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## A comparative analysis of stock market volatility depending on investment time horizon

**Abstract**

*Introduction.* It is of topical importance today to study the ratio between the returns and risk of the Ukrainian stock market depending on the duration of the investment period. The relevant analysis should be conducted with regard to the markets of European post-socialist countries that have common features of development.

*Purpose.* The purpose of the research is to define the influence of time factors on the returns and risk of financial assets through the numbers of stock indices (Ukrainian PFTS index, Polish stock index WIG, Czech stock index PX), the analysis of volatility of Ukrainian and European stock markets and the identification of patterns of their development.

*Methods.* To conduct the research, the authors use the analysis of dynamic series, statistical, structural analysis, comparative analysis and correlation-and-regression analysis.

*Results.* In the article, a comparative analysis of the volatility of the Ukrainian and European stock markets was conducted based on statistical research of temporal changes of stock indices. Their common development trends and differences, which can be explained by the peculiarity and specificity of the Ukrainian stock market, are revealed. The results of the analysis show that, with the increasing investment time horizon, the spread between maximum and minimum income returns is reduced, and the minimal income return itself becomes extremely positive. As the research shows, the peculiarity of the Ukrainian stock market is its significantly higher income return, which, however, is accompanied by a much higher risk, especially during the seven to nine year investment period.

*Conclusion.* The Ukrainian stock market involves high risks, which does not make it attractive for conservative investors. However, it is considered to be a very attractive investment destination for risky investors, especially for a medium-term period of 7-12 years, since they may expect returns several times higher than at Polish and Czech markets under investigation.

**Keywords:** Stock Market; Returns; Risk; Stock Indices; Investment Time Horizon; Volatility; Warsaw Stock Exchange; Prague Stock Exchange; Ukrainian PFTS index; Polish stock index WIG; Czech stock index PX

**JEL Classification:** G10; G14

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**Волатильність фондового ринку в залежності від часового горизонту інвестування: порівняльний аналіз<sup>1</sup>**

**Анотація.** Сьогодні актуальності набуває потреба дослідження співвідношення доходності та ризику інструментів українського фондового ринку в залежності від тривалості терміну інвестування. Аналіз доцільно проводити, порівнюючи інструменти українського фондового ринку з відповідними інструментами ринків європейських постсоціалістичних країн, що мають спільні риси розвитку. Метою дослідження є виявлення впливу часових факторів на доходність та ризик фінансових активів через показники фондових індексів, аналіз волатильності українського та європейських фондових ринків, а також виявлення закономірностей їх розвитку. У роботі використано методи аналізу динамічних рядів, статистичного, структурного, порівняльного, кореляційно-регресійного аналізу. На основі статистичного дослідження часових змін фондових індексів проведено порівняльний аналіз волатильності українського та європейських фондових ринків. Виявлено спільні тенденції їх розвитку, а також відмінності, що пояснюються особливістю та специфікою українського фондового ринку. Український фондовий ринок є значно ризиковим, що не робить його привабливим для консервативних інвесторів. Водночас для агресивних інвесторів, що схильні до ризику, український ринок є досить привабливим напрямом інвестування.

**Ключові слова:** фондовий ринок; доходність; ризик; фондові індекси; часовий горизонт інвестування; волатильність.

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**Волатильность фондового рынка в зависимости от временного горизонта инвестирования: сравнительный анализ**

