

Music Sentiment and Stock Returns Around the World

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CICF2021 Working Paper

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2021/07/22

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1. Introduction: Background & Motivation

- The behavioral finance literature shows that investor sentiment significantly affects stock returns, which pioneered a range of sentiment measures – they specify an exogenous shock to a country's mood, such as international sporting results, aviation disasters, or the weather, and assume that it affects the sentiment of the marginal investor.

1. Introduction: Background & Motivation

- Rather than studying shocks to sentiment, we wish to seek an endogenous measure that reflects a country's actual sentiment at a point in time.
 - Actual sentiment may be driven by a wide variety of different events and thus does not require us to pre-specify a particular set of events.
 - Actual sentiment aims to capture the extent to which events affect investor mood.

1. Introduction: Literature

- Investor sentiment measures:

- Edmans, Garcia, and Norli (2007): International sporting results.
- Kaplanski and Levy (2010): Aviation disasters.
- Chen et al. (2019): Terrorist attacks.
- Kamstra, Kramer, and Levi (2020): Clock changes.
- Baker and Wurgler (2006): The market-based sentiment index.
- Hirshleifer and Shumway (2003); Goetzmann et al. (2015): Cloud cover.
- Kamstra, Kramer, and Levi (2003): Daylight hours.
- Da, Engelberg, and Gao (2015); Gao, Rhen, and Zhang (2020): Textual analysis of internet searches to measure sentiment.

1. Introduction: Literature

- Investor sentiment measures:

- Mehr et al. (2019): Study 315 cultures and find that they use similar kinds of music in a similar context, suggesting there are universal properties of music that likely reflect commonalities of human cognition throughout the world.
- Fernandez-Perez, Garel, and Indriawan (2020): Documents a correlation between weekly music sentiment and stock returns in the US, but only available for a short time series.

1. Introduction: Literature

- Individuals reflect mood in music choices:
 - Cantor and Zillman (1973): Induce emotions in subjects by showing them films and find that they then prefer emotionally congruent music.
 - North and Hargreaves (1996): Participants' preference for music matches their current emotional states.
 - Saarikallio and Erkkilä (2007): Subjects who are sad or angry are inclined to listen to sad music to express their emotions or attain closure.

1. Introduction: Literature

- Individuals reflect mood in music choices:
 - Chen, Zhou, and Bryant (2007): The desire to listen to sad music is strongest immediately after experiencing a negative mood; They are only likely to listen to uplifting music when some time has passed.
 - Hunter, Schellenberg, and Griffith (2011): The typical preference for upbeat music is eliminated after inducing a sad mood.
 - Van den Tol and Edwards (2013): People listen to sad music after experiencing negative circumstances due to feeling connected with the music.

1. Introduction: Research Objective

- Investigate the relation between music sentiment and stock market returns, also the affecting factors.
- The relation between music sentiment with other existing mood measurements.
- What else could music sentiment measure.

1. Introduction: Contribution

- The music proxy is available at high frequency, globally comparable, and language-free, which is an actual endogenous sentiment measurement.
- Update on a preliminary paper by Fernandez-Perez, Garel, and Indriawan (2020) which is only available for a short time series.
 - Cross-section of 40 countries to verify the robustness.
 - Cross-country analyses exploiting variation in limits to arbitrage.
 - Study the impact of sentiment on volatility and mutual fund flows.

2. Model Design: Data

- Music sentiment:
 - Source: Spotify.
 - ◆ Daily statistics of the top 200 songs.
 - ◆ Valence: Measures the musical positivity, ranges from 0 to 1.
 - ◆ Stream: Over 54,000 unique songs with over 450 billion streams in total. On average, there are 8.4 million streams daily, with around 42,000 streams per song.
- MSCI Stock market indices:
 - Source: Refinitiv.
- Sample: 40 countries.
- Period: January 1, 2017 to August 28, 2020.
- Frequency: Daily.

