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The Russian-Ukrainian War as an Impetus to the Destabilization of World Business: Reactions of Stock Markets

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Abstract

The conducted analysis identified Ukraine as a significant element of the modern world economic order. Being a part of the world digital economy even without a developed industrial sector and advanced market institutions, Ukraine has been accepted as an integral part of the world economic space. The war unleashed by Russia significantly disrupted its functioning. Under the influence of war, the market's interests have been turned toward the least risky products and significantly higher diversification.

The markets have interpreted the Russian-Ukrainian war as real news that has been immediately displayed by stock markets optimal portfolios. The simultaneously provided analysis revealed the separation of social and corporative visions of world order on some even developed markets.

Analysing the behavior of Chinese companies on the Russian and other markets revealed that, in modern conditions, the R&D sector could become a real mirror of potential war influence analysis.

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Introduction

The war started by Russia became a significant challenge for Ukraine. It also became a challenge for the whole world. Our

analysis is primarily focused on the economic sphere.

It seemed to the aggressor that, lacking modern industry and stably functioning market institutions (banking system, stock market, etc.), the Ukrainian state would not be able to counter aggression ("maximum 3 days" is the most popular expression of the Russian TV news in the first days of the new invasion) and wouldn't also become a significant loss for world business. The disappearance of Ukraine as an independent player on the map should've gone unnoticed according to the northern neighbor vision.

It seems that Moscow lacks a systematic vision of the modern world. First of all, the democratic nature of the state, primarily in the information space, has become an unambiguous determinant of its integration. At the same time, information integration is a prerequisite for development.

The position of certain companies regarding the war in the first days of the aggression was instantly reflected in the dynamics of the share price and indices on the stock market. It was a serious confirmation of the stock market as a tool for expressing social priorities.

Based on this, our analysis will be carried out on the basis of five groups of companies: a potentially optimal portfolio for investments in the world in the pre-war and wartime periods; the companies most represented in Ukraine in the pre-war period; and the IT sector, in which Ukraine has long occupied one of the leading positions in the world. Two other groups —most represented foreign businesses in Russia and Chinese companies being present on the Russian market after February 2022—are the helpful basis for analysis of the mixed reaction of the world. For certain reasons, the positions of Chinese businesses will be given special attention.

It is important to give an answer to the question of whether a foreign business that continues its work on the territory of the aggressor country maintains pre-war stock market score levels. It is a kind of test of international solidarity.

No less interesting is the question of a big gift to China in the form of the entire economy of Russia. Is this gift so dreamlike for Chinese business?

The result of this research should be an answer to the question of whether the war against Ukraine, as a way of realizing the Russian vision of the world order, contrary to Russian expectations, became an additional impetus to Ukraine's integration into the world economy.

Four hypotheses are proposed for testing in this study:

- Hypothesis 1: Being a part of the world digital economy (an economy based on online connections), even without a developed industrial sector and market institutions (not involved significantly in world trade), Ukraine has been accepted as an integral part of the world economic space.
- Hypothesis 2: Markets have interpreted the Russian-Ukrainian war as real news that has been immediately displayed by stock markets optimal portfolios.
- Hypothesis 3: The separation of social and corporative visions of world order can coexist even in times of covert or full military conflict.

- Hypothesis 4: Currently, the R&D sector could become a real mirror of potential war influence analysis; Instead of analyzing the involvement of countries as participants in trade to analyze a potential conflict, it is preferable to analyze their involvement in the processes of innovation formation.

Review

Schneider and Troeger (2006) have published one of the most influential studies of the economic effects of war. Israel-Palestinian, US-led alliance against Iraq, and conflicts on the territory of former Yugoslavia have become the objects of their analysis. The authors studied western stock market reactions to these conflicts. On this basis, they argued for the spread of commercial liberalism.

In Barbiery and Schneider's (1999) article, a controversial approach was proposed to the two-way impact of the economy and conflict, which is that "trade will have a negligible and, in the perspective of one important model at least, even an amplifying effect on conflict".

Polachek (1980), using a ten-year, thirty-country data base, found a numerical expression of similar dependence: "A doubling of trade on average leads to a 20% diminution of belligerence".

Goldstein (1985) argued that Kondratieff's long economic waves are synchronous with a cycle of war between core nations. "The war cycle has lengthened somewhat, the wars themselves have shortened, and their severity has increased a hundredfold".

Hudson and Urquhart studied the effect of World War Two on the British stock market. They examined the ‘negativity effect’ (stock returns react significantly to bad news but insignificantly to good news) and made an assessment whether stock returns reacted more strongly to negative events or positive events. They found limited evidence of strong links between war events and market returns although it was a support for the ‘negativity effect’ (2015).

Frey and Waldenstrom (2004) analyzed the two markets in relation to turning points in the war (Austria, Sweden). They used a quantitative methodology on historical financial market data as a useful complement to traditional historical analysis.

Shaker et al. studied the reactions of shareholders in the European financial markets to Russia’s recognition of the Ukrainian-occupied regions of eastern Ukraine as two puppet autonomous states.

They expected the European stock market, an integrated trading partner of Russia's economy, to respond negatively to this crisis, owing to increasing political instability, geographic proximity and the consequences of any sanctions imposed on Russia. They observed a considerable industry-wide variation in average abnormal return (AAR) and cumulative abnormal return (CAR) surrounding the event period.

“While firms in the Netherlands had the most negative AAR, companies in the UK experienced a positive and significant AAR on the event day, and firms domiciled both in Denmark and in Switzerland had significant negative CAR during the

days surrounding the event and the pre-event periods.

They decided that war will have a serious impact on the global economy. This research was conducted at the very beginning of the ongoing Russia–Ukraine new hot war stage so the authors noted it is possible that it might not fully reflect the outcome of the crisis (Shaker & al, 2022).

In OECD assessment of global financial markets for 2022 we read: "the Russian aggression against Ukraine raises a variety of implications for sustainable investment opportunities and approaches, including for ESG rating. Notably, elevated energy prices … could incentivize many energy distributors and users to accelerate their transition to renewables to become more energy independent". The Russian invasion inspired financial markets to a sharp rise in commodity prices, and sharp equity price declines. Corporate and sovereign credit market conditions have deteriorated beyond Russian markets (OECD, 2022).

Tosun and Eshraghi demonstrated that "the stock markets of Hungary, Russia, Poland, and Slovakia were first to react in anticipation of the military actions in Ukraine, showing negative returns in pre- event days already, whereas the stock markets of Australia, France, Germany, India, Italy, Japan, Romania, South Africa, Spain, and Turkey were adversely affected in the post-invasion days". The next analysis has shown that the European and Asian markets were significantly and adversely affected by the Russia – Ukraine war (2022).

Tosun and Eshraghi investigated the financial market reaction to announcements of companies remaining in Russian market during the eventful two weeks following the invasion. The author's findings showed that a portfolio of remainers "underperforms the leavers and the market benchmark". Investors imposed a significant market penalty on the remainers. Simultaneously it was an evidence of higher trading volume and selling pressure on remainers, suggesting equity markets are acutely sensitive to corporate decisions in times of war. "The findings provided evidence of higher trading volume due to selling pressure on remainers" (2022).

Wang &al (2022) evaluated the transmission of returns and volatility "in the universe of commodities around the war in Ukraine". According to authors the total volatility spillover increases from 35% to 85%, exceeding the level seen during the pandemic.

Ming &al (2022) found some unexpected result of Russian aggression against Ukraine. "In response to the Russia-Ukraine war, stocks more exposed to the regulatory risks of the transition to a low-carbon economy performed better, suggesting that investors expect an overall slowdown in this transition". These stock price effects were particularly strong in the US. In Europe, the effects were less obvious or even opposite.

Boungou and Yatie (2022) concentrated their research interest on the world stock market indices reaction to the ongoing war between Ukraine and Russia. Using daily stock market returns in a sample of 94 countries and covering the period from 22 January 2022 to 24 March 2022, they revealed a negative relationship between the Ukraine-Russia war and world stock market returns. "They found that these effects were most pronounced for countries bordering Ukraine and Russia, as well as for those UN member states that demanded an end to the Russian offensive in Ukraine".

Alam &al (2022) showed that “gold and silver (commodities) and the United States, Canada, China, and Brazil (stock markets) are the receivers from the rest of the commodities/market’s transmitters of shocks during this invasion crisis”. According to authors’ vision ongoing war could be considered the biggest change since the occurrence of the financial crisis in the year 2008, which critically influenced even the oil and gold markets.

According to Izzeldin et al. (2023), the invasion was interpreted by investors as real news compared to COVID-19, when the reaction could be identified as a lagged response. The Russian-Ukrainian war has accelerated inflationary pressure worldwide. Negative dynamics in the commodity markets and rising inflationary pressure "may plunge global economies into recession".

At the same time, modern analysis of the impact on the economy requires greater attention to transformational processes in the direction of increasing the importance of intangible assets.

"The new economy is not an invention or an innovative "breakthrough", but rather the result of processing the current economy in a quasicontinuity of physical and human dominated by knowledge and globally". Based on Romania's experience, Gâf-Deac poses a desirable trend for humanity in the transition to a new economy oriented on intangible assets (Gâf-Deac, 2017).

Data and methods

We get all the data for calculations from the web sites: yahoo.finance, investing.com, and focus-economics.com based on the tickers of the respective companies and the corresponding Python and R language packages. In most cases, the maximum possible period for analysis is chosen, based on the time the company has been on the market. Sometimes this restriction adapts to opportunities of the group of companies.

It is applied as portfolio analysis instruments the next Python packages: EfficientFrontier, pypfopt, numpy, pandas_datareader, matplotlib.pyplot, yahoo_fin and packages PortfolioAnalytics, fPortfolio, timeSeries of R.

The portfolio optimization is realized based on Sharp Ration or utility maximization.

Machine learning methods are chosen to estimate business predictability. A random forest is a capable estimator that uses averaging to improve predictive accuracy and control overfitting. In the case of gradient boosting, in each stage, a regression tree is fitted on the negative gradient of the given loss function. The Support Vector Machine Regressor helps us because of our interest in the radial kernel.

Research

Ukrainian stock market: still exists

Even before the pandemic, the appearance of Ukrainian companies on foreign stock markets was considered an extraordinary event. These about ten companies, sometimes with headquarters in other countries, were mainly of oligarchic origin and represented the agricultural market. At the same time, these companies were characterized by relative stability. At present, the Ukrainian stock market, even in its limited and exclusive form, is not functional. Therefore, the only option for forecasting is the Polish WIG Ukraine index, which contains only Ukrainian companies.

With the help of the machine learning method (random forest, R^2 = 66%), we can get a prediction of this index for the next 50 days. As could be easily recognized, the market expects a fall (it is enough to read the advice of dozens of analysts) while at the same time it believes in the correction of the situation and the obvious perspective of the Ukrainian agricultural sector (Fig. 1).

