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THE STOCK MARKET OF UKRAINE AND ITS RELATIONSHIP WITH STOCK MARKETS OF THE WORLD USING THE EXAMPLE OF CORRELATION OF STOCK INDICES

The work provides a brief definition of the stock market and describes its role in the economy. The place and significance of stock exchanges as an organized part of the stock market is revealed. For introductory purposes, a list of the world's most famous stock exchanges is provided, with an emphasis on the peculiarities of their history and activity. Stock indices are described as a result and consequence of stock exchange trading, some of the most famous of them are listed. The transition to the stock market of Ukraine with its operators (exchanges) and indices is underway. The question arises about the existence of dependence between stock indices of Ukraine and stock indices of other countries of the world. It is proposed to use correlation analysis in order to find and confirm the existence of links between indices, and a brief description of the analysis is provided. An overview of the data collected for calculations is given. The results of the work are a list of correlation coefficients for pairs of stock indices, which confirm the idea of certain dependencies between them.

Keywords: stock market, stock exchange, stock index, correlation coefficient, relationship.

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ФОНДОВИЙ РИНОК УКРАЇНИ ТА ЙОГО ЗВ’ЯЗОК ІЗ ФОНДОВИМИ РИНКАМИ СВІТУ НА ПРИКЛАДІ КОРЕЛЯЦІЇ ФОНДОВИХ ІНДЕКСІВ

В роботі надається коротке визначення фондовому ринку та описується його роль для економіки. Розкривається місце та значення фондових бірж як організованої частини фондового ринку. В ознайомлювальних цілях наводиться перелік найвідоміших бірж світу, робиться наголос на особливостях їх історії та діяльності. Описуються фондові індекси, як результат та наслідок біржової торгівлі цінними паперами, перераховуються частина найвідоміших з них. Робиться перехід до фондового ринку України з його операторами (біржами) та індексами. Ставиться питання про існування залежності між фондовими індексами України та фондовими індексами інших країн світу. Пропонується використати кореляційний аналіз з метою пошуку та підтвердження існування зв'язків між індексами та надається його (аналізу) стисла характеристика. Дається короткий опис даних, зібраних для проведення розрахунків. Результатами роботи є перелік коефіцієнтів кореляції для пар фондових індексів, що підтверджують ідею про певні залежності між ними.

Ключові слова: фондовий ринок, фондова біржа, фондовий індекс, коефіцієнт кореляції, взаємозв’язок.

Introduction. The stock market plays an important role for countries with a market economy. In addition to the formation of additional sources of necessary income and/or placement of temporarily free financial resources, it provides specialists with additional opportunities for analysis. The activity of organized elements of the market (stock exchanges) makes it possible to calculate powerful indicators of economic activity - stock indices. Domestic specialists pay a lot of attention to the issues of the existence of the stock market of Ukraine, its problems and prospects for development, the activity of stock exchanges, analysis (including technical) of indices, at the same time, some issues remain outside their attention. Given the certain simplicity of calculation and the value of indices for economic analysis, the issue of their forecasting becomes particularly acute. For a successful and high-quality prediction of the future, it is first necessary to determine the factors affecting the object of the forecast. Based on the extraordinary circumstances in which the financial sector of Ukraine has been for more than two years, it does not seem appropriate to search for these factors in the middle of the country. Instead, it is possible to study the forces affecting processes in countries with similar dynamics of stock market development. This paper is devoted to the issue of determining the relationship between stock indices of different countries.

Presentation of basic material. For Ukraine, the definition of the stock market is established by law. According to Article 4 of the Law of Ukraine "On Capital Markets and Organized Commodity Markets" [1] (which was adopted to replace the Law of Ukraine "On Securities and Stock Exchange" [2] of 1991), the stock market together with the market of derivative financial instruments and money market refers to capital markets and represents "a set of stock market participants and legal relations between them regarding the emission (issuance), circulation, fulfillment of obligations, redemption and accounting of securities (including derivative securities)." This definition corresponds to other approaches existing in economic theory and quite accurately describes the essence of the market and does not say anything about its role and place in the country's economy.

