



The Relationship Between World and Local Stock Indices

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ARTICLE INFO

Received October 11, 2019
Revised from October 30, 2019
Accepted November 7, 2019
Available online March 15, 2020

JEL classification: F30, G15, G16

DOI: 10.14254/1800-5845/2020.16-1.4

Keywords:

Stock market,
stock indices,
stock exchange,
cointegration

ABSTRACT

The article presents the results of the study on the impact of stock indices of world exchange on the indices of local exchanges through the example of the Ukrainian stock index. The purpose of the article was to confirm the hypothesis of the existing influence of the indexes of world stock exchanges on the indices of local stock exchanges. Time series of Standard & Poor's Global Ratings, NIKKEI 225, FTSE, DAX, WIG and PFTS stock indices were used for the study for the period from 2010 to 2017. On the basis of the analysis of the parameters of descriptive statistics, the relationship between the indicated indices with different levels of narrowness was determined. Using the Sharpe model, the absolute risk of the PFTS index was determined as the sum of specific and systematic risks. To test the time series for stationarity, the expanded Dickie-Fuller test and the Phillips-Perron test were used. It has been determined that the analysed time series are the rows characterized by non-stationary and random roaming series, while the S & P index has the most powerful trend, and WIG and FTSE have weaker trends. The hypothesis was put forward about the fact that world exchanges form the conjuncture on local exchanges, in particular Ukrainian exchange, which is confirmed by the results of the Granger causality test, as well as by cointegration tests.

INTRODUCTION

At the present stage, the global financial market plays a leading role in the development of economic processes, as it ensures the transfer of financial flows at different levels: global, subnational and national, provides adequate assessment of financial risks, and the ability to absorb exogenous and endogenous shocks. Among all segments of the financial market, the special role is given to the stock market, which has the closest connection with the real sector of the economy through transactions with stock shares both with their initial public offering and with turnover on the secondary market. Depending on the macroeconomic situation in the country and the formation of global economic indicators that affect the cost of capital and generate the corresponding financial risks, each of these markets may develop at a more or less rapid pace.

Stock markets of different countries are increasingly included in integration processes and become interdependent. This is facilitated by the development of economic relations and modern

financial technologies, while stock markets have a significant impact on the economic growth of developed countries as well as (Chancharat, 2009; Koirala, 2011; Wei, 2018). The state of the world's financial markets has a significant impact on the status of individual national economies, especially if these economies are small in size and with a high degree of openness to global financial flows. Ukraine's economy is among such economies, that is why it is extremely important to determine, as well as to predict the impact of world finances on the state of economic development with a purpose of preventive measures developing to reduce risks at the macroeconomic, meso- and microeconomic levels (Kravchenko, 2017).

A key indicator that reflects the functioning of the stock market is the stock index. Stock indexes are important for different groups of economic agents in the focus of information, as well as depending on their functions - diagnostic, indicative and speculative. On the one hand, they reflect the trends of the market development, the speed of their changes, the vector of the movement of the short-term conjuncture, which is primarily interesting for professional participants of the financial market, securities traders, investors, using the indicative function. In addition, indicative and diagnostic functions are important for issuers of securities because stock index values are based on the dynamics of market prices for the shares of particular companies undergoing a listing procedure (depending on the stock exchange more or less rigid) and from this point of view they are interesting for their owners and key stakeholders, because in this case, in fact, the rating of the company is determined by financial indexes.

On the other hand, the behavior of the stock index can be viewed through a diagnostic function and will reflect the state and dynamics of the development of the national economy as a whole and its separate sectors. We also should take into account that stock indices, along with other macroeconomic indicators, such as the discount rate, balance of payments, deficit or surplus of the state budget, are used to determine the overall financial stability of the economy. In this context, local stock indices, the peculiarities of their formation and the relations with world-class stock indices are used by financial regulators to determine predictive indicators of national economies development and are the basis of public financial policy. In addition, the speculative function of stock indices is manifested in their role in derivative transactions, besides the indices are highly sensitive at very short time intervals, and therefore they are one of the main signals for futures and options contracts.

One of study directions of stock index behavior is a study of relationships that are formed between stock indices not only of separate stock exchanges but also of relationships that may arise between stock indices of world stock exchanges such as New York, Tokyo, London and Frankfurt. stock exchanges with local stock exchanges such as the Ukrainian PFTS Stock Exchange. In the course of such research, it is essentially possible to find out how much the local stock markets and thus to some extent the national financial systems are influenced by financial globalization processes. As a result, we can predict potential external risks for the financial stability of the national economy and develop adequate anti-crisis measures.

