The Role of Financial Indices in Measuring Stock Exchange Performance - A Comparative Study Between Global, Regional, and National Indices –

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Abstract:

This study aims to analyze financial indices and examine how their values are calculated and utilized to evaluate the performance of stock exchanges. It addresses three main methods for calculating these indices: price-weighted, value-weighted, and arithmetic and geometric means. The study explores the advantages and disadvantages of each method, providing illustrative examples to demonstrate how the choice of method impacts the results of the index.

Computational methods were employed to illustrate how the relative weights of stocks in indexes are determined based on price or market value. It also discussed the procedures for calculating average index values employing arithmetic and geometric means. The study also analyzed various prominent financial indices globally, including those from the United States, Europe, Asia, and the Arab world.

The results demonstrate that each method for calculating indices has advantages and disadvantages, making it essential for investors to thoroughly understand these methods when comparing their portfolios' performance with market benchmarks. The study also highlighted the importance of understanding the basis for calculating indices to ensure accurate evaluation and comparison.

Keywords: Stock Exchange Performance Indices; Price-Weighted Approach; Value-Weighted Approach; Arithmetic and Geometric Means; Dow Jones Industrial Average (DJIA); Algerian Stock Exchange Index (DZAIR INDEX).

JEL Classification Codes: G10, N20.

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1. Introduction :

Study Background:

Financial indices are crucial for measuring and analyzing stock exchange performance. They play a fundamental role in guiding investment strategies and decision-making. Since their inception, financial indices have evolved to satisfy the needs of investors and analysts, with various methods utilized to calculate them. Indices such as the Dow Jones and the S&P 500 are prominent examples, using different approaches, including price-weighted or value-weighted methods.

Research Problem statement:

The main problem statement lies in the diversity of methods for calculating financial indices and the differences in their findings based on the principles utilized in each method. The challenge is to identify the most suitable method for each type of index and its effect on interpreting market performance. Furthermore, understanding how different methods impact index results can be complex for investors and decision-makers.

Research Questions:

1. What are the different methods used to calculate financial indices?
2. How do these methods affect the evaluation of market performance?
3. What are the advantages and disadvantages associated with each method?
4. How can investors and decision-makers benefit from understanding these methods to make better investment decisions?

Study Importance:

This study is significant because it highlights the need to understand the differences between various methods of calculating financial indices and how they affect market performance evaluation. Such understanding is crucial for enhancing investment strategies and making decisions based on accurate data, leading to better financial outcomes and reduced risks.

Study Objectives:

The research seeks to explore the different methods for calculating financial indices and evaluate the effect of each on index results. The main objectives include:

1. Analyzing the methods utilized to calculate financial indices.
2. Assessing the advantages and disadvantages of each method.
3. Comparing the results of indices based on different methods.
4. Offering recommendations on selecting the most suitable methods for evaluating stock exchange performance.

Research Motivations:

The motivation for this research arises from the urgent need to understand how calculating financial indices impacts the evaluation of stock exchange performance. Understanding these effects helps enhance financial analysis tools and offers more accurate insights into market performance, enhancing the ability to make strategic investment decisions.

Study Structure: The study will cover the following sections:

1. Introduction.
2. Definition and Uses of indices.
3. Indexes Types.
4. How indices are constructed.
5. Major financial indices worldwide.
6. Conclusion.

7. Bibliography List.

2. Indices Definition and Their Uses:

An ***index*** is a statistical tool that allows for measuring, tracking, and comparing the performance of financial markets by evaluating the price movements of a sample of securities traded in either organized or unorganized markets, or both, and predicting their future trends.

Financial market indices are associated with various uses, some of the key ones include: (Ibrahim Hindi, 2006).