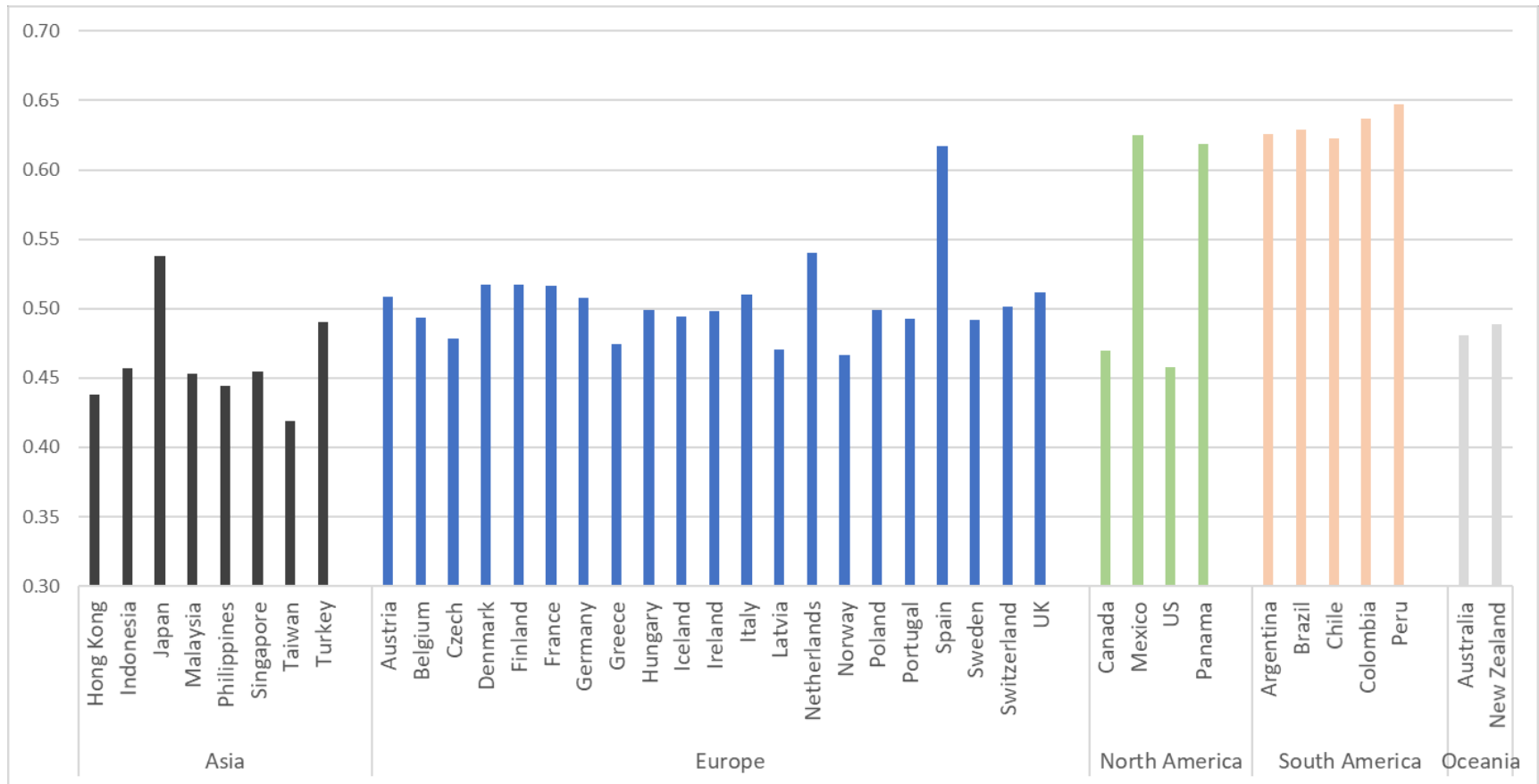
2. Model Design: Variable

- Stream-Weighted Average Valence (SWAV)

$$SWAV_{i,d} = \sum_{j=1}^{200} \left(\frac{\text{Streams}_{j,i,d}}{\sum_{j=1}^{200} \text{Streams}_{j,i,d}} \cdot \text{Valence}_{j,i,d} \right)$$

2. Model Design: Variable

- Stream-Weighted Average Valence (SWAV)



2. Model Design: Variable

- Music Sentiment

- To match our music sentiment with the stock market and macroeconomic data, we aggregate the information at a weekly level to avoid non-synchronicity between the opening and closing times of the stock markets and the time of the day that Spotify reports their daily statistics.