1. LITERATURE REVIEW

Most studies that analyse the interconnections between stock markets of different countries and regions, economies with different levels of development, indicate their presence, regardless of which economic and mathematical methods and statistical tests were used, besides it is worth noting that the overwhelming majority of these studies is based on the method of cointegration (Engle and Granger, 1987). Such a link was found in the analysis of stock markets in the developed countries of the European Union such as Austria, France, Germany and the United Kingdom, and developing countries which have stock markets that exist not for a long time - Czech Republic, Hungary, Poland and Romania, as well as Russian Federation (Horobet and Lupu, 2009). In addition, it is established that the impact is bilateral, both from developed markets to emerging markets, and vice versa. In the study of the relationship between the stock market in

India as a developing country and the stock markets of the BRICS countries, as well as a number of other countries whose stock markets are located adjacent to each other, it is noted that India's economy is most financially integrated with frontier countries – Malaysia, Taiwan, but India's stock market is gradually integrating with emerging markets (DASH et al., 2018).

The problems of interconnections between the world stock markets and the stock markets of Asian countries were investigated in papers (Gulzar et al., 2019). Regarding the relationship between the stock markets of China and Asian countries such as Indonesia, Malaysia, Philippines, Singapore, Thailand, G. Caporale et al. (2019) carried out a detailed analysis in their study using the cointegration method for the period from November 2002 to March 2018, and proved the existence of long-term interconnections, noting that the global financial crisis led to their weakening. Similar studies are also conducted in Latin American countries (Torre-Torres et al., 2018; Cabrera et al., 2017).

The study of the interconnections that exist between the world stock markets due to the value of SPX, SMI, FTSE, DAX, CAC stock indices, conducted by M. Gagnon et al. (2016), which used a fractionally co-integrated VAR model and proved the existence of financial integration as well as the side effects of volatility both during the global financial crisis and during non-crisis time. So, this issue is being studied in many studies and in different regions of the world. At the same time, it can be noted that researches of the interconnections that arise between Ukrainian stock indexes and world stock indices are practically absent. While choosing a basic stock index for our research, we relied on the results obtained in scientists' researches of the analysis of the status of Ukrainian stock exchanges and the behaviour of stock indices, in particular the study on the determination of the frequency of excessive price reactions, on the example of the PFTS index and the UX index (Plastun et al., 2018), which analysed a number of hypotheses about the possibility of using these indices as predictors of crisis phenomena in the economy, as well as for forecasting of profitability of shares and using a correlation analysis, regression analysis with fictitious variables, and also statistical tests (expanded Dicky-Fuller test of Granger causality test) proved that the indicated indices are informative and can be used for the development of trading strategies.

In addition, a study on the impact of force majeure in Ukraine (economic force majeure, social force majeure and terrorist acts, natural and technological disasters) on the basic stock PFTS index of Ukraine. As a result, it is proved that the stock PFTS index quickly absorbs all information, manifests itself in one-day fluctuation and does not demonstrate the existence of a profitable trading strategy (Caporale et al., 2019). Taking into account these studies, it is possible to use the PFTS index as the most informative index of the Ukrainian stock market to assess the impact of world stock indices.

2. METHODOLOGY AND DATA

In the basis of this study there is a hypothesis of effective markets (Fama, 1970). The essence of this hypothesis is reduced to the fact that all existing information on the market relating to a particular security immediately manifests itself at its exchange rate, and any new information immediately manifests itself in price changes, while the change itself is random. Consequently, stock indices that are formed on the basis of stock prices are also informative regarding the state of stock markets and their interaction with each other.

The dynamics of international stock indices such as Standard & Poor's Global Ratings was used for the study, which is formed as a weighted average on the base of free-float indicators of the largest US companies whose shares are traded on the NASDAQ Stock Exchange and the New York Stock Exchange; NIKKEI 225 international stock index, formed as the average arithmetic price of the shares of the 225 most active companies in the Tokyo Stock Exchange; FTSE (Financial Times Stock Exchange) – an index reflecting the capitalization of shares on the London Stock Exchange; DAX – the index calculated on the basis of the capitalization of shares quoted on the

Frankfurt stock exchange; WIG – index calculated on the basis of the information of the Warsaw Stock Exchange; PFTS – the domestic index of the First Stock Trading System. Thus, the study uses the data of the largest world and regional stock exchanges to determine the link between them and the state of the domestic stock market. The study uses the time series of international indexes for the period from 2010 to December 2017.

The study adopted the hypothesis that world exchanges have a decisive influence on the formation of the conjuncture of Ukrainian stock exchanges. The research is carried out using a number of methods, namely: a correlation analysis was used to establish the relationship between the studied indices; β -coefficient of Sharpe's was used to determine the systemic risk; the Phillips-Perron tests and the Dickey-Fuller extended test were used to verify the statistical properties of time series; the author of the study used a method of cointegration taking into account the low power of these methods. In addition to this the author used the inverse analysis method based on MPP (most probable failure point) -based dimension (Lee et al., 2008), which allowed to take into account the possible significant failures in the behavior of individual indices of the individual components, as well as failures in their paired behavior indices PFTS/S&P, PFTS/NIKKEI 225, PFTS/FTSE, PFTS/DAX, PFTS/WIG.