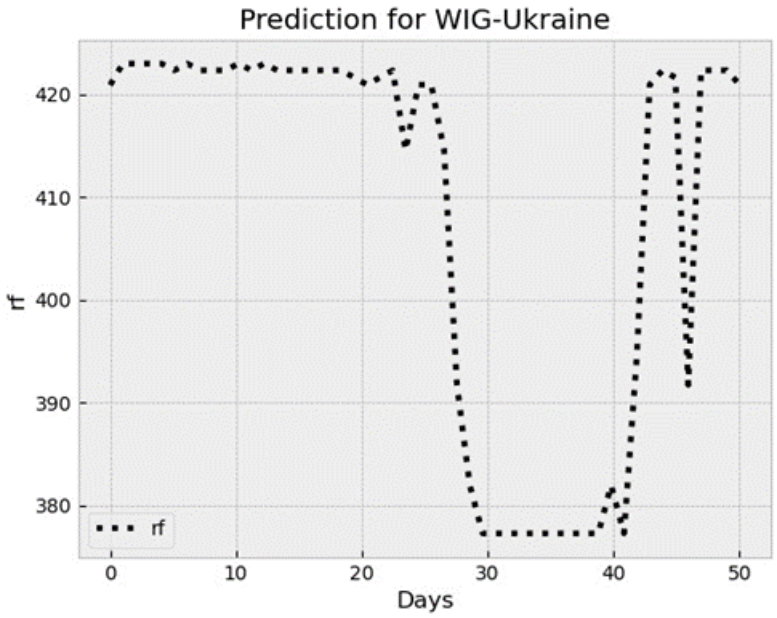


Figure 1. Falling with faith in the near future

Source: own elaboration

Global rethinking

At the beginning, we form a conditional portfolio of the best choices for an investor to analyze the asset market. We include traditional commodities like gold and silver, oil, the dynamics of the euro-dollar exchange rate, and ten-year US Treasury bonds. This would have been enough decades ago, but today we add the Crypto 200 Index and a number of the most popular cryptocurrencies: Ethereum, Tether, Solana, and Binance. With the help of Yahoo Finance tools, it is easy to find out, for each specific date, the leaders of the spectrum of industries by capitalization level. Therefore, we choose the first positions in the ranking of separate industries: basic materials, consumer cyclical, consumer defensive, energy, communication services, financial services, real estate, and utilities (for 2023.03.24).

War has changed conditional optimal portfolio significantly (Tabl. 1).

Table 1. Sharpe Ratio based approach

2012.01.01 – 2022-02.24	2022.02.24 – 2023.03.24
[('CL=F', 0.0), ('GC=F', 0.0), ('EURUSD=X', 0.0), ('^TNX', 0.0), ('SI=F', 0.0), ('^CMC200', 0.0), #('BTC-USD', 0.0), ('PLD', 0.0), ('AAPL', 0.0), ('MSFT', 0.0), ('NEE', 0.35099), ('JNJ', 0.0), ('UPS', 0.0), ('GOOGL', 0.0), ('AMZN', 0.11155), ('WMT', 0.0), ('XOM', 0.0), ('BRK-A', 0.0), ('ETH-USD', 0.0), ('USDT-USD', 0.0), ('USDC-USD', 0.0), ('SOL-USD', 0.53747), ('BUSD-USD', 0.0)]	[('CL=F', 0.0), ('GC=F', 0.31609), ('EURUSD=X', 0.0), ('^TNX', 0.40962), ('SI=F', 0.0), ('^CMC200', 0.0), ('BTC-USD', 0.0), ('PLD', 0.0), ('AAPL', 0.0), ('MSFT', 0.0), #('NEE', 0.04805), ('JNJ', 0.0), ('UPS', 0.0), ('GOOGL', 0.0), ('AMZN', 0.0), ('WMT', 0.0439), ('XOM', 0.18235), ('BRK-A', 0.0), ('ETH-USD', 0.0), ('USDT-USD', 0.0), ('USDC-USD', 0.0), #('SOL-USD', 0.0), ('BUSD-USD', 0.0)]
Expected annual return: 615.2% Annual volatility: 94.5% Sharpe Ratio: 6.49	Expected annual return: 33.9% Annual volatility: 18.4% Sharpe Ratio: 1.73

Used tickers: 'CL=F' (Crude Oil), 'GC=F' (Gold), 'EURUSD=X' (EUR/USD), '^TNX' (Treasury Yield 10 Years), 'SI=F' (Silver), ^CMC200' (CMC Crypto 200 Index by Solacti), 'BTC-USD' (Bitcoin USD), 'PLD' (Prologis), 'AAPL' (Apple), 'MSFT' (Microsoft), 'NEE' (NextEra Energy), 'JNJ' (Johnson & Johnson), 'UPS' (United Parcel Service), 'GOOGL' (Alphabet), 'AMZN' (Amazon.com), 'WMT' (Walmart), 'XOM' (Exxon Mobil), 'BRK-A' (Berkshire Hathaway), 'ETH-USD' (Ethereum USD), 'USDT-USD' (Tether USD), 'USDC-USD' (USD Coin USD), 'SOL-USD' (Solana), 'BUSD-USD'(Binance USD). Note: based on pypfopt.efficient_frontier of Python.

As the selection of the optimal portfolio based on the Sharpe ratio shows, the wartime new selection retains only a minimal orientation to the previously selected assets. The emphasis in the portfolio is concentrated on gold and ten-year US Treasury bonds. At the same time, new realities on the energy market have made investments in the energy sector one of the main priorities. In the conditional portfolio created by us, cryptocurrency as one of the main priorities has lost its importance.

Significantly different result could be achieved using package fPortfolio in R (method 'utility maximization'). Note that this model has a number of input restrictions. It was chosen the coefficients in the range of 0.01 to 0.9. The smaller impact of risk in such a model allows the optimal portfolio to include a spectrum of risky cryptocurrencies (Tabl. 2).

Table 2. Portfolio utility maximization based approach

2018.01.01 - 2022.02.24 (before the war short)	2022.02.24 – 2023.03.24 (war time)
EURUSD=X (0.222), NEE (0.042), XOM (0.012), USDC-USD (0.068), SOL-USD (0.014), BUSD-USD (0.488). Other ingredients with weights = 0.01	GC=F (0.018), BRK-A (0.020), ETH-USD (0.016), USDT-USD (0.264), SOL-USD (0.012), BUSD-USD (0.520). Other ingredients with weights = 0.01
2012.01.01 – 2022.02.24 (before the war long)	2020.03.11 – 2021.12.15 (pandemic active phase)
EURUSD=X (0.062), BTC-USD (0.016), UPS (0.012), GOOGL (0.080), WMT (0.012), XOM (0.030), USDC-USD (0.648). Other ingredients with weights = 0.01.	GC=F (0.070), EURUSD=X (0.024), SI=F (0.012), MSFT (0.018), NEE (0.020), JNJ (0.018), AMZN (0.040), WMT (0.018), USDT-USD (0.548), USDC-USD (0.118), BUSD-USD (0.014). Other ingredients with weights = 0.01

Source: based on packages PortfolioAnalytics and fPortfolio of R.

Is the main factor affecting this portfolio even in period 2022 – 2023 the pandemic itself (appearance, strengthening, weakening), and not Russia's aggression on the territory of Ukraine? It was possible to observe similar effect in pandemic active phase but significantly weaker. Useful material for such analysis was two competing portfolios based on the Sharpe Ratio and utility maximization. To complete the selection process, it was used a risk map and analyze the effectiveness of investments based on cumulative return.

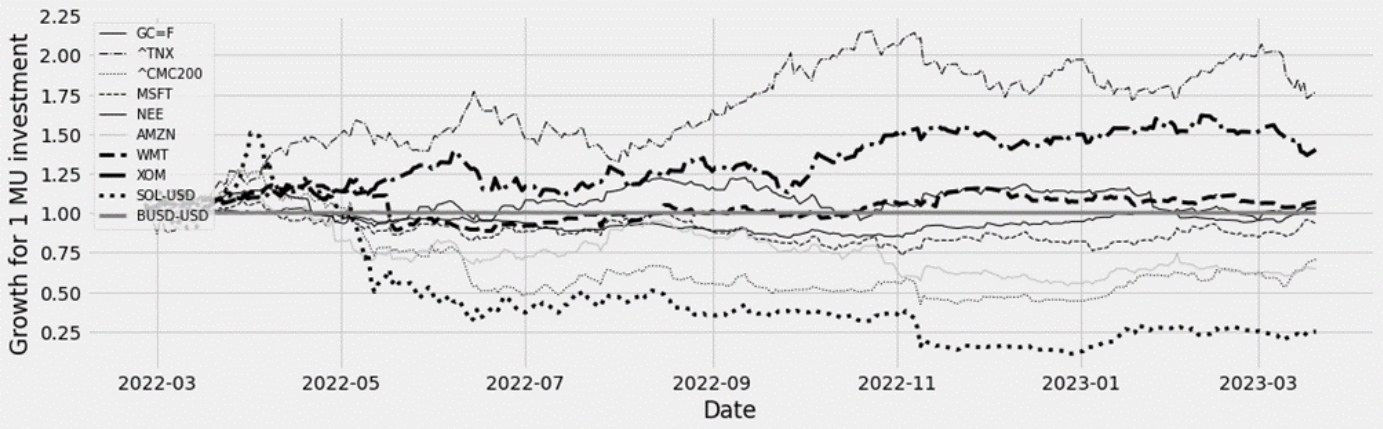


Figure 2. Effectiveness of investment

Source: own elaboration

Testing of the specified approaches based on the analysis of investment efficiency allows us to assert that the portfolio selected on the basis of the Sharpe ratio (Tabl. 1) was the optimal solution (Fig. 2). Due to their excessive risk, cryptocurrencies have been removed from the optimal choice (lower the growth = 1). The analysis of cumulative return is a serious argument in such a discussion.

The analysis of the reaction to the war by the optimal portfolio based on two different methods, the dynamics of cumulative return, allows us to claim that the market reaction can be defined as "real news", which confirms the

suggestion of Izzeldin et al. (2023). Our hypothesis 2 is working.

Foreign business represented in Ukraine

As was expected, companies with subsidiaries in Ukraine should suffer the most from the consequences of Russian aggression. GlobalData (globaldata.com) allows us to find 15 companies with 4–10 subsidiaries. If you look at the risk map and the dynamics of the share price, such a significant war impact is not visually apparent (Figs. 3–4). The foreign investor did not react too much to the events in Ukraine. This can be explained by the comparably small volume of operations usually carried out by such companies on the Ukrainian market.

At first glance, it seems that our hypothesis 1 does not work and that the loss of the Ukrainian market for global business does not have significant consequences. It would seem that despite well-developed market institutions, Ukraine has not been integrated into the world economy since the restoration of independence in 1991. The main objection is the claim that the world of modern information flows allows an absolutely new type of integration. Its basis can be the institutional environment of other countries if such information exchange does not contain obstacles from the government's side. Chakravorti et al. (2021) have demonstrated this interesting tendency based on the Digital Evolution Index and Digital Evolution Momentum. According to this last indicator, Ukraine, even in the midst of the pandemic, occupied a high 37th position among the 90 studied markets. Additionally, it is worth highlighting Ukraine’s 49th place in the ranking of the Global Innovation Index (WIPO, 2021).