$$\text{Music Sentiment}_{i,t} = SWAV_{i,t} - SWAV_{i,t-1}$$

2. Model Design: Variable

- MSCI index per country

No	Country	MSCI Index (USD)	MSCI Index (local)	No	Country	MSCI Index (USD)	MSCI Index (local)
1	Argentina	MSARGT\$	MSARGTL	21	Japan	MSJPAN\$	MSJPANL
2	Australia	MSAUST\$	MSAUSTL	22	Latvia	RIGSEIN	RIGSEIN
3	Austria	MSASTR\$	MSASTRL	23	Malaysia	MSMALF\$	MSMALFL
4	Belgium	MSBELG\$	MSBELGL	24	Mexico	MSMEXF\$	MSMEXFL
5	Brazil	MSBRAZ\$	MSBRAZL	25	Netherlands	MSNETH\$	MSNETHL
6	Canada	MSCNDA\$	MSCNDAL	26	New Zealand	MSNZEA\$	MSNZEAL
7	Chile	MSCHIL\$	MSCHILL	27	Norway	MSNWAY\$	MSNWAYL
8	Colombia	MSCOLM\$	MSCOLML	28	Panama	IFFPNM\$	IFFMPAL
9	Czech	MSCZCH\$	MSCZCHL	29	Peru	MSPERU\$	MSPERUS
10	Denmark	MSDNMK\$	MSDNMKL	30	Philippines	MSPHLF\$	MSPHLFL
11	Finland	MSFIND\$	MSFINDL	31	Poland	MSPLND\$	MSPLNDL
12	France	MSFRNC\$	MSFRNCL	32	Portugal	MSPORD\$	MSPORDL
13	Germany	MSGERM\$	MSGERML	33	Singapore	MSSING\$	MSSINGL
14	Greece	MSGREE\$	MSGREEL	34	Spain	MSSPAN\$	MSSPANL
15	Hong Kong	MSHGKG\$	MSHGKGL	35	Sweden	MSSWDN\$	MSSWDNL
16	Hungary	MSHUNG\$	MSHUNGL	36	Switzerland	MSSWIT\$	MSSWITL
17	Iceland	ICEXALL	ICEXALL	37	Taiwan	MSTAIW\$	MSTAIWL
18	Indonesia	MSINDF\$	MSINDFL	38	Turkey	MSTURK\$	MSTURKL
19	Ireland	MSEIRE\$	MSEIREL	39	UK	MSUTDK\$	MSUTDKL
20	Italy	MSITAL\$	MSITALL	40	US	MSUSAM\$	MSUSAML

2. Model Design: Variable

- Weekly Return (RET)
 - Weekly return (Friday-end) of the country's stock market index. Index values are in US dollars.

$$RET_{i,t} = \frac{MSCI_{i,t} - MSCI_{i,t-1}}{MSCI_{i,t-1}}$$

2. Model Design: Variable

- All variables' definition and sources

Variable	Description	Source
<i>ADS</i>	U.S. macroeconomic activity index.	Aruoba, Diebold, and Scotti (2009)
<i>BAN</i>	Dummy variable equal to 1 if country's i stock market is under short-selling ban at week t , and 0 otherwise.	Yale Program on Financial Stability
<i>DCC</i>	Deseasonalized cloud cover	National Oceanic and Atmospheric Administration
<i>EPU</i>	News-based measure of U.S. economic policy uncertainty.	Baker et al. (2016)
<i>Music Sentiment</i>	Total change in the stream-weighted average valence of the top-200 songs individuals of country i listen to in week t .	Spotify
<i>Net Flows</i>	Weekly net flows of open-end equity mutual funds.	Morningstar
<i>RET (%)</i>	Weekly return (Friday-end) of the country's stock market index. Index values are in US dollars.	Refinitiv
<i>Valence</i>	The musical positivity conveyed by a song ranging from 0.0 to 1.0.	Spotify
<i>VIX</i>	Implied volatility of the S&P 500.	Chicago Mercantile Exchange
<i>VOL</i>	Weekly stock market volatility measured as the standard deviation of the daily stock market returns within the week.	Refinitiv
<i>World RET (%)</i>	Weekly return of the MSCI World Index. This global equity index represents large and mid-cap equity performance across all 23 developed markets countries. It covers approximately 85% of the free float-adjusted market capitalization in each country. Index values are in US dollars.	Refinitiv

