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An influence of external factors on the product evolution of cultural artefacts as music genres

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이 논문을 공학 석사 학위 논문으로 제출함

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Abstract

An influence of external factors on the product evolution of cultural artefacts as music genres

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Music evolution is an important cultural phenomenon. It is connected to other types of evolution such as biological and technological ones. However, not many papers explore cultural artefacts related to music evolution in terms of the concepts of product and technological evolution. Moreover, there are limitations in the quantitative exploration of external factors affecting music evolution. This paper overcomes these gaps by examining the evolution of genres as cultural artefacts in the UK via the method of topic modeling called LDA. LDA allows studying how the content of topics that cover genres have changed through three time periods from the 1990s to 2010s. The external factors that influence this evolution were identified through cointegration test, Granger-Causality test, and regression analysis. The external factors were based on the literature review and have a form of time series data. The following results were found through the research. Firstly, it was found out that music evolution in the UK has a form of rock as a dominant genre with specialized genres. Secondly, it was identified that the differences between contents of topics have reduced that imply a decrease of differences between genres. Thirdly, it was indicated that “Females’ power” and

number of Internet users are the extremal factors that influences the evolution of genres in the UK and caused changes in genres' compositions in the observed period of time. The obtained results might be used so as to predict how genres may change and music evolution occurs in the future.

Keywords: Music evolution; genres; external factors; LDA; Fixed effects model

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Chapter 1. Introduction

Our world is built on the concept of evolution. We can see evolution everywhere: in biology, medicine, culture, fashion, computer sciences, agriculture, etc. From generation to generation, it is possible to observe both significant and insignificant changes across different products, services, concepts, and bases. One such fundamental and extremely important area of evolution is music, which has deeply old roots that have evolved through centuries.

The primary theories of musical evolution were created by scholars Savage and Mehr. Their concepts of music's cultural evolution are strongly connected to biological evolution and unitarity (Fitch, 2006; Mehr et al., 2021; Savage, 2019). For example, while discrete heritable units in biology are genes and amino acids, in music, they are notes and phrases. When in biology we consider mutation, in musical evolution there are mistakes and embellishments. Additionally, in musical evolution, natural selection means selection by the audience, performers, judges, and consumers (Savage, 2019).

Simultaneously, there are several debates regarding the validity of various musical evolution theories in comparison with one another (Dubourg et al., 2021; Harrison & Seale, 2021; Savage et al., 2021). However, there are a few basic theories that create a basis for further research on musical evolution. For example, one such concept, created by Spencer, relates to progressive evolution in comparative musicology (Petrov, 2012). This theory follows two main assumptions. First, cultures evolve from simple to complex, and as they do so, they move from primitive to civilized. Second,

music evolves from simple to complex within societies as they progress. Based on these assumptions, more modern theories of macroevolution and microevolution in music have been developed (Savage, 2019).

In other words, the evolution of music is tightly connected to general, biological evolution. Moreover, in some papers, genres are often considered as units of music or cultural artifacts that evolve and reflect a direction of musical evolution (Li et al., 2021). Another name for this unit is a meme or "an analytical tool allowing examining the cultural evolution" (Situngkir, 2004). In particular, some authors are currently exploring how genres differ and unite during particular periods of time, which allows for genres to be defined as significant measures of musical evolution (Youngblood et al., 2021).

Other potentially important theories related to the evolution of genres within the framework of musical evolution are the product life cycle (PLC) concept and product family evolution. Though these concepts are primarily related to technological and product evolution, they can also be applied to musical evolution as well. If we consider a genre as an individual meme, its development might be associated with the PLC stages (Kivi et al., 2012; Tellis & Crawford, 1981). On the other hand, considering a group of genres as variants connected to each other that are evolving in a similar way refers to product family evolution (Biswas et al., 2022; Hou et al., 2013). Also to consider, in musical evolution, there may be a "dominant" genre related to technological evolution's concept of dominant design (Anderson & Tushman, 1990; Brem et al., 2016; Cecere et al., 2015; Hylving et al., 2012). Another critical notion is that any type of evolution—including biological,

cultural, and technological—is influenced by the external environment, in other words, by external factors (Savtotti & Trickett, 1992). In the context of cultural evolution, these external factors are defined as ecological factors (Scott-Phillips et al., 2018). In their turn, the ecological factors that might affect the development of music primarily refer to politics (Lockard, 1996; Meier, 2019; Simpson, 2017; Wang et al., 2021; Wood, 2014), demographics (Kumar & Akash, 2020; LeBlanc et al., 1999), social factors (Finch, 2015; Rashidi, 2020), and technological factors (Darchen et al., 2022; Kruse, 2010; Walzer, 2017). Therefore, the changes in these parameters might in turn bring changes to the musical attributes, or, with application to the cultural evolution, might bring changes to memes.

Taking into consideration that music plays a significant role in many individuals' lives, it is important to explore how it evolves as well as what influences its development. The studies dedicated to this topic are critical not only for singers, composers, and other stakeholders related to music, but also for consumers of musical products (Mac-Callum et al., 2012). Understanding music attribute changes may provide information about customers' preferences and, consequently, may have an impact on the popularity of a particular musical agent (Bagley et al., 2022). Moreover, understanding the reasons for this development may help to predict possible future modifications (Buskell, 2019).

However, few papers explore musical evolution within a framework of technological evolution despite the similarity between both concepts. Examining musical evolution and, in particular, genre evolution via the same methods as the phylogenetic tree, for example, is uncommon.

Another gap in the research is limited study of UK musical evolution using the quantitative methods. Despite the United Kingdom's extensive history of music development and several "interventions" to worldwide culture (Clement, 2018), few works have used the above-referenced methods to explain specific changes in this musical evolution. Moreover, though the modern history of musical evolution in the United Kingdom began in the 1990s, it has not been properly explored yet.

Last but not least, most studies examine external factors that influence musical evolution in terms of qualitative methods. Though ecological factors themselves have quantitative nature (Miton et al., 2020; Scott-Phillips et al., 2021; Smith & Georges, 2015), there is a gap in implementing quantitative methods to explore reasons for specific changes in musical attributes. This study tries to overcome the above-mentioned gaps.

The main objectives of this research can be defined as follows: to explore modern musical evolution in the United Kingdom by applying a method related to technological evolution and considering genre as the main unit of analysis as well as discovering the external factors that influence this development. Therefore, the following two research questions were asked: 1) How have genres developed in the United Kingdom from 1991 to 2010? and 2) What external factors have affected this evolution? A topic modeling method called LDA, which is widely accepted in technological and product evolution, was conducted to answer the first research question. Using this method allowed for exploring cultural evolution from the uncommon point of product technological evolution. Several methods related to econometrics

for time series data—in particular the cointegration test, the Granger-Causality test, and the regression model—were applied for the second research question to identify what and how external variables cause particular changes in UK musical evolution during the observed time period. This study has the following structure. The second chapter presents the literature review with subchapters dedicated to general technological product evolution, musical evolution, and an overview of factors that impact musical evolution. The third chapter indicates the methodology and provides a description of the methods used. The fourth chapter describes the data from the research. The fifth chapter analyzes the obtained results. The final chapter provides conclusion and discusses limitations of the current study and recommendations for further research.

Chapter 2. Literature review

2.1 Overview of technological product evolution

Product evolution might be considered based on many examples. This phenomenon is primarily focused on particular technologies and their implications. This subchapter refers to the term product evolution in general, with definitions, descriptions, and particular cases where it might be applied described further. In particular, theories regarding the PLC, product family evolution, and dominant design are considered as are their potential application to a genre as a meme of musical evolution.

2.1.1 The product life cycle

First of all, the definition of product evolution or the evolution of technology products is presented. Many researchers consider product evolution in the term “the product life cycle” or the PLC (Cox, 1967; Kivi

et al., 2012; Massey, 1999; Rink & Swan, 1979; Tellis & Crawford, 1981). The product life cycle may refer to the following concepts. Firstly, there are particular types of the product life cycle (Cox, 1967; Rink & Swan, 1979). By collecting data from various studies related to the PLC topic, Rink & Swan (1979) presented the literature review where they identify the following types of the cycles:

- Classical;
- Cycle-recycle;
- Cycle-half recycles;
- Increasing sales;
- Decreasing sales;
- High plateau;
- Low plateau;
- Stable maturity;
- Growth maturity;
- Innovative maturity
- Growth - Decline - Plateau;
- Rapid penetration.

All types of these cycles have their shapes with unique curves. However, despite the variety of types of PLC, there is a similar construction of the PLC. The majority of scholars identify four or five stages of the PLC. For example, Cox (1967) highlighted these stages with respect to the measures of the PLC. These measures are related to catalog life and commercial life and the latter is respectively divided into commercial birth and commercial death. The above characteristics were considered by Cox in a framework of

the drug industry. However, the stages of the PLC might still be formed via these measurements:

1. The Introduction stage. There is a time period between the catalog birth and the commercial birth of a product.
2. The Growth stage. It is the stage between the commercial birth and the maximum revenue for a month.
3. The Maturity stage encompasses a time period between the maximum revenue for a month and commercial death.
4. Finally, the Decline stage covers the period between commercial death and catalog death.

Similarly, Tellis and Crawford (1981) created their approach for the determination of the PLC. The authors' cycle contains five stages and is largely based on the evolution of biology. In particular, they explored the phenomena of four changes that trigger the evolution of a product with respect to biological evolution. There are the following changes: cumulative, motivated, directional, and patterned.

Then, every change influences the product life cycle that allowing the identification of the following stages of the cycle:

- Divergence.
- Development.
- Differentiation.
- Stabilization.
- Demise.

The more modern methods for the determination of the PLC have their origin in previous research (Cox, 1967; Tellis & Crawford, 1981). For

example, Kivi et al. (2012) also presented the evolution of a product as the four-stage model:

1. Model introduction - an introduction of the product.
2. The start of sales - a start of receiving and growth of sales as well as revenue.
3. The sales period - is directly the peak of a product.
4. The end of sales - a “death” of a product.

To sum up, the PLC has a significant application in the product evolution theory. The majority of products follow the schemes presented in the above scholars’ papers. Genre as an individual meme of music evolution might also be considered as a product that passes the same stages during its lifetime.

2.1.2 Dominant design

Furthermore, the principle of dominant design should be defined (Anderson & Tushman, 1990; Brem et al., 2016; Cecere et al., 2015; Hylving et al., 2012). Some pioneering authors (Abernathy & Utterback, 1988; Anderson & Tushman, 1990) have determined dominant design as a vital part of technological progress. Anderson and Tushman (1990) stated that a product’s dominant design is included in the PLC, occurring in the second stage of the cycle. Thus, the following definition of dominant design could be stated: “it is a single architecture that establishes dominance in a product class” (Akiike, 2013; Anderson & Tushman, 1990; Hylving et al., 2012). Hylving et al. (2012) indicated the importance of dominant design for product development. They highlighted the connection between dominant design, product design, and cross-organizational processes.

Dominant design is related to the term “standard” because it could be described as a standard for other products in an industry (Abernathy & Utterback, 1988). However, certain recent scholars distinguish the determination of these terms. For example, Brem et al. (2016) highlighted that dominant design and standards are not identical despite being linked. In their opinion, standards are technical requirements appropriate for all products in a class, whereas dominant design is a result of competition in the PLC. Similarly, Cecere et al. (2015) stated that dominant design does not necessarily integrate “the best features and performances.” Therefore, it cannot be considered the only standard for all other products.

To sum up, dominant design is an important feature of the PLC that demonstrates the dominance of a particular product in a class. However, the dominant design might not be a so-called standard. If we consider genres as products, dominant design among these musical features might be identified as well.

2.1.3 The product family evolution

Another important approach should be considered in the context of product evolution. If the PLC explores a product as one unit (Cox, 1967; Kivi et al., 2012; Massey, 1999; Rink & Swan, 1979; Tellis & Crawford, 1981), then the product family unites sets of similar products (Biswas et al., 2022; Deelstra et al., 2009; Hou et al., 2013; Mohagheghi & Conradi, 2004; Xinsheng Xu et al., 2008). In other words, a product family might be defined as a community of products with similar characteristics (Meyer & Utterback, 1993; Mohagheghi & Conradi, 2004).

Product family evolution is a concept related primarily to technologies and

manufacturing firms (Hou et al., 2013; Mohagheghi & Conradi, 2004). Hou et al. (2013) determined product family evolution to be adaptation to a market influenced by various dynamic factors. Similarly, other authors (e.g., Biswas et al., 2022; Mohagheghi & Conradi, 2004) identified product family evolution as changes in products' variants that are affected by myriad factors that should be considered.