- **Indices as a Reflection of the General Economic Condition of a Country:** Since the activities of institutions trading their securities in the market represent a major portion of the economic activity in a country, a carefully designed index to measure the overall market condition is regarded as a reflection of the general economic condition of the country if the institutions operate efficiently.
- **Providing a Quick Overview of Portfolio Performance:** Investors can quickly gauge changes in their portfolio returns—whether positive or negative—by comprehending the trend in the market condition index (which measures the market return rate) without needing to track each security individually. If all of an investor's investments are in a specific industry with its index, monitoring this index is preferable.
- **Evaluating the Performance of Professional Managers:** A manager is considered professional if he fulfills a return higher than the market return rate. In other words, the actual return achieved by their portfolio should be greater than the return rate of the market portfolio, which the index represents.
- **Predicting Future Market Conditions:** Historical analysis of market condition indices can demonstrate patterns of changes that might occur. If analysts determine such patterns, they can predict future market developments, even if only approximately, which helps in making sound investment decisions at the right time.
- **Estimating Portfolio Risks:** Indices can be utilized to measure the systemic risk of a portfolio by calculating the beta coefficient (β), which reflects the risk between the return rate of the portfolio and the return rate of the market portfolio, measured by the return rate of a general market index.

Furthermore, the use of indices has expanded beyond merely determining market trends. They have become financial instruments traded on exchanges just like any ordinary security.

3. Indices Types:

There are two main criteria for classifying indices: their function and their tradability (Qablan, 2011).

Criterion 1: Classification Based on Function

- **General Indices:** These highlight the overall market condition, measuring market trends across various economic sectors, and seek to reflect the economic status of the concerned country. This is particularly true if the sample utilized to construct the index represents all traded stocks and all sectors in a way that reflects their contribution to the Gross Domestic Product. In this case, the financial market can be viewed as a mirror reflecting the economic status of the studied country.
- **Sectoral Indices:** These measure market behaviour regarding a specific sector, such as the industrial or services sectors. Examples include the Dow Jones Industrial Average and the

S&P 500 for public services (which will be discussed further).

Criterion 2: Classification Based on Tradability

- **Tradable Indices:** They are traded in specific financial markets. The first exchange of this kind opened in Kansas City, USA, in 1982. Examples include the Nikkei 225 and Nasdaq 100.
- **Non-Tradable indices:** These indices are not traded on exchanges, such as the Dow Jones and all Arab stock exchange indices.

Notably, many indices differ in calculation methods, objectives, convertibility, or overseeing bodies. The diversity and development of indices have reached a point where " indices of indices " have been created.

4. How to Construct Indices:

Indices are constructed based on four foundational principles:

- A suitable sample
- A clear definition of weights for each constituent (stock) within the sample
- A clear and simple method for calculating the index value

These principles are outlined as follows: (Ibrahim Hindi, 2006) (Hussein, 2008).

4.1 Sample Suitability:

The sample refers to the set of securities (traded in either organized or unorganized markets or both) utilized in calculating the index. This sample should be suitable in three respects: size, breadth, and source:

Size: The general rule is that the larger the number of securities included in the index, the more representative it is of the market condition.

Breadth: The selected sample should address different market sectors without bias.

Source: This refers to the source of the stock prices employed for the index, which should ideally be the primary market where those securities are traded, such as the closing price.

4.2 Relative Weights of Sample Constituents:

Relative weights refer to the proportionate stock value within the sample, i.e., the institution's representation in the index (with the total weights always summing to one). There are three common inputs for determining the relative weight of a stock within the index's stock set:

4.2.1 Price-Based Weighting Approach: When there is one share for each selected institution to build the index, the weight of each share is automatically determined based on the ratio of the stock price to the total price of the individual stocks making up the index. This total is known as the absolute index value (Index Value).

Example (01): Table 1 is an example of calculating the absolute index value using the price-based approach.

Table 1. Example of calculating the absolute index value using the price-based approach.

Stock	P_1	W_1	P_2	W_2
A	50	0,5	80	0,53
B	40	0,4	50	0,33
C	10	0,1	20	0,13
Index Absolute Value	100		150	

Source: (Ibrahim Hindi, 2006) (Hussein, 2008).