3. RESULTS

World trends show the gradual integration of stock exchanges in the world, which is manifested in similar behaviour of stock indexes. In particular, the impact of larger exchanges on smaller ones has been recorded, which was manifested through a similar price dynamics and closer relations between exchanges from the same region. Theoretically, we can say that the law of gravity functions in this situation. Taking into account the noted observations, the author raised the problem of impact of the largest world stock indices (American – S & P Global Ratings, Japanese – NIKKEI 225, English – FTSE 250 and German – DAX) and Polish (WIG) on the indices of a local stock market (Ukrainian – PFTS). In terms of risk assessment, it will be interesting to compare the level of volatility of these markets, as well as their power and direction of influence.

Despite of fact that, in terms of capitalization, the German stock exchange is inferior to American, Japanese and English, it is one of the world's ones and is also capable to influence powerfully on regional exchanges (in particular, Ukrainian) and the largest exchanges of the world. Figure 1 shows the time series of individual indices in pairs: the PFTS index and individual indices of the world stock exchanges. The data is taken from the post-crisis period from January 2010 to December 2017. Even a runaway observation makes it possible to notice the similarity in the formation of the values of the selected indicators. Reverse trend points coincide with similar time points, trend lengths is also approximate. Some differences are observed only in their capacity. In the case of the PFTS exchange index, we can see that during the first period of 2010-2011 the crisis at the Ukrainian stock exchange was larger than at the world stock exchanges. After 2011, trends` capacity vary according to the American (S & P 500), Japanese (NIKKEI 225), English (FTSE 250), German (DAX) and Polish (WIG) exchanges, and there is a similar trend behaviour according to the PFTS index.

In a long perspective, we can see a more stable situation on the American and Japanese exchanges than on the European ones. Trends at European exchanges are still stronger than at American and Japanese ones, although they all have the same length. The similarity of the development of time series of stock indexes indicates that there is a correlation between them, but in practice cointegration will be more important. A stable situation on the US stock exchange is confirmed by certain descriptive characteristics (Table 1)