Product family evolution is connected with various important attributes of a product. For example, families of products tend to be united on a particular platform (Deck, 1997). Additionally, mass customization as a fulfillment strategy for customers' needs without key technological losses is important (Hou et al., 2013; Xinsheng Xu et al., 2008). In their turn, mass customization is connected to product family design (Hou et al., 2013) and product family architecture (Xinsheng Xu et al., 2008).

Product family evolution is usually examined in cases of software (Deelstra et al., 2009; Hou et al., 2013; Xinsheng Xu et al., 2008). However, the above theoretical statements could be applied to attributes of musical evolution. During musical evolution, genres might form a family and evolve similarly under the same influencing factors. The concept of mass customization could be applied as well if we consider music as a technology that tries to overcome consumers' needs.

2.2 Overview of music evolution

Evolution theory has been discussed since Charles Darwin throughout history. Scholars attempt to apply evolution theory in analyzing the development of music. The majority of the scholars intend to trace the development of music back to the zoological symbolism of sound, which is

applicable among all animals as a method of communication. A further analysis based upon zoological studies is to apply the evolution of music in a social framework, thus, indicating the social bunding and emphasizing the formation of the communal identity.

2.2.1 What is the music evolution?

Since Charles Darwin published his *On the Origin of Species* (1859), evolution has become a popular but controversial topic and research method in biological, zoological, and geographical research. Since the late 19th century, the concept of evolution extends to cultural, social, and historical research and has even influenced political movements. The sphere of music is not an exception. The theory of evolution played a central role in the formation of academic musicology in the late 19th century (Adler, 1885/1981; Rehding, 2000). Despite the academic desolation of evolutional theory in musicology and cultural anthropology (Carneiro, 2003), the concept of biological evolution is reintroduced in the analysis of the origin and formation in musicology by music psychologists. According to Patrick Savage, “the biological evolution of the ability to make and experience music (the evolution of musicality) has re-emerged as important to the contemporary musicological research subject.” (Savage, 2019). Furthermore, Savage believes that the evolution of music strongly represents a Darwinist evolutionary theory. Savage indicates that some scientists have explored musical microevolution through controlled experiments by using techniques initially designed to explore the controlled evolution of biology and language. The experiment results represent that the evolution of music goes through a “natural selection” process. This

simulated evolution experiment shows that pleasant music evolved from almost random noise throughout. Infer from this, the evolution of music, especially the popularity of various musical genres in different eras, is entirely influenced by audience choice (Mac-Callum et. al., 2012). Savage demonstrates that musical evolution, like biological evolution, follows some general evolutionary rules (Savage, 2017).

Evolution refers to changes in the frequency of heritable variation. Darwin's theory of evolution by natural selection is not genes but contains three essential requirements: (1) variation must exist between individuals; (2) variation must be inherited through intergenerational transmission; (3) due to competitive selection, some variants must more easily be inherited than other variants (Darwin, 1859). The changes may be in the direction of simplicity to complexity, and there may be a general trend toward the formation of comprehensive collectivity or dies out without further development (McShe & Brandon, 2010; Currie & Mace, 2011; Allen et.al., 2018; Neietal, 2010). Victor Grauer believes that the evolution and global spread of human song styles are similar to the evolution and spread of anatomically modern humans in Africa. Certain groups of contemporary African hunter-gatherers have retained ancestral singing styles common to humans for tens of thousands of years ago (Grauer, 2011). Other scholars further conclude this idea that music development follows a trend of evolution alongside the changing of genes, culture, and language (Leroi & Swire, 2006). Savage (2019) further suggests that music and genes preserve a history of human migration and cultural contact based on this understanding. In doing so, Savage intends to present that music evolution

is a by-product cohering the development of commonality in culture and society. Savage reenforces Kartomi's (2001) argument, which rejects applying evolutionary theory to musical instrument classification because "the concepts of evolution and lineage apply only to living organisms that can inherit genes from their ancestors." The evolution context cannot be analyzed as an independent factor of musicology. In other words, the music itself cannot evolve autonomously because it is not an organic combination but is attached to the broad category of culture and society.

Considering the evolution of music in a social-cultural framework, Sharp (1907) indicates three crucial factors in modern music development: (1) continuity, (2) variation, and (3) selection. This theory is suitable for the comprehensive analysis of music evolution. Concrete speaking, this categorization, to a large extent, represents the development of folk music in the developing process of its tradition and uniqueness: (i) continuity which links the present with the past; (ii) variation, which springs from the creative impulse of the individual or the group; and (iii) selection by the community, which determines the form or forms in which the music survives (International Folk Music Council, 1955). Savage believes that the theory of cultural evolution can provide a unified theoretical framework for studying multi-level (macro and micro) understanding and reconstruction of musical change across cultures, genres, and time periods (Savage 2019; Titon 1992).

However, a different voice arises. Scholar Nicole Creanza (2021) further indicates that it is impossible to apply the same evolution method as genetic evolution over the historical development of music. In a broader sense,

Creanza does not consider cultural evolution as a whole in a genetic evolution manner. Unlike genetics, the mutation of culture can also be the source of new traits. Cultural innovation can occur through multiple processes and at various scales. Cultural characteristics can accumulate in intermittent bursts. Creanza indicates that the uniqueness of diverse international cultures is formed due to certain “rejections” of inherited culture, where the past root will be hardly discovered. In turn, this mutation may herald the beginning of a new cultural heritage. Generally speaking, the evolution of culture comes from inheritance and mutation, and these two ways influence each other.

2.2.2 The origin of music

The majority of scholars intend to agree that the evolution of music originated through a typical zoological behavior of all animals (Savage et al., 2021; Mehr et al., 2021; Creanza et al., 2021; Fith, 2006). All scholars agree that the discussion is diverse from the source of sound production through a scientific perspective and the purpose of music development as a means of communication. Patrick Savage and Samuel Mehr discuss the possible purposes of music development from two different perspectives respectively. The hypothesis that music is developed to promote social connection is highly consistent with social psychological research on the need for belonging. Complex mechanisms have been developed throughout human evolution against isolation and involvement in social interaction (Gabriel, 2021).

2.2.2.1 Patrick Savage: Music as a Collective Social Phenomenon

As discussed in the previous paragraph, Savage intends to explain music evolution from a cultural perspective. The keyword “social ties” refers to

the formation, strengthening, and maintenance of subordinate ties with specific characteristics (i.e., a series of social processes producing bonding relationships that support prosocial behavior). As a social primate, this connection is psychologically and biologically critical for human survival and reproduction (e.g., enhanced predator protection, cooperative parenting, cooperative foraging, expansion, and territorial defense). Social bonding is a consequence of interactions during music production and subsequently through long-term changes in group members' tendency to attach and their associated long-term pro-sociality. In this sense, music evolution originated from the social interconnection while promoting further social communication and recognition of identity. Based on this understanding, Savage calls his theory "co-evolution": musical systems evolve synchronously with human musical abilities through gene-cultural co-evolution. Savage builds on arguments by Patel (2018) and Podlipniak (2017) that music first emerged as a cultural "invention", which further creates the context for the later selection of human musicality. Savage then proposes a research method, "the Music and Social Bonding (MSB) hypothesis". This hypothesis posits that human musicality's core biological component evolves into mechanisms underpinning social bonds. Human musicality has evolved as a mechanism to support social connections (Del Mastro, 2021). Biologically, musicality relies on multiple neurocognitive components in the social formation that may have developed at different times and for various reasons: musicality is less a single tool than a "cognitive toolkit". To a large extent, musicality aims to construct a social bond.

Some scholars criticize Savage for the overemphasis on the social-communal perspective, which ignores the possible innovation of independent music from individual personnel. Where there is less collective action in certain regions, music creation is less likely to be socially collaborative, but that does not mean there is no music creativity in such areas (Kraus, 2021; Hell & Margulis 2021; Patel, 2021). Juslin (2021) points out specifically that although Savage acknowledges that emotion is a crucial aspect of social bonding, he does not fully engage with the psychological mechanisms behind the emotion of music creativity—which belongs to the individual—other than the social neural mechanism. All mechanisms of individual emotion may facilitate social bonding in unique ways—some more important than others. Savage does not directly compromise with these scholars' doubts, as the response only presents a possible non-social characteristic of music as a purpose. Savage indicates explicitly that specific characteristics of human musicality can also be used for non-social purposes, such as personal emotion regulation. However, such indication does not show whether the process of music production is purely a social factor. Dunbar (1993) proposes a theory called "Ancestral Bonding Mechanisms" (ABM). Dunbar considers music as a mechanism that allows simultaneous connections with larger groups. Whether from personal composition or collaborative development, the origin of music is not crucial to music's social purpose. Instead, the continuity of music almost entirely depends on the participation and promotion of the others, as the phenomenon of cultural continuity (Creanza et al., 2021). In group participation in musical activity, a coherent and harmonious fusion of voice

leads to a sense of positive anticipation, fulfillment of expectations, and mutual achievement (Savage, 2021).

2.2.2.2 Samuel Mehr: Music as Means of Communication

Samuel Mehr (2021) is aware of Savage's social musicality theory. Mehr does not disagree with Savage however considers Savage's research is mainly limited. He categorizes Savage's MSB as an adaptationist view, where music evolves to build and maintain social bonds. The other two categories of music development, according to Mehr, are a by-product view, where music becomes a result of non-musical adaptations, and a second adaptationist view, where music evolves into companion quality. Mehr developed his theory mainly based on these two perspectives. For Mehr, music is evolved not only within human society but also in animals. Mehr agrees that music participates in the role of constructing social bonds. However, the construction means, even music itself, originated from the mutual understanding of signals. Unlike Savage's suggestion that musicality evolves to facilitate sociality, Mehr proposes that musicality develops to support specific behaviors. In this theory, music as a signal serves functional, peer-to-peer communication. Mehr believes that in non-human animals, most sound adaptations have evolved to send signals. The usage of complex, song-like vocalizations as signals is detectable in distantly related animals, including various birds, marine mammals, primates, and insects. These provide essential functions related to mating and territorial defense. Mehr further introduces the function of music during mating as evidence to support the "music is functional" theory. Benítez-Burraco (2021) believes Mehr acknowledges that "music does not directly induce social cohesion: rather, it signals existing social cohesion achieved through other means".

The “other means” embody the functional purpose as the origin of music. In other words, music develops first in a practical manner of communication to enhance social cohesion other than providing any direct effect on social commonality (contra to Savage).

As for the signal transmission method, on average, the receiver benefits from the response to the signal, and the signal sender benefits from the receiver’s response. Such a signal does not require a standard social agreement on the symbol of movements. Instead, a communication system could exist merely between limited groups with unique instructive signals. Thus, unlike Savage’s social formation of music as a collective purpose of communication, Mehr focuses on the individual sense of expression of the need from a subjective perspective. Mehr agrees with Savage that sounds can be a communal activity such as territorial defending in some cases. Still, it also reflects an essential type of contact between parents and children. These provide functions of mutual interest to parents and offspring. This vertical-generic evolution of the sounding/music system indicates the development of music could be a one-line, unique possibility of inheritance. Mehr’s emphasis on the peer-to-peer communication function of music between parents and children can also be seen as reinforcing the “companion quality” of music evolution. It can be concluded that Mehr focuses on intergroup alliances and mother-child relationships, while Savage focuses on intragroup associations (Kennedy, 2021).

Mehr’s theory also faces critical analysis from various scholars. Honing (2021) directly points out the fundamental weakness of Mehr’s theory on the origin of music. Mehr’s claims about language and music in their

hypothesis are less clear. Much of the argument seems to apply equally to the origin of language. Morrison (2021) pointed out that Mehr's theory is based on the assumption of the existence of the recipient and immediately introduces a social component at the beginning of the music. Apparently, Mehr forgets to consider the case when music is an independent, personal "entertainment" for emotional adjustment (As Savage mentioned, see above).

Based on the "signal" theory, Mehr defines music primarily as auditory communication, and interdisciplinary aspects of music perception involving vision and proprioception are thus excluded. In this context, Mehr is not sufficient to explain contemporary music as a liturgical, cultural performance, i.e., music as a way of combining auditory aspects (music, speech, and voice) with gestures (parades, dance, and drama) and material culture (decorations, discs, and concerts, etc.) unified integration (Wald-Fuhrmann, 2021). Dubourg further developed this argument, arguing that Mehr's article focuses on musical adaptations from communication, likely grounded in credible signals of collective strength. Still, Mehr failed to explain how and why music develops new social functions beyond coordinated signaling (Dubourg, 2021). From another perspective, the purely aesthetic and appreciation role of music has also been deliberately ignored by Mehr.