Where:

P_1: Price of the stock at the end of the first period (e.g., a day, a year, etc.);

P_2: Price of the stock at the end of the second period;

W_1: Weight of the stock within the index during the first period;

W_2: Weight of the stock within the index during the second period.

A drawback of this input is that the relative weight is based solely on the stock price, which may not reflect the significance or size of the institution. The index may favour stocks with relatively higher prices, making it sensitive to changes in these higher-priced stocks.

In some cases, the index might increase despite most constituent stocks declining due to a significant rise in the prices of very few high-value stocks. Therefore, the index might increase even if overall market prices fall. (Al-Muhailmi, 2006).

Furthermore, using the mentioned approach may cause a distortion in the index if a derivative is issued for one of the sample stocks. In such cases, the price of the concerned (derivative) stock reduces while the number of shares raises, which decreases its weight and significance—thereby impacting the index value without any objective reason.

4.2.2 Equal Weighting Approach:

The equal weighting approach means that the total investment amount in each type of stock comprising the index is equal in the base year. As a result, subsequent changes in the index value will reflect the actual market performance.

Practically, equal weighting in the face of varying stock prices necessitates calculating a hypothetical quantity, determined as the inverse of the price, so that the values (price × hypothetical quantity) are equal.

The absolute value of the index according to this approach = Sum (stock price × hypothetical quantity).

Example (02): Table 2 an example of calculating the absolute value of the index employing the equal weighting approach.

Table 2. Example of calculating the absolute value of the index employing the equal weighting approach.

Stock	P_1	Q	W_1	P_2	W_2	R
A	50	0,020	1,0	80	1,60	0,60
B	40	0,025	1,0	50	1,25	0,25
C	10	0,100	1,0	20	2,00	1,00
Index Absolute Value			3,0		4,85	

Source: (Ibrahim Hindi, 2006) (Hussein, 2008).

Where:

Q: The hypothetical quantity calculated;

W_1 the first and second The relative value (weight) of the stock within the index during :W_2 ، periods, respectively, and equals (Q × P);

R: The return on the stock, i.e., the value of $(W_2 - W_1)$ for each stock.

A drawback of this input is that it assigns equal weights to the stocks despite possible differences in the size and significance of the institutions that issued them. Additionally, if the relative weights are equal in the first year, this equality often disappears with price changes.

4.2.3 Value-Based Weighting Approach:

The relative weight of a stock is based on the total market capitalization of each institution in the index. The absolute value of the index is then calculated by summing these values, i.e., the total price of each institution's shares multiplied by the number of shares.

Example (03): Table 3 is an example of calculating the absolute value of the index using the value-based approach.

Table 3. Example of calculating the absolute value of the index using the value-based approach:

Stock	Q	P_1	MV_1	P_2	MV_2
A	60	50	3000	80	4800
B	70	40	2800	50	3500
C	120	10	1200	20	2400
Index Absolute Value			7000		10700

Source: (Ibrahim Hindi, 2006) (Hussein, 2008).

Where:

Q: Number of shares of the institution;

MV_1, MV_2**:** Market value (P × Q) of the institution's shares in the two periods, respectively.

This approach avoids the main disadvantage of the price-based method, as the stock price is no longer the sole determinant of the relative weight. Institutions with equal market value for their ordinary shares will have equal relative weight within the index, regardless of the stock price or the

number of shares issued. This demonstrates that the issuance of new shares will not disrupt the index.

While indices calculated based on value have these advantages, they are criticized for favouring stocks with large market capitalizations while neglecting stocks issued by smaller institutions in terms of the number of shares issued.

Notably, each approach yields different findings. Hence, investors need to comprehend the basis on which indices are calculated to compare the performance of their financial portfolios against market performance. This necessitates calculating the portfolio return in the same manner as the compared index.