In today's world, the stock market performs several important tasks. Firstly, it provides an opportunity for subjects of economic relations to attract the additional capital they need, both investment and debt, by placing relevant securities on the market and selling. Secondly, which is inextricably linked and derived from the first point, it creates additional investment opportunities for those looking for additional opportunities to protect and increase their savings. Thirdly, due to the possibility of quick purchase and sale of securities, it expands the list of liquid assets to which business entities have access. Fourthly, as a result of the established norms and rules that all market participants are obliged to observe, and the disclosure of important information necessary for making informed decisions, it contributes to the growth of transparency and trust among all participants in market relations. And fifthly, as a consequence of the above mentioned, the stock market stimulates economic growth in the country.

All the functions mentioned above are inherent in the so-called organized stock market, which is a system of securities trading, where transactions take place on specialized trading platforms, better known as "stock exchanges". They create a place for all market participants

(such as investors, brokers, and dealers) to carry out securities purchase and sale transactions, as well as develop and ensure the functioning of the mechanisms for their implementation in accordance with the current legislation and their own rules and regulations.

Important characteristics of operations on stock exchanges are:

1) standardization – participants and operations must comply with clearly defined rules and procedures;

2) transparency – information on prices and volumes of transactions carried out on the stock exchange is available to the general public, including all interested parties;

3) liquidity – due to current standards and transparency of operations, securities traded on the stock exchange can usually be easily purchased and sold at market prices;

4) regulation - the activity of stock exchanges is subject to additional supervision by the relevant authorized state authorities.

The activity of the organized market can take place simultaneously with the functioning of its opposite - the over-the-counter stock market, which also has some attractive properties - first of all, a lower level of regulation and, accordingly, greater flexibility of the operations carried out. However, these advantages entail a higher level of risk for potential participants. This type of market is beyond the scope of this work.

Today, there are hundreds of stock exchanges in the world. The most famous of them [3] are:

1) New York (New York Stock Exchange or NYSE), which has a long history, started at the end of the 18th century, and is the largest stock exchange in the world. The main principle of the activity of this exchange is the principle "everyone sees everyone" - it provides users with the opportunity to monitor the actions of all participants at any moment of time, to have access to the general market situation;

2) The Automated Quotation Service of the National Association of Securities Dealers, better known as NASDAQ (National Association of Securities Dealers Automated Quotation), is the second (along with the NYSE) main stock exchange in the USA. This is a relatively young organization that trades shares of high-tech companies;

3) London Stock Exchange (LSE) is one of the most famous stock markets in the world (accounting for almost half of all international transactions) and one of the oldest exchanges in Europe. It was officially founded at the beginning of the 19th century, but its history dates back to the second half of the 16th century;

4) Tokyo (Tokyo Stock Exchange - TSE), the first stock exchange in Asia according to the market capitalization of the companies represented there;

5) Shanghai Stock Exchange (SSE) is one of the leading stock exchanges in Asia and the largest trading platform in China. An important feature of this exchange is the division of securities into those traded exclusively in yuan and those denominated in US dollars. Foreigners can freely operate with the latter.

The value of the activity of these and all other stock exchanges for the economy of individual countries and the whole world lies not only in ensuring transactions with securities, but also in providing information about them to a wide range of interested parties. One of the directions of its use is the calculation, according to the appropriate methodology, of so-called stock indices - indicators that measure and reflect the efficiency of one or more stock markets [4]. They are calculated on the basis of the prices of securities (for example, shares) of a certain list of companies that are traded on the stock exchange, or the values of other stock indices. And the exchange itself, as well as other institutions and organizations related to the trading of securities, can do the calculation directly.