2.2.2.3 Conclusion of Savage and Mehr's Music Evolution Theories

In sum, both Savage and Mehr emphasize social bonds in their narratives. Savage discusses social connections in musical evolution. Mehr concentrates on credible signals of social functionality and relationships (Rendell, 2021). Kennedy (2021) concludes that both Savage and Mehr

share an understanding of music as an adaptive “bond” in a social framework, that music: (1) strengthens the “bond” with social teammates; (2) provides clues to group members; (3) enhances coordination within the group. The first and second adaptive “social ties” must be based on reliable signals, which is Mehr’s argument.

Both scholars sloppily view music biologically as a biological instinct, equating the presence of any innate sensitivity to musical structure in early infancy with the adult form of this ability without going deep into analysis through the interaction with current social phenomena (Hannon, 2021). Both scholars, especially Mehr, clearly limit music to the framework of language in social communication and do not consider that music can be developed before the existence of language. This assertion is not supported by sufficient evidence. As for why music must exist as a group communication signal, Mehr does not offer a convincing explanation (Lieberman, 2021). Both scholars’ arguments are limited to considering music as the natural production of sound rather than deeply analyzing the social-cultural evolution of music into the genre-cultural differentiation. Neither of them makes a profound distinction between the complexity of human society (both cultural and aesthetic) and the biological nature of the musical sound itself as a social signal. Musicality is a complex trait: it must be pointed out that the understanding of the multifaceted and interdisciplinary nature of musical evolution underlies this study. However, the assumption of two scholars focusing on a minimal range of causal factors (biological and organic social formation factors) is insufficient to explain the evolution of music in all its aspects (Killin, 2021).

2.3 Contemporary Music Evolution as a Social Phenomenon

According to the analysis above, Savage and Mehr discuss music evolution from a purely biological scientific perspective. Both scholars' data collection and analysis concentrate on the origin of music. Savage's and Mehr's research profoundly present the relationship between society and music evolution in a biological-anthropological framework. However, such research is detached from the substantive social-cultural evolvement of music. Neither do both scholars' research expand further to provide case studies in the development of contemporary musicology as cultural evolution.

This collective of articles takes case studies from contemporary music evolutions. These case studies analyze the development of the music of various genres throughout the 20th century in different regions. These studies fill the lack in Savage and Mehr's theory of musical evolution through the intermingling and complementary development of music and history, geography, culture, society, and even politics.

2.3.1 Institutionalisation of Music---Case Study on Irish Music

Savage's (2021) discussion on the collective social impact in the evolution of music provides an idea of music formalization. Music is a signal shared within a specific group to strengthen social bonds. A standard shared understanding, and appreciation of sound/music is required. Bradley Almond (2012) indicates that institutionalization refers to the systematic process of an institution achieving and maintaining its self-regulating and autonomous state through standardization. Concerning the music industry, the evolution and innovation of musical institutionalization by adapting to

different times, societies, and the surrounding environment are conducive to the inheritance of a specific music system among social groups. Almond chooses the evolution of Irish traditional music as a case study. Irish music today includes thousands of melodies, but most of them continue with musical traditions from the 19th century or earlier. As Savage said, the collective nature of music plays a crucial role in the survival of traditional music. Due to many social factors, such as the Great Famine in Ireland in the 19th century, the population of Ireland declined, and the inheritance of music culture was in crisis. The solution still took the form of working through social groups, starting with the Conradh Na Gaeilge (Gaelic Union) in July 1893. At the same time, other aspects of Irish society, such as the Church, are involved in rescuing traditional Irish music and cultural values. In 1935, the execution of the *Public Dance Halls Act* caused traditional music to reconsider its development in a controlled and commercialized environment. Still, the act also secured traditional music's status as a national symbol in competition with contemporary exotic music (Gedutis, 2005). It can be seen from this that the preservation of Irish traditional music originates from the unified goal of various forces in the society and, at the same time, keeps pace with the times and contacts with the popular elements of the current culture. Institutionalization essentially guarantees this integration and transformation of music and society.

Thus, Almond's case study on the evolution of Irish music strongly supports the traditional theory of evolution, "survival of the fittest". The standardization through institutionalization in the preservation of musical tradition also coherence with Savage's view on the continuity of the

existence of music within a collective social framework. The case study of Irish music presents Savage's theory of music as a collective social interaction activity while supporting Mehr's claim that music is a standard signal to characterize groups.

2.3.2 Independent Music

Savage and Mehr’s theory on musicology is limited to the social framework. There is a type of music that does not require a social group's collective participation. It is the origin of independent music creativity. Daniel Walzer (2017) analysis in detail how independent music involves. Independent producers' artistic and aesthetic preferences are inspired by personal choice, personality, and intrinsic value. It might contain external social influences. However, agreeing with Savage, in many cases, such creativity reflects merely the personal emotion and will of the musician. Turino (2008) argues recordings shaped pop culture is essential as more open-source technologies provide a platform for newbies to express their views. Such modern technology is wildly accessible with a reasonable cost and adjacent start-up. More importantly, a quick and accessible music production method provides musicians with more creative freedom and individuality. At the very least, independents no longer need a significant brand to start or monopolize their creative path. This evolutionary change in music also stems from business models. While recording studios play an essential role in the global music economy, they must constantly find new business models to generate revenue and stay afloat as technology changes. As competition and business models change, so does the innovation of opportunistic music entrepreneurs. This kind of personal production that

does not require professional music equipment can significantly reduce costs, so the big record companies tend to cooperate with independent music producers. Giving independent musicians the freedom to create creatively can stimulate creative potential while allowing companies to work more harmoniously with musicians. Independent musicians will have unparalleled freedom to develop their styles and produce music. This DIY autonomy inspires their creativity, whether the project is profitable or not. Therefore, the development of independent music production can be seen as a commercial evolution adapted to the market.

Indeed, the preservation and spreading of individual music require collective social action, at least a recipient, according to Mehr. Walzer also expresses the marketing method of independent music creativity, which is inevitably involved in both technology and social communication. The unavoidable need for indie music distribution to be connected to global media technology unless the creation is entirely private. Independent musicians generally use modern social software such as YouTube and internet music platforms Spotify and SoundCloud to publicize their work and spread it in the community (Taha, 2011). Network technology enables musicians and producers to excess their creativities without geographical restrictions. Furthermore, advances in technology allow for a productive flow of expressed ideas, thus explaining the “web studio” ideology. The Internet can also be seen as a new type of collective community. Although different from traditional society, the operation and communication mode of the Internet has evolved from conventional group communication. With the rise of the internet community, corresponding normative regulations have

also been proposed. Thus, the evolution of the internet independent music production from the commercial perspective coincides with the social-communal musicality of Savage and Mehr.

Strachan (2007) argues that there is a large community of amateur and semi-professional artists and businesses beyond commercial music, each dedicated to connecting their creativity with a sense of unique culture. These independent organizations are inspired to create art that opposes the ideologies expressed by the commercial music industry. But their interconnectedness and cooperation are still inseparable from sociality. Unique artists of different styles are connected because of their interests and creative inspiration to gain a foothold in the music community and resist the commercial monopoly of major music brands.

In sum, independent music creativity does not require the effort of the community. However, the circulation and inheritance of independent music are still inseparable from group communication, whether for commercial purposes or as a hobby.

2.4 Evolution of British Music---Case Studies on Multiculturalism

Since the Second World War, Britain experienced a radical social and cultural shift. Not only did the Cold War lead British society to a new social-political stage, but also the liberal, punk rock, and the “lost generation” culture-filled every corner of the British society. At the same time, while playing an essential role in the post-war economic reconstruction, immigrants from South Asia also brought subcontinental culture into Britain and merged with local cultural elements. The multicultural fusion accelerates the evolution of British music and pop

culture during the 1960s-1980s. There are two case studies on the famous rock band “Queen” by Guillaume Clement (2018) and Rajinder Dudrah (2011) on the evolution of Bhangra Music in Midland.

2.4.1 The Queen

The Queen is considered one of the most successful rock bands in British music history. Their songs undoubtedly represent the trend of popular rock culture in the 1970s-1980s. However, there is a lack of study on the social and cultural significance of how Queen promotes the evolution of British rock. Majorities tend to be attracted only by the legendary life of Freddie Mercury. Of the few recent studies on Queen, most come from musicology (McLeod, 2001) and analyze their position in the history of pop canon (Desler, 2013).

Queen is not only at the crossroads of various popular music cultures (heavy metal, glam rock, progressive rock, etc.), but the band's fusion of these music cultures has contributed to the development and success of British pop music around the world. Queen emerged in the early 1970s when the overlook of British pop was filled with new acts and sub-genres and became an essential part of the musical mainstream. In the 1980s, in order to adapt to the market, Queen introduced electronic music as the contemporary cultural trend in their music creation and expanded this fusion of rock's commercial market and artistic vision through touring performances.

Clement further points out that the evolution of Queen’s unique rock genre is closely linked to society and politics. Their style stems from several prominent subcultures of the 70s, from psychedelic rock and the hippie

movement to glam rock. In the 1980s, Freddie Mercury adopted a completely different style, with much shorter hair and his signature mustache, which reflected the changing subculture in Britain and his sexuality and the changing nature of British homosexual culture. Almost every single of their albums showcased a different stratum of the British rock scene at the time. While the band itself clarified its apolitical nature, some songs still feature references to widespread political and social issues such as the Cold War, unemployment, and race.

Therefore, the evolution of Queen, both in terms of style and meaning of songs, is full of the absorption of the surrounding culture and social environment. At the same time, through its influence, these social phenomena are made public through music. Queen's evolution is a collective synthesis of social and musical influences.

2.4.2 British Bhangra Music

British Bhangra is a pop music genre that incorporates Punjabi beats, music and lyrics, British pop, R&B, soul, reggae, grime, and other world sounds. This genre of music comes from Punjabi immigrants after the war. Bhangra music has been widely spread in advertisements in multicultural cities worldwide and songs and music in Bollywood movies since the beginning of the 21st century.

Susan Smith (1994) introduces a theory of "soundscape", which is essential in asserting the status of music as a distinct type of sound with sociocultural significance and quality. This sound needs to be placed alongside research that prioritizes a vision to better understand the city and culture. In this case, the music as a soundscape is both local and global. Such fusion music

genres are influenced by music worldwide while localizing themselves to adapt to the surrounding society.

South Asian immigrants in the Midlands initially use traditional music to shape their sense of self-identity. The early Bhangra music originated from the folk songs of Punjabi and English sung by South Asian immigrants in pubs in the 1960s, combined with local British culture. In the 1980s, Bhangra quickly spread across the UK South Asian community, especially among South Asian youth. Bhangra music began to draw inspiration and fusion in reggae, soul, jazz-funk, hip hop, and British pop.

Monia Acciari (2014) conducts research from the social networking perspective of South Asian music growth in the UK. British Asian musicians and practitioners meet during the BASS 'Made in Britain' festival in Birmingham to debate the industry's future on the local and international stage. The discussion focuses on the institutionalization and inheritance of music through the connection between generations. Using Apache Indian as an example, the author attempts to demonstrate that the academy teaching system contributes to the heritage of modern Bhangra music. Apache Indian aims to harmonize societal values, embrace and integrate local culture through music education and highlight what academia and the arts can do for local communities. The evolution of Bhangra music is achieved through networking with previous generations of musicians and the surrounding society, to gain a foothold in society and present a reverse influence to the surroundings (which is in agreement with Mehr's theory as discussed above). Acciari summarises the elements of today's multicultural music, namely: (1) the importance of writing and

talking about emotions; (2) the need to embody ethnic and cultural integration; (3) The notes, sounds, and lyrics are fine-tuned to appeal to specific audiences and use the language of British Asian artists as a vessel to reach international audiences; (4) the use of technology (internet) is critical to the creative process.

In sum, the evolution of British Bhangra music again represents the sociality of music. Whether creation or dissemination, it is necessary to conduct horizontal exchanges with the surrounding society and further integrate local culture to achieve the spread of influence beyond the ethnic boundaries while maintaining the traditional characteristics of the nation. Some standardized measures are essential to ensure the inheritance of music while learning from the local culture.