4.3 Index Value Calculation Procedures:

After selecting the sample, determining the relative weight for each stock according to the appropriate method, and calculating the absolute value accordingly, the average index value continuously changes. This value is usually computed at short intervals, typically less than a minute.

In real stock exchanges, the change in the index value typically appears on the trading screen as (X points) or (X%), demonstrated after a symbol (Δ) coloured green for an increase or a symbol (∇) coloured red for a decrease.

Indices differ in how their values are calculated. Some of them calculate their values based on price relatives. Conversely, others calculate their values based on the average stock prices forming the index, either as an arithmetic mean (the common case) or a geometric mean (in a few cases).

Below is an interpretation of how to calculate **the average value of the index**, i.e., **the average return of the index** stocks in each case:

4.3.1 Arithmetic Mean:

$$\frac{\text{t total prices of the sample stocks over time}}{\text{Sample stock number}} = \text{Index average value}$$

$$\mathbf{I_t} = \frac{\sum_{i=1}^{N} \mathbf{P_i}}{\mathbf{N}}$$

Where:

P_i: Prices of stocks i, where i = 1, 2, 3… N;

N: Sample size, i.e., the number of stocks forming the index;

I: The index (Index);

This method is commonly utilized, such as in the (DJIA 30) index in the US and the (Nikkei 225) index in Japan.

One of its disadvantages is that when stocks are split, their prices decrease, and their weight or effect on the index reduces, causing the index to drift downwards. Thus, most indices adjust the denominator.

Example (04): Referring back to Example (01), we find that the average value of the index is:

$I_1 = \frac{\sum_1^n P_i}{N} = \frac{100}{3} = 33{,}33$ Points

$I_2 = \frac{\sum_1^n P_i}{N} = \frac{150}{3} = 50$ Points

Thus, the rate of return on the index (Return on Index), which is the change in the average value of the index between two time periods t_1 and t_2 , is :

$\frac{33{,}33-50}{33{,}33}$ x 100 % =50 %

This indicates that the return on the index increased by 50% in the second period compared to the first.

Referring back to Example (02), we find that the average value of the index is:

$I_1 = \frac{3}{3} =$ 1Point

$I_2 = \frac{4{,}85}{3} = 1{,}62$ Points

Thus, the rate of return on the index is:

$\frac{1-1{,}62}{1}$ x 100 % =62%

This demonstrates that the return on the index decreased by 62% in the second period compared to the first.

4.3.2 Geometric Mean:

$$\mathbf{I_t = \sqrt[N]{P_1 \times P_2 \times \ldots\ldots \times P_N} I_t = (P_1 \times P_2 \times \ldots\ldots \times P_N)^{\frac{1}{N}}}$$ أو

Where:

N: Sample size;

Such as the Financial Times 30 Index, the Value Line 30 Index, and the New York Stock Exchange Composite Index.

It is criticized for its slow increase and rapid decrease compared to indices calculated based on the arithmetic mean.

Example (05): Returning to our example, we find that the average value of the index is:

$I_1 = \sqrt[3]{50 \times 40 \times 10} = 27{,}14$ Points

$I_2 = \sqrt[3]{80 \times 50 \times 20} = 43{,}09$ Points

Therefore, the rate of return on the index is:

$\frac{27{,}14-43{,}09}{27{,}14}$ x 100 % =58,77 %

This shows that the return on the index increased by 58.77% in the second period compared to the first.

4.3.3 Index Numbers:

For indices calculated based on price index numbers, they utilize the Paasche index number weighted by quantities as their basis, which takes the following form

$$\text{Paasche's index}_t = \frac{\sum p_t Q_t}{\sum p_0 Q_t} \times I_0$$

Where:

- p_0: The price of the company's stock in the base year.
- p_t: The price of the company's stock in the comparison year t.
- Q_t: The quantity or number of the company's shares in the base year.
- I_0: The initial value assigned to the index is calculated utilizing the index number, usually set at 100 or 1000 points in the base year for comparison purposes.