**Аннотация.** Сегодня особую актуальность приобретает необходимость исследования соотношения доходности и риска инструментов украинского фондового рынка в зависимости от продолжительности срока инвестирования. Анализ целесообразно проводить путем сравнения особенностей инструментов украинского фондового рынка и соответствующих инструментов рынков европейских постсоциалистических стран, имеющих общие черты развития. Целью исследования является выявление влияния временных факторов на доходность и риск финансовых активов через показатели фондовых индексов, анализ волатильности украинского и европейских фондовых рынков, а также выявление закономерностей их развития. В работе использованы методы анализа динамических рядов, статистического, структурного, сравнительного, корреляционно-регрессионного анализа. На основе статистического исследования временных изменений фондовых индексов, проведен сравнительный анализ волатильности украинского и европейских фондовых рынков. Выявлены их общие тенденции развития и различия, которые объясняются особенностью и спецификой украинского фондового рынка. Украинский фондовый рынок является в значительной степени рисковым, что не делает его привлекательным для консервативных инвесторов. В то же время для агрессивных инвесторов, склонных к риску, украинский рынок является достаточно привлекательным направлением инвестирования.

**Ключевые слова:** фондовый рынок; доходность; риск; фондовые индексы; временной горизонт инвестирования; волатильность.

## 1. Introduction

Stock indexes, the change of which is a signal to investors to make decisions about the purchase or sale of certain securities, are among the main indicators that characterise the state of the stock market. Today, the stock market in Ukraine is characterised by considerable volatility and instability, causing investors to assume significant market risk. Focusing on classical postulates of the risk and return ratio, most investors prefer to use short-term (up to 5 years) financial tools, while compensating higher returns for increased risk. At the same time, more investors conclude about activating long-term investment, while modern financial science increasingly emphasises the need to consider the time factor of the investment horizon, which significantly influences the risk of investing. Thus, the influence of time factors on investment risks should be studied via using Ukrainian stock indexes as a factual basis. Also, it is required to carry out a comparison with other post-socialist countries as part of the research.

## 2. Brief Literature Review

An analysis of scientific literature shows that the issue of time factor in assessing the risk and return ratio is considered in the works by a number of foreign scholars. The first research on this issue was made by H. Markowitz (1952) [1] and W. Sharpe (1970) [2], the classics of the theory of financial investment, who laid the ground for a risk assessment methodology for various types of financial investment. Further on, the issue of time factor in the risk assessment on different horizons of the investment duration was considered in the works by R. Merton (1973) [3], S. Harvey (1991), D. Robertson, S. Wright (1998) [5], R. Gibson (2002) [6], R. Ibbotson, P. Chen (2002) [7], A. Ang, R. Hordrick, Y. Xing, X. Zhang (2004) [8], F. Nardari, J. Scruggs (2005) [9]. The results of their research, made on the factual basis of the American stock market, showed that there are different interdependencies between returns and risks of financial assets at different investment horizons which differ significantly in terms of types of assets (stocks, bonds, treasury bills), as well as duration of the investment horizon. The studies show that with an increase of the investment horizon, the volatility of stocks significantly decreases, making them more attractive for investors as compared with bonds. The volatility of European stock markets was researched by B. Harrison, W. Moore (2012) [10], D. Gjika, R. Horvath (2013) [11], J. Okičić (2014) [12], A. Hepsag (2016) [13], B. Yavas and L. Dedi (2016) [14].

Similar studies were carried out by the Russian scientists N. Berzon (2014) [15], A. Abramov, A. Radygin, M. Chernova (2015) [16], A. Boyarsky (2016) [17]. They analysed the impact of time factors on returns and risk in the stock market taking the developing Russian, which in many respects similar to the Ukrainian stock market, as an example and coming to different and sometimes opposite conclusions, about the investment attractiveness of various financial instruments.

The Ukrainian scientists, who have significantly contributed to the development of the methodology and practice of the related issue, are S. Lyashenko (2009) [18], L. Kostyrchak (2012) [19], M. Shuba (2015) [20] and others. Based on statistical data, the works by these scientists consider various aspects of development of the Ukrainian stock market, including its volatility and problems of existence.

At the same time, studies on returns and investment risks are intended to describe mainly the US and Russian stock markets, whereas the Ukrainian stock market with all its peculiarities and features has been underresearched.

**3. The purpose** of the article is to define the impact of time factors on the returns and risk of financial assets through the numbers of stock indices and study of volatility of the Ukrainian stock market in comparison with the stock markets of post-socialist European countries.