2.5 Psychological and ecological factors

Psychological and ecological factors might be considered as critical elements of the evolution of culture. The phenomenon of these factors has been described in many papers (Buskell, 2019; Georges, 2017; Miton et al., 2020; Scott-Phillips et al., 2018; Smith & Georges, 2015). In particular, expanding usage of these terms developed significantly through a paper by Scott-Phillips et al. (2018) that explained Cultural Attraction Theory (CAT). According to the article, cultural attraction as a key part of the theory could be defined as the probability of choosing one particular cultural aspect over another. In other words, CAT explains why and how consumers prefer one cultural artifact over others as well as how these preferences have changed or evolved across time. Another important aspect is that these particular factors, so-called factors of attraction, significantly influence culture and its

evolution.

Scott-Phillips et al. (2018) identified two main factors—psychological and ecological—and later provided global (universal) and local levels as an additional measurement. It is important to note that some scholars consider psychological factors equal to cognitive ones (Sperber & Hirschfeld, 2004), which is potentially convoluted. However, Scott-Phillips et al. (2018) decided to base their explanation on the classical determination of psychological factors of attraction.

The authors defined psychological factors as "preferences, dispositions, cognitive competencies, beliefs, acquired skills, know-how, memories, and other aspects related to psychology that are held by a biological individual and that influence a cultural item that an individual owes" (Scott-Phillips et al., 2018). Therefore, it might be said that psychological factors are the inner processes of people that have an impact on cultural processes, cultural items, and the approaches to their development. These processes might be devoted to the learning capacities of particular technological invention or art style preferences, for example (Sperber & Claidière, 2008). However, the essential point is that psychological factors imply an internal environment that is based on internal individuals' properties.

Conversely, ecological factors have the opposite meaning. These factors have an essence of the external environment (Sperber & Claidière, 2008). More precisely, the authors (Miton et al., 2020; Scott-Phillips et al., 2018) identified that ecological factors widely encompass the external biological and physical environment. Ecological factors may include the following concepts:

- social structure
- the physical environment
- behaviors
- artifacts
- technological innovation (Scott-Phillips et al., 2018)

Languages as a part of social community, a ritual ceremony as behavior, and climate as an element of physical environment are all examples of these concepts. Also important to mention, these phenomena and processes largely affect changes in culture (Sperber & Claidière, 2008). Therefore, it is possible to define ecological factors as external elements primarily from the physical world that are characterized by various features that simultaneously influence cultural evolution.

Also of significance is that both psychological and ecological factors can be either global or local (Scott-Phillips et al., 2018). Global factors are characterized by universality and are usually used among a large population whereas local factors are characterized as specific and more applicable to small communities (Scott-Phillips et al., 2018; Sperber & Claidière, 2008).

Later, these same authors expanded the concepts of psychological and ecological factors to the more specific topic of musical evolution (Scott-Phillips et al., 2021). For example, a position of rhythms is considered a global psychological factor while “knowledge of existing musical genres in a local community” and prosodic biases based on a mother’s language (Abboub et al., 2016) are examples of local psychological factors. A good example of a global ecological factor is the “natural sounds of people's voices,” whereas the usage of local materials such as bamboo and wood

(Wegst, 2008) in the production of musical instruments is a valuable local ecological factor. As can be seen from the above examples, both local and global ecological and psychological factors have significant effect on the evolution of music.

The theory of psychological and ecological factors is widely used in papers dedicated to cultural evolution and related phenomena, especially musical evolution. Additionally, scholars are paying more and more attention to ecological factors in particular.

For example, following the above-referenced paper and the concept of factors of attraction, Miton et al. (2020) conducted research regarding restrictions on the cultural evolution of rhythms. They identified psychological factors as "capacities and dispositions," whereas ecological factors are defined as "aspects of the physical environment that impose constraints and offer opportunities to human action and interaction" (Miton et al., 2020). The scholars explored the influence of drum pads as an ecological global factor on the evolution of rhythms, which indicates the importance of the ecological factors of attraction on musicality.

Other authors decided to explore how ecological factors impact the composers' evolution (Georges, 2017; Smith & Georges, 2015). In particular, some studies investigate how composers follow each other and vary from one another as well as how their music has changed across time. Certain ecological factors' influence on evolution is measured. More precisely, a list of "ecological measures" or "ecological categories" was created that includes, for example, geographical location, school association, and instrumentation emphases (Smith & Georges, 2015).

In summary, one could emphasize that psychological and ecological factors are essential concepts that have significant impact on cultural evolution, and especially on musical evolution. As factors of attraction, they identify why people in global or local communities favor one cultural aspect to another and why these preferences have changed over time. While psychological factors are primarily related to each individuals' internal processes, ecological factors cover the external environment and related phenomena. Because this paper is focused on external or ecological factors, the following subchapters are dedicated to categories of that element and describe the factors within an ecological concept that influence musical evolution.

2.5.1 Political factors

As ecological factors are considered external, there are particular social structures involved with this type of factor that influence musical evolution. Specifically, there are political factors. Politics and the political situation in a particular region might greatly affect the production and consumption of music, the mood of songs and artists, the development of genres, and other related phenomena (Lockard, 1996; Meier, 2019; Simpson, 2017; Wang et al., 2021; Wood, 2014).

Myriad political events, such as war, can influence the evolution of music. Several studies have described the influence of wars on changes in music preferences, music genres, and music itself (Lockard, 1996; Pope, 2012; Takeshi, 1998; Wang et al., 2021).

Some authors claim that wars stimulate intervention of specific cultures from one country to another that occurs because wars can imply physical

intervention into another country (O'Connell, 2011). For example , some papers are dedicated to the influence of the United States on changes in music, musical elements, and musical education that happened in Japan after World War II (Pope, 2012; Takeshi, 1998). Pope (2012) introduced the term "exoticism," saying that "exotic music came from foreign countries (in this case the USA) and therefore give pleasure to the audience being a part of a foreign culture." An example of exoticism in post-war Japan is the popularity of Arabian songs and melodies as well as the development of Arabian jazz ("jazu songu") that came from the United States.

Another example of war's effect on music is the case of Malays (Lockard, 1996), as World War II impacted the evolution of this ethnic group's music genres and music industry significantly. Before the war, there was a predominance of traditional and folk music characterized by important localized themes. However, in the second half of the 20th century after the war, the influence of Western and a few Eastern cultures (e.g., Chinese and Indian) significantly affected the country's music industry and made it more modernized and international.

Therefore, it can be said that wars as political factors significantly influence musical evolution by uniting and synthesizing different cultures (Gable, 1990). World War II, arguably one of the most meaningful political events of the 20th century, could be considered the biggest military trigger of global musical evolution (Wang et al., 2021).

Other political issues are also founded as important factors in musical evolution. For example, sometimes music is used to unite citizens and solve internal problems (Lockard, 1996; Wood, 2014). To illustrate, Wood (2014)

explored the development of patriotic songs caused by the young US government's desire to provide harmony and unity for its citizens. Similarly, Lockard (1996) found that some songs were influenced by dissatisfaction with various political issues such as colonialism, polygamy, and the growth of urbanization.

Other studies have explored the development of particular genres that established the identity of a particular group, community, or even country (Kastin, 2010; Kwame Harrison & Arthur, 2011; Wood, 2014). An excellent example of this phenomenon is the sharp emergence and growth of the rap genre in the United States in the 1970s (Kwame Harrison & Arthur, 2011). One reason for the genre's evolution was desire for representation of black culture.

Before this genre began dominating in black culture, the group identity was conditioned by jazz (Kastin, 2010). Again, similar to rap, the development of jazz, for which the overwhelming majority of representatives were black people, was caused by a drive to identify "black power" and "black pride" as well as to resist the typical oppression of the time (Kastin, 2010).

Some genres have developed and become extremely popular as a means to show the identity of an entire nation. For example, the predominance of country music in the mid-20th century in the United States was largely due to the desire of many American people to be associated with the traits reflected in country music, such as patriotism, family values, and nostalgia (Meier, 2019).

Conversely, other genres were developed in protest and opposition against particular political regimes as well as identification with them (Von Faust,

2016). Heavy metal is a good example of such a genre (Brown, 2021; Gracyk, 2016; Von Faust, 2016). Heavy metal is often described by scholars as not only a genre but also a subculture that is characterized by confrontation (Gracyk, 2016). Young people in the USSR have shown this resistance as they confronted the communist regime via the heavy metal genre that came to the country after the Cold War (Von Faust, 2016).

Overall, musical evolution can be triggered by many political aspects. Some genres, songs, and other musical elements are developed because people can unite and overcome difficult times through music. In other cases, certain musical items have evolved because of their ability to identify important properties of social groups, communities, and nations. Finally, musical evolution can also occur from dissatisfaction with political issues.

2.5.2 Demographic factors

A demographic analysis allows identification of factors such as gender, age, and race (LeBlanc et al., 1999). Some literature has proven that these parameters impact music preferences significantly (Kumar & Akash, 2020; LeBlanc et al., 1999). For example, one research study identified that gender and age affect music preference, such as females preferring Islamic music compared with males favoring hip hop and rap (Kumar & Akash, 2020). Moreover, there are significant differences between preferences of genres in various age groups (Clark & Giacomantonio, 2015). When considering genre preference as a feature of musical evolution, we can claim that these factors are important to its development.

More specific research demonstrates how gender and age influence evolution. To illustrate, Tai et al. (2018) conducted a study about the

evolution of instruments such as the violin. The visual appearance of the instrument changed in the 17th century to make it more appropriate for women's voices, which had gained popularity and begun to replace men. Similarly, in Malaya (Lockard, 1996) the popularity of Chinese pop music began with the increase in women singers who were invited to perform at many amusement park cafes in the country.

In the previous section, the impact of particular racial groups on musical evolution was briefly described (Kastin, 2010; Kwame Harrison & Arthur, 2011; Wood, 2014). However, the dominance of certain genres, singers, songs, and compositions may not only be a political act but perhaps also an effect of the peaceful intervention of a race's culture (Kwame Harrison & Arthur, 2011).

For example, in Malay, the development of pop music and culture was largely influenced by an influx of Chinese and Indian culture after World War II (Lockard, 1996). In addition, Western culture intervention on local musical evolution came from those same Chinese and Indian representatives who attended English-speaking schools.

Another significant example is the evolution of British Asian music in the United Kingdom (Acciari, 2014),specifically, the influence of the Indian national group, which helped develop genres such as bhangra (Dudrah, 2011).

In summary, musical evolution can be influenced in many ways, such as by demographics like sex, age, and nationality. The emergence and development of some genres, styles, singers, and other musical attributes are connected to the influence of particular nationalities and gender groups

as well as individual's age preferences.

2.5.3 Social and cultural factors

Social and cultural factors imply particular characteristics related to society and the environment in certain areas. For example, by considering the evolution of traditional Irish music, Almond and DeJordy (2012) identified four values—commercial, moral, ideological, and expressive—that determine the occurrence and development of musical attributes. During certain historical periods, these values were impacted by social practices dominating Irish society.

Cultural factors assume the presence of particular societal characteristics. Darchen et al. (2022) explored the factors influencing electronic music in Brisbane, Australia, and they found that this genre developed from cultural peculiarities like the city's isolation from other settlements and the consequent appearance of a translocal music scene. Additionally, this genre's evolution was justified by other factors like community radio stations and the sub-tropical climate that emphasized the importance of outdoor parties.

Similarly, Webb (2007) highlighted the difference between the domination of genres in London and Bristol. For example, the same drum and bass genre sounds different between those two regions due to Bristol's cultural features, such as the do-it-yourself (DIY) aspect and their anti-corporate position.

Such specific cultural characteristics of myriad regions influence the emergence, dominance, and development of particular genres anywhere in the world like Toronto (Finch, 2015) or Los Angeles (Rashidi, 2020). In

summary, one could say that the cultural peculiarities of a country's citizens and even whole cities reflect their routine, day-to-day lives and also reflects their musical preferences and therefore the development of particular music attributes, such as genres.

2.5.4 Technological factors

The Internet and other related digital technologies play a key role in both music and musical evolution. It should be noted that technology is especially important to the development of independent music (indie music), which has production based on the DIY concept (Darchen et al., 2022; Kruse, 2010; Walzer, 2017). There are many reasons why the Internet and the evolution of music (indie music in particular) are connected.

First and foremost, Wang et al. (2021) stated that the Internet erases the differences between music listeners level of wealth. In other words, the Internet contributes to the popularization of music. While in previous centuries music and the possibility to listen to it was considered a privilege for wealthy people, nowadays it has become far more accessible to individuals from all social classes, largely via the Internet.