Example (06):

Referring to Example 03 and assuming that the index value in the base year is 1000 points, the average value of the index in period t is:

$$I_t = \frac{10700}{7000} \times 1000 = 1528{,}57 \quad \text{Points}$$

5. Major Financial Market Indices Worldwide:

The conclusion of a research paper needs to summarize the content and purpose of the article.

The significant advancements in information and communication technology have resulted in the creation of numerous indices by various entities such as investment funds, major newspapers, financial institutions, and financial markets. Each of these entities designs its indices to satisfy the diverse needs of its users. Thus, it is common to find multiple indices for a single market, with one typically being the most prominent. The most significant global financial market indices include:

5.1 In the United States:

Indices in this country can be categorized into two main groups. The first group includes indices where the relative weight within the sample depends on the stock price at which the share is sold. The second group consists of indices where the relative weight is based on the total market value of the shares issued by the company. The most notable examples of these two types are (Ibrahim Hindi, 2006):

- **Dow Jones Industrial Average (DJIA):** This index is regarded as one of the oldest and most well-known indices. It was first published in the "Wall Street Journal" on July 3, 1884, and named after its designer, Charles Henry Dow, and his partner, Edward Jones. Initially, the index was based on a sample of 9 stocks from 9 industrial companies. It increased to 12 stocks on May 26, 1898, 20 in 1916, and 30 in 1928. Since then, no additional stocks have been added to the sample. These 30 stocks represent 30 companies, each with high market value, prominence, size, and many shareholders. Despite criticisms of the index, especially

its narrow sample size and its calculation based on price-weighted methodology, it is one of the most famous and widely utilized market indices.

- **Standard & Poor's 500 (S&P 500):** This broad-based index includes 500 stocks, representing approximately 80% of the market value of shares traded on the New York Stock Exchange (Morvan, 2009). These stocks belong to 400 industrial companies, 40 utilities such as electricity and water, 20 transportation companies, and 40 financial institutions, all large companies trading their shares on major exchanges or in the over-the-counter market. Unlike the Dow Jones Index, the S&P 500 is not a simple average but an index number with a base period of 1941-1943, where the index was set at 10 points. As previously mentioned, this index is based on market value input.

5.2 In European Countries:

The main financial market indices in European markets can be summarized as follows (Morvan, 2009).

- **FTSE 30 Index:** This is a closed index comprising 30 stocks from the largest institutions in the UK. It is considered as one of the oldest and most widely utilized British financial market indices, established in 1935. It represents 35% of the market value of shares traded on the London Stock Exchange, reflecting the overall market movements. It employs the geometric mean for its calculations based on an equal-weight methodology.
- **CAC 40 Index:** This closed index consists of the 40 most traded stocks on the Paris Stock Exchange. It was first utilized on December 31, 1987, with a base value of 1000 points. Currently, it is employed as the underlying asset for many financial derivatives.

5.3 In Asian Countries:

The key financial market indices in Asian markets include: (Al-Muhailmi, 2006).

- **NIKKEI 225 Index** is the most significant index for Asian stocks, consisting of the 225 largest Japanese companies listed on the Tokyo Stock Exchange. Its elements are adjusted annually. It is calculated daily by the "Nihon Keizai Shimbun" newspaper, published since 1971. The index is a price-weighted average in the Japanese yen.
- **HANG SENG Index:** This is a market capitalization-weighted index of 33 companies representing about 70% of the total market value of the Hong Kong Stock Exchange. The index involves four sectors: trade and industry, finance, public utilities, and real estate. It began with a base value of 100 points on July 31, 1964.

5.4 In Arab Countries:

There are various indices in Arab financial markets, with the most common and widely utilized ones comprising:

- **EGX 30 Index in Egypt (formerly known as CASE 30):** This index was designed and calculated by the Egyptian Stock Exchange, which began publishing its data on February 2, 2003, through data providers, market newsletters, the stock exchange website, newspapers, etc. The index was launched on January 2, 1998, with a base value of 1000 points. It involves the top 30 companies in liquidity and activity, weighted by market capitalization (Index EGX30).