## 4. Results

Indicators of the modern stock market in Ukraine and most post-socialist European countries are certain financial indices that reflect the dynamics of changes in stock quotes on the stock exchanges. In Ukraine, as well as in most post-socialist countries, a stock market began to emerge in the mid-1990s. Today, it is represented by stock exchanges such as JSC Stock Exchange, JSC Ukrainian Stock Exchange, JSC FB Perspektyva and PJSC INNEX Stock exchange. The main development indicator of the Ukrainian securities market recognised in our state as well as abroad is the PFTS index. Since 1 October 1997, it has been calculated on the basis of prices of the most liquid shares of PFTS [21].

As a comparison, the Polish stock index WIG [22] was used in the research. It is the first stock index to have been calculated since 16 April 1991 and used to cover all the companies in the Warsaw Stock Exchange (WSE) Main list, which meet the criteria for participation in the indexes. The Czech PX index [23] was also used. It is an official price index of the Prague Stock Exchange and represents the price index with a significant rate of the liquid shares. The starting point of the calculation was 1 October 1997. At this time horizon, the research on the market volatility change was conducted with regard to the following investment intervals: 1, 3, 6, 9 months and 1 ... 19 years. While analysing returns on the investment intervals, we used an exponential sliding average with one-month successive offset. Such research methods were chosen in view of a similar approach described in the works by N. Berzon [24], A. Boyarsky [17] and other scholars.

Due to a rather short period of existence of the Ukrainian, Polish and Czech stock markets, the analysis was conducted on the basis of the monthly returns data calculated by the formula:

$$r_i = \frac{(I_i - I_0)}{I_0 \cdot t} \times 100, \quad (1)$$

where  $r_i$  is monthly returns over the  $i$  period;

$I_i$  is the value of the relevant stock index at the beginning of the investment period;

$I_0$  is the value of the relevant stock index at the end of the investment period;

$t$  is the number of months to make the investment period.

An established risk-measurement indicator was used to assess the investment risk: standard deviation is  $\sigma$ , which is calculated on the basis of the variance ratio by the following formulas [24]:

$$\sigma_r^2 = \frac{\sum_{i=1}^n (r_i - \bar{r})^2}{n-1}, \quad \sigma = \sqrt{\sigma_r^2}, \quad (2)$$

where  $\bar{r}$  is average monthly returns over the  $i$  period;

$n$  is the number of observations in the sampling.

Table 1 and Figures 1-4 show the indices of maximum, minimum and average returns and the indices of standard deviations for different time horizons of investment for the Ukrainian, Polish and Czech stock markets.

Table 1 and Figures 1-3 show that an increase in the minimum average monthly return with an increase in the investment horizon is characteristic for all the stock markets. Besides, it becomes positive at the turn of 11-13 years, which suggests a gradual decrease in the net risk for an investor. The Polish and Czech stock markets are also characterised by a gradual decrease in the spread between the maximum and minimum returns, which eventually becomes less than 1%.

In general, the behaviour of return indices in the Polish and Czech stock markets is very similar. The same can be said about risk (Figure 4), which decreases with an increase of the investment period. In this case, the study of the shift trend in standard deviation (risk) shows a rather high value of the approximation index  $R^2$  for the obtained equations, which shows their reliability.

A slightly different situation is observed in the Ukrainian stock market (Figure 1), where the shift of spread between the maximum and minimum returns is unsustainable. If the value of the minimum return is close to that of other European markets, then the value of maximum return is characterised by very high volatility, which leads to an increase in the risk of investing. According to the results of the research, the highest return is typical for the seven to nine year investment period with the risk value for the period being also at its maximum, which in general proves the postulates of the theories of profitability and risk ratio. An interesting feature of the Ukrainian stock market is also the highest value of the minimum return (1.3-1.5% per month, ranging from 15.6% to 18% per year at the turn of 14-17 years, with further decrease. This suggests long-term investment prospects for conservative investors.