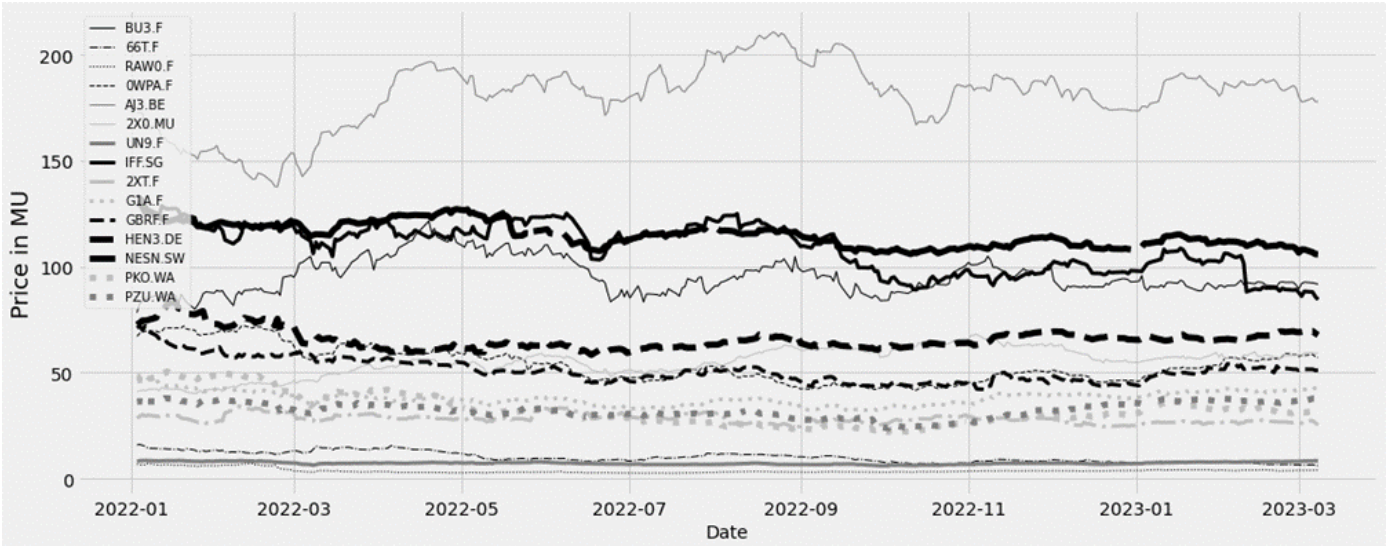


Figure 3. Price dynamics of the most represented foreign companies on the Ukrainian market

Used tickers: 'BU3.F' (Bunge), '66T.F' (Scatec ASA), 'RAW0.F' (Raiffeisen Bank International), '0WPA.F' (WPP), 'AJ3.BE' (Acciona SA), '2X0.MU' (Corteva), 'UN9.F' (UNIQA Insurance Group), 'IFF.SG' (International Flavors & Fragrances), '2XT.F' (DXC Technology), 'G1A.F' (GEA Group), 'GBRF.F' (Geberit), 'HEN3.DE' (Henkel), 'NESN.SW' (Nestlé), 'PKO.WA' (Powszechna Kasa Oszczednosci), 'PZU.WA' (Powszechny Zaklad Ubezpieczen). Source: own elaboration

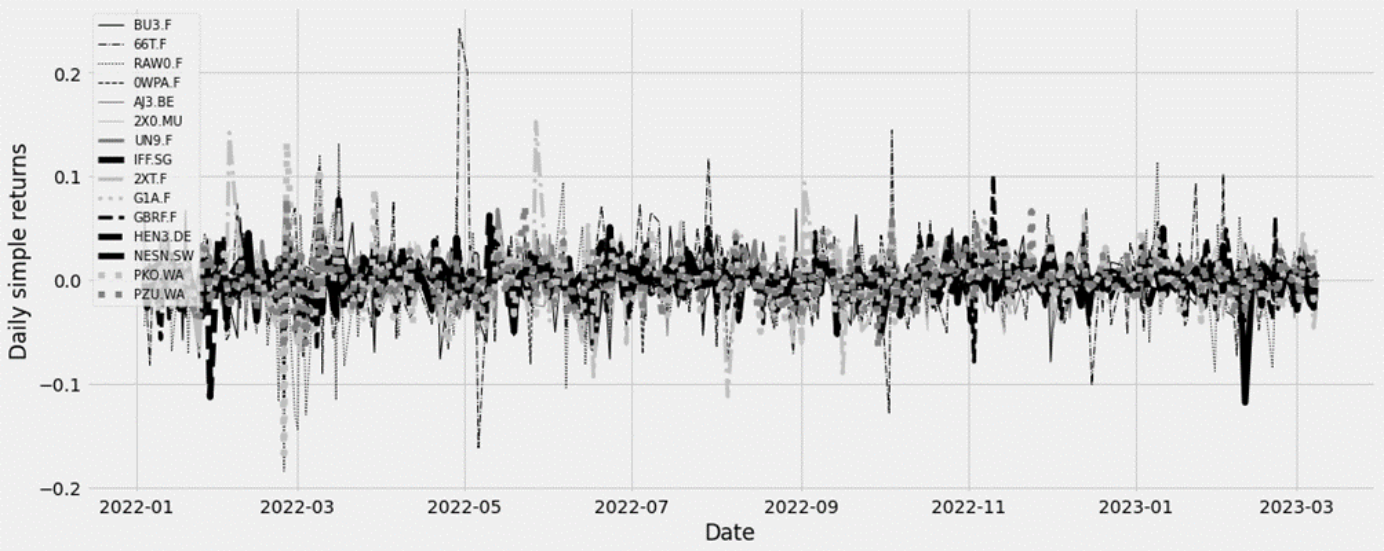


Figure 4. Risk dynamics of the most represented foreign companies on the Ukrainian market

Source: own elaboration

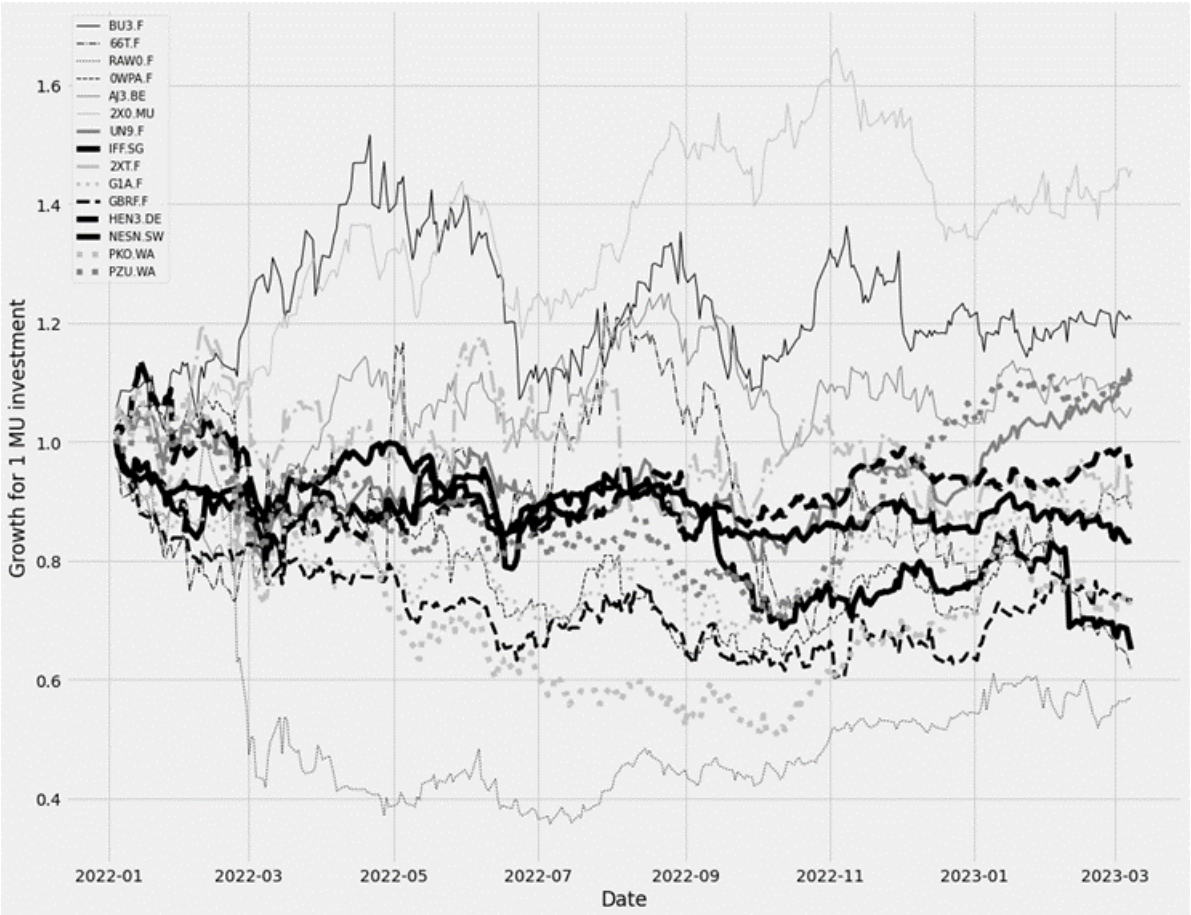


Figure 5. Investment growth

Source: own elaboration

Simultaneously if attention is paid to the cumulative growth of return (Fig. 5), negative processes and trends become differentiated. Of course, it's understandable that the reason for the losses is not only the problematic functioning of

business in warring Ukraine, but also the need to determine the presence on the Russian market and the possible impact of sanctions. This influence on the Austrian Raiffeisenbank is most visible in the figure. The bank agreed to leave the Russian market only a year after the start of the war hottest stage, and therefore abused its monopoly connection to the SWIFT system. With the exception of 5 companies, most lost investment growth rates.

Our next step will be another attempt to build an optimal portfolio based on the maximum Sharpe ratio (Tabl. 3). In the first part of the study, we convinced ourselves of the appropriateness of this approach. Even a cursory review of the "pre-war" and "wartime" portfolios allows one to notice a complete loss of positions for such companies as Norwegian Scatec, Austrian Raiffeisen Bank, and Swiss Nestle. At the same time, due to their reserve or even basic markets, other companies came to the first positions and kept the overall attractiveness of the portfolio at the same level (Sharpe Ratio about 1.17 - 1.19). Thus, the market experienced a negative impact on individual companies, but in general, its functioning maintained its effectiveness (Tabl. 3).