This data is important to all stakeholders. In dynamics, they provide an idea of the state of the market in general, or its separate part (depending on the securities of which companies are selected for calculation) and are indicators of the direction of economic development. Thus, the growth of index values indicates positive trends, and the decline reflects negative phenomena. Accordingly, the state can use them to evaluate the implemented economic policy and directions that require additional attention, and investors - business entities and private individuals - to make decisions about their own investment strategies.

The most famous stock indices include [4, 5]:

1) the Dow Jones index, based on the shares of the 30 largest US companies, some of which are traded on the New York Stock Exchange, and the other - on the NASDAQ exchange. It is one of the oldest US market indices in existence. It was created by Charles Dow, editor of The Wall Street Journal and founder of Dow Jones & Company, and first published on May 26, 1896;

2) the S&P 500 index, which is calculated by Standard & Poor's and contains information on the value of securities of 503 companies that are also traded on the NYSE and NASDAQ;

3) the FTSE 100 index - the most popular index of the London Stock Exchange - has been calculated by the Financial Times agency (accordingly, the abbreviation stands for Financial Times Stock Exchange) since 1984 and is based on the share prices of 100 companies with the largest capitalization traded on the stock exchange;

4) TOPIX and NIKKEI 225 – indices based on the results of trading on the Tokyo Stock Exchange. TOPIX is Japan's main stock index developed by the Tokyo Stock Exchange. It is calculated on the basis of all shares from the so-called first section of the exchange which includes the most common and most liquid shares of large corporations of the country. NIKKEI 225 is the second important index of Japan which takes into account the prices of shares of 225 largest companies from the aforementioned first section of the stock exchange. Since 1970, it has been calculated and published by Nihon Keizai Shimbun, Inc.;

5) SSE Composite index – used by the Shanghai Stock Exchange since the end of 1990 and is based on the prices of all shares listed on the exchange.

In Ukraine, the development of the domestic stock market, even more than 30 years after its formation, is insufficient, and it does not meet the requirements and needs of the economy, and does not perform the main functions that markets in developed countries have. Today, its main purpose is the placement of domestic government loan bonds. In January 2024, the volume of transactions with these securities amounted to 35.22 billion hryvnias, or

91.7% of all transactions on the organized stock market [6]. At the same time, the proportion of shares in exchange trading (which combines transactions with shares of domestic companies, foreign issuers and CIFs) reached only 0.036% (13.83 million hryvnias) of the total volume. Of course, today this situation is partially explained by Russian aggression against Ukraine, but a similar picture was observed long before 2022. Since 2016, only once (in 2017) the part of shares traded on the organized stock market of Ukraine was more than 1%. And during this period, for three years in a row (from 2019 to 2021), it fluctuated between 0.12% and 0.18% with total trading volumes from 304.97 to 451.96 billion hryvnias.

The main disadvantage of such a structure of trade operations on the country's organized stock market is its debt orientation. All funds raised in this way will need to be returned after some time with the payment of a certain income to the owners - that is, we have a constant increase in the debt burden on the state economy. Obviously, the government needs to make efforts to increase the volume of investment (primarily long-term) operations.

All listed operations of the organized stock market, in accordance with current legislation, are carried out on the trading platforms of its operators, which are better known as stock exchanges. Their activity and development began together with the creation of the domestic stock market. In recent years, there has been a process of consolidation of operations with securities at separate platforms. Thus, starting from 2014-2015, the number of Ukrainian stock exchanges decreased from 10 to 3 [7]:

1) joint-stock company "PFTS Stock Exchange" - the oldest of the Ukrainian stock exchanges operating today, which dates back to the end of 1995. Today, it is the leading operator of the country's stock market, providing more than 50% of all securities trades;

2) the private joint-stock company "Perspektiva Stock Exchange", established in 2006, is the second stock exchange in Ukraine, constantly competing with PFTS and giving way to it only a few years ago;

3) joint-stock company "Ukrainian Stock Exchange" - the smallest (in terms of trading volume) and the youngest Ukrainian stock exchange (founded in 2008) - defines its main goal as "increasing the competitiveness of the financial market of Ukraine and creating conditions for attracting not only foreign, but also internal capital" [8]. Today, the Ukrainian Stock Exchange actively competes with the PFTS for primacy in transactions with shares of domestic and foreign issuers.

