НАУКОВЕ ФАХОВЕ ВИДАННЯ

У журналі опубліковані наукові статті з актуальних проблем економічної науки.

Для наукових працівників, викладачів, студентів економічних спеціальностей, працівників фінансово-кредитних установ та підприємницьких структур й інших зацікавлених осіб.

Матеріали публікуються мовою оригіналу в авторській редакції.

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THE BALTIC COUNTRIES:
BUSINESS STRATEGY RECOGNITION

КРАЇНИ БАЛТІЇ:
ВИЗНАННЯ БІЗНЕС–СТРАТЕГІЇ

Summary. *The article is devoted to business strategy recognition in the Baltic states. The small Baltic countries (Lithuania, Latvia, and Estonia) very quickly returned to the market economy system. A manifestation of such unification is, in particular, the predominance of modern industries in the optimal portfolios of these markets. At the same time, the markets retain the traditional commitment of the Baltic countries to certain industries, such as the banking sector and farming.*

The impact of the pandemic and the war unleashed by Russia in Europe had a significant, but not long-lasting, impact on these countries. This can be observed in the basic dynamics of investment growth and risk over the last four years. Three separate portfolios are created based on the next indices ingredients: Vilnius SE General for Lithuania, Riga General for Latvia, and Tallinn SE General for Estonia. A joint portfolio from the participants of individual portfolios with non-zero weights is built. Based on the weighting coefficients of this portfolio, the proximity of the Baltic markets to developed markets is analysed. Also their level of competition or diversification is determined in the article. The presence or absence of a long -term strategy on the basis of the 5-factor model of Fama-French is revealed. As the analysis based on Fama-French model and the approach using neural networks showed, only for half of the participants in the optimal portfolio of the region the mentioned crisis phenomena did an impact on the companies' strategies. A modification of the approach based on neural networks used in this study is an attempt to simulate a crisis in the market by adding a hidden layer with an increased number of neurons (factors) as a sign of a crisis in the market.

Key words: *portfolio optimization, neural network, prediction model.*

Анотація. *Стаття присвячена дослідженню бізнес-стратегії в країнах Балтії. Невеликі країни Балтії (Литва, Латвія, Естонія) дуже швидко повернулися до системи ринкової економіки. Проявом такої уніфікації є, зокрема, переважання сучасних галузей в оптимальних портфелях цих ринків. У той же час ринки зберігають традиційну прихильність країн Балтії до певних галузей, таких як банківський сектор і сільське господарство.*

Вплив пандемії та війни, розв'язаної Росією в Європі, мали значний, але нетривалий вплив на ці країни. Це можна спостерігати в динаміці зростання інвестицій та ризику за останні чотири роки. На основі наступних складових індексів створено три окремі портфелі: Vilnius SE General для Литви, Riga General для Латвії та Tallinn SE General для Естонії. Спільний портфель побудовано з учасників індивідуальних портфелів з ненульовими вагами. На основі вагових коефіцієнтів цього портфеля аналізується близькість ринків Балтії до розвинених ринків. Також у статті визначено рівень їх конкуренції чи

диверсифікованості. Виявлено наявність чи відсутність довгострокової стратегії на основі 5-факторної Фама-Френч моделі. Як показав аналіз на основі Фама-Френч моделі та підходу з використанням нейронних мереж, лише для половини учасників оптимального портфеля регіону зазначені кризові явища вплинули на стратегії компаній. Модифікація підходу на основі нейронних мереж, що використовується в цьому дослідженні, є спробою змоделювати кризу на ринку шляхом додавання прихованого рівня зі збільшеною кількістю нейронів (факторів) як ознаки кризи на ринку.

Ключові слова: оптимізація портфеля, нейронна мережа, модель прогнозування.

Problem setting. From the point of view of business traditions, integration of economies, and directions of international cooperation, the small Baltic countries are a separate and extremely interesting area for research. This applies, in particular, to farming, the banking sector, and information technologies. At the same time, how exactly the recently ended pandemic and Russian aggression against Ukraine affect the stock markets of these countries is an interesting and painful question of further movement in the direction of developed markets.

First of all, we create three separate portfolios based on the next indices ingredients: Vilnius SE General for Lithuania, Riga General for Latvia, and Tallinn SE General for Estonia. We analyse this portfolio in relation to cumulative return and risk, analysing the leaders and problematic participants. After that, we build a joint portfolio from the participants of individual portfolios with non-zero weights. Based on the weighting coefficients of this portfolio, we try to analyse the proximity of the Baltic markets to developed markets, as well as their level of competition or diversification.