2. Model Design: Summary Statistics

Country	<i>Music Sentiment</i>	<i>RET (%)</i>	<i>VOL (%)</i>				
Argentina	-0.0194	0.1398	2.0753	Japan	0.0253	0.1538	0.8232
Australia	0.0060	0.2525	0.9381	Latvia	0.0770	0.3035	0.8996
Austria	0.0290	0.0741	1.2106	Malaysia	0.0432	0.1125	0.6114
Belgium	0.0270	0.0582	0.9915	Mexico	0.0123	0.0716	1.2243
Brazil	0.0145	0.1372	1.6600	Netherlands	0.0357	0.3491	0.8050
Canada	0.0466	0.1959	0.7361	New Zealand	0.0072	0.3865	0.9546
Chile	-0.0108	0.0039	1.1919	Norway	0.0328	0.2340	1.0801
Colombia	0.0264	0.0622	1.2169	Panama	0.0266	-0.0017	0.6966
Czech	0.0471	0.2190	0.8137	Peru	0.0144	0.1486	1.1447
Denmark	0.0388	0.3861	0.8940	Philippines	0.0043	0.0922	1.0960
Finland	0.0195	0.3443	0.9629	Poland	0.0388	0.2365	1.2256
France	0.0099	0.2067	0.8714	Portugal	0.0038	0.2848	0.9510
Germany	-0.0039	0.2060	0.9261	Singapore	0.0099	0.1365	0.8014
Greece	-0.0076	0.0278	1.5133	Spain	0.0096	0.1074	0.9876
Hong Kong	-0.0005	0.1556	0.8981	Sweden	0.0455	0.2943	1.0311
Hungary	0.0336	0.2886	1.2470	Switzerland	0.0273	0.3538	0.6982
Iceland	0.0322	0.1398	0.9631	Taiwan	-0.0075	0.3874	0.9151
Indonesia	-0.0181	0.1576	1.1703	Turkey	0.0051	-0.0450	1.7205
Ireland	0.0297	0.2516	1.0284	UK	0.0242	0.0807	0.8432
Italy	0.0113	0.2479	1.0628	US	0.0363	0.3320	0.7823

3. Empirical Result

- Prior measures validation
 - Test if other investor sentiment measures are also available for our sample countries over the sample period.

3. Empirical Result

- Prior measures validation
 - Seasonal factors (e.g., Thaler, 1987; Kamstra, Kramer, and Levi, 2017; Birru, 2018; Hirshleifer, Jiang, and DiGiovanni, 2020):
 - ◆ January is associated with the improving mood of the New Year period; For Northern Hemisphere countries, March is associated with the highest recovery from seasonal affective disorder (SAD). In contrast, the months of September and October are associated with the highest onset of the SAD effect.
 - ◆ Variable – Positive / Negative Months.

3. Empirical Result

- Prior measures validation

- Weather conditions – Cloud Cover (e.g., Hirshleifer and Shumway, 2003; Goetzmann et al., 2015):

- ◆ Data: National Oceanic and Atmospheric Administration website, the degree of cloud cover, which takes on integer values from zero (clear sky) to eight (overcast sky).

- ◆ Variable – Deseasonalized Cloud Cover (DCC): The average daily cloud cover is calculated per country using hourly values from 6am to 12pm across the country's various weather stations. Since daily cloud cover is highly seasonal, we deseasonalize it by subtracting each week's mean cloudiness from the time-series mean.

3. Empirical Result

- Prior measures validation
 - Test if other investor sentiment measures are also available for our sample countries over the sample period.

Music Sentiment $_{i,t}$

$$= \alpha + \beta_1 \cdot \text{Positive Months}_t + \beta_2 \cdot \text{Negative Months}_t \\ + \beta_3 \cdot \overline{\Delta DCC}_{i,t} + \varepsilon_{i,t}$$

3. Empirical Result

- Prior measures validation

Music Sentiment_{*i,t*}

$$= \alpha + \beta_1 \cdot \text{Positive Months}_t + \beta_2 \cdot \text{Negative Months}_t + \beta_3 \cdot \overline{\Delta DCC}_{i,t} + \varepsilon_{i,t}$$

<i>Music Sentiment</i>	(1) Calendar-based mood proxy		(2) Weather-induced mood proxy		(3) Calendar-based + Weather-induced mood proxy	
<i>Positive months</i>	0.013	(0.29)			0.014	(0.33)
<i>Negative months</i>	-0.319***	(-7.35)			-0.318***	(-7.31)
$\overline{\Delta DCC}$			-0.158***	(-2.95)	-0.167***	(-2.99)
Fixed Effects	Country, year		Country, month		Country, year	
R ²	0.88%		1.81%		1.03%	
#Obs.	5890		7,560		5857	

3. Empirical Result

- Prior measures validation (Daily)

Daily Music Sentiment_{*i,d*}

$$= \alpha + \sum_{j=1}^6 \beta_j \cdot Week_{i,j,d} + \theta \cdot \Delta DCC_{i,d} + \varepsilon_{i,d}$$