Two stock exchanges of Ukraine calculate their own stock indices, namely the PFTS Index (calculated by the PFTS Stock Exchange since October 1, 1997) and the Ukrainian Shares Index (or UX Index, a product, respectively, of the Ukrainian Exchange since March 26, 2009). Both indicators are price indexes weighted by the volume of securities issuance and take into account the free float indicator (that is, the amount of securities that is in free circulation on the market). In both cases, the basis for calculating indices is formed exclusively from securities included in the list of the stock exchange that performs the calculation. The list of companies whose shares are used to calculate indices [9, 10] is presented in table 1.

Table 1 - List of issuers whose shares are used in the calculation of stock indices of Ukrainian stock exchanges (as of April 3, 2024)

PFTS Index		**Ukrainian Shares Index**	
Ticker	**Name of the issuer**	**Ticker**	**Name of the issuer**
BAVL	Raiffeisen Bank	BAVL	Raiffeisen Bank
CEEN	Centerenergo	CEEN	Centerenergo
DOEN	Donbasenergo	DOEN	Donbasenergo
KVBZ	Kryukiv Wagon Building Plant	KVBZ	Kryukiv Wagon Building Plant
TATM	Ukrainian energy machines	TATM	Ukrenergomashyn
UTLM	Ukrtelecom	MHPC	MHP SE

As can be seen from the given data, both lists of issuers whose shares are used by Ukrainian stock exchanges in calculating indices are almost identical. Therefore, it can be assumed that there should be a significant relationship between these indicators. In addition, taking into account the openness of the Ukrainian economy and the fact that in today's world economic processes are interconnected, a similar connection should simply exist between Ukrainian and some foreign indices. It is considered appropriate to begin the study of such relationships with the help of correlation analysis.

Correlation analysis is a statistical method used to determine the presence, density, and direction of a relationship between multiple variables. The result of this analysis is the correlation coefficient, which demonstrates the existing relationship and its direction. The values of the coefficient can vary from -1 to 1, where both boundaries demonstrate a strong relationship between the variables, but in the case of -1, this relationship is negative, i.e., as the values of one variable increase, the values of the other decrease, and 0 - shows a complete lack of correlation. The Chaddock scale shown in table 2 can be used to evaluate and interpret other values.

Table 2 - Chaddock's scale for assessing correlation density

The absolute value of the coefficient	**Strength of correlation dependence**
< 0,3	Negligible
0,3 - < 0,5	Weak
0,5 - < 0,7	Moderate
0,7 - < 0,9	Strong
> 0,9	Very strong

In the simplest case, when we are talking about a linear relationship between two variables, the correlation coefficient (also known as Pearson's correlation coefficient) can be calculated using the formula:

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2(y_i-\bar{y})^2}} \quad (1)$$

where r is the correlation coefficient, n is the number of observations, x_i, y_i are the values of the variables (in our case, stock indices) for the *i*-th observation, $\bar{x}, \bar{y}$ are the average values of the variables.

The given formula can also be used to calculate Spearman's rank correlation coefficient (if the ranks are not integers). The main difference between the Spearman coefficient and the Pearson coefficient is that it is not used to calculate the values of the variables, but their ranks - ordinal numbers assigned by increasing or decreasing values.

To calculate correlation coefficients and achieve the goals of this work, the following stock indices (domestic and foreign) were chosen: Ukraine – PFTS and UX, Austria – ATX, Belgium – Bel 20, Bulgaria – BSE Sofix, Croatia – Crobex, Cyprus – Cymain, Czech Republic – PX, Denmark – OMXC20, Estonia – Tallin SE General, Finland – OMX Helsinki 25, France – CAC 40, Germany – DAX, Greece – Athens General Composite, Hungary – Bumix, Ireland – ISEQ, Italy – Italy 40, Latvia – Riga, Lithuania – Vilnius SE General, Malta – MSE, Netherlands – AEX, Poland – WIG20, Portugal – PSI 20, Romania – BET, Slovakia – SAX, Slovenia – Blue-Chip SBITOP, Spain – IBEX 35, Sweden – OMX S30, United Kindom – FTSE 100, USA – NYSE, and China – SSE 100. Also selected are data for the period from January 01, 2014 to February 09, 2024.