Second, the Internet is connected to economic and educational factors that influence musical evolution. For example, the Internet provides more possibilities and access to knowledge for education, and it has been proven that higher levels of education have a positive impact on the development of the indie music genre (Walzer, 2017). Moreover, the Internet and digital technologies provide opportunities to reduce production and distribution expenditures, which affects the economical range of musicians (Kruse, 2010).

Last but not least, the Internet is tightly connected to the concept of globalization. Musicians might reach far beyond their local societies (Darchen et al., 2022) and distribute their music all across the world. Online marketplaces, YouTube, and virtual scenes provide opportunities to expand musical attribute dominance across various regions and societies (Walzer, 2017).

Overall, the Internet and digital technologies influence musical evolution in several ways in the modern era by giving different social classes access to music, providing economic and educational benefits, and enhancing music attribute promotion through globalization.

Chapter 3. Methodology

3.1 Latent Dirichlet Allocation (LDA)

In order to answer the first research question, the Latent Dirichlet Allocation or LDA model was conducted. This method allows exploring topics that are valuable in particular documents (*Introduction to Latent Dirichlet Allocation*, n.d.). LDA is one of the topic modeling techniques that help to examine latent topics extracted from documents (Alash & Al-Sultany, 2020). Hence, LDA is the appropriate method for this research because with a study of topics that were meaningful for a specific period of time, it is possible to identify how their importance has changed over time. Therefore, an evolution process of topics might be constructed (Edison & Carcel, 2021). In this chapter, the description and principles of LDA are defined, and an application of the method to the case is presented.

A short history of LDA and topic modeling are described in this subchapter. Before the establishment of this model, the majority of authors use Latent

Semantic Indexing (LSI) in order to identify topics of words and at the same time decrease limitations related to dimensionality (Berry & Young, 1995; Deerwester et al., 1990). The approach allows for gaining significant compression in big texts and reduces shortcomings related to description length (Deerwester et al., 1990).

Later, the more advanced model of LSI which is called probabilistic Latent Semantic Analysis (PLSI) was developed (Hofmann, 2004). Despite the fact that it overcame some gaps in LSI, there still were disadvantages to this approach. For example, the mechanism of the linearity of parameters leads to overfitting (Blei et al., 2001). Moreover, an issue with the calculation of the probability not in the training set brings to the limitations in an assumption of exchangeability for the words (Cifarelli & Regazzini, 1996). The LDA model helps to overcome this shortcoming of exchangeability (Blei et al., 2001).

LDA represents the approach that allows creating topics of words from documents with certain probabilities (Jelodar et al., 2018). In a more general explanation, via LDA it is possible to construct a model that calculates a generative probabilistic of a corpus, or a collection of documents (Blei et al., 2001). In other words, there are documents that consist of random sets of latent topics, and every topic has a particular probability distribution of connected words (Blei et al., 2001).

For the research of music genres, particular steps were conducted. First of all, the database was created. The data for this database is taken from the MusicBrainz portal which is one of the largest music encyclopedias with various sources of data regarding music. The database for the research is

based on the already established database from the portal (*MusicBrainz Database / Schema - MusicBrainz*, n.d.) with the selection of some variables.

The next step was to identify topics of genres with respect to LDA based on the database. LDA model was created via Python. More precisely, Gensim is a Python library with machine learning algorithms that were applied. Gensim is considered one of the most appropriate and precise tools for LDA (Habibabadi & Haghighi, 2019; Kastrati et al., 2020; Min et al., 2019). The data was cleaned as a part of preprocessing stage with the final of 15869 artists out of initial 40000 artists who performed in a period from 1991 to 2010. This period of time was chosen so as to provide the modernity of genres. More precisely, this period of time was divided into three sub-periods in order to show the distribution of genres in different periods and consequently their evolution. These sub-periods are from 1991 to 1999 (called the 1990s), from 2000 to 2005 (called the 2000s), and from 2006 to 2010 (called the 2005s).

The primary stage was to indicate the coherence score or topic coherence. The coherence score in LDA reflects the similarity of words in each topic (Chehal et al., 2020). More precisely, the degree of similarity between high-scoring words is calculated. It might be said that the higher the coherence score the better a topic is (Chehal et al., 2020).

In order to calculate the coherence score, the following steps were conducted (Chehal et al., 2020):

1. The top n frequently occurred words were indicated in every topic.
2. The pairwise scores for the frequently occurred words were computed

via UCI measure:

$SCORE_{UCI}(w_i,w_j)=logp(w_i,w_j)/p(w_i)P(w_j)$ (1)

3. The pairwise scores were aggregated that were expressed with the Eq. (2):

$CoherenceScore=\sum i<jscore(w_i,w_j)$ (2)

where w_i, w_j are the top frequently occurring words.

4. The means of the coherence scores were calculated.

Moreover, it is possible to identify the optimal number of topics based on the coherence score. This point is reached when the number of points and the coherence score are high enough so as to not provide further value through growth (Alash & Al-Sultany, 2020). These optimal points for the topics of the genres were found via elbow technique and curve for each established time period (the 1990s, the 2000s, the 2005s).

A number of appropriate topics for each time period were identified based on the above procedure. Then, in terms of LDA, the topics of genres were created for three periods of time. The topics include genres that are indicated as the top 30 most salient terms from documents. The high saliency of a word implies that this term is more appropriate to define a particular topic. Term saliency is calculated as follows (Chuang et al., 2012):

*Saliency (w) = P (w) * distinctiveness (w) = P (w) * [sum_t P(T|w) * log (P(T|w)/P(T))]* (3)

where w - is a term (word); P (w) - the likelihood of the frequency of a term; P (T|w) - the likelihood that observed word w was generated by latent topic T; P(T) - the likelihood that any randomly-selected term w was

generated by topic T. Distinctiveness provides information about how term w determines a particular topic so if a term is contained in every topic, its distinctiveness is small. Hence, by multiplying distinctiveness and the likelihood (P), a saliency is found that determine a classification of a composition of a topic with an identification of generic and distinctive terms.

Another important metric of words is relevance. This measurement specifies the role of a term inside a topic. In other words, it reveals to what degree a term is related to a topic. Sievert & Shirley (2014) defined the relevance with the following formula:

$$Relevance\ (w|\ t) = \lambda\ *\ p\ (w|\ t) + (1-\ \lambda)\ *\ p\ (w|\ t)/p(w) \quad (4)$$

where w - is a word; t - is a topic; λ - is a lambda that weight the Pr of a word within a topic in terms of its lift (Sievert & Shirley, 2014). In particular, the aim is to find the most appropriate λ with an assumption that λ =1 is the familiar ranking of terms in decreasing order while λ =0 is sole term by its lift. The relevance reflects relations between terms and topics, and the probability of the entry of a particular term into a topic.

The music genres were identified as the most relevant terms. Each topic contains different genres (words) with a particular estimated frequency. Every topic has a form of a “bubble” whose size reflects marginal topic distribution. In other words, the number of words that are included in each topic is reflected.

The topics are located on the intertopical distance map with multidimensional scaling. The x-axis is the transverse axis that is called

PC1 while the y-axis is the longitudinal one (Liu et al., 2019). Moreover, it should be noted that the proximity of each “bubble” indicates the proximity of each topic.

Besides, the so-called “Innovative index” was created. Firstly, the “Non-innovative index” that measures the similarity of genre composition between adjacency periods was calculated. In other words, it looks at how similar words in each cluster or distributions of words are close to each other in different years. Then, the differences between genres with respect to heterogeneity were calculated as *1-” Non-innovative index”*. The “Innovative index” allows identifying whether genres have evolved in terms of their proximity and separation. It shows whether a structure of topics change through every year.

In order to create “Non-innovative index” and consequently “Innovative index” the Hellinger distance was applied. The Hellinger distance allows measuring the distance between two probability distributions (Mu et al., 2019). First and foremost, Bhattacharyya coefficient (BC) that indicates the similarity between two probability distributions is calculated with the following equation (Mu et al., 2019):

$$BC\,(p1, p2) = \Sigma\sqrt{p1(x)p2(x)} \quad (5)$$

where p1 is the probability distribution of one topic while p2 is the probability distribution of the second topic. Therefore, via Bhattacharyya coefficient it is possible to identify “Non-innovative index” that show the similarity of genres distributions between two adjacency time periods. The value of BC varies from 0 to 1 and consequently the closer value for a particular year to 1 the closer probability distributions.

Then, “Innovative index” was evaluated via the Hellinger distance (H). On the contrary, the Hellinger distance may indicate how far the distributions are from each other or, in other words, the differences between distributions (Mu et al., 2019). Hence, the differences between genres’ compositions or topics’ distributions might be calculated with the equation:

$$H(p1, p2) = 1 - \sqrt{\Sigma}\sqrt{p1(x)p2(x)} \quad (6)$$

3.2 Cointegration test, Granger-Causality test, and Linear Regression

Due to the reason that this research has time series data, there is a need to use cointegration test so as to indicate relations between variables and answer the second research question. Cointegration test allows identifying whether variables have stochastics trends or stationary ones. In other words, there is a test of hypothesis that *z* is a stochastics series (Abadir et al., 2013). Hence, the null hypothesis might be stated as the series is not stationary while alternative hypothesis is that the series is stationary (Mills, 1990). The stationary means that a model has descriptive statistics of its variables such as means and variances permanent over time and consequently have precise data for predictions.

So as to check the hypotheses the Augmented Dickey Fuller (ADF) test was conducted. The test was performed so as to look at stationary of series at the particular level of significance. The following equitation is applied for the ADF test:

$$y_t = \beta_t + \alpha y_{t-1} + \varphi\, delta\, Y_{t-1} + \varepsilon_t \quad (7)$$

where t is the time index; α is an intercept constant; β is the coefficient on a time trend; y_{t-1} is lag 1 of time series; delta Y(t-1) is the first difference of

the series at time (t-1); φ is the coefficient presenting process root; ε is an independent identically distributes residual term.

The critical values for the levels of significance equal to 1 %, 5 % and 10 % were found through the DF-GLS test. Then, the ADF test was conducted for time series that are "Innovative Index", "Females' power", Internet users, and Number of Non-EU immigrants by taking into account ε as the residual series and an assumption that $\theta = 1$. For the test we have to reject the null hypothesis of non-stationary if the obtained results are less than the critical values. So as to perform the ADF test the library *tseries* was applied in *R*.

The next step was to conduct Granger-Causality test. This test is applied so as to explore whether one time series variable might be used so as to predict another time series variable and is conducted with an assumption of Eq. 8 (Mills, 1990).

$$P[Y(t+1) \in A \mid \Upsilon(t)] \neq P[Y(t+1) \in A \mid \Upsilon_{-x}(t)] \quad (8)$$

where P is probability; Y(t+1) is time series; A is an arbitrary non-empty set; $\Upsilon(t)$ and $\Upsilon_{-x}(t)$ are the information available as of time t in the entire universe with X excluded in the second case. Therefore, if Eq. 8 is accepted it is valid to say that H0 is rejected, and X causes Y.

In other words, this test allows to look whether one time series variable influence the second time series variable. For this test there are also two hypotheses: H0 is that time series X do not cause time series Y whereas H1 is time series X cause time series Y. The rejection of null hypothesis is based on the assumption that the obtained p-value is smaller than 0,05. The Granger-Causality test was performed in *R* with the library *lmtest.*

Finally, multiple linear regression model was constructed so as to find out

values of variables (Mills, 1990). Regression model reflects how regressors influence the dependent variable. More precisely, a vector autoregressive model (VAR) was applied so as to assume the multivariate time series. For this aim variables the function *tslm* was applied in *R* that corresponds to the following equation for time series variables:

$$X(t) = \sum A\tau X(t-\tau) + \varepsilon(t) \quad (9)$$

where $X(t)$ is a d-dimensional multivariate time series; $A\tau$ is a matrix for every τ; and ε is a white Gaussian random vector (Mills, 1990).

The "Innovative Index" calculated during LDA analysis was considered a dependent time series because it indicates the evolution of genres based on the differences that occurred between them during an observable time period. The independent time series are based on the literature review. However, as was already mentioned the majority of factors that influence music evolution have qualitative nature (Kastin, 2010; Kwame Harrison & Arthur, 2011; Lockard, 1996; Meier, 2019; O'Connell, 2011; Pope, 2012). Therefore, there was necessary to highlight measures that might be quantitative. The final selected variables are described in the chapter Data.