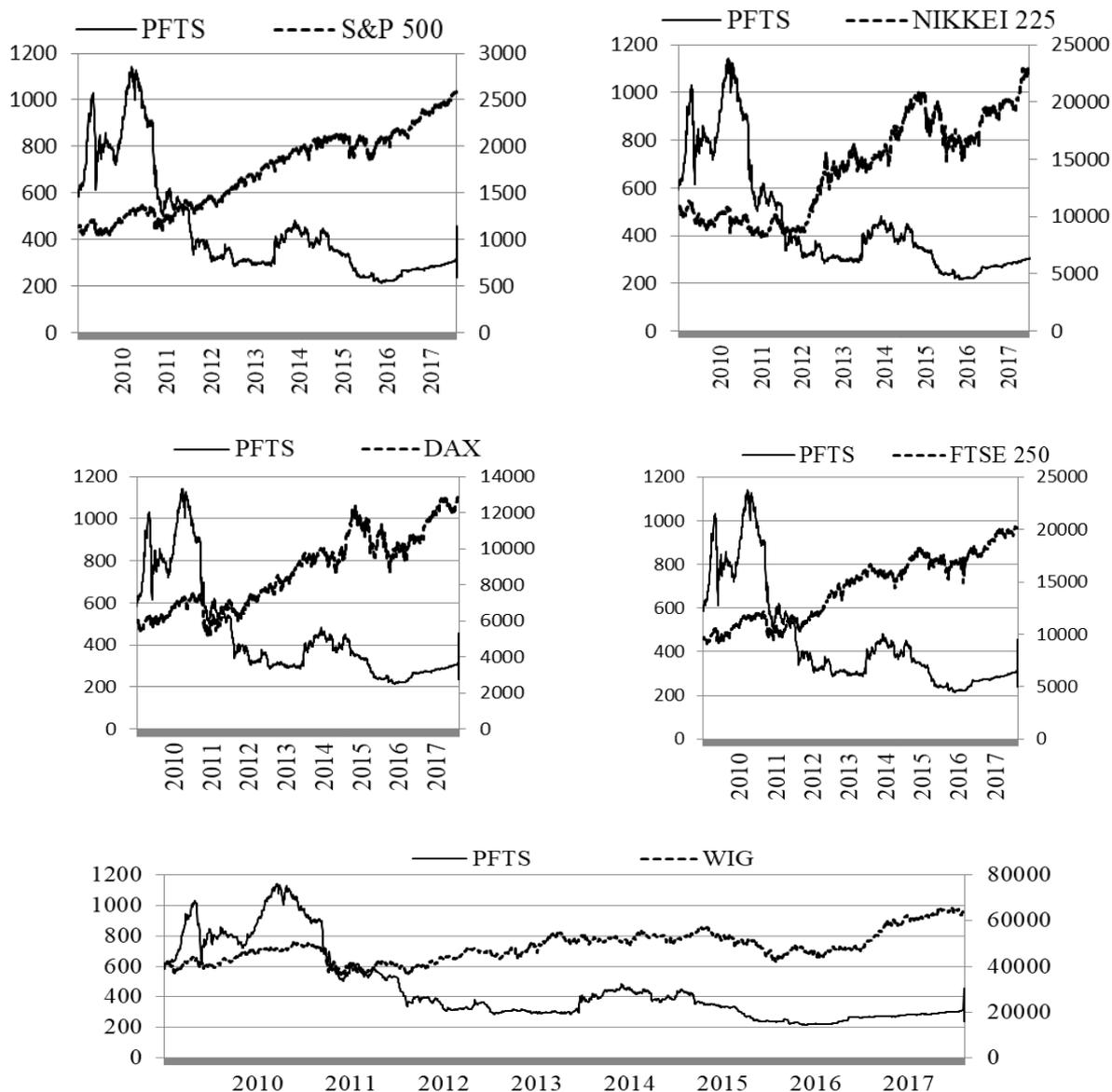


Figure 1. Time series of stock indexes for the 2010–2017 period

Source: compiled by the authors

Table 1. Main descriptive characteristics of time series of stock indexes for the 2010–2017 period

Stock exchange index	Descriptive characteristics			
	Average value	Standard deviation	Volatility coefficient	Most probable failure point
S&P 500 (SPX)	1746,08	438,90	32,85	1,255886
Nikkei 225 (N225)	13377,49	3824,82	47,97	1,367553
PFTS	455,64	237,70	50,38	1,306951
DAX	8365,70	1841,33	43,90	1,347744
FTSE 250	13878,32	2842,19	33,27	1,308129
WIG	46903,75	4871,27	35,22	1,553353

Source: compiled by the authors

The lowest value of the volatility coefficient – 32.85% – was obtained for the American stock exchange. The indexes of the Ukrainian and Japanese exchanges have been not so stable: PFTS – 50.38%, NIKKEI 225 – 47.97%. This situation gives investors more opportunities for better financial results. All the time series differed from the normal one by distribution of values primarily due to asymmetry. The dimension of the MPP indicate that we are dealing with time series of accidental wandering, from which the S&P 500 index can be classified as the index with the most powerful trends, and the WIG and FTSE 250 indexes as indices with weaker trends. Time series of profitability rates (Figure 2) and the descriptive characteristics of these series are presented below (Table 2).