The large amount of data used for analysis does not allow them to be presented within the framework of this work. A certain idea about them can be made from the descriptive statistics given in table 3.

In order to isolate the impact of Russian aggression against Ukraine from the data, coefficients were also calculated for the periods from January 1, 2014 to February 23, 2022 and December 31, 2021.

Correlation coefficients between domestic and foreign stock indices calculated by the Pearson correlation coefficient formula (including Spearman's rank coefficients) are shown in tables 4 and 5.

Table 3 - Descriptive statistics of stock index values used to calculate correlation coefficients

Index	**Descriptive statistics**					
	n	**Mean**	**SE**	**Median**	**Min**	**Max**
ATX	2 535	2 892,34	9,61	3 000,21	1 630,84	4 057,59
Bel 20	2 589	3 647,72	6,35	3 660,00	2 528,77	4 402,32
BSE Sofix	2 500	570,58	1,76	578,46	405,80	789,80
Crobex	2 517	1 895,93	4,31	1 853,23	1 364,98	2 686,88
Cymain	2 494	54,75	0,41	47,06	25,95	147,90
PX	2 532	1 083,32	3,22	1 049,27	690,37	1 481,68
OMXC20	2 528	1 236,95	8,70	1 014,77	620,04	2 556,10
Tallin SE General	2 538	1 297,97	7,51	1 234,48	731,61	2 141,55
OMX Helsinki 25	2 542	4 034,41	14,44	4 036,23	2 686,47	5 786,90
CAC 40	2 589	5 492,03	19,01	5 309,22	3 754,84	7 677,47
DAX	2 565	12 514,82	40,88	12 385,89	8 441,71	17 033,24
Athens General Composite	2 491	843,00	4,23	823,55	440,88	1 404,88
Bumix	2 524	3 120,30	22,59	3 572,37	1 361,01	5 663,97
ISEQ	2 578	6 721,83	21,39	6 617,80	4 347,73	9 290,35
Italy 40	2 561	2 160,30	6,24	2 134,20	1 428,90	3 056,60
Riga	2 518	922,26	5,78	1 022,29	408,03	1 434,37
Vilnius SE General	2 519	701,94	3,64	684,75	429,67	1 028,74
MSE	2 495	4 089,38	9,36	4 021,76	3 229,98	4 912,45
AEX	2 589	571,81	2,41	548,05	376,27	851,77
WIG20	2 529	2 113,06	5,44	2 179,71	1 305,73	2 630,37
PSI 20	2 589	5 389,13	13,52	5 301,70	3 596,08	7 734,95
BET	2 527	9 223,13	47,46	8 416,03	6 018,98	15 803,32
SAX	2 515	318,98	0,97	329,85	193,90	405,55
Blue-Chip SBITOP	2 528	905,75	3,59	840,10	646,68	1 386,17
IBEX 35	2 590	9 284,40	20,94	9 263,90	6 107,20	11 866,40
OMX S30	2 542	1 742,48	6,40	1 625,00	1 246,10	2 456,17
FTSE 100	2 554	7 007,15	10,60	7 114,69	4 993,89	8 014,31
NYSE	2 543	12 949,08	43,67	12 622,10	8 777,40	17 353,80
SSE 100	2 239	6 241,50	20,90	6 146,41	4 228,20	10 968,62
PFTS	2 518	434,93	2,20	500,51	215,27	607,85
UX	2 511	1 365,55	7,56	1 456,13	532,13	2 145,38

Table 4 - Pearson correlation coefficients for assessing the relationship between indices