Table 3. Optimal portfolio for most represented multinational companies

Before: Stock Start Date = '2018-01-01' today = '2022-02-23'	Wartime: Stock Start Date = '2022-02-24' today = '2023-03-15'
[('BU3.F', 0.00615), ('66T.F', 0.05467), ('RAW0.F', 0.22547), ('0WPA.F', 0.0), ('AJ3.BE', 0.12197), ('2X0.MU', 0.12284), ('UN9.F', 0.0), ('IFF.SG', 0.0), ('2XT.F', 0.0), ('G1A.F', 0.0), ('GBRF.F', 0.15763), ('HEN3.DE', 0.0), ('NESN.SW', 0.31127), ('PKO.WA', 0.0), ('PZU.WA', 0.0)]	[('BU3.F', 0.05775), ('66T.F', 0.0), ('RAW0.F', 0.0), ('0WPA.F', 0.0), ('AJ3.BE', 0.33751), ('2X0.MU', 0.36116), ('UN9.F', 0.129), ('IFF.SG', 0.0), ('2XT.F', 0.0), ('G1A.F', 0.02384), ('GBRF.F', 0.0), ('HEN3.DE', 0.0), ('NESN.SW', 0.0), ('PKO.WA', 0.0), ('PZU.WA', 0.09073)]
Expected annual return: 21.8% Annual volatility: 17.0% Sharpe Ratio: 1.17	Expected annual return: 22.3% Annual volatility: 17.1% Sharpe Ratio: 1.19

Note: based on pypfopt.efficient_frontier of Python.

Table 4. Optimal portfolio based on Utility maximization

Before war. Restrictions: min=.01, max=.90, from = "2018-01-01" to = "2022-02-23" 0WPA.F (0.116), AJ3.BE (0.120), UN9.F (0.092), NESN.SW (0.496), PZU.WA (0.076), others - 0.01
Wartime. Restrictions: min=.01, max=.90, from = "2022-02-24" to = "2023-03-17" BU3.F (0.088), 66T.F (0.014), RAW0.F (0.018), 0WPA.F (0.016), AJ3.BE (0.038), 2X0.MU (0.128), UN9.F(0.076), G1A.F (0.062), GBRF.F (0.054), NESN.SW (0.372), PZU.WA (0.094), others - 0.01

Notes: based on packages PortfolioAnalytics and fPortfolio of R.

On the other hand, the approach based on the maximization of the utility of the portfolio allows for revealing the tendency toward the loss of relative leadership of individual companies and greater diversification (Tabl. 4). At this stage of our analysis, we have not yet found confirmation for hypothesis 1. Its relevance requires a transition to the market for information services.

A special situation regarding IT business

Ukrainian IT companies are considered the most promising potential participants on the foreign stock markets. Moreover, the cooperation of this sector with foreign companies, its presence in foreign markets directly or indirectly is an obvious fact today. For their part, foreign IT companies conducted and are conducting active in Ukraine, which is why they were also influenced by military actions. Many of them tried to take their employees out of Ukraine in the most active stage of war, financially helped their branches in Ukraine and individual employees who found themselves in the territories under threat of occupation. Many of such companies even now have R&D offices in Ukraine.

Table 5. Vulnerability of the represented IT sector

Before: Stock Start Date = '2018-01-01' today = '2022-02-23'	Wartime: Stock Start Date = '2022-02-24' today = '2023-03-15'
[('GOOG', 0.92519), ('SNAP', 0.03684), ('LYFT', 0.0), ('ORCL', 0.03796), ('BIGC', 0.0), ('GTLB', 0.0)]	[('GOOG', 0.0), ('SNAP', 0.0), ('LYFT', 0.0), ('ORCL', 1.0), ('BIGC', 0.0), ('GTLB', 0.0)]
Expected annual return: 23.6% Annual volatility: 28.8% Sharpe Ratio: 0.75	Expected annual return: 14.3% Annual volatility: 29.5% Sharpe Ratio: 0.42

Notes: only public companies are included in the portfolio. In addition to them, hundreds of private foreign companies operate on the market. Used tickers: 'GOOG' (Alphabet), 'SNAP' (Snap), 'LYFT' (Lyft), 'ORCL' (Oracle), 'BIGC' (BigCommerce Holdings), 'GTLB' (GitLab). Note: based on pypfopt.efficient_frontier of Python.

For the IT - portfolio could be observed serious decline of Sharpe Ratio. It is hardly possible to claim that the main reason for such a change (Tabl. 5) was the easing of pandemic restrictions. This type of business requires international stability and cooperation. This especially applies to companies operating in the automation market. Oracle's business is characterized by large clients, so the impact of military operations in Ukraine or even the loss of the Russian market had little impact on the company. It could be easily recognized that some companies have lost their positions in the optimal portfolio, but we do not yet understand the reasons for this.

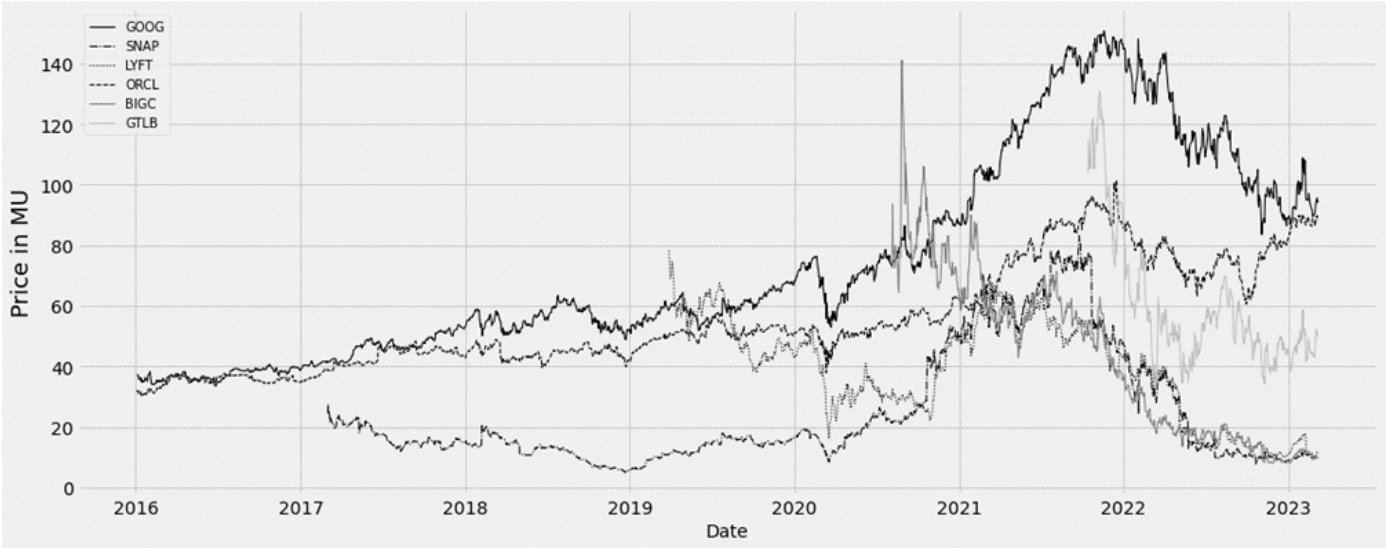


Figure 6. IT sector price dynamics

Source: own elaboration

Investigating the price dynamics of the shares of the chosen companies, it is easy to see that the downward trend arose even before the February stage of Russian aggression (Fig. 6). Similarly, we do not have unambiguous estimates like in case of examining the risk map (Fig. 7). On the other hand, analysing the level of risk, it could be said that the international instability of the pandemic period was significantly surpassed by the war year (February, 2022 – February, 2023). It was observed the same phenomenon on the investment efficiency analysis graph (Fig. 8).

Only in this specific case of the risk map for IT companies we can clearly diagnose a noticeable worsening of the situation in connection with the war unleashed by Russia. For part of the business from the selected portfolio, the risk level has increased several times.

This analysis supports our thesis 1.