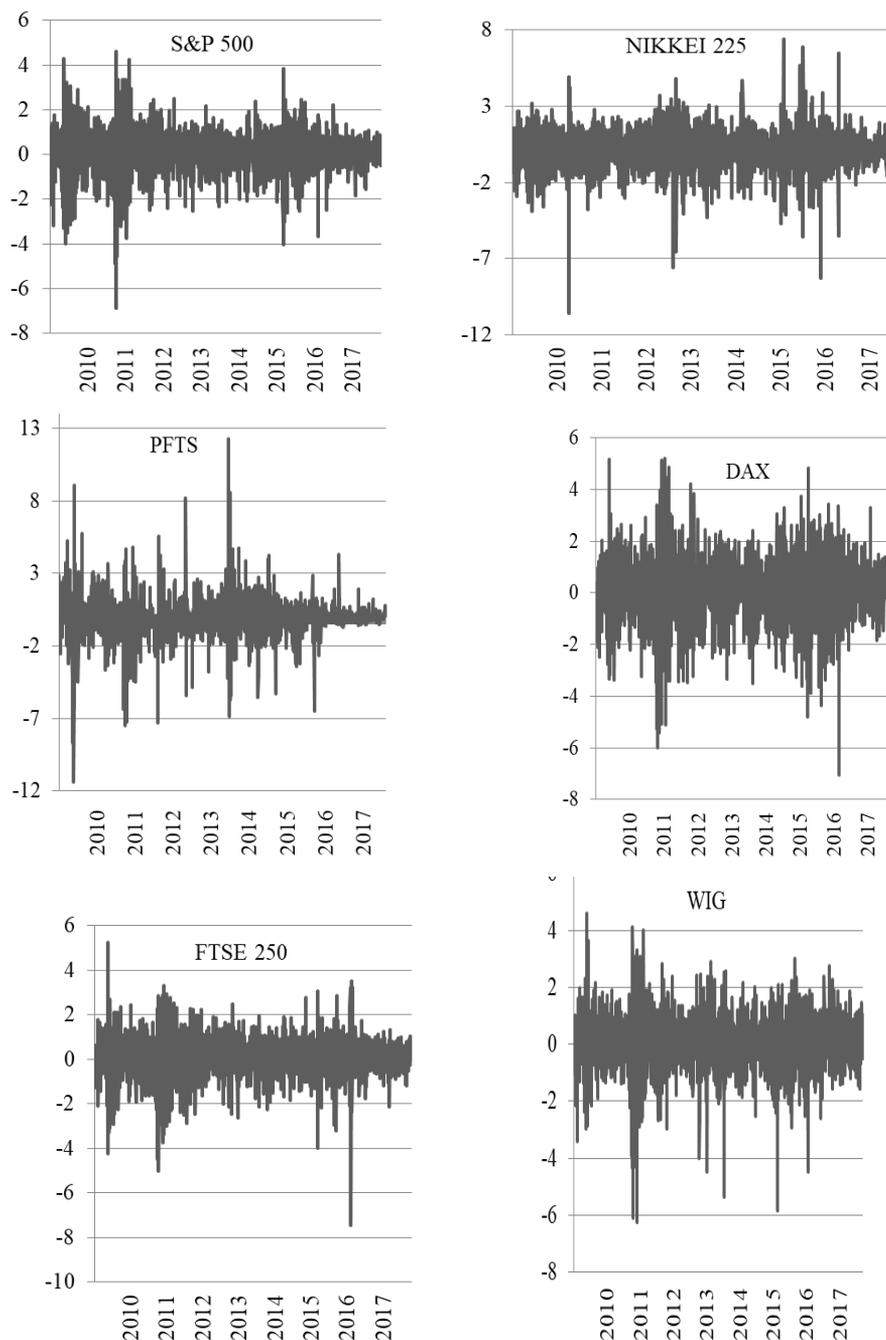


Figure 2. Time series of profitability rates of stock indices for the 2010–2017 period

Source: compiled by the authors

The average change in the index values slightly varied. The largest change was recorded for S&P 500, NIKKEI 225 and FTSE 250, respectively, 0.043%, 0.0387% and 0.039%, which also indicates not so strong trends than in the case of the rest of the indices. WIG index had a slightly lower average rate of return – 0.022%. The negative average rate of return was recorded for the PFTS index – -0,031%.

The rates of profitability of the PFTS index characterized by he highest volatility, measured by the standard deviation and the rates of profitability of the S&P 500 index had the lowest volatility. 1.42% was the result of PFTS index. 0.93% was the result of the S&P 500 index.

Periods with unusual changes in values can be distinguished for all indices. Dimensions of MPP are formed at the level from 1.658 to 1.84 and indicate the variable investment risks. It is possible to distinguish periods with relatively small variability – 2012–2014, and periods with unusual variability – 2011, 2016. Such a situation somewhat complicates the prediction of investment risk.

Table 2. The main descriptive characteristics of the profitability norms of stock indices for the 2010–2017

Stock exchange index	Descriptive characteristics		
	Average value	Standard deviation	Most probable failure point
S&P 500 (SPX)	0,042694	0,929122	1,690164
Nikkei 225 (N225)	0,038735	1,356852	1,731431
PFTS	-0,03135	1,424987	1,689907
DAX	0,037362	1,241792	1,840419
FTSE 250	0,038586	0,940957	1,657589
WIG	0,022342	0,996094	1,759505

Source: compiled by the authors

The coefficients of the linear correlation of Pearson (Table 3) indicate the similarities in the formation of the values of the indexes. As it turned out, the values of the indices of the Polish and Ukrainian exchanges most closely correlate with the values of the DAX index. Such a great result is the manifestation of strong trends in these markets. The weakest value of the WIG and BUX indices is correlated with the NIKKEI 225 index. The values of the correlation coefficients for the rates of profitability are the lowest. The results of the analysis of the indices and rates of profitability indicate that the long-term conjuncture in the Polish and Ukrainian markets is similar to conjuncture of other European markets, and the impact of the Japanese stock exchange is the weakest. However, in a short period of time stock exchanges can behave differently.

Table 3. Correlation and beta coefficients between the indices of the world stock exchanges and the index of the Ukrainian stock market

Stock exchange index	Correlation – prices	Correlation – norms of profitability	Beta coefficient
S&P 500 (SPX)	-0,70987	0,02918	0,0444
Nikkei 225 (N225)	-0,46575	-0,01267	-0,0093
DAX	-0,62931	0,03571	0,0406
FTSE 250	-0,69550	0,02621	0,0394
WIG	-0,34771	0,03435	0,0490

Source: compiled by the authors

Table 3 also shows the coefficients of the Sharpe beta model, which represent the effect of changes in the rates of profitability of world stock exchange indices on changes in the rates of profitability on the PFTS index. The presented results indicate rather the calm reaction of the indices of local exchanges, since the values of the beta coefficients are formed at a significantly lower level than 1. The response to changes in the rate of profitability of the WIG index is the strongest.

Figure 3 shows the effect of the rates of profitability of world indexes on the rate of profitability of the PFTS index. The points placed in the I and III quadrants of the coordinate system indicate the dates when the positive norms of the profitability of the PFTS index corresponded to the positive norms of the profitability of a particular index, and the negative ones corresponded to negative norms. The points placed in the II and IV quadrants of the coordinate system indicate the dates when the opposite changes of values were recorded. The number of such cases is approximately the same.