Chapter 4. Data

4.1 Data for LDA analysis

So as to explore the evolution of modern music evolution in the UK the database from the portal MusicBrainz was constructed. For the precise analysis, the following variables were chosen:

1) name - the name of an artist;
2) other_tag - additional tags related to an artist such as a country, genre, or activity;

3) ISNI code;
4) genre - a particular genre related to an artist;
5) Born in - where an artist was born;
6) Area - a region where an artist is identified with. For this variable the tag of United Kingdom (UK) was established so as to provide data only for this region;
7) Founded in - where an artist was founded;
8) Gender;
9) Dissolved - how long an artist was performed;
10) Type - whether an artist is a group or an individual;
11) Founded - when an artist started their performance;
12) Sort name - a variant of the artist's name.

However, the main attention is paid to the genre and other_tag variables because they contained the necessary words that were used for the LDA analysis. For each selected time period the following number of genres was identified (Table 1). It should be noted that some genres have different writing for the same genre (for instance, ‘electroni’ and ‘electronic’) and they should be counted as the same words.

Period	Top 20 genres	The overall number of types of genres
1990s	'rock': 51, 'alternative roc': 49, 'electronic': 43, 'punk': 42,	293

	'indie roc': 25, 'folk': 20, 'drum and bass': 17, 'britpo': 17, 'metal': 14, 'death metal': 14, 'techno': 14, 'drum and bas': 14, 'indie rock': 13, 'pop': 13, 'britpop': 12, 'indi': 12, 'downtemp': 11, 'alternative danc': 11	
2000s	'rock': 126, 'alternative roc': 59, 'punk': 54, 'indi': 40, 'indie rock': 39, 'electronic': 37, 'indie roc': 37, 'electroni': 36, 'fol': 33, 'pun': 28, 'meta': 27, 'po': 24, 'pop': 24, 'thrash metal': 24, 'indie po': 23, 'roc': 20, 'heavy meta': 19, 'death meta': 18, 'indie': 18, 'folk': 17	346
2005s	'rock': 232, 'indi': 161, 'alternative roc': 116, 'meta': 84, 'indie roc': 65, 'po': 64, 'electroni': 62, 'pop': 60, 'punk': 59, 'pun': 55, 'roc',: 50, 'indie rock': 49, 'indie po': 47, 'fol': 42, 'doom meta': 40, 'electronic': 39, 'hard roc': 38, 'grung': 37, 'indie': 36, 'blue': 33	401

Table 1. Description data of genres

4.2 Data for the regression analysis

As it was already noted the control variables were selected based on the literature review. These variables reflect some important aspects described in the literature review, but they are numeric continuous variables, at the same time. Moreover, it is important to note that data for this question have time series form. Hence, the changes of variables' values are examined. All in all, there is the following description of the dependent and independent variables (Table 2).

Variable	Description	Mean	Standard deviation
"Innovative Index"	The differences of genre composition between adjacent periods, $0 < I < 1$	0.3463	0.0980
"Female's power"	Median weekly earnings for full-time female employees, in GBP	320.95	66.596
"Immigration flow"	Number of Non-EU immigrants entering the United Kingdom, in thousands	256.9	84.939
Internet users	The number of Internet users	23031016	20530850

Table 2. Description statistics for the variables

Firstly, such demographic factor as sex plays a role in the preferences of particular genres and therefore their development (Kumar & Akash, 2020; LeBlanc et al., 1999). The dominance of particular genres might be explained as the domination of males' opinions in a society, or "males' power" (Schaap & Berkers, 2020). Therefore, it might be suggested that changes in women's positions in a society, or in other words "females'

power" may in some ways influence the evolution of music. In order to evaluate "females' power" the data of "median weekly earnings for full-time female employees" was used. An increase in this economic parameter may indicate that women receive more opportunities and influence in society (Fang & Walker, 2015; Javdani & McGee, 2019). The data for this indicator in the period from 1991 to 1996 was taken from archive databases (*Average Salary between 1980 and 1997 - Office for National Statistics*, n.d.) while data between 1997 to 2010 is based on modern sources from Statista (*Full-Time Weekly Salary in the UK 2021, by Gender*, n.d.). As can be seen from Figure 1 there was a gradual increase in the UK's women's salaries during the observed period. Hence, females' economic position enhanced from 1991 to 2010.

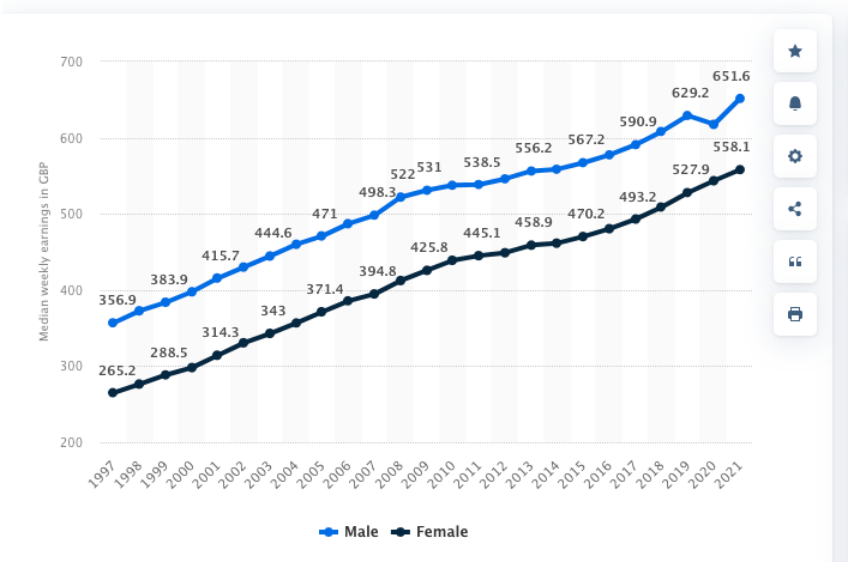

Figure 1. Median weekly earnings for full-time female employees, in GBP.
Source: Statista.

Secondly, it was identified through the literature review that music and, in particular, genres are used so as to show the identity of a particular nationality or race (Lockard, 1996; Meier, 2019; Simpson, 2017; Wang et

al., 2021; Wood, 2014). Besides, it was identified that Asian immigrants have a great effect on the emergence and development of some genres in the UK (Acciari, 2014; Dudrah, 2011). Hence, a number of non-EU immigrants in the period from 1991 to 2010 was found (*Long-Term Migration Figures UK 2020*, n.d.). It is shown in Figure 2 that there was a sharp growth of non-EU immigrants in 1997 with the subsequent slight decrease in the next years.

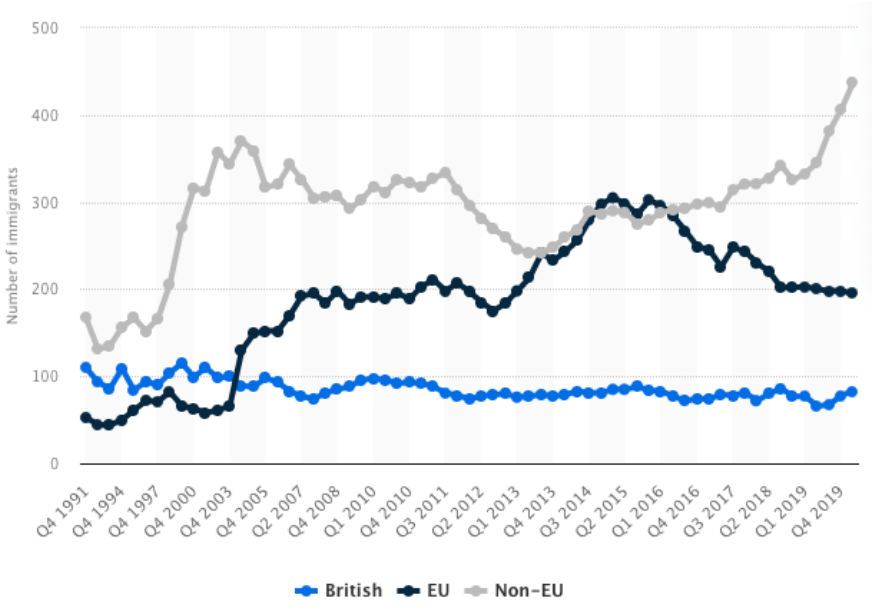

Figure 2. A number of immigrants entering the United Kingdom, in thousands. Source: Statista.

Thirdly, it was found that the Internet had a great influence on the development of genres and music in general in the 21st century (Darchen et al., 2022; Kruse, 2010; Walzer, 2017). Therefore, the number of Internet users in the UK between 1991 and 2010 was taken as one more independent variable. The number of Internet users seems to be the most appropriate variable in this case due to the reason that Internet appeared and started to spread in the 1990s. Therefore, Internet is the most suitable technology that might be applied in this case. Despite there are some other technologies that

are meaningful for music such as, for example, music platforms as Spotify and Apple Music, they were launched only in 2006 and 2015 respectively that means they are not suitable for this research.

The percentage of Internet users based on the data from the World Bank (*Great Britain - Place Explorer - Data Commons*, n.d.) was multiplied by the total number of the UK's population so as to find the number of Internet users. It is identified that at the beginning of the 21st century there was a dramatic increase in Internet users. However, after 2004 the growth became more gradual. The number of Internet users in the UK by the end of the observed period made up more than 85 per cents.

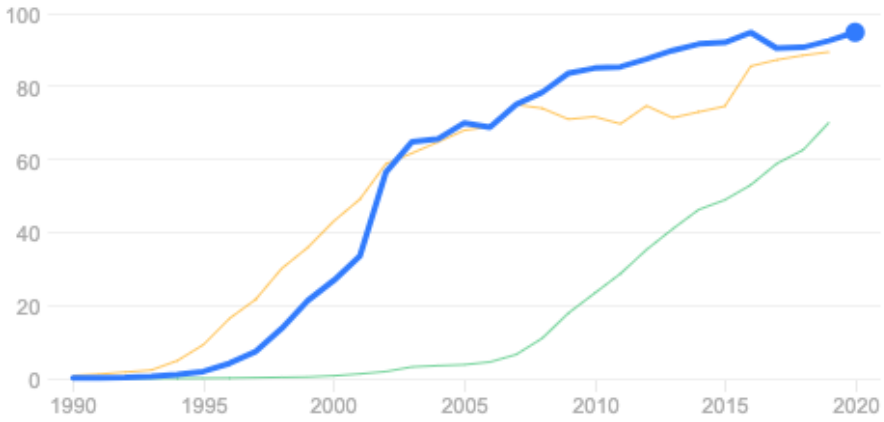

Figure 3. The percentage of Internet users in the UK. Source: World Bank.

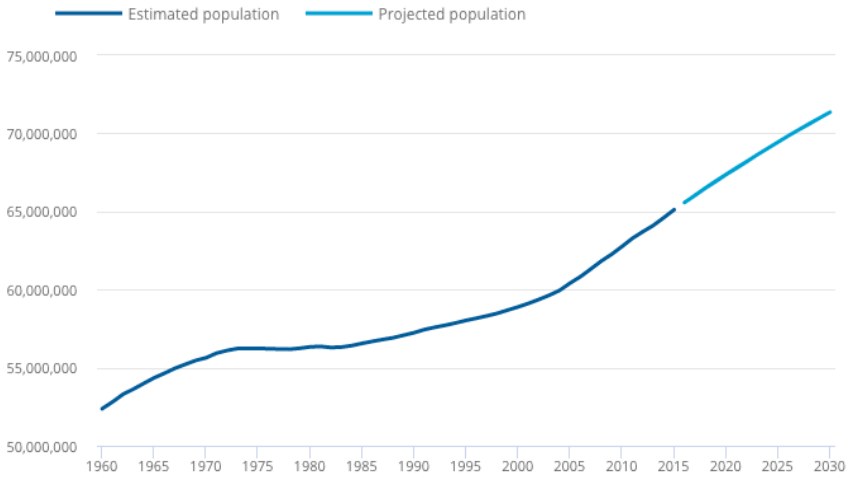

Figure 4. UK population estimates and projections. Source: Office for National Statistics.

Chapter 5. Empirical results

5.1 LDA results

First of all, the coherence scores for three time periods were calculated. As it was already noted (see Methodology) the coherence score allows for identifying the most optimal number of topics. According to the results, the following optimal numbers of topics were indicated: 24, 57, and 58 topics for each time period respectively. The coherence scores for every period are presented in Figures 5, 6, and 7. It might be concluded that the number of topics has increased more than twice in the 21st century since the 1990s. In other words, there is more diversity in genres for the reviewed period.