Tab. 1: Indices of average monthly returns on the stock markets at different investment time horizons, %

Investment horizon	PFTS Index (Ukraine)				Index WIG (Poland)				PX Index (Czech Republic)			
	Max.	Min.	Average	$\sigma$	Max.	Min.	Average	$\sigma$	Max.	Min.	Average	$\sigma$
1 month	49.49	-33.19	1.13	11.85	24.32	-24.69	0.75	6.64	21.66	-27.04	0.49	6.80
3 months	35.71	-20.49	1.50	8.70	15.55	-11.40	0.83	4.17	17.44	-14.19	0.55	4.08
6 months	24.94	-11.75	1.87	7.03	11.95	-7.69	0.87	3.09	13.89	-9.44	0.58	3.02
9 months	20.13	-8.55	2.16	6.27	9.26	-5.83	0.86	2.60	8.39	-6.91	0.59	2.50
1 year	26.13	-6.85	2.44	6.18	6.59	-4.55	0.86	2.30	7.77	-4.85	0.61	2.29
2 years	21.96	-3.02	2.87	5.58	5.57	-2.45	0.91	1.77	6.55	-2.50	0.71	1.94
3 years	20.25	-1.98	3.32	6.07	5.75	-1.18	0.92	1.60	6.47	-1.64	0.78	1.99
4 years	36.00	-1.37	4.39	8.19	6.53	-0.81	1.02	1.64	7.08	-1.11	0.90	2.00
5 years	34.10	-1.31	5.27	8.63	6.35	-0.68	1.12	1.55	5.92	-0.89	0.97	1.85
6 years	38.22	-1.08	6.27	8.88	5.95	-0.47	1.12	1.23	6.22	-0.73	0.98	1.64
7 years	27.25	-0.87	7.00	8.15	3.27	-0.28	1.13	0.92	4.37	-0.59	0.97	1.37
8 years	46.07	-0.82	8.41	11.19	3.56	-0.19	1.19	0.97	3.94	-0.52	0.92	1.22
9 years	62.18	-0.74	8.85	12.85	4.07	-0.31	1.16	0.94	3.90	-0.51	0.83	1.14
10 years	17.65	-0.61	6.42	5.77	2.40	-0.09	1.08	0.65	2.43	-0.38	0.69	0.77
11 years	38.97	-0.29	6.78	8.16	2.21	0.21	1.12	0.54	1.85	-0.31	0.62	0.55
12 years	41.88	-0.13	7.47	9.54	2.33	0.58	1.26	0.50	1.87	-0.16	0.69	0.47
13 years	20.14	0.54	5.85	5.10	2.24	0.70	1.29	0.36	1.32	0.11	0.68	0.30
14 years	11.09	1.50	4.29	2.29	1.97	0.68	1.31	0.33	1.21	0.32	0.66	0.21
15 years	11.24	1.33	4.13	2.84	2.12	0.74	1.27	0.32	1.10	0.27	0.63	0.16
16 years	12.67	1.03	4.26	3.33	1.95	0.52	1.20	0.37	0.98	0.20	0.57	0.20
17 years	7.23	1.59	3.55	1.53	1.64	0.77	1.10	0.21	0.86	0.25	0.51	0.16
18 years	6.64	0.84	3.43	2.20	1.61	0.78	1.13	0.27	0.89	0.35	0.52	0.14
19 years	3.19	0.61	1.53	0.79	1.23	0.75	1.07	0.15	0.54	0.28	0.42	0.07