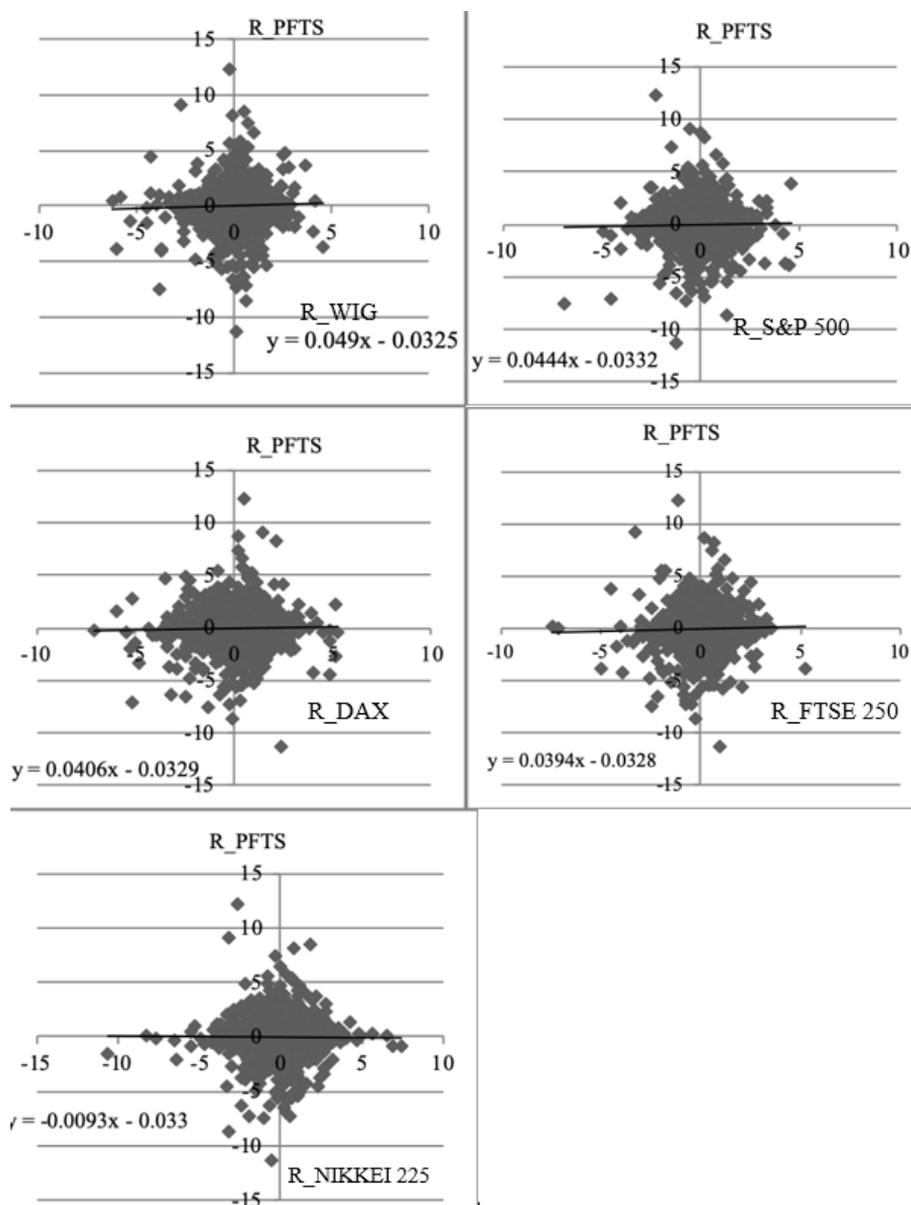


Figure 3. Influence of the norms of profitability of world indexes on the norm of profitability of the PFTS index – Sharpe model

Source: compiled by the authors

The Sharpe model makes it possible to distinguish a systematic risk within the absolute risk, measured by the dispersion of the norms of profitability, which reflects the influence of the independent factor, as well as the specific risk, reflecting the influence of other factors. Table 4 assumes the value of this risk for the PFTS stock index in absolute and relative terms. As it turned out, practically the whole share of aggregate risk falls on a specific risk.

Table 4. Absolute risk of the PFTS index as the sum of specific and systematic risks

<i>Stock exchange index</i>	<i>Absolute risk</i>	<i>Systematic risk</i>	<i>Specific risk</i>
S&P 500 (SPX)	0,000086	0,00000040	0,00008593
Nikkei 225 (N225)	0,000184	0,00000002	0,00018409
DAX	0,000154	0,00000033	0,00015387
FTSE 250	0,000089	0,00000032	0,00008822
WIG	0,000099	0,00000049	0,00009873
<i>Stock exchange index</i>	<i>Absolute risk, %</i>	<i>Systematic risk, %</i>	<i>Specific risk, %</i>
S&P 500 (SPX)	100	0,46	99,54
Nikkei 225 (N225)	100	0,01	99,99
DAX	100	0,22	99,78
FTSE 250	100	0,36	99,64
WIG	100	0,49	99,51

Source: compiled by the authors

More information on the statistical properties of time series of stock indices is provided by stationarity tests (Table 5). ADF test (Extended Dickie-Fuller Test) and PP test (Phillips-Peron Test) were used in the analysis.

