Does pop music exist? Hierarchical structure in phonographic markets

Andrzej Buda *

ul. Oriona 15/8 67-200 Głogów, Poland

ABSTRACT

I find a topological arrangement of assets traded in phonographic markets which has associated a meaningful economic taxonomy. I continue using the Minimal Spanning Tree and the correlations between assets, but now outside the stock markets. This is the first attempt to use these methods on phonographic markets where we have artists instead of stocks. The value of an artist is defined by record sales. The graph is obtained starting from the matrix of correlation coefficients computed between the world's most popular 30 artists by considering the synchronous time evolution of the difference of the logarithm of weekly record sales. This method provides the hierarchical structure of the phonographic market and information on which music genre is meaningful according to customers. Statistical properties (including the Hurst exponent) of weekly record sales in the phonographic market are also discussed.

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1. Introduction

Phonographic markets are well defined complex systems almost as old as financial markets. They are studied by economists and sociologists [1–5], but have never been explored by mathematicians and physicists. Since Thomas Edison (1877) the phonograph, gramophone or record player has been commonly used for playing sound. Although in 1906 these devices were elusive for common people, the Italian tenor Enrico Caruso was the first and only artist who sold more than 1,000,000 copies of his record before The Beatles [6]. In 1948 Columbia released the first ever long playing record (LP) that would hold at least 20 min per side. Since 1967's The Beatles 'Sgt Pepper's Lonely Hearts Club Band' long playing records have dominated the phonographic markets worldwide. The new formats (vinyl, cassette, compact disc and mp3, etc.) were more and more popular. Thus, Michael Jackson's 'Thriller' has become the most popular record ever and sold over 110,000,000 copies [7].

On the other hand, currently his success is impossible to repeat because of digital piracy, marginal utility, etc. [8]. Global music sales in 2009 fell by 7% to US $17 billion. This is disappointing, but amid the decline there are some very positive points. No fewer than thirteen countries saw music sales grow in 2009, including important markets such as Australia, Brazil, South Korea, Sweden and the UK [7]. Digital sales in some of those markets rose at very encouraging rates, reflecting the new opportunities of online and mobile channels [8].

Since 1991, Nielsen SoundScan began tracking sales data from cash registers collected from 14,000 retail, mass merchant, and non-traditional (on-line stores, venues, digital music services, etc.) outlets in the United States, Canada and the UK. Previously, Billboard tracked sales by calling stores across the US and asking about sales—a method that was inherently error prone and open to outright fraud [6,9].

Traditionally, the record charts are based on weekly record sales. According to the IFPI (International Federation of the Phonographic Industry), the world's largest phonographic markets are: the USA, Japan, Great Britain, France and Germany (Fig. 1) [7,8]. 80% of weekly record sales belong to the four biggest record companies (Universal, EMI, Sony BMG and Warner

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* Tel.: +48 505 680 977.
E-mail address: andrzejbuda@wp.pl.
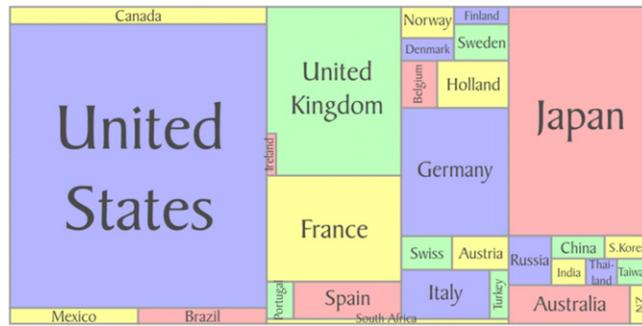
Fig. 1. According to the IFPI more than 95% of the total revenue of music in 2003 was derived from the 30 major countries in the proportion shown above, organized by geographic location.

Table 1
Analogy between financial and phonographic markets.

Stock market	Phonographic market
Stock prices	Weekly record sales
Price returns	Change of weekly record sales
Correlation between stock prices	Correlation between artists
Distance between stocks	Distance between artists
Main indice portfolio	Top selling artists
Industry sectors and subsectors	Music genres

Bros). All the world's most popular artists are signed to these companies [7]. Thus, since 2003 it is possible to find their weekly record sales exactly [10].

The phonographic market differs from financial markets because the price of a record (LP, CD, mp3) is constant. Therefore, the value of an artist is defined by weekly record sales. In my research, I have chosen the portfolio of the world's most popular 30 artists according to the record sales between September 2003 and September 2011.

The motivation of the present study concern the search for the kind of topological arrangement between artists and built Minimal Spanning Tree and the associated subdominant ultrametric hierarchical tree. This method has been successful in spin glass systems [11,12] and financial markets [13–16] because of meaningful economic taxonomy. The topology and hierarchical structure associated with it, has been obtained by using information present in the time series of stock prices only.

In this paper, I use these methods on the phonographic market where we have artists instead of stocks. The value of an artist is defined by weekly record sales. The graph is obtained starting from the matrix of correlation coefficients computed between the world's most popular 30 artists by considering the synchronous time evolution of the difference of the logarithm of weekly record sales.

2. Method of analysis: phonographic vs. stock market

Initially, I have chosen the world's most popular 30 artists that sold more than 11 000 000 copies according to their record sales between September 2003 and September 2011. The top selling 30 artists and their weekly record sales are considered analogous to the assets traded in the stock markets. The criterion of the comparison given in Table 1 describes the similarity between phonographic and stock markets.

The correlation coefficient defines a degree of similarity between the synchronous time evolution of a pair of assets.

$$\rho_{ij} = \frac{\langle Y_i Y_j \rangle - \langle Y_i \rangle \langle Y_j \rangle}{\sqrt{\left(\langle Y_i^2 \rangle - \langle Y_i \rangle^2\right)\left(\langle Y_j^2 \rangle - \langle Y_j \rangle^2\right)}} \tag{1}$$

where i and j are the numerical labels of assets, Y_i is the price return.

$Y_i = \ln[P_i(t)] - \ln[P_i(t-1)]$ where $P_i(t)$ is the weekly record sales of artist i on day t. The statistical average is a temporal average performed on all the trading days of the investigated time period. By definition, ρ_{ij} may vary from -1 to 1. The matrix of correlation coefficients is a symmetric matrix with ρ_{ii} and the $n(n-1)/2$ correlation coefficients characterize the matrix completely.

The correlation coefficient reflects similarity between assets. It can be used in building the hierarchical structure in financial markets and finding the taxonomy that allows us to isolate groups of assets that make sense from an economic point of view. In this research, a matrix of correlation coefficients is computed between the world's most popular 30 artists by considering the synchronous time evolution of the difference of the logarithm of weekly record sales between 22.09.2003 and 12.09.2011.