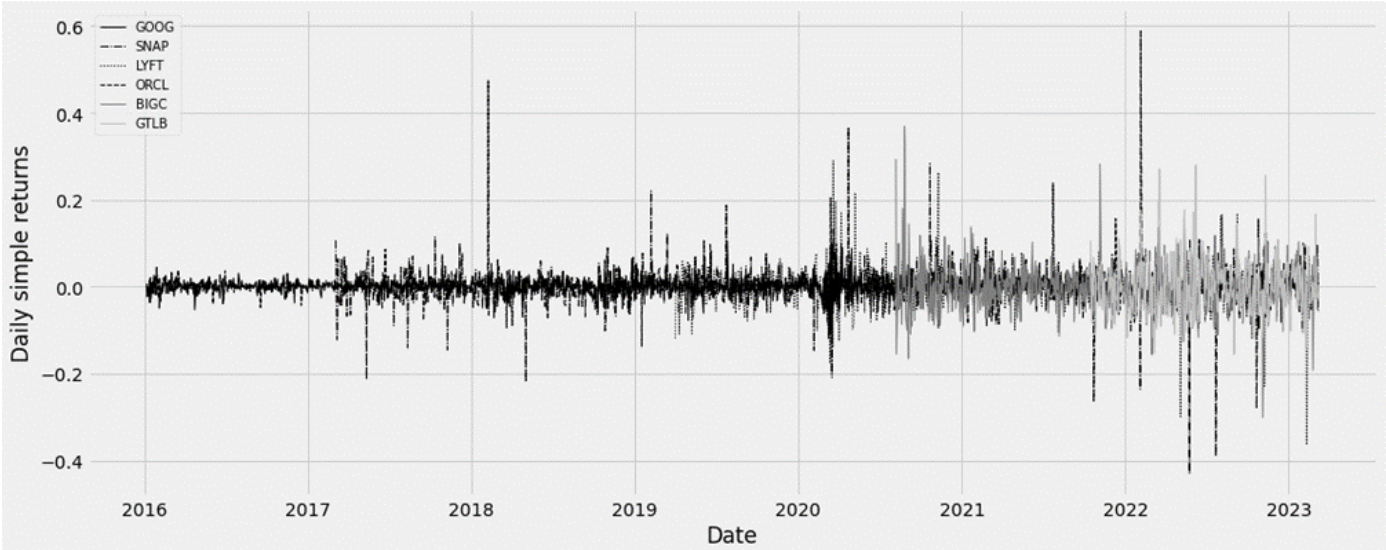


Figure 7. IT sector risk dynamics

Source: own elaboration

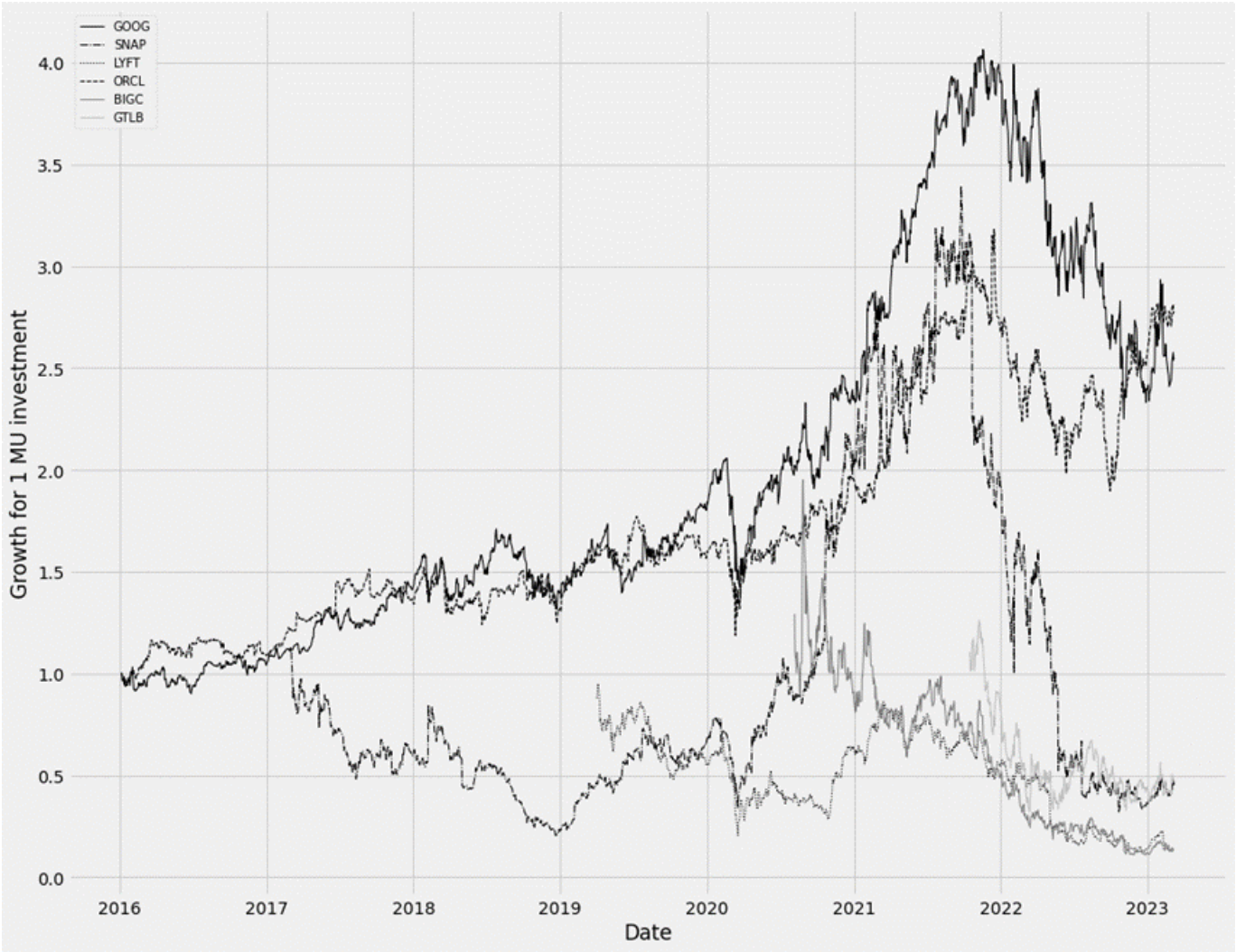
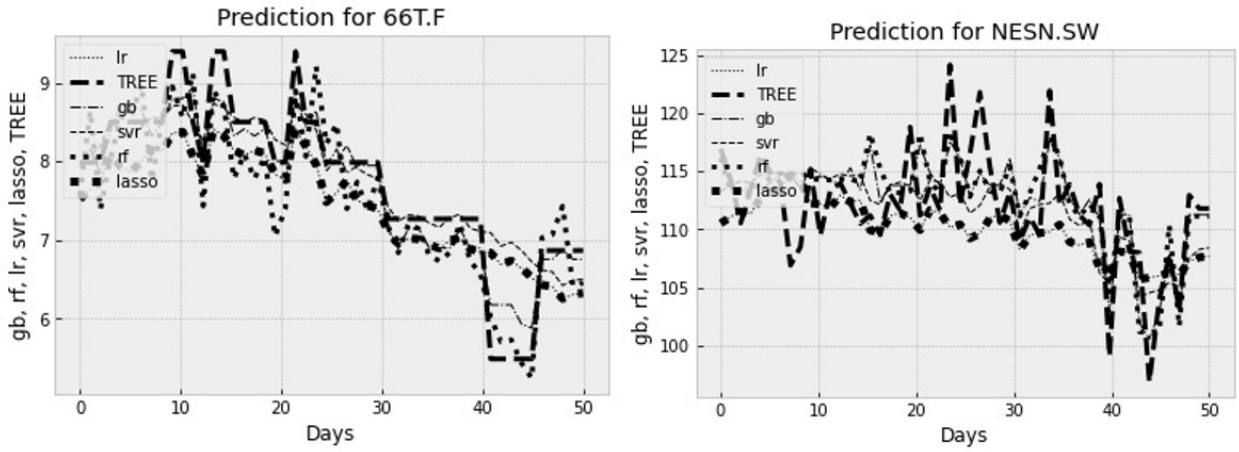


Figure 8. IT sector investment growths

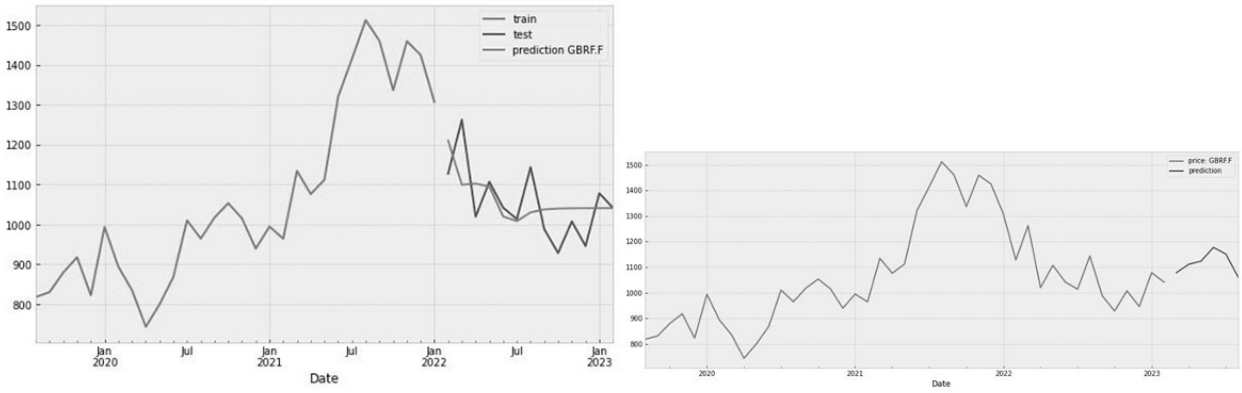
Source: own elaboration

Short-term predictions based on machine learning and ARIMA

A range of machine learning methods support our findings regarding the impact on individual companies. The most obvious case is Scatec and Nestlé for companies represented (Fig. 9) and SNAP – GTLB case for IT – companies with R&D offices (Fig. 10). If for the IT business we see a tendency to recovery, adaptation under new conditions, companies seriously affected by restrictions on work in traditional markets continue to lose their positions (Scatec with ticker 66T.F, Nestle with ticker NESN.SW). Continuation of the war is critical for them.

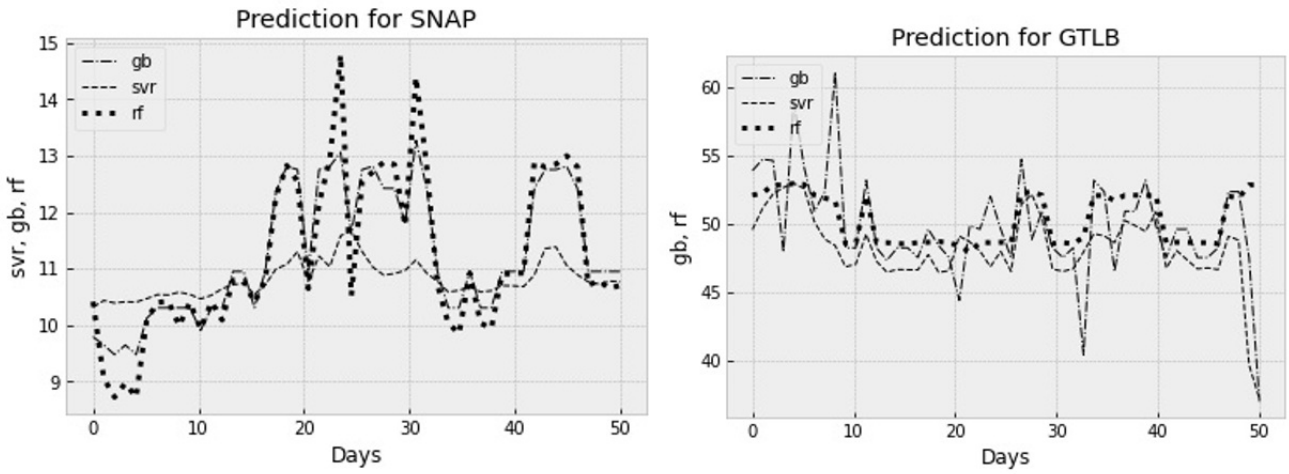


Used methods: lr – linear regression, TREE – decision tree, gb - Gradient Boosting, svr – support vector regressor, rf – random forest, lasso - lasso

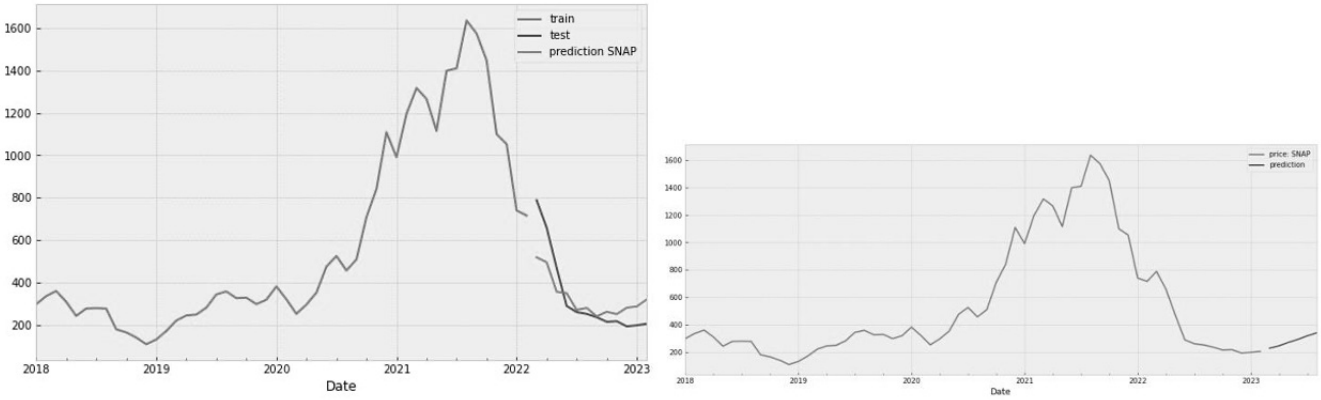


Used method: ARIMA, all monthly data divided on train part and test part. Left part – training and testing parts of the model; right part - prediction

Figure 9. What to expect in the next 50 days for companies represented



Used methods: gb - Gradient Boosting, svr – support vector regressor, rf – random forest



Used method: ARIMA, all monthly data divided on train part and test part. Left part – training and testing parts of the model; right part - prediction

Figure 10. Prediction for IT – sector

It is worth noting that all applied methods are based on the analysis of statistical data of companies for previous periods. If in the case before the pandemic, the reliability of such predictions seemed quite high, the pandemic and the heated phase of the war between Russia and Ukraine significantly reduced the credibility of such approaches. Perhaps more attention in strategy analysis should be paid to game theory methods and especially Axelrod tournament, but these approaches are not part of this research.