Table 5. Stationarity tests for logarithms of stock indexes

<i>Stock exchange index</i>	<i>ADF</i>	<i>PP</i>
S&P 500 (SPX)	-0,567868	-0,387579
Nikkei 225 (N225)	-0,410597	-0,318852
PFTS	-1,078398	-1,011452
DAX	-0,963230	-0,894712
FTSE 250	-0,829802	-0,919027
WIG	-1,417821	-1,303276

Source: compiled by the authors

The results of ADF and PP tests are approximate. As it turned out, time series of the values of stock indices are characterized by non-stationary, which may indicate the presence of accidental wandering. Although non-fulfilment of the assumption about the normality of the distribution of the remnants of the used models is the problem of recognizing of these series by the series of accidental wandering. The represented values of the MRP dimension also indicated an accidental wandering (Table 1), but for some time series, they were formed at the level close to the upper limit of the rejection of the hypothesis of accidental wandering. This could indicate the possibility of returning of the index value to the average level, after relatively large deviations from this level. The increase in the values of stock indexes in all cases was considered stationary. This means that the time series of the values of stock indexes are integrated at level 1.

In the study, we accept the hypothesis that world stock exchanges create a conjuncture at the local exchanges, in particular at Ukrainian one. The proof of this hypothesis is the results of the Granger causality test (table 6, table 7).

Table 6. Causality test for value series of stock indices

<i>Stock exchange index (SEI)</i>	<i>PFTS is not a reason of SEI</i>	<i>SEI is not a reason of PFTS</i>
S&P 500 (SPX)	1,61946	0,38796
Nikkei 225 (N225)	1,50195	0,26433
DAX	0,67143	0,31759
FTSE 250	2,42834	0,35831
WIG	2,09260	0,15491

Source: compiled by the authors

Two test delays were taken in the study of the causality of the value of stock indexes. The zero hypothesis about the value of the PFTS stock index that is not the cause of the values of individual indices of the world stock exchanges can't be discarded. This means that the introduction of the value of the PFTS exchange index, which represents the formation of the values of the indices of world stock exchanges, into the model does not lead to an increase in the quality of such a model.

There is a completely different situation regarding the effect of the value of the index of the world stock exchange on the value of the PFTS index. In this case, the hypothesis of non-causality was rejected. This means that the inclusion of the indexes of world exchanges into a model that describes the value of the PFTS stock index significantly improves the properties of such a model, in particular, in the field of forecasting. However, the obtained results, taking into account the non-stationary of time series of indices, are characterized by a limited probability.

The results of causality tests for the growth series of the values of stock indices are more probable (Table 7). In this case, testing of two delays was also carried out. General conclusions are identical. The introduction of the PFTS index does not significantly improve the properties of the models of world stock indexes. Instead, the introduction of world stock market indices into a model that describes the change in the PFTS index significantly improves their properties.

Table 7. Causality tests for series of profitability norms of stock indices

<i>Stock exchange index (SEI)</i>	<i>PFTS is not a reason of SEI</i>	<i>SEI is not a reason of PFTS</i>
S&P 500 (SPX)	1,30348	0,16284
Nikkei 225 (N225)	0,26351	1,67670
DAX	1,86792	0,52006
FTSE 250	3,29424	0,44755
WIG	3,83009	0,31942

Source: compiled by the authors

The causality tests confirm the correlation study of the impact of world market indices on the indices of local stock exchanges. They confirm the presence of such influence. The next proof of this fact is the cointegration tests (table 8). Tests revealed the lack of cointegration of the PFTS index with the indices of the world's stock exchanges, which was predictable in view of other long-term trends.

Table 8. Cointegration tests, PFTS index value as a dependent variable

<i>Stock exchange index</i>	<i>Cointegration equation</i>			<i>Cointegration tests</i>	
	<i>c_i</i>	<i>S(c_i)</i>	<i>p</i>	<i>ADF</i>	<i>PP</i>
S&P 500	0,225597	0,004041	0,0000	-0,054844	0,206141
Nikkei 225	0,026546	0,000504	0,0000	-0,185040	-0,060410
DAX	0,045336	0,000781	0,0000	-0,669217	-0,624207
FTSE 250	0,027658	0,000472	0,0000	-0,336982	-0,407503
WIG	0,009007	0,000122	0,0000	-1,121826	-1,032997

Source: compiled by the authors

In addition, a study was conducted to integrate the PFTS stock index with the entire group, which included five indexes of world exchanges. The results are presented in Table 9, and the graphs of the remains of the cointegration equations are presented in Figure 5.