	01.2014 – 02.2024		01.2014 – 02.2022		01.2014 - 12.2021	
	PFTS	**UX**	**PFTS**	**UX**	**PFTS**	**UX**
PFTS	1,000000	0,868955	1,000000	0,874660	1,000000	0,872650
UX	0,868955	1,000000	0,874660	1,000000	0,872650	1,000000
NYSE	0,673726	0,803584	0,629644	0,814929	0,626520	0,816730
Blue-Chip SBITOP	0,654977	0,746960	0,640168	0,771745	0,655064	0,791428
Bumix	0,707864	0,859762	0,691266	0,867959	0,685285	0,864649
BET	0,616807	0,731283	0,604085	0,762163	0,607241	0,770717
AEX	0,627534	0,756084	0,575123	0,764517	0,568332	0,762547
Vilnius SE General	0,666174	0,774792	0,625088	0,799167	0,619750	0,797415
OMX Helsinki 25	0,610030	0,755546	0,552381	0,765064	0,543369	0,761044
CAC 40			0,529646	0,745504	0,523209	0,747884
Tallin SE General	0,585844	0,734622		0,740515		0,743901
Riga	0,618169	0,783672	0,563235	0,767879	0,553476	0,761317
OMX S30	0,588007		0,524311		0,515551	
ATX		0,713086				

Table 5 - Spearman correlation coefficients for assessing the relationship between indices

	01.2014 – 02.2024		01.2014 – 02.2022		01.2014 - 12.2021	
	PFTS	**UX**	**PFTS**	**UX**	**PFTS**	**UX**
PFTS	1,000000	0,842411	1,000000	0,881581	1,000000	0,883711
UX	0,842411	1,000000	0,881581	1,000000	0,883711	1,000000
NYSE	0,692425	0,825319	0,688789	0,843949	0,688835	0,844313
Blue-Chip SBITOP	0,719198	0,829807	0,780855	0,877797	0,782029	0,878803
Bumix	0,649824	0,796537	0,608625	0,774273	0,605173	0,776530
BET	0,650628	0,785138	0,665099	0,801430	0,665100	0,801055
AEX	0,631809	0,774807	0,612721	0,778196	0,612066	0,777516
Vilnius SE General	0,605748	0,750261	0,589005	0,767036	0,588370	0,766104
OMX Helsinki 25	0,632921	0,765150	0,566716	0,762452	0,565148	0,760688
CAC 40	0,591740		0,564050	0,750270	0,562016	0,749713
Tallin SE General	0,602987	0,772018		0,774710		0,773807
Riga		0,752025				
PX		0,763351	0,565770	0,760811	0,563437	0,759633
SAX	0,670594		0,619161		0,615947	

As can be seen from the given data, there is indeed a direct correlation of high strength (from 0.84 to 0.88) between domestic stock indices. They also correlate with their foreign counterparts. At the same time, the links of the Index of the Ukrainian Stock Exchange have a high strength (> 0.7), while for the PFTS they mostly fall into the range from 0.5 to 0.7 (that is, they are characterized by average strength). Seven of the twenty-nine indices selected for analysis (namely NYSE, Blue-Chip, SBITOP, Bumix, BET, AEX, Vilnius SE General, OMX Helsinki 25) are present in the list of 10 with the highest value of the correlation coefficient for each of the selected time periods.

Conclusions. So, based on the results of calculations of Pearson's correlation coefficient and Spearman's rank correlation coefficient, it can be stated that 1) there is a high correlation between the values of domestic stock indices; 2) the same dependence (high for the Index of Ukrainian shares and less for the PFTS Index) can be traced between the specified indicators of Ukraine and a number of indices of other countries. It should be remembered that this dependence is not direct, that is, the indices do not depend on each other, but depend on a number of objective economic factors that are similar for different countries. The work performed in this way is the basis for conducting further research on the relationship between the stock market of Ukraine and the stock markets of the world, assessing the influence of foreign markets on the domestic market, and forecasting its reaction to such influence.

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