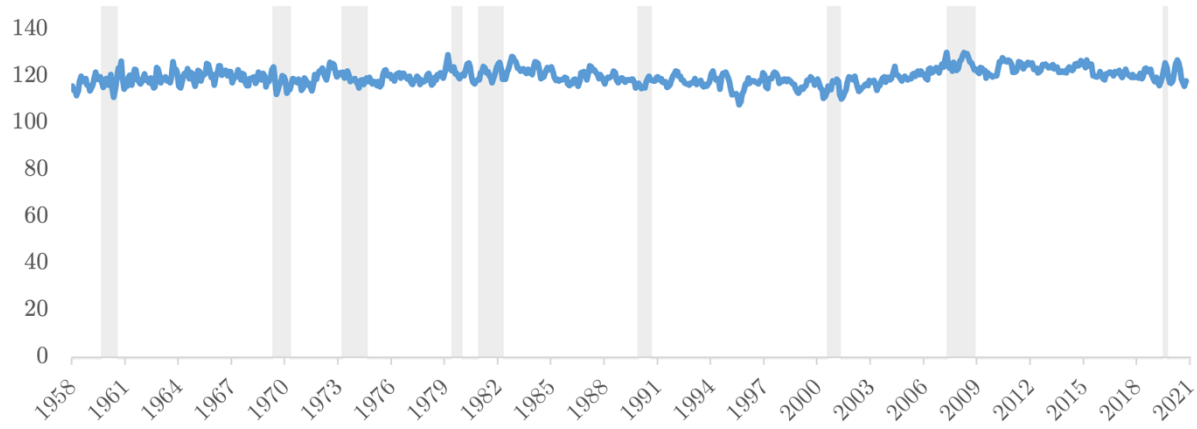
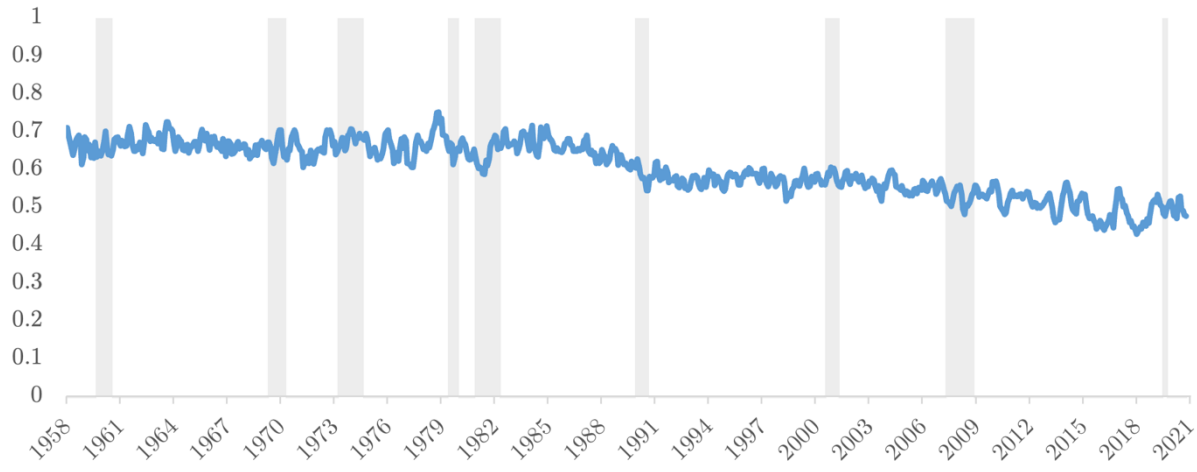


Figure A14: Average Valence (Happiness) of Billboard Hot 100 Songs Over Time



Note: The gray shaded lines in Figures A3-A14 indicate times of economic recession in the U.S. (see NBER 2021)