Further, we intend to reveal the presence or absence of a long-term strategy on the basis of the 5-factor model of Fama-French (possibly maximal period, factors for emerging markets) [1]. If this approach does not show a sufficient result (the necessary criteria are not met), we move on to modelling based on neural networks rejecting linearity [2].

The next Python packages are applied as a portfolio analyses instrument: EfficientFrontier, pypfopt, numpy, pandas_datareader, matplotlib.pyplot, yahoo_fin and packages PortfolioAnalytics, fPortfolio, timeSeries of R.

A modification of the approach based on neural networks used in this study is an attempt to simulate a crisis in the market by adding a hidden layer with an increased number of neurons (factors) as a sign of a crisis in the market. A significant reduction in the number of model steps or variation in the level of accuracy of the model is, for us, a sign of a significant impact of the crisis on the company's strategy.

Analysis of recent research and publications. Currently, there are a number of studies of the general state of the stock market in the CEE, both individually and in general. At the same time, it is interesting to observe the in-depth problems of certain industries that are significantly represented on these markets.

Baele et al. (2015) provided a comprehensive and detailed analysis of CEE equity markets from the middle 1990s until 2015. He used firm-level data to create custom-made indices and indicators to maximize coverage. It was found that there were substantial differences across CEE indices. The final diagnosis of the market can be characterized as "considerable heterogeneity in the degree, dynamics, and determinants of market development" across the different markets. Using market size, liquidity, and concentration indices, Hungary and Poland have been chosen among the most developed markets; Serbia, Latvia, and the Slovak Republic are among the least developed [3].

Pataccini (2020) emphasizes that the banking sector in the Baltics displays one of the highest rates of foreign penetration in the world. According to his findings "the policies chosen by the Baltic governments not only sought further economic and financial integration with the EU but also shielded the foreign bankŕs interests" [4].

Lithuania's banks have largely escaped the worst effects of the dual crises of the COVID-19 pandemic and the war in nearby Ukraine. Gillet (2022) describes the wish of Lithuania to benefit from efforts to establish a pan-Baltic capital market, covering Latvia, Lithuania, and Estonia, which is currently under development [5].

Meanwhile, Kaufmann et al. (2011), investigating Lithuanian farming businesses, suggested that the main motivations for future in-conversions in farming are primarily connected with economic reasons as well as farm management. These depended primarily on the farm type. Their research pointed to substantial farm-support deficits. They found in Lithuania an unusual mix: "relatively low information and support services are coupled with a high level of subsidy and low market prospects in the short to medium term". Connecting Lithuanian farm businesses, they critically discussed the "effects of land capitalization" of relatively high direct organic subsidies, which might have "distorting effects if they are not linked to production levels" [6]. We will be able to observe the impact of this phenomenon on the composition of the optimal portfolio of the Baltic States.

Greblikaite et al. (2017) exploring our chosen region proposed "to diversify family farms activities with additional innovative activities and deeper involvement of young farmers in the family business". Other possible solutions to "lack of financial

resources", "poor family businesses," "lack of values keeping families together", and lack of interest to diversify activities were a bigger involvement of social entrepreneurship in rural areas [7].

The direction of investment in e-commerce in Poland and the Baltic States is very promising. Companies try to expand loyalty programs because they can increase sales. Chomać-Pierzecka et al. (2022) place emphasis on this driving force of each active market [8].

Shaker et al. (2022) examined the effect of the Russia-Ukraine war on the European stock markets. The European stock markets "tended to react negatively to this crisis". He found that on February 24, 2022, European stocks "incurred a significant negative abnormal return". "The negative stock price reactions continued in the post-event period. The magnitude of the stock price reactions to this crisis exhibits considerable variation across industries, countries, and the size of the company". Investors have reacted strongly to the Russia-Ukraine war. The author supposed that governments should take immediate actions to ensure financial stability in their countries [9].

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 January 22, 2022, to March 24, 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" [10].

Yousaf et al. (2022) 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 [11]. Our research aims, in particular, to reveal the impact of Russian aggression on the market of the Baltic countries.

The formulation of the goals of the article is to determine the business strategy recognition in the Baltic countries.

Presentation of the main research material.

Investment growth analysis. Regardless of the lack of necessary improvements for family farming businesses in Lithuania, this branch is number 1 on the market (AB Linas Agro Group, LNA1L. VS). As a result of this, based on the interaction of industries, we observe nearby food production (AB Vilkyskiu pienine, VLP1L.VS). Again, logically, the land bank, even in such a small country, provided land plots for leasing, which turned out to be quite a profitable business (INl1L.VS, AB INVL Baltic Farmland) (Fig. 1).