<i>Daily Music Sentiment</i> _(<i>i,d</i>)	(1) Calendar-based mood proxy		(2) Calendar-based mood proxy		(3) Calendar-based + Weather-induced mood proxy	
<i>Monday</i> _(<i>d</i>)	-0.324***	(-35.53)			-0.321***	(-35.33)
<i>Tuesday</i> _(<i>d</i>)	-0.057***	(-8.49)			-0.057***	(-8.38)
<i>Thursday</i> _(<i>d</i>)	0.023***	(3.46)			0.022***	(3.27)
<i>Friday</i> _(<i>d</i>)	0.103***	(10.85)			0.102***	(10.40)
<i>Saturday</i> _(<i>d</i>)	0.330***	(41.80)			0.330***	(41.55)
<i>Sunday</i> _(<i>d</i>)	-0.350***	(-43.44)			-0.343***	(-42.56)
$\Delta DCC_{(d)}$			-0.034***	(-13.25)	-0.035***	(-14.77)
Fixed Effects	Country, month		Country, month		Country, month	
R ²	13.84%		0.71%		14.15%	
#Obs.	53,358		52,152		52,152	

3. Empirical Result

- Music sentiment and stock market returns

$$\begin{aligned} RET_{i,t} \\ = \alpha + \beta_1 \cdot \text{Music Sentiment}_{i,t} + \sum \Gamma \cdot \text{Controls}_{i,t} \\ + \varepsilon_{i,t} \end{aligned}$$

3. Empirical Result

- Music sentiment and stock market returns

Control Variable	Description
$World\ RET$	The contemporaneous weekly world return
VIX	The contemporaneous implied volatility
ΔEPU	Weekly change in economic policy uncertainty
ΔADS	Weekly change in macroeconomic activity
$\overline{\Delta DCC}$	Average daily change in deseasonalized cloud cover over the week
RET_{t-1}	The one-week-lagged market return

3. Empirical Result

- Music sentiment and stock market returns

<i>RET (%)</i>	Panel A: Contemporaneous Music Sentiment				Panel B: One-week lagged Music Sentiment			
<i>Music Sentiment</i>	8.285***	(3.27)	7.180***	(3.70)	-16.553***	(-6.34)	-4.655**	(-2.26)
<i>World RET</i>			0.870***	(55.10)			0.868***	(54.60)
<i>VIX</i>			-0.001	(-0.03)			-0.001	(-0.10)
<i>ΔEPU</i>			-0.003***	(-6.51)			-0.003***	(-6.42)
<i>ΔADS</i>			0.021	(0.43)			0.010	(0.20)
<i>ΔDCC</i>			0.047	(0.54)			0.037	(0.43)
<i>RET</i> _(<i>t</i>-1)			-0.037***	(-2.57)			-0.036***	(-2.49)
Fixed Effects	Country, month		Country, month		Country, month		Country, month	
R ²	3.10%		36.71%		3.22%		36.65%	
#Obs.	7,560		7,520		7,560		7,520	

3. Empirical Result

- Music sentiment and stock market returns
 - Robustness checks: To avoid the concern that sentiment affects the exchange rate, we re-estimate using market returns in local currency.

<i>RET (%)</i>	Contemporaneous				One-week lagged			
<i>Music Sentiment</i>	4.599**	(2.13)	5.059***	(2.69)	-10.579***	(-4.72)	-5.525***	(-2.79)
Fixed Effects	Country, month		Country, month		Country, month		Country, month	
Controls	No		Yes		No		Yes	
R ²	2.29%		20.96%		2.43%		20.97%	
#Obs.	7,600		7,520		7,560		7,520	