Source: Compiled by the authors

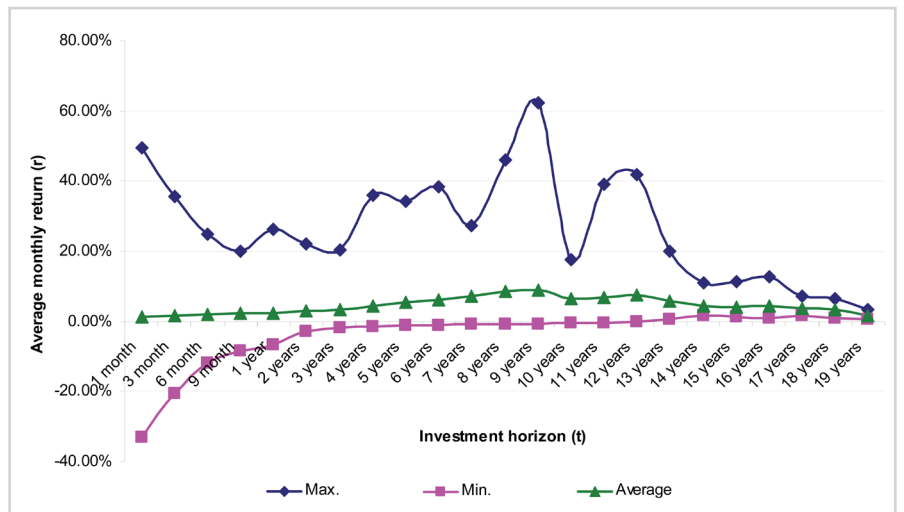


Fig. 1: Indices of the monthly return of the Ukrainian stock market depending on the investment horizon  
Source: Compiled by the authors

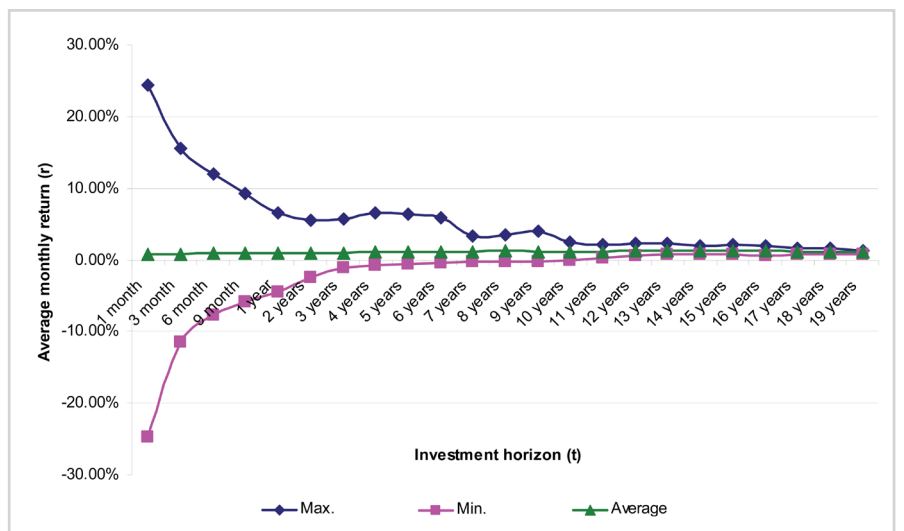


Fig. 2: Indices of the monthly return of the Polish stock market depending on the investment horizon  
Source: Compiled by the authors