The Latvian market has become more modern and diversified. Here the main emphases are networking (SAF Tehnika A/S, SAF1R.RG), healthcare provision (AS Latvijas Juras medicinas centrs, LJM1R.RG),
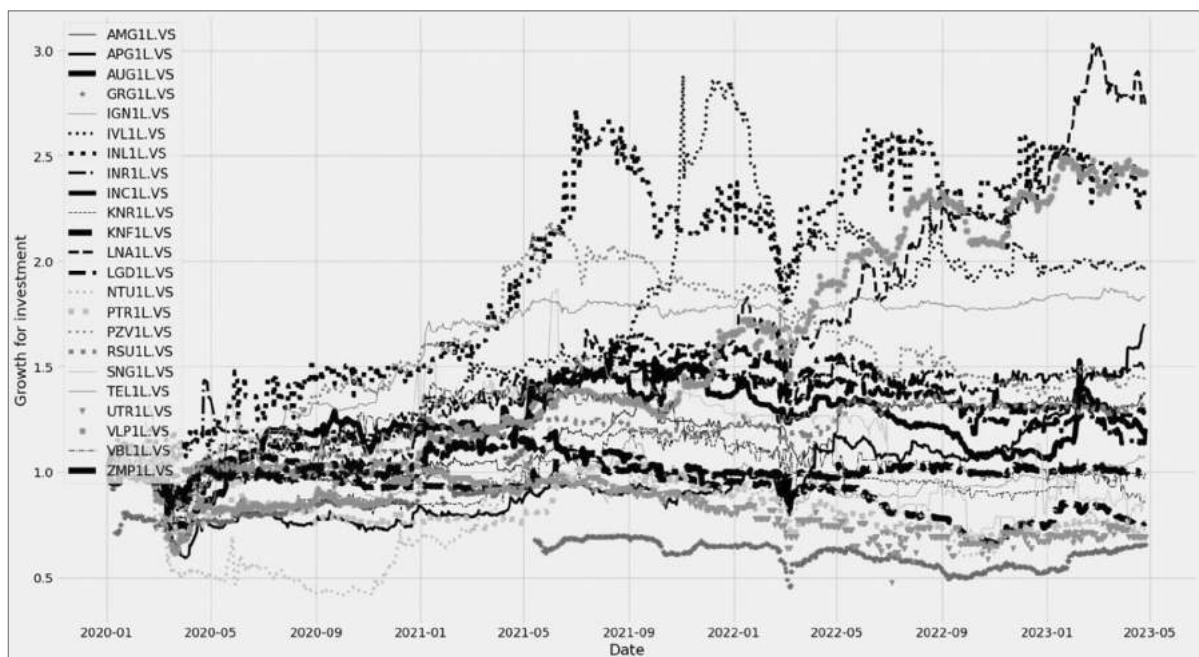
Fig. 1. Lithuania: investment growth

Source: own elaboration
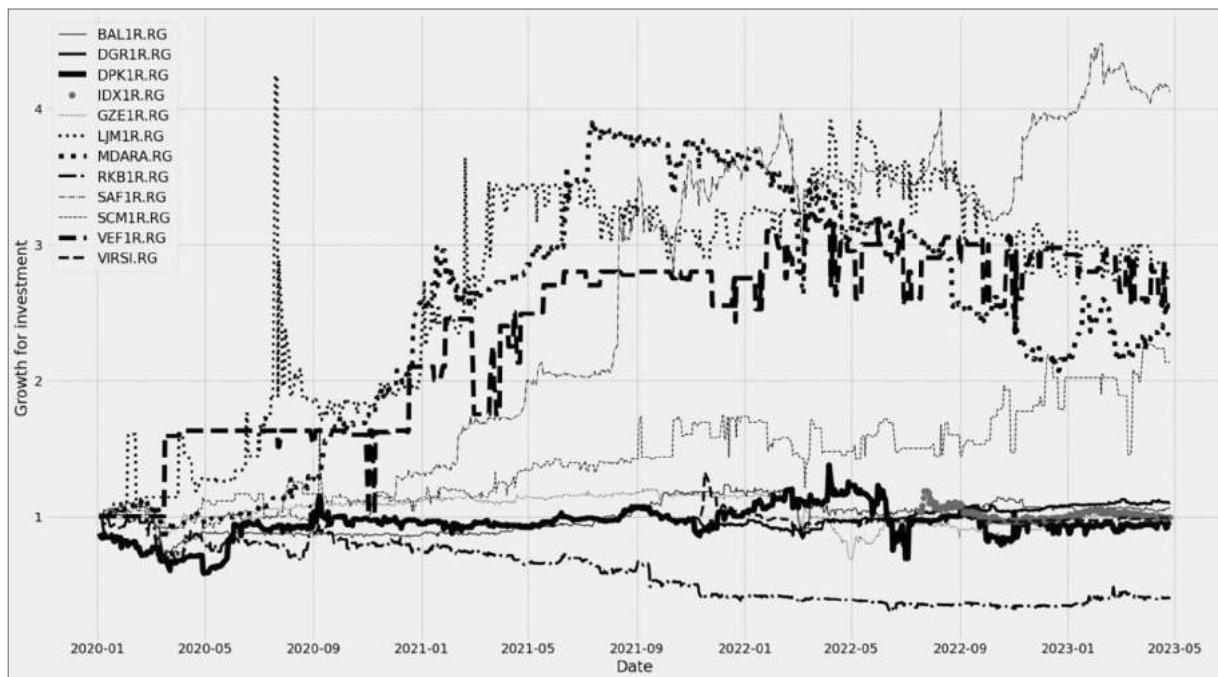
Fig. 2. Latvia: investment growth
Source: own elaboration