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Country OUT	Contemporaneous				One-week lagged			
	without controls		with controls		without controls		with controls	
Argentina	8.431***	(3.39)	7.048***	(3.70)	-16.565***	(-6.39)	-5.043**	(-2.47)
Australia	8.776***	(3.45)	7.287***	(3.70)	-16.906***	(-6.40)	-4.961**	(-2.37)
Austria	7.624***	(3.01)	6.438***	(3.29)	-16.242***	(-6.20)	-4.289**	(-2.06)
Belgium	8.520***	(3.34)	6.985***	(3.56)	-16.379***	(-6.18)	-4.398**	(-2.10)
Brazil	8.169***	(3.27)	6.635***	(3.48)	-15.963***	(-6.16)	-4.095**	(-2.02)
Canada	8.923***	(3.45)	7.656***	(3.81)	-16.072***	(-5.97)	-4.642**	(-2.17)
Chile	8.220***	(3.27)	7.017***	(3.61)	-16.327***	(-6.24)	-4.433**	(-2.14)
Colombia	8.415***	(3.35)	6.950***	(3.59)	-15.964***	(-6.12)	-4.195**	(-2.03)
Czech	8.641***	(3.37)	7.156***	(3.63)	-16.265***	(-6.12)	-4.226**	(-2.02)
Denmark	8.545***	(3.35)	7.376***	(3.74)	-16.855***	(-6.34)	-5.089**	(-2.42)
Finland	8.383***	(3.28)	7.278***	(3.66)	-16.891***	(-6.33)	-5.071**	(-2.39)
France	9.293***	(3.60)	7.583***	(3.77)	-17.474***	(-6.50)	-4.835**	(-2.25)
Germany	8.139***	(3.19)	6.933***	(3.49)	-16.957***	(-6.40)	-4.923**	(-2.33)
Greece	9.262***	(3.72)	7.902***	(4.15)	-17.375***	(-6.83)	-5.539***	(-2.81)
Hong Kong	8.354***	(3.30)	7.135***	(3.65)	-16.426***	(-6.25)	-4.521**	(-2.18)
Hungary	8.484***	(3.35)	6.975***	(3.59)	-16.480***	(-6.27)	-4.709**	(-2.27)
Iceland	8.730***	(3.32)	6.675***	(3.33)	-16.978***	(-6.22)	-4.463**	(-2.11)
Indonesia	8.824***	(3.50)	7.349***	(3.79)	-16.395***	(-6.26)	-4.800**	(-2.32)
Ireland	8.614***	(3.36)	7.180***	(3.61)	-16.530***	(-6.20)	-4.730**	(-2.23)
Italy	8.095***	(3.16)	6.893***	(3.47)	-16.329***	(-6.13)	-4.286**	(-2.03)
Japan	8.787***	(3.47)	7.251***	(3.71)	-16.866***	(-6.41)	-4.709**	(-2.26)
Latvia	9.360***	(3.57)	7.767***	(3.87)	-17.764***	(-6.53)	-5.584***	(-2.62)
Malaysia	8.593***	(3.38)	7.209***	(3.68)	-16.677***	(-6.31)	-4.750**	(-2.27)
Mexico	8.371***	(3.33)	7.137***	(3.68)	-16.111***	(-6.16)	-4.450**	(-2.15)
Netherlands	8.899***	(3.49)	7.154***	(3.62)	-16.657***	(-6.28)	-4.781**	(-2.27)
New Zealand	8.523***	(3.36)	6.925***	(3.54)	-16.096***	(-6.10)	-4.184**	(-2.01)
Norway	8.696***	(3.44)	7.288***	(3.73)	-15.857***	(-6.03)	-4.007*	(-1.93)
Panama	8.621***	(3.40)	7.390***	(3.77)	-16.266***	(-6.17)	-4.433**	(-2.13)
Peru	8.656***	(3.44)	7.342***	(3.78)	-16.432***	(-6.28)	-4.566**	(-2.21)
Philippines	8.485***	(3.37)	7.085***	(3.65)	-16.277***	(-6.22)	-4.403**	(-2.13)
Poland	9.172***	(3.59)	7.347***	(3.74)	-17.420***	(-6.58)	-5.160**	(-2.46)
Portugal	8.535***	(3.36)	7.428***	(3.77)	-16.437***	(-6.23)	-4.679**	(-2.25)
Singapore	8.447***	(3.34)	7.151***	(3.66)	-16.440***	(-6.26)	-4.661**	(-2.24)
Spain	8.384***	(3.32)	6.907***	(3.54)	-16.245***	(-6.20)	-4.343**	(-2.09)
Sweden	8.489***	(3.32)	7.197***	(3.63)	-16.795***	(-6.31)	-4.888**	(-2.32)
Switzerland	8.947***	(3.46)	7.519***	(3.77)	-17.147***	(-6.38)	-4.955**	(-2.33)
Taiwan	8.575***	(3.38)	7.523***	(3.85)	-16.637***	(-6.32)	-4.903**	(-2.36)
Turkey	7.399***	(2.96)	6.258***	(3.26)	-15.531***	(-5.97)	-3.891*	(-1.91)
UK	8.934***	(3.44)	7.254***	(3.60)	-16.689***	(-6.18)	-4.695**	(-2.18)
US	9.063***	(3.48)	7.662***	(3.75)	-16.618***	(-6.11)	-5.025**	(-2.31)

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3. Empirical Result

- Music sentiment and stock market returns
 - The potential concern with a contemporaneous analysis is reverse causality, so we study the link between daily music sentiment and next-day stock.