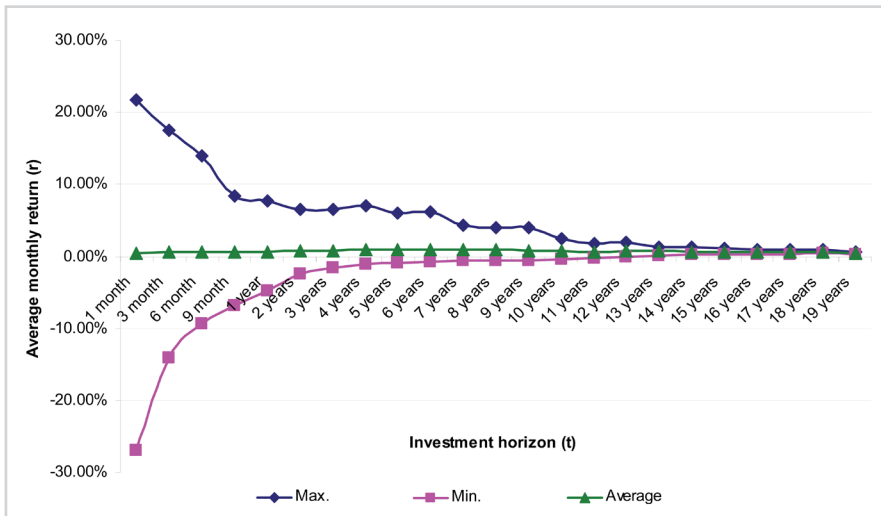


Fig. 3: Indices of the monthly return of the Czech stock market depending on the investment horizon  
Source: Compiled by the authors

5. Conclusion

The research confirms the decrease of volatility of the stock market when increasing the investment horizon. However, this is more typical of stable European markets. As for the Ukrainian stock market, it can be noted that it has some specific features, which is revealed in much greater volatility, especially for short and medium terms and conditioned by high sensitivity and low resistance to the influence of external and internal factors (political instability, financial crises, etc.), which in turn reflects the general state of affairs in the real sector of the economy. Naturally, this does not make it attractive for conservative investors. At the same time, the Ukrainian stock market turns out to be a very attractive investment destination for aggressive risky investors, especially for a medium-term period (7-12 years), since the returns are several times higher than those of Polish and Czech markets.

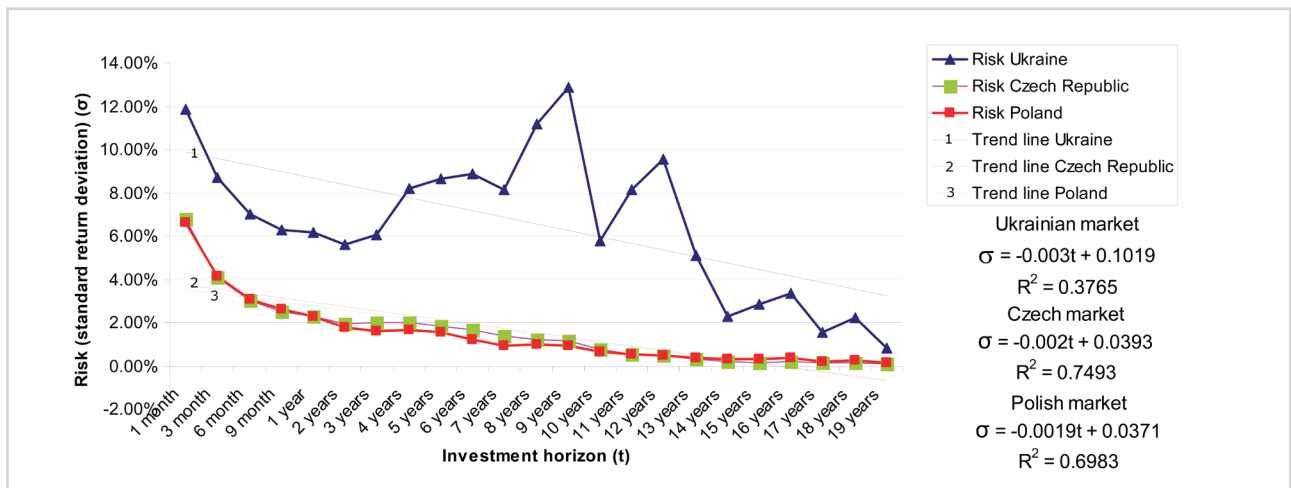


Fig. 4: Indices of stock market risk depending on the investment horizon Indices of stock market risk depending on the investment horizon  
Source: Compiled by the authors

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