- **Amman Stock Exchange Index (Jordan):** The Amman Stock Exchange began calculating a new market capitalization-weighted index in 1992, with the base date set as December 31, 1991, with an initial value of 100 points, changed to 1000 points starting in 2004. The index is based on a sample of 50 representative companies, increased to 60 in 1994, 70 in 2001, and 100 in 2007. Five criteria were employed to select this sample, reflecting the size and liquidity of the institutions: market value, trading days, turnover rate, trading volume, and number of traded shares. Sectoral representation is also considered in sample selection (Major Indexes).
- **DZAIR INDEX (Algeria):** The Algerian Stock Exchange introduced a reference index called "DZAIR INDEX," which consists of all companies listed on the main market across various sectors. It is intended to reflect the general market trend. The management and calculation of the DZAIR INDEX are handled by the Algerian Securities Market Management Company (SGBV) officials. It is calculated employing a market capitalization weighting method, with each value in the index corresponding to the number of tradable shares for each listed company. The index is calculated based on closing prices at the end of each trading session, with a base of 1000 points starting from January 3, 2008. (Belfitah, 2017).

5.5 MSCI (Morgan Stanley Capital International) Indices:

Morgan Stanley calculates indices for global financial markets, which investment institutions have widely utilized over the past thirty years to measure and compare their investment performance with the overall market. It applies a uniform methodology to build and update indices for 23 developed and 26 emerging markets.

The main types of these indices include: (Al-Muhailmi, 2006).

- **MSCI Emerging Markets Index:** This market capitalization-weighted index of free-floating shares measures the performance of emerging financial markets globally. As of December 2003, this index included 26 emerging economies, three of which are Arab countries: Egypt, Jordan, and Morocco.
- **MSCI All Country World Index:** This is a market capitalization-weighted index of free-floating shares that measures the performance of financial markets across all developed and emerging countries. As of December 2003, this index covered 49 countries, including Egypt, Jordan, and Morocco.
- **MSCI Emerging Markets Europe, Middle East, and Africa Index:** This market capitalization-weighted index of free-floating shares measures the performance of emerging financial markets in Europe, the Middle East, and Africa. As of December 2003, this index, known as "EM EMEA," included 10 countries: the Czech Republic, Hungary, Poland, Russia, Turkey, Jordan, Egypt, Morocco, and South Africa.

6. Conclusion:

This study offers a comprehensive review of methods for calculating stock market indices, examining the two main methods for weighting: based on price and based on market value. The findings demonstrate that each of these methods has advantages and disadvantages that directly impact the accuracy of the index in representing market performance.

Key Findings:

- **Price-Based Weighting Method:** Simplifies index calculation but exposes it to the risk of assigning inaccurate weights to stocks, potentially leading to unjustified fluctuations in index values.
- **Market Value-Based Weighting Method:** Allows for a more accurate representation of market performance by considering the market value of companies. However, it may overlook the effect of smaller companies with many shares.
- The study emphasized that calculating indexes utilizing arithmetic or geometric means leads to different results, reflecting the index's response to price and weight changes in varying ways.

Implications: The study highlights the significance of selecting the appropriate method for calculating indices based on specific investment goals and understanding how each method impacts performance analysis and portfolio comparison with market performance. Knowledge of the underlying principles employed to build indices provides essential information for investors and decision-makers to evaluate performance accurately and make informed decisions.

Suggestions for Future Research: Further research is recommended to assess the effect of modern methods for calculating indices, including artificial intelligence techniques and advanced graphical analysis. Futhermore, exploring the impacts of adjustments in index calculation rules on accuracy in representing and analyzing performance in both developed and emerging financial markets would be valuable.

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