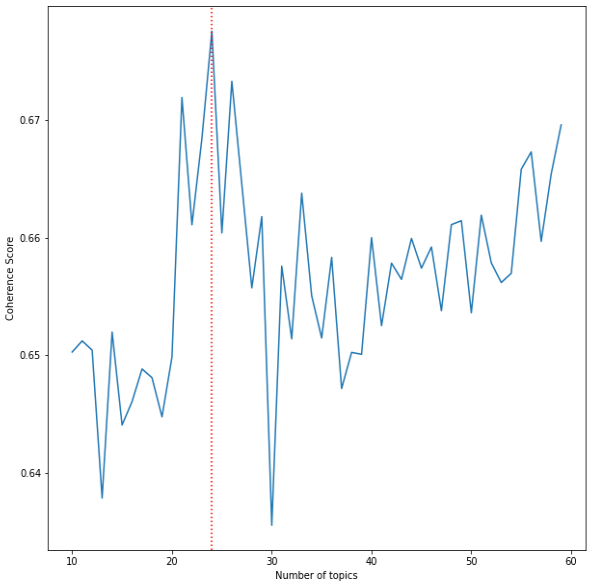

Figure 5. The coherence score for music genres in the 1990s

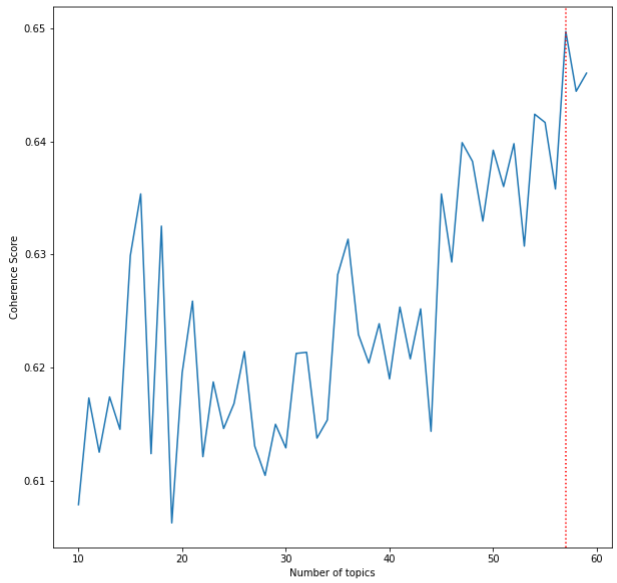

Figure 6. The coherence score for music genres in the 2000s

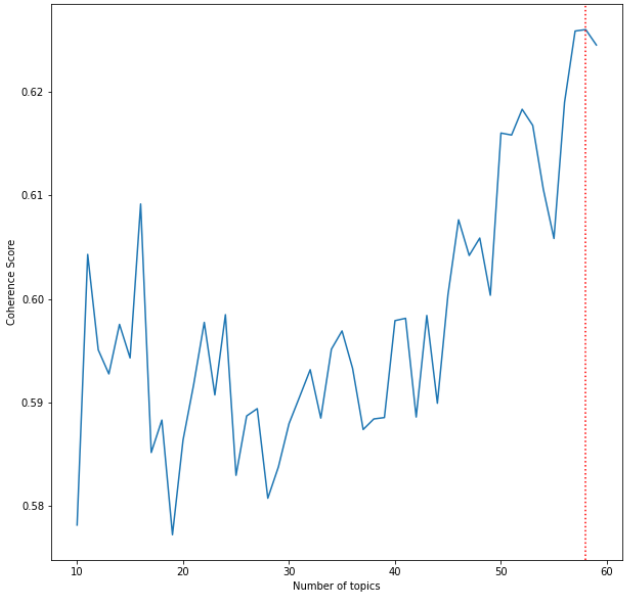

Figure 7. The coherence score for music genres in the 2005s

Secondly, the topic modeling results are presented via the intertopical distance map and the most salient terms. As can be seen from the data, the most dominant genre of the 1990s is rock. Rock is contained in almost every topic including the biggest topics such as № 2, 19, 20, and 21. Therefore, these topics might be called “Rock” topics.

Rock correlates with another popular genre which is alternative rock. The topics that include these two genres are proximate to each other and are located on the left side of the intertopical distance map. For example, alternative rock is the most relevant term for one of the biggest topics № 3. Alternative rock is also close to the family “indie rock” and electronic music and consequently topics that contain these genres, for instance, № 3 and 12 might be called “Alternative rock”.

Another significant genre that identified the music structure in the UK in the 1990s is electronic music. It might be said that electronic music is more closely related to alternative rock. Both genres are significant for the topic № 3 and are located on the left side of the map.

Finally, there is a genre called punk that was also significant for the UK’s music in the 1990s but differed from the above genres. The topics related to punk are quite big but located on the right side of the intertopical distance map. For example, there are topics № 7, 16, and 24 that might be called “Punk”. It might be said that punk is more connected to Britpop and folk music.

Overall, it might be concluded that in the 1990s despite the prevalence of the rock genre there were several more significant genres that indicate a relative variety of genres in this period. In particular, there were three quite interconnected to each other genres that are called rock, alternative rock, and electronic music with topics related to each other and often contain the same above genres. At the same time, punk is quite far from the above genres and presents itself as a separate unit of a genre. The results are shown in Figure 8.

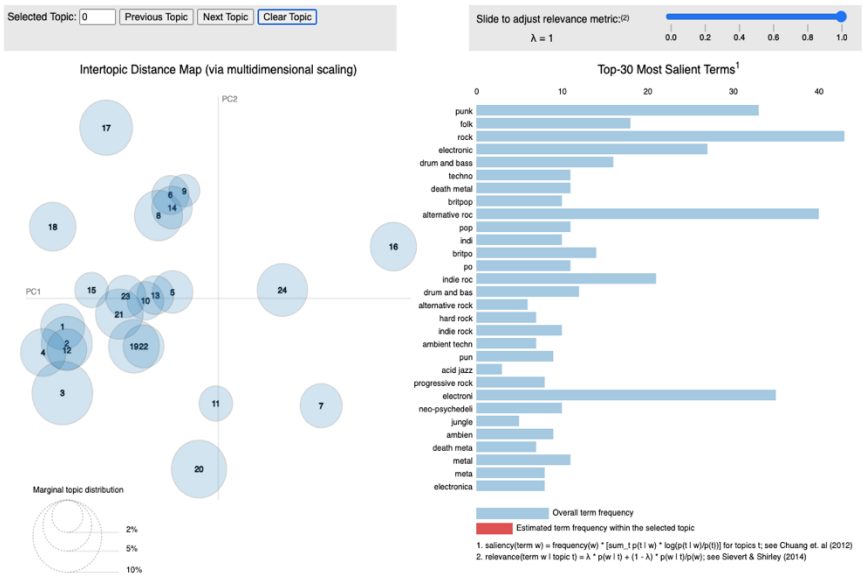

Figure 8. LDA results for the 1990s

With the beginning of the 21st century, the situation in the UK's music industry has changed significantly. The most important conclusion is that despite the emergence of new genres and consequently an increase in topics, there is still the domination of the rock genre. At the same time, there are no big prevailing topics in comparison with the 1990s. Moreover, it should be noted that rock is involved in the biggest clusters such as, for instance, № 13, 26, and 48 but these clusters are mostly located on the right part of the map and separate from other clusters. Therefore, rock might be identified as the separate but the most significant genre of the 2000s. Interestingly, in this era rock became more related to punk, grime, and indie music.

At the same time, there was a concentration of small but interconnected clusters on the left side of the map. These topics imply different genres with the prevalence of many genres from doom metal to post-rock. More precisely, there might be topics called "Metal genre" (№ 14), "Progressive rock" (№ 3), "Ambient music" (№ 4), "Techno" (№ 38) that all together

construct a “family” of related topics with similar content of genres. With an application of the results for the previous period it might be said that more large and “independent” topics became smaller but closer to each other that show their evolution in terms of a reduction of differences between topics and consequently genres.

To sum up, there is a conclusion that in the first half of the 2000s there was a domination of rock with the emergence of a variety of “small” genres. In comparison with the 1990s, some big topics were decreased but at the same time became more connected with each other while the dominant rock became more independent (Figure 9).

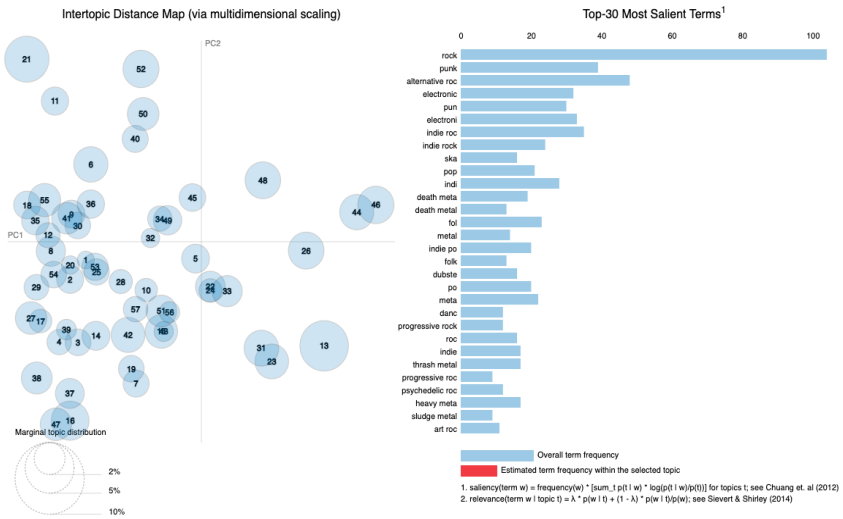

Figure 9. LDA results for the 2000s

Some changes accompanied the 2005s. Firstly, the concentration on “small” topics switched to the right side of the intertopic distance map. Secondly, rock has remained to be the dominant but separate genre located on the left part of the map.

Nevertheless, in comparison to the previous five years, several genres have

started to become popular that reducing the domination of rock. In particular, alternative rock that might be considered a part of the “family” with rock and was significant in the 1990s has become more important again. Alternative rock is associated with rock and is mostly located in the same topics on the left side of the map. However, it is also located in several big clusters with interconnected genres. Hence, compared to rock, alternative rock had links with other genres as well and cannot be considered independent.

Another finding is an occurrence of the completely new significant genre of independent music or so-called indie music. Indie music is also quite a separate genre that is mostly related to the “family” genres of indie rock and indie pop. It might be said that similar to rock it almost was not linked to “small” genres and had an independent structure.

At the same time, indie music is also related to such genre as pop. Moreover, the above two genres have connections that started from the 1990s. It might be said that in terms of the PLC theory by Cox (1967) in the 2005s indie music reached its Maturity stage while in the 1990s there was an Introduction stage. The evolution of independent music consequently might be justified with the “roots” from pop music. In other words, there were two “branches” of indie and pop genres that were separated mainly by different ways of commercialization. While pop music is more directed to higher commercialization and centralized management, independent music mainly relies on independency of artists, the DIY structure, new business models, and creativity instead of profit (Turino, 2008; Walzer, 2017). Besides, it should be noted that independent music has similar traits with punk that

was popular in the 1990s. In particular, both genres have independent structure and are connected to such genre as pop or, more precisely, Britpop that can be seen from the fact that they are located in the same or close topics.

To summarize, the period of the 2005s had a similar tendency to the 2000s with the domination of the separate rock genre and a concentration of a variety of "small" linked genres. At the same time, there were differences as well. In particular, some genres such as alternative rock and indie music have become more significant. Besides, while alternative rock had some connection with the "independent" rock, indie music became separated from other genres including rock, with the exception of several related "families" and pop (Figure 10).