RET_d (%)	(1)	(2)	(3)	(4)	(5)	(6)
$Music\ Sentiment_{(d-1)}$	1.883** (2.04)	1.915** (2.14)				
$Music\ Sentiment_{(d-2)}$	0.392 (0.41)		0.132 (0.15)			
$Music\ Sentiment_{(d-3)}$	-0.241 (-0.26)			-0.3707 (-0.41)		
$Music\ Sentiment_{(d-4)}$	0.798 (0.86)				1.140 (1.29)	
$Music\ Sentiment_{(d-5)}$	-2.157** (-2.32)					-2.447*** (-2.72)
$World\ RET_{(d+1)}$	-0.022 (-1.63)	-0.022 (-1.59)	-0.022 (-1.61)	-0.022 (-1.61)	-0.022 (-1.61)	-0.022* (-1.66)
$World\ RET_{(d)}$	0.857*** (62.50)	0.858*** (62.52)	0.858*** (62.52)	0.857*** (62.53)	0.857*** (62.49)	0.858*** (62.60)
$World\ RET_{(d-1)}$	0.190*** (17.75)	0.190*** (17.71)	0.190*** (17.68)	0.190*** (17.68)	0.190*** (17.69)	0.190*** (17.69)
$RET_{(d-1)}$	-0.044*** (-5.72)	-0.044*** (-5.72)	-0.044*** (-5.74)	-0.044*** (-5.72)	-0.044*** (-5.71)	-0.044*** (-5.71)
$RET_{(d-2)}$	-0.027*** (-4.01)	-0.027*** (-4.01)	-0.027*** (-4.03)	-0.027*** (-4.04)	-0.027*** (-4.03)	-0.027*** (-4.07)
$RET_{(d-3)}$	-0.004 (-0.64)	-0.004 (-0.63)	-0.004 (-0.62)	-0.004 (-0.62)	-0.004 (-0.63)	-0.004 (-0.65)
$RET_{(d-4)}$	-0.011* (-1.70)	-0.011* (-1.69)	-0.011* (-1.67)	-0.011* (-1.70)	-0.011* (-1.72)	-0.011* (-1.70)
$RET_{(d-5)}$	0.005 (0.74)	0.005 (0.75)	0.005 (0.77)	0.005 (0.75)	0.005 (0.73)	0.005 (0.76)
$VIX\ controls$	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1
$\Delta EPU\ controls$	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1
$\Delta ADS\ controls$	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1	d-1, d, d+1
$\Delta DCC\ controls$	d-1, ..., d-5	d-1, ..., d-5	d-1, ..., d-5	d-1, ..., d-5	d-1, ..., d-5	d-1, ..., d-5
Fixed Effects	Country, month, day- of-week	Country, month, day- of-week	Country, month, day- of-week	Country, month, day- of-week	Country, month, day- of-week	Country, month, day- of-week
R ²	25.55%	25.53%	25.51%	25.51%	25.52%	25.52%
#Obs.	35,945	36,013	36,013	36,013	36,013	36,013

4. Additional Analysis

- Limits to arbitrage

- Use difference-in-difference (DID) analyses around short-selling bans by some of sample countries during the COVID-19 pandemic as a shock that increased limits to arbitrage.

Country	Begin	End
Austria	18/03/2020	18/05/2020
Belgium	16/03/2020	18/05/2020
France	17/03/2020	18/05/2020
Greece	17/03/2020	18/05/2020
Indonesia	02/03/2020	Still in place as of 28/08/2020
Italy	12/03/2020	18/06/2020
Malaysia	23/03/2020	Still in place as of 28/08/2020
Philippines	15/03/2020	16/04/2020
Spain	12/03/2020	18/05/2020
Taiwan	18/03/2020	18/06/2020
Turkey	28/02/2020	Still in place as of 28/08/2020

4. Additional Analysis

- Limits to arbitrage

$$\begin{aligned}
 RET_{i,t} &= \alpha + \beta_1 \cdot \text{Music Sentiment}_{i,t} + \beta_2 \\
 &\cdot \text{Music Sentiment}_{i,t} \times BAN_{i,t} + \beta_3 \cdot BAN_{i,t} + \Sigma \Gamma \\
 &\cdot \text{Controls}_{i,t} + \varepsilon_{i,t}
 \end{aligned}$$