The use of a graphic method for such an analysis can be quite illustrative. In the left part (Figs. 11–12), we see all possible combinations of risk and return for the selected portfolios in the pre-war period, and in the right, the current situation. The worsening result is quite telling.

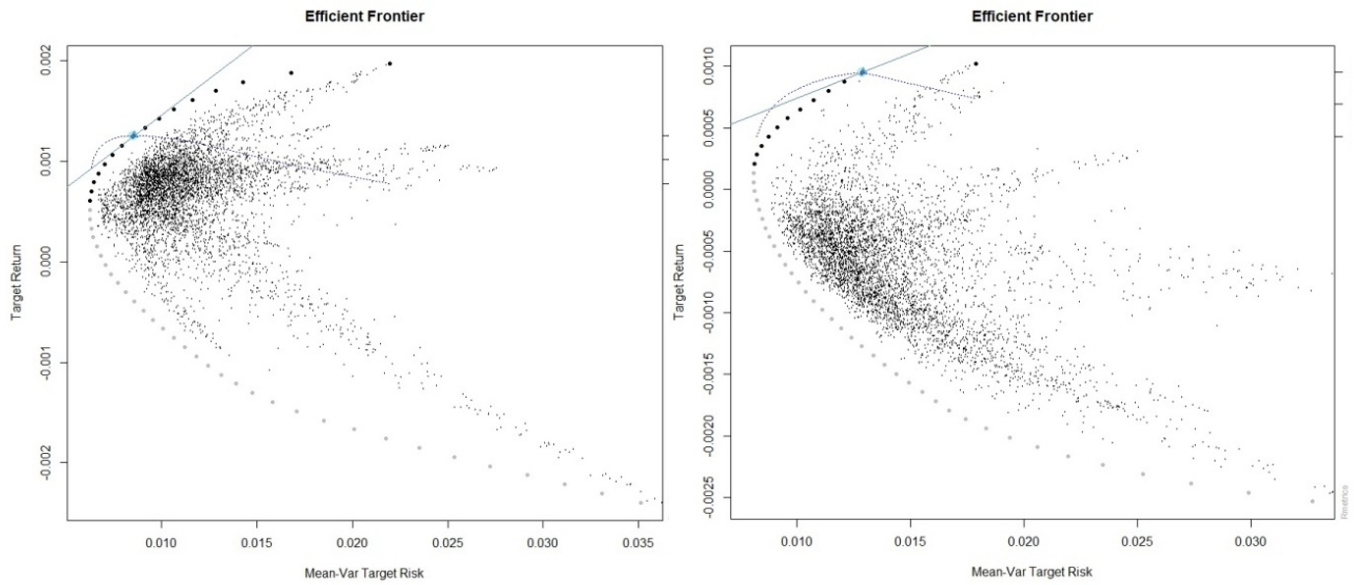


Figure 11. Represented businesses Efficient Frontier in pre-war and wartime

Notes: left part – before war, right part – wartime.

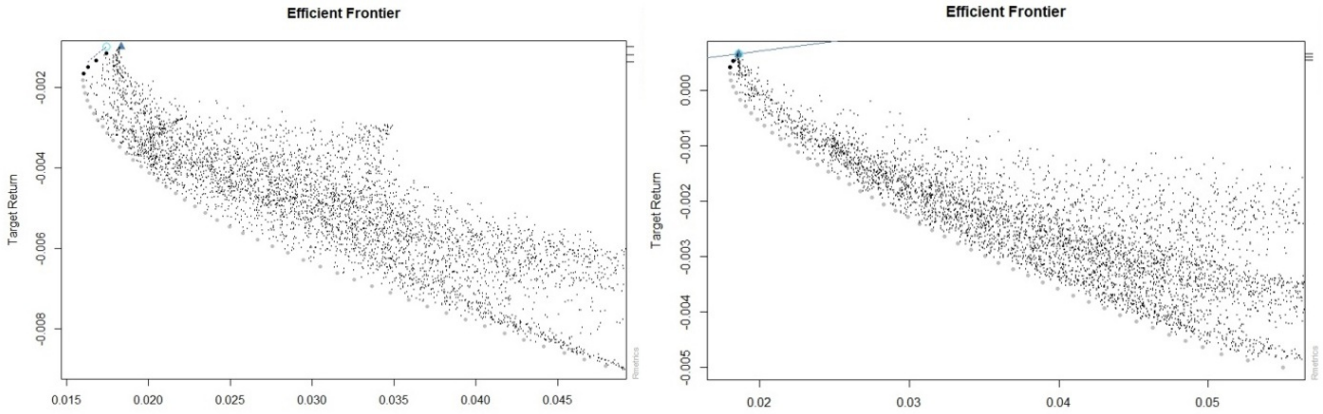


Figure 12. Efficient Frontier for companies' portfolio with R&D offices in Ukraine in pre-war and wartime

Let us once again emphasize the much greater adaptability of IT businesses. It could be noticed that the situation with risk and profitability deterioration for the businesses represented in Ukraine remains significantly worse than for the IT sector.

Based on this analysis, additional tests confirmed the relative invulnerability and greater predictability of the IT sector compared to other sectors of the economy. The growth of budget revenues in Ukraine from the relevant sector, even in war conditions, is a clear confirmation of this fact (in general $7.34 billion according to State Tax Authority in 2022).

Foreign business represented on the Russian market

Even worse tendencies could be performed for international business represented with subsidiaries on the Russian market considering the periods 'before the 2022-02-24' and 'in wartime' (2022-02-24 - 2023-02-24).

It would be quite easy to imagine groups of companies with a sudden desire to take advantage of a special, almost monopoly status on a market with a large amount of oil and gas dollars (yen, rupee, etc.) still being received by Russia. As high-quality European technology products disappear, there is a special niche for inferior Chinese smartphones and laptops. All of the above also applies to building materials, paints, etc. And if there are no problems with "understanding" in the eyes of a national investor or a stock market investor where the company has issued a package of shares, the rise in profitability is guaranteed. What is really happening?

It is interesting that for foreign businesses represented in Russia, the Russian expansion in February 2022 was not reflected in the increase of risk for the optimal portfolio. At the same time, some companies dropped out of such a portfolio, and some, disregarding public opinion, continued to work on the market of the occupying state. It has worsened the profitability situation for such companies generally from 30.3% to 22.6% (Tabl. 6).

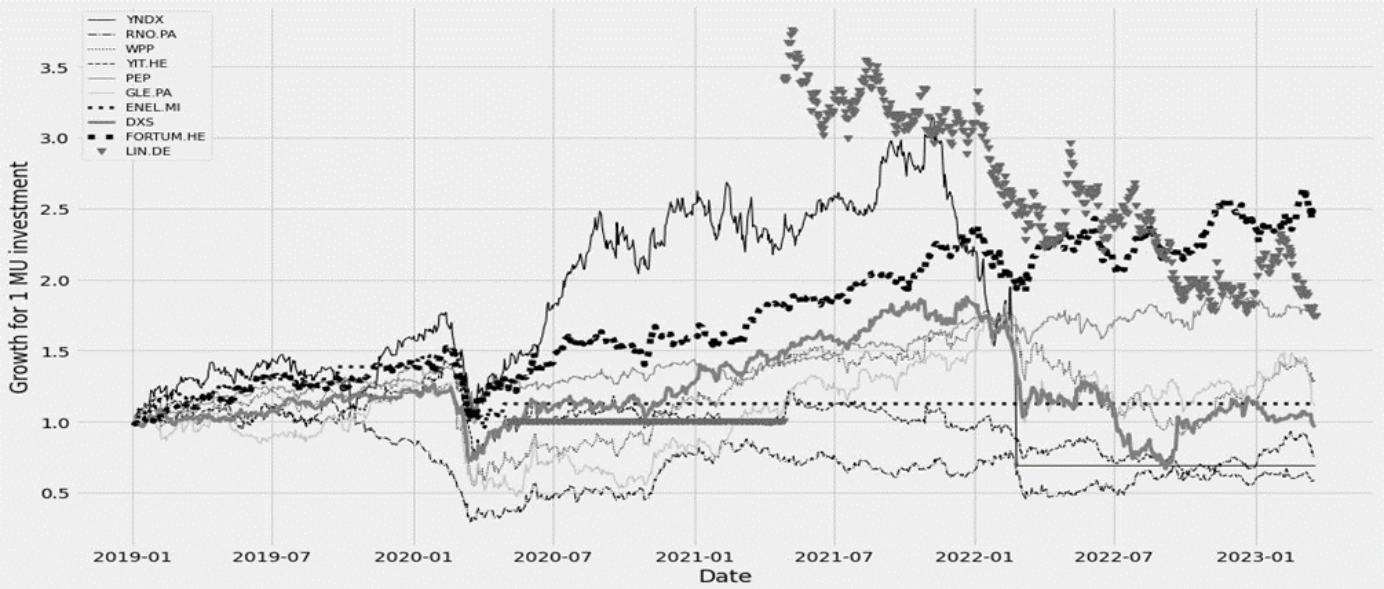


Figure 13. Cumulative returns for most represented on Russian market

Used tickers: Yandex (YNDX), Renault (RNO.PA), WPP (WPP), YIT (YIT.HE), PepsiCo (PEP), Societe Generale (GLE.PA), Enel (ENEL.MI), TCS Group Holding (TCS.IL), DXC Technologies (DXC), Fortum (FORTUM.HE), Linde (LIN.DE), Mohawk Industries (MWK.BE)

Table 6. Illusion of optimality on the Russian market

2012-01-01 – 2023-03-24	2019-01-01 – 2022-02-24	2022-02-24 – 2023-02-24
[('YNDX', 0.0), ('RNO.PA', 0.0), ('WPP', 0.0), ('YIT.HE', 0.0), ('PEP', 0.63915), ('GLE.PA', 0.0), ('ENEL.MI', 0.08831), ('TCS.IL', 0.0), ('DXC', 0.0), ('FORTUM.HE', 0.0), ('LIN.DE', 0.25568), ('MWK.BE', 0.01685)])	[('YNDX', 0.0), ('RNO.PA', 0.0), ('WPP', 0.0), ('YIT.HE', 0.0), ('PEP', 0.32996), ('GLE.PA', 0.0), ('ENEL.MI', 0.0), ('TCS.IL', 0.27123), ('DXC', 0.0), ('FORTUM.HE', 0.0), ('LIN.DE', 0.35969), ('MWK.BE', 0.03911)])	[('YNDX', 0.0), ('RNO.PA', 0.0), ('WPP', 0.0), ('YIT.HE', 0.0), ('PEP', 0.21375), ('GLE.PA', 0.0), ('ENEL.MI', 0.0), ('TCS.IL', 0.0), ('DXC', 0.0), ('FORTUM.HE', 0.0), ('LIN.DE', 0.78625), ('MWK.BE', 0.0)])
Expected annual return: 13.5% Annual volatility: 16.2% Sharpe Ratio: 0.71	Expected annual return: 30.3% Annual volatility: 23.8% Sharpe Ratio: 1.19	Expected annual return: 22.6% Annual volatility: 20.6% Sharpe Ratio: 1.00

Notes: based on pypfopt.efficient_frontier of Python.