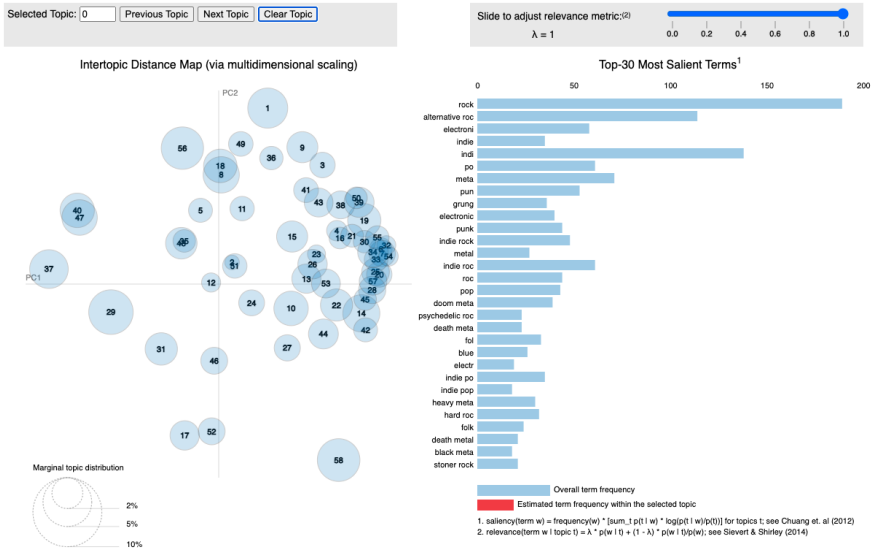

Figure 10. LDA results for the 2005s

To sum up, the evolution of genres as cultural artefacts related to product technological evolution in the UK in a period between 1991 to 2010 might be described as follow. During the all observed period rock is defined as the

main and the most dominant genre of British culture that is considered as a heritage of Queen and other extremely popular rock bands from the 1970s-1980s (Desler, 2013). In terms of product evolution rock might be considered as “dominant design” but without the implementation of a standard (Brem et al., 2016). Thus, this genre evolved from the above period and contributed to the emergence of some other genres both “small” ones and big such as alternative rock. In the 1990s there also was the prevalence of such an “independent” genre as punk. Despite it lost its popularity in the 21st century, punk also has a kind of “descendant” in a form of indie music. The general structure of modern music evolution in the UK is the following: in the 1990s there were four dominant genres (among them three were connected in “families”) with not big number of “small” genres and consequently with low variety; in the 2000s rock remained the only significant genres but a large increase of “small” genres; in the 2005s the emergence of old and new dominant genres with the ongoing growth of “small” connected genres.

Thirdly, the “Innovative index” that considered the differences between words in topics was measured (see Appendix 1). The following results were identified. There was a fluctuation in the period from 1991 to 2003 where values varied from 0,33 to 0,5 each year. Thus, in this period there was not any strong increase or decrease in differences between genres.

On the other hand, since 2004 the “Innovative index” had a sharp decline two times and then after a slight growth in 2007 and 2008 proceeded to decrease. These findings might be interpreted as follow. The differences between words in topics have decreased. Therefore, the differences between

genres have decreased as well. Genres became more similar to each other, and the radical evolution was decelerated.

Overall, with the implementation of the results from both LDA and the "Innovative index" there is the following conclusion. On the one hand, genres in the UK evolved, their number has increased and therefore it is possible to say that the variety of genres has raised during observed periods of time. On the other hand, the "Innovative index" shows that the topics have become more similar, they are tended to unite into "families" with similar characteristics. Thus, with the evolution of genres in terms of the growth of the number of genres, these genres became more similar in context.

5.2 Cointegration test, Granger-Causality test, and Linear Regression results

Table 3 indicates the results of ADF test for time series. It was found out that 1 % critical values for these tests is -1,30. Results of ADF test statistics (Table 3) show that all time series are less than critical values at least at 1 % level. Hence, it is possible to reject the null hypothesis and assume that time series are stationary. In their turn, it concludes that time series are cointegrated.

"Innovative Index"	-1,72
"Female's power"	-1,39
"Immigration flow"	-1,62

Internet users	-2,16

Series	ADF Test

Table 3. Cointegration test results

The next result is related to Granger-Causality test. Table 4 indicates the following results. It might be said that that there are two time series that influence “Innovative index” of genres. “Female’s power” and Internet users both have p-values that are smaller than 0,05. Therefore, it is possible to state that we reject the null hypothesis in these cases.

The results might be interpreted as follow. Firstly, “Female’s power” causes the changes in “Innovative Index” at 0.001 significance level. Secondly, changes in the number of Internet users in the UK also causes the changes in the compositions of topics at 0.01 significance level. Last but not least, the changes in the number of non-EU immigrants do not have any effects on the changes in “Innovative Index” and there is not possible to reject the null hypothesis. Hence, only “Females’ power” and Internet users influence the “Innovative Index”.

“Female’s power”	0.0061**
“Immigration flow”	0.2068
Internet users	0.01165 *

Series	Granger-Causality Pr(>F)

Table 4. Results of Granger-Causality test

Finally, results of regression analysis are presented at Table 5. The interpretation of these results is the following. Firstly, “Female’s power” is a significant variable with the small negative value. Through the topic modeling analysis, it was indicated that despite each time period there is an occurrence of more topics the differences between genres became smaller. In other words, probability distributions between genres became closer with each year especially in the 21st century. Negative value of “Females’ power” means that the enhancement of women’s economic positions negatively influences changes in genres’ compositions with a value of 0.0021. Therefore, an increase in women’s salaries decrease the similarity between genres.

Constant	0.9126** (0.29)
“Female’s power”	-0.0021** (0.001)
“Immigration flow”	0.00029 (0.00039)
Internet users	0.1656* (0.2574)
R-squared	0.63
Observations	20

Notes: Standard errors are shown in parentheses. * p<0.10, ** p <0.05, *** p<0.01.

Table 5. Regression results for the music evolution in the UK between 1991 and 2010

Secondly, changes in the number of Internet users also have an effect on the changes of genres' compositions. However, this influence has a positive value that might be defined as follow. An increase of Internet users in the country makes genres closer to each other. It proved some conclusions from the literature that the Internet unite people and influence globalization with the following occurrence of the similarity between genres (Darchen et al., 2022; Kruse, 2010; Walzer, 2017).

To conclude, the second research question might be answered with the following findings. There are two time series that cause the changes in genres' compositions or, more precisely, a decrease of differences between "small" genres. There are changes in females' salaries or Female's power and changes in the number of Internet users in the UK. Moreover, while the first variable has a negative value that means that it reduces changes in "Innovative Index" the second variable has a positive effect on the dependent variable that indicates an increase of proximity of genres. Many articles identify that immigrant influence changes in the music industry at particular countries. Nevertheless, this research rejects this idea. By quantitative methods, it was found out that the changes in the numbers of immigrants do not cause changes in the genres' compositions. However, it should be noted that this finding might cover only the chosen time period.

Chapter 6. Conclusion and discussion

Music plays a big role in people's lives. Music might be used for different purposes and reflect particular values and preferences. Moreover, music has evolved through time that correlates with biological and product evolutions.

This paper explores how music might develop based on the principles of product and technological evolution and what factors influence this development.

In order to explore music evolution, a meme of the genres was chosen. A genre is an appropriate unit to examine evolution because it reflects specific characteristics of songs and singers. Besides, a genre is associated with a product in technological evolution that allows using suitable methods for its research.

So as to examine the development of genres as cultural artifacts in terms of product evolution the particular region and time period were selected that are the UK from 1991 to 2010. British music has a long history with a great influence on global culture and therefore it is important to understand how the development of music happened in this country. Moreover, not many papers examine the more modern period of music evolution that started in the 1990s. The method of LDA from the class of topic modeling was conducted for this research objective.

Another important task was to identify what triggered the emergence and dissemination of particular genres in the selected time period. The quantitative method of Fixed Effects was chosen in order to reach this goal. This method allows overcoming the gap of lack of papers exploring external ecological factors via quantitative approaches. The factors that might influence British music evolution was based on the conducted literature review.

Overall, the following findings were identified. Firstly, rock is the major and “dominant” genre in a selected time period. Rock might be associated

with the concept of dominant design in product evolution (Anderson & Tushman, 1990; Brem et al., 2016; Cecere et al., 2015; Hylving et al., 2012). This genre prevailed among other genres and was associated with the majority of British singers. However, throughout time this genre has become more and more independent from other genres.

Secondly, according to the LDA analysis, it was indicated that topics are diverse. Each subsequent time period is characterized by an increase in the number of genres. Moreover, it might be said that this diversity is revealed mainly among “small genres”. In other words, during each time period, there were several “big genres” except rock that dominated society, but they were separate from “small” communities of genres.

On the other hand, it was found that there is a low and decreasing difference for the “Innovative Index”. It is interpreted as contents in topics becoming similar. In other words, “small” topics have become more homogeneous in their contents. By taking into account three of these results the general conclusion might be constructed. Rock is major but there are many “small” genres whose number was increasing each year. Besides, these topics are diverse but the contents in the topics became similar. It means that the music evolution in the UK might be characterized by the structure of rock as a dominant genre with specialized topics or genres.

Last but not least, the external factor that significantly influenced the above situation in the music market in the UK was indicated. Despite the fact that scholars examined various factors based mainly on attempts to reflect the identity of particular groups of individuals, the regression analysis showed that for the chosen period there were two factors that had an impact on

genres' evolution. These factors are "Females' power" measured as the improvements in the economic situation of the British women with negative value and an increase of Internet users in the country with positive value. In other words, the growth of Internet users contributed to the emergence of more "small" specialized genres while the enhancement of the economic position of females had opposite effect. Besides, the changes in the number of Immigrants do not have particular effects on the above music evolution in the UK and the emergence of "specialized genres".

This research has several limitations that should be highlighted. First of all, as was already mentioned the majority of papers that explore the factors that affected the music evolution are based on qualitative methods. Therefore, it is hard to find continuous variables that might properly reflect categorical factors. Thus, there were some issues with an appropriate selection of variables for the regression analysis. Secondly, in order to make the research more specific, a particular time period was chosen. However, this choice limited the number of observations that might have influenced the significance of the variables.

In order to overcome these limitations, further studies might be conducted. Further research might be related to the construction of more advanced evolution schemes such as a phylogenetic tree, for example. Moreover, the comparison between factors that influence music evolution in different countries via quantitative methods might be conducted. There might be practical implications of the research with the prediction of future changes in the UK's music industry. In particular, with time series it is possible to explore whether genres will become closer or more different in the future

by conducting an appropriate analysis.

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Appendices

Appendix 1. “Innovative index”

1991	0,37365003
1992	0,47238425
1993	0,4262819
1994	0,42402896
1995	0,35503321
1996	0,34237168
1997	0,34716424
1998	0,46192294
1999	0,40075352
2000	0,33219426
2001	0,4243604
2002	0,50378647

2003	0,40480677
2004	0,25389776
2005	0,2359309
2006	0,24926667
2007	0,30960759
2008	0,26695846
2009	0,21348828
2010	0,12904232

Abstract (Korean)

음악 진화는 중요한 문화적 현상입니다. 그것은 생물학적 및 기술적 진화와 같은 다른 유형의 진화와 관련이 있습니다. 그러나 제품 및 기술 진화의 개념 측면에서 음악 진화와 관련된 문화적 유물을 탐구하는 논문은 많지 않습니다. 또한 음악 진화에 영향을 미치는 외부 요인의 정량적 탐색에는 한계가 있습니다. 이 논문은 영국의 문화 유물로서의 장르의 진화를 주제 모델링 방법을 통해 검토함으로써 이러한 격차를 극복합니다. 1990 년대부터 2010 년대까지 세 가지 기간 동안 장르를 다루는 주제의 내용이 어떻게 변했는지 연구 할 수 있습니다. 이 진화에 영향을 미치는 외부 요인은 공동 통합 테스트,그레인저-인과 관계 테스트 및 회귀 분석을 통해 확인되었습니다. 외부 요인은 문헌 검토에 기초하고 시계열 데이터의 형태를 갖는다. 연구를 통해 다음과 같은 결과가 발견되었습니다. 첫째,그것은 영국에서 음악 진화는 전문 장르와 지배적 인 장르로 바위의 형태를 가지고 있음을 발견했다. 둘째,장르 간의 차이의 감소를 의미하는 주제 내용 간의 차이가 감소한 것으로 확인되었습니다. 셋째,"여성의 힘"과 인터넷 사용자 수는 영국의 장르 진화에 영향을 미치고 관찰 된 기간에 장르 구성의 변화를 일으키는 극단적 인 요인이라는 것이 지적되었습니다. 얻어진 결과는 장르가 어떻게 변화 할 수 있고 음악의 진화가 미래에 어떻게 발생 하는지를 예측하기 위해 사용될 수 있습니다.

주요어 : 음악 진화;장르;생태적 요인; LDA;고정 효과 모델
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