<i>RET (%)</i>	Panel A: Contemporaneous				Panel B: One-week lagged			
<i>Music Sentiment</i>	6.332***	(2.54)	6.533***	(3.38)	-14.019***	(-5.45)	-3.006	(-1.48)
<i>Music Sentiment x BAN</i>	106.541***	(3.80)	33.116*	(1.71)	-121.953***	(-4.46)	-83.025***	(-3.66)
<i>BAN</i>	0.097	(0.25)	-0.267	(-0.85)	0.445	(1.22)	-0.1065	(-0.34)
<i>World RET</i>			0.867***	(54.74)			0.867***	(54.49)
<i>VIX</i>			0.001	(0.23)			0.001	(0.24)
<i>ΔEPU</i>			-0.003***	(-6.46)			-0.003***	(-6.42)
<i>ΔADS</i>			0.031	(0.64)			0.005	(0.11)
<i>ΔDCC</i>			0.045	(0.53)			0.038	(0.44)
<i>RET_(t-1)</i>			-0.037***	(-2.57)			-0.032**	(-2.24)
Fixed Effects	Country, month		Country, month		Country, month		Country, month	
R ²	3.42%		36.76%		3.82%		36.92%	
#Obs.	7,600		7,520		7,560		7,520	

4. Additional Analysis

- Stock market volatility

$$VOL_{i,t} = \alpha + \beta_1 |Music\ Sentiment|_{i,t} + \sum \Gamma \cdot Controls_{i,t} + \varepsilon_{i,t}$$

<i>VOL (%)</i>	Without Controls		With Controls	
<i>Music Sentiment</i>	3.836***	(3.67)	1.693**	(2.06)
<i>World RET</i>			-0.049***	(-11.13)
ΔEPU			0.000**	(2.37)
ΔADS			0.008	(0.62)
$\overline{\Delta DCC}$			-0.019	(-0.94)
$VOL_{(t-1)}$			0.464***	(29.00)
$RET_{(t-1)}$			-0.028***	(-7.74)
Fixed Effects	Country, month		Country, month	
R ²	21.48%		41.79%	
#Obs.	7,600		7,520	

4. Additional Analysis

- Net equity fund flows
 - If sentiment affects investment decisions, we would expect it to influence trades of mutual funds.
 - Use one-week lagged music sentiment because it takes several days for flows to be settled and reported (Da, Engelberg, and Gao, 2005).

$$\begin{aligned} & \text{Net Flows}_{f,i,t} \\ &= \alpha + \beta_1 \cdot \text{Music Sentiment}_{i,t-1} + \sum \Gamma \cdot \text{Controls}_{i,t} \\ &+ \varepsilon_{i,t} \end{aligned}$$

4. Additional Analysis

- Net equity fund flows

<i>Net Flows_(t)</i>	Without Controls		With Controls	
<i>Music Sentiment_(t-1)</i>	2.594**	(2.24)	3.145 ***	(2.77)
<i>World RET</i>			0.079 ***	(9.62)
<i>VIX</i>			-0.016 ***	(-6.58)
<i>ΔEPU</i>			0.000*	(1.76)
<i>ΔADS</i>			-0.003	(-0.12)
<i>ΔDCC</i>			0.044	(0.83)
<i>RET_(t-1)</i>			18.470***	(3.42)
<i>Net Flows_(t-1)</i>			0.000	(1.33)
Fixed Effects	Fund, month		Fund, month	
R ²	14.52%		14.77%	
#Obs.	1,806,850		1,797,028	

5. Conclusion

- Music is a continuous, high-frequency, global scale, and does not require the pre-specification of particular mood-affecting events or words, actual measurement for mood.
- Other measures such as seasonal factors and cloud covers are closely connected to this music-based sentiment measure.
- We find a significant positive relation between music sentiment and contemporaneous market returns, also a significant price reversal the following week.

5. Conclusion

- The relationship between music sentiment and market returns is stronger for countries with greater limits to arbitrage, such as those that implement short-selling restrictions during the COVID-19 pandemic.
- Music sentiment also predicts increases in net mutual fund flows.
- Absolute sentiment changes would trigger a rise in stock market volatility.
- Overall, the actual sentiment of a nation's citizens significantly affects asset prices.