Table 9. Cointegration tests, the value of the PFTS index as a dependent variable, the aggregate effect of the indices of world exchanges

Stock exchange index	Cointegration equation			Cointegration tests	
	c_i	$S(c_i)$	p	ADF	PP
S&P 500	-0,616379	0,044199	0,0000	-3,450338	-3,141737
Nikkei 225	-0,010951	0,002566	0,0000		
DAX	0,039401	0,007893	0,0000		
FTSE 250	-0,036982	0,006637	0,0000		
WIG	0,038405	0,000593	0,0000		

Source: compiled by the authors

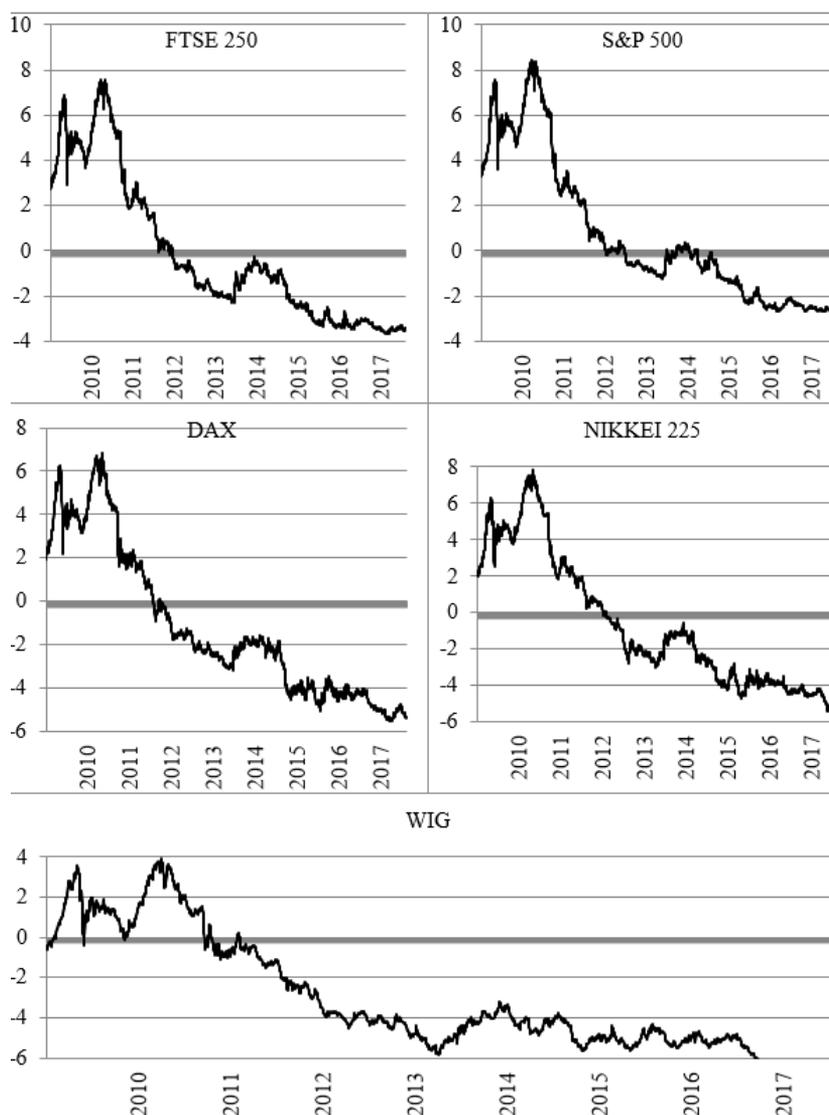


Figure 4. Remains from the cointegration equation, PFTS index as a dependent variable

Source: compiled by the authors



Figure 5. Remains of the cointegration equation, the value of the index PFTS as a dependent variable, the combined effect of the indexes of world exchanges

Source: compiled by the authors

The results of the research show that there is a long-term equilibrium between the PFTS stock exchange index and the group consisting of global stock market indices.

CONCLUSION

To summarize we can note that the Ukrainian stock market is influenced by the world stock markets of Great Britain, Germany, the USA, as well as local markets, in particular the Polish stock market. Studies have confirmed that, taking into account the insignificant size of the Ukrainian stock market, its development has no effect on world financial processes. The impact is only one-sided from the powerful markets to Ukraine, and the nature of this influence only manifests itself in the long-term, such influence is not proved in the short-term terms.

It should be noted that this study is only a separate fragment of the study of existing interconnections between the stock market of Ukraine and the world stock markets. In future we shall focus on the study of the links between different segments of the Ukrainian stock market – share market, bond market and other financial and commodity assets – with world stock markets.

In the conclusion we should note that global financial market plays a leading role in the development of economic processes, as it ensures the transfer of financial flows at different levels: global, subnational and national, it provides an adequate assessment of financial risks, and the ability to absorb exogenous and endogenous shocks. Besides, the relation between the financial sector and the real economic sector is most fully secured by the stock market through stock transactions, both through IPO and through secondary market operations.

The most important information about the state of the stock market of the country is accumulated by stock indices, which perform a number of functions - diagnostic, indicative and speculative. Besides, stock indices, along with other macroeconomic indicators, such as the discount rate, balance of payments, deficit or surplus of the state budget, are used to determine the overall financial stability of the economy. Investigation of the relationships between stock indices of global stock exchanges and local stock exchanges allows us to determine a degree of involvement of local stock markets in world financial globalization processes and to assess potential external risks.

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