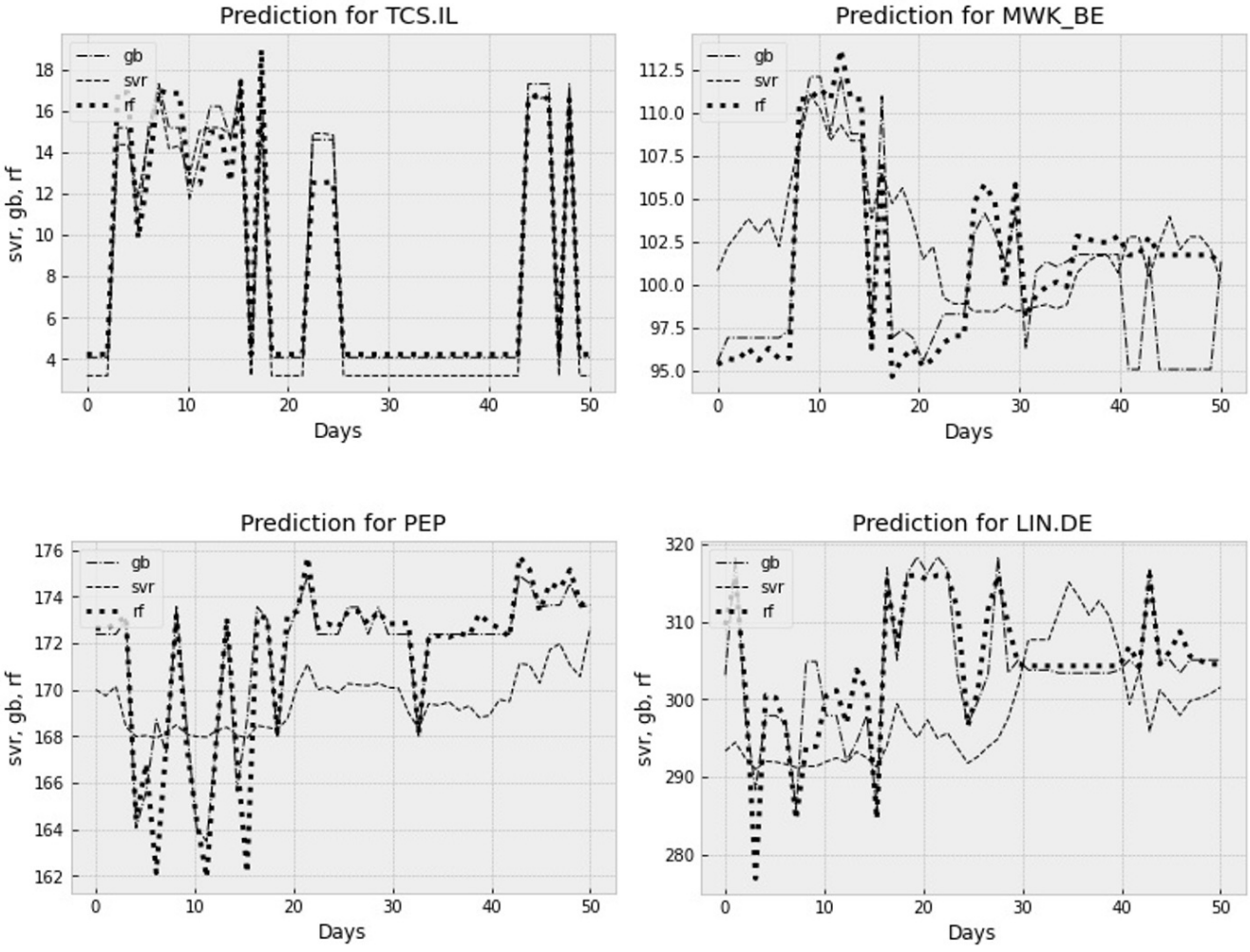


Figure 14. Solidarity and non-solidarity demonstration

Used tickers: TCS Group Holding – TCS.IL (left Russian market), Mohawk Industries – MWK.BE (present), PepsiCo – PEP (present), Linde – LIN.DE (present)

Obviously, from the point of view of profitability, the loss of such a large market has become a challenge for socially responsible companies. Contrary to this, for the businesses that remained on the Russian market (PepsiCo, Linde, etc.) the trends are not worsening yet (Fig. 4). It supports our hypothesis 3 about the coexistence of different world orders. Differentiated corporate interests and social interests coexist. Some developed societies tolerate this state of affairs, so investment preferences and priorities remain unchanged.

Does Chinese business look like the obvious winner?

The possible winner of this new situation had to become Chinese business. But did it really happen that way?

Table 7. Chinese business reaction on the new rules of the game

2012-01-01 – 2023-03-24	2014-01-01 – 2022-02-24	2022-02-24 – 2023-02-24
[('000617.SZ', 0.0), ('1288.HK', 0.0), ('9618.HK', 0.0), ('9988.HK', 0.0), ('0939.HK', 0.0), ('2628.HK', 0.0), ('0941.HK', 0.0), ('1186.HK', 0.0), ('0700.HK', 0.28667), ('1800.HK', 0.0), ('2202.HK', 0.0), ('000800.SZ', 0.0), ('600050.SS', 0.0), ('0763.HK', 0.0), ('600309.SS', 0.24223), ('600519.SS', 0.4711), ('300870.SZ', 0.0)]	('000617.SZ', 0.0), ('1288.HK', 0.0), ('9618.HK', 0.0), ('9988.HK', 0.0), ('0939.HK', 0.0), ('2628.HK', 0.0), ('0941.HK', 0.0), ('1186.HK', 0.0), ('0700.HK', 0.07283), ('1800.HK', 0.0), ('2202.HK', 0.0), ('000800.SZ', 0.0), ('600050.SS', 0.0), ('0763.HK', 0.0), ('600309.SS', 0.0621), ('600519.SS', 0.86507), ('300870.SZ', 0.0)	('000617.SZ', 0.0312), ('1288.HK', 0.0), ('9618.HK', 0.0), ('9988.HK', 0.0), ('0939.HK', 0.0), ('2628.HK', 0.0), ('0941.HK', 0.69755), ('1186.HK', 0.0), ('0700.HK', 0.0), ('1800.HK', 0.0), ('2202.HK', 0.0), ('000800.SZ', 0.0), ('600050.SS', 0.27125), ('0763.HK', 0.0), ('600309.SS', 0.0), ('600519.SS', 0.0), ('300870.SZ', 0.0)
Expected annual return: 27.0% Annual volatility: 26.0% Sharpe Ratio: 0.96	Expected annual return: 43.5% Annual volatility: 30.1% Sharpe Ratio: 1.38	Expected annual return: 34.2% Annual volatility: 21.2% Sharpe Ratio: 1.52

Used tickers: China National Petroleum Corporation (000617.SZ), Agricultural Bank of China (1288.HK), JD.com (9618.HK), Alibaba (9988.HK), China construction Bank (0939.HK), China Life Insurance Company (2628.HK), China Mobile (0941.HK), China Railway Construction Corporation (1186.HK), Tencent (0700.HK), China Communications Construction Company (1800.HK), China Vanke (2202. HK), FAW Group (000800.SZ), China United Network Communications (600050.SS), ZTE (0763.HK), Wanhua Chemical Group (600309.SS), Shenzhen Honor Electronic (300870.SZ). Note: based on pypfopt.efficient_frontier of Python.

The problem with such an analysis is the difficulty of comparing the pre-war and post-war period, given the vulnerability of

the Chinese economy to the on-going impact of the pandemic. The period starting in 2014 can be singled out separately, as being correlated with the deterioration of the perception of Russia by Western countries as a result of its aggressive actions towards Ukraine. As it could be seen, based on the ratio of return and risk, we have no reason to say that the optimal portfolio has significantly improved and that Chinese business has won as a result of the gift: the complete Russian economy.

It could be recognized a significant decline in annual returns after February 2022 and a relatively better risk situation for Chinese companies. It doesn't look like an alternative for Western markets and something that could be called a significant achievement. The reason for the improvement in the risk situation may be the easing of pandemic restrictions.

Table 8. Chinese business reaction: utility analysis

from = "2019-01-01" to = "2022-02-24", min=.01, max=.90	from = "2022-02-24" to = "2023-03-24", min=.01, max=.90
000617.SZ (0.030), 1288.HK (0.138), 9988.HK (0.020), 0939.HK (0.172), 2628.HK (0.016), 0941.HK (0.456), 1186.HK (0.012), 0700.HK (0.022), 000800.SZ (0.018), 600309.SS (0.034), 600519.SS (0.020), 300870.SZ (0.012) Others weight coefficients are 0.01	1288.HK (0.562), 0939.HK (0.018), 0941.HK (0.206), 2202.HK (0.014), 000800.SZ (0.018), 0763.HK (0.026), 600309.SS (0.014), 600519.SS (0.052). Others weight coefficients are 0.01

Notes: based on packages PortfolioAnalytics and fPortfolio of R

The dynamics of portfolios based on utility optimization (Tabl. 8) made it possible to reveal certain tendencies of the Chinese invasion of the Russian market. This concerns the growth of the role of the banking sector in comparison with the portfolio of the pre-war period of a certain specialization (agricultural sector, construction), the significant penetration of companies working on the real estate development market (let's recall the Chinese experience of financing by citizens of not yet built housing), communication equipment (ZTE plaza). At the same time, many companies have lost or worsened their positions. It is interesting that this happened to the companies represented on the American stock markets (Alibaba, Tencent).