and real estate management and renting (AS VEF, VEF1R.RG) (Fig. 2).

As expected, leading positions on the Estonian stock market were hidden behind the banking sector (AS LHV Group, LHV1T.TL, and Coop Pank AS, CPA1T.TL). But it is also worth noting the unexpected success of the company Nordic Fibreboard AS (SKN1T.TL), which works in the sphere of production and sale of building materials. It concentrates its activity in the Nordic, Russian, and Baltic regions. Such a large sales market makes the company a market leader (Fig. 3).

Risk analysis. Like the most successful investments in Lithuania (Fig. 4), the most risky businesses are concentrated in the spheres of agricultural lease, farming, and food production. The change in order does not negate the fact that the most profitable businesses on the market are usually the most risky.

Fig. 3. Estonia: investment growth
Source: own elaboration
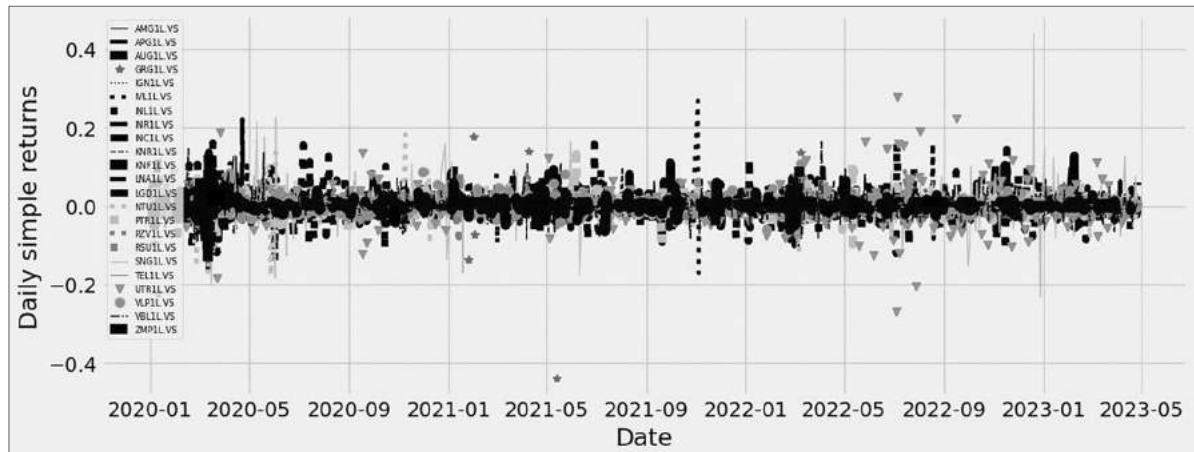
Fig. 4. Daily simple returns dynamics in Lithuania
Source: own elaboration

It is clear from the example of the Latvian market that the risk situation that arose during the war in Europe started by Russia was not as devastating as the one created by the pandemic **(Fig. 5)**. We observe that

Ukrainian military resistance allowed the businesses of neighboring countries to stabilize rather quickly.

For the Estonian market **(Fig. 6)**, the business that had the closest connections with the Russian market