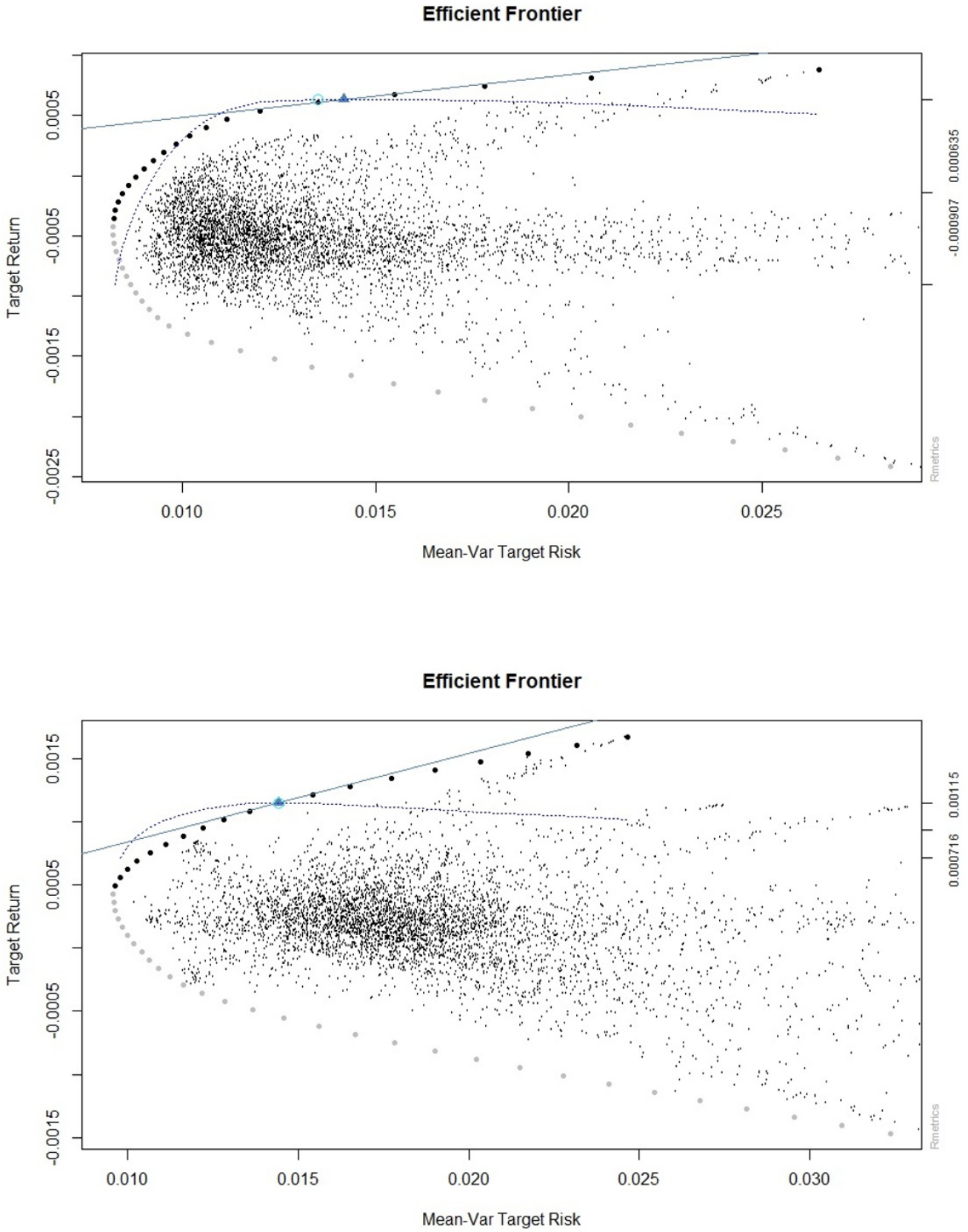


Figure 15. Efficient Frontier graphical presentation: 2020 – 2022 (upper) and after 2022 (lower)

Notes: calculation based on fPortfolio of R.

Efficient Frontier method based on R packages allows us to reveal next change in the situation regarding the Chinese

companies. We accepted initial position as market in period 2020-02-01 – 2022-02-24 (Fig. 15). Under the influence of the pandemic, there was both an increase in the level of risk and an almost threefold drop in profitability. But if we compare this situation with 2022-02-24 – 2023-03-30 China's gift in the form of the Russian market allowed for more than two-fold improvement in profitability, although it slightly worsened the risk situation (closer to 0.015 mean variance target risk).

This improvement is not very far from status of the period 2012–01-01 – 2021-12-15 before the pandemic (Fig. 16). It could be detected for this period even higher risk (explanation for Sharpe Ratio in Tabl. 7) level but that period profitability currently seems not to be achievable.

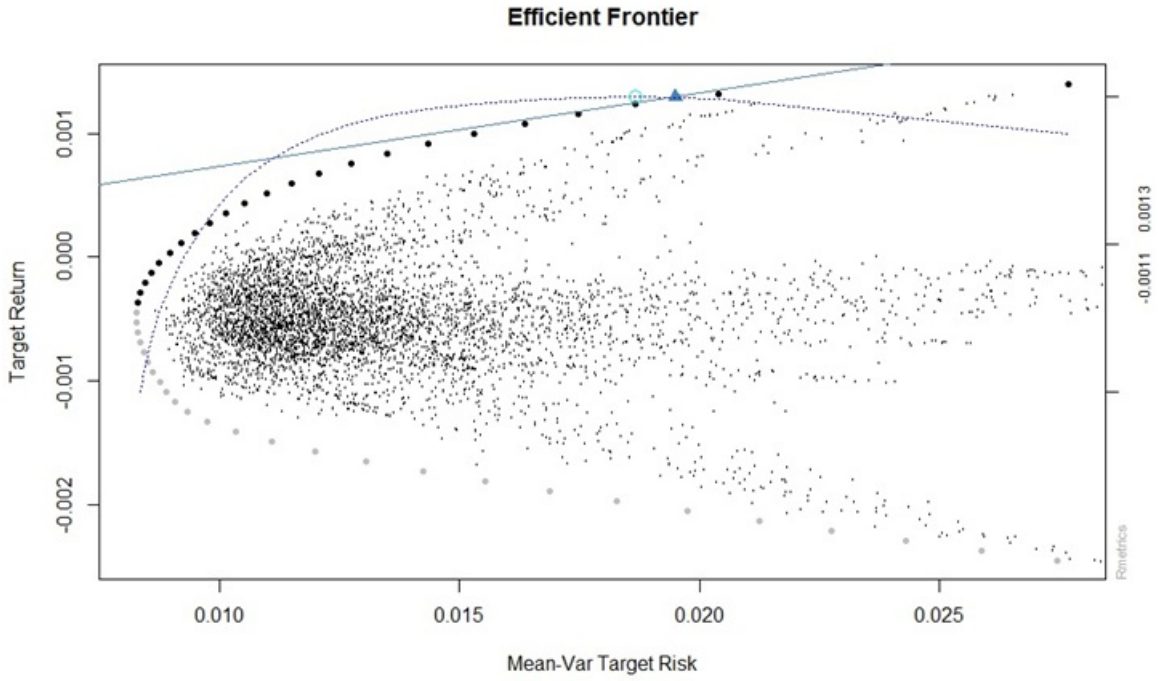


Figure 16. Chinese dream reality before pandemic

Clustering of market participants based on development indicators (every of them is investment in research and development by various sectors) allows us to answer the question of what China's behavior will be in the coming years (Fig. 17). Unfortunately, such data are available only before the pandemic period, but they confirm the thesis about China's unwillingness to change the model of interaction with other world market participants. It is obvious that assumptions should be made about the rationality of the players, since the behavior of the Russians in recent years convinces of the appropriateness of modeling in which there are both rational and irrational decisions. Being separated from other countries of this type it means losing current status or in other words - the same shares of investment but not appropriate object of investment. As you see China is represented in one cluster with Korea, Netherlands, France and even Estonia. Maybe China will rethink its own vision of development, but for now it is just like that.

With information about the deterioration of the situation of Chinese technology companies on the American market, the

deterioration of their position even on the Chinese market, and the presence of China in the same innovation cluster as developed markets, we can claim that our hypothesis 4 has been confirmed. Despite the short-term gains on the Russian market, the Chinese economy is suffering from the long Russian-Ukrainian war and needs its immediate end.

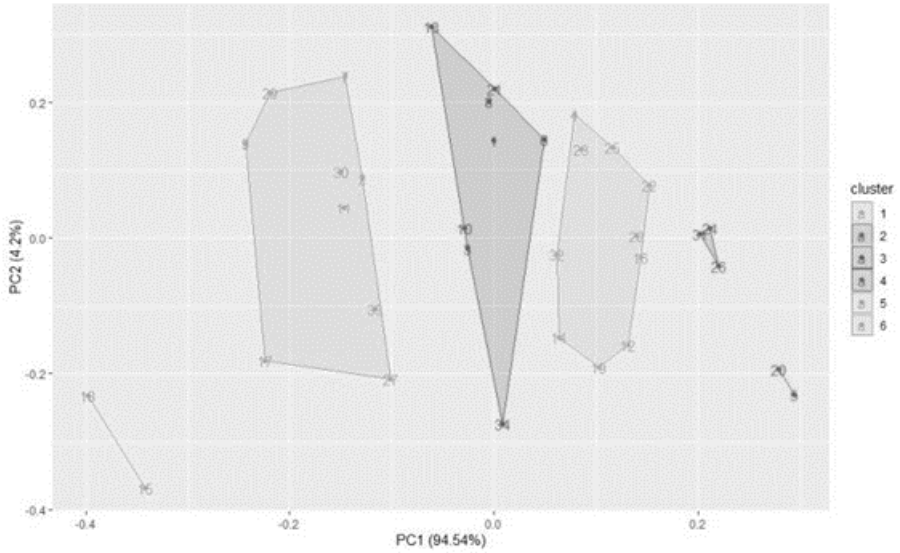


Figure 17. Cluster analysis: China position in R&D investment

Notes: 34 – China, 33 – USA, 21 – Netherlands, 8- Estonia, 10 – France, 18 – Korea. Data source: OECD, 2014 and later. Factors for clusterization: GOVERD – government expenditure on R&D, BERD – business expenditure on R&D, HERD – higher educational expenditure on R&D, PSERD – public sector expenditure on R&D (as percentage). It was chosen 6 clusters according to elbow method. Different methods proposed different number of clusters but such choice is the most illustrative for us. It was used packages cluster, stats, NbClust of R.

Conclusions

In our research all proposed hypotheses have been confirmed. Markets have interpreted the Russian-Ukrainian war as real news that has been immediately displayed by stock markets optimal portfolios. It could be recognized on the market the coexistence of separated social and corporative visions of world economic order. R&D sector could be accepted as a real mirror of potential war influence analysis.

The conducted analysis unambiguously identified Ukraine as a statistically significant element of the world economic order.

Forming a conditional world optimal portfolio based on the most attractive products and companies, it was possible to identify several significant changes characterizing investment processes in the pre-war and wartime periods.

Chinese business does not look like an obvious winner in the new situation. There are both acquirers and losers in the new optimal portfolio, despite new opportunities for companies operating in the field of technology, construction, financial services.

R&D orientation analysis allowed us to reveal real advantages and losses of China from this war. In sense of modern economy China is as much a losing state from the Russian-Ukrainian war and related processes as the Western world. It could be emphasized that the expectation of potential sanctions (a significant increase in riskiness) can be an important deterrent mechanism for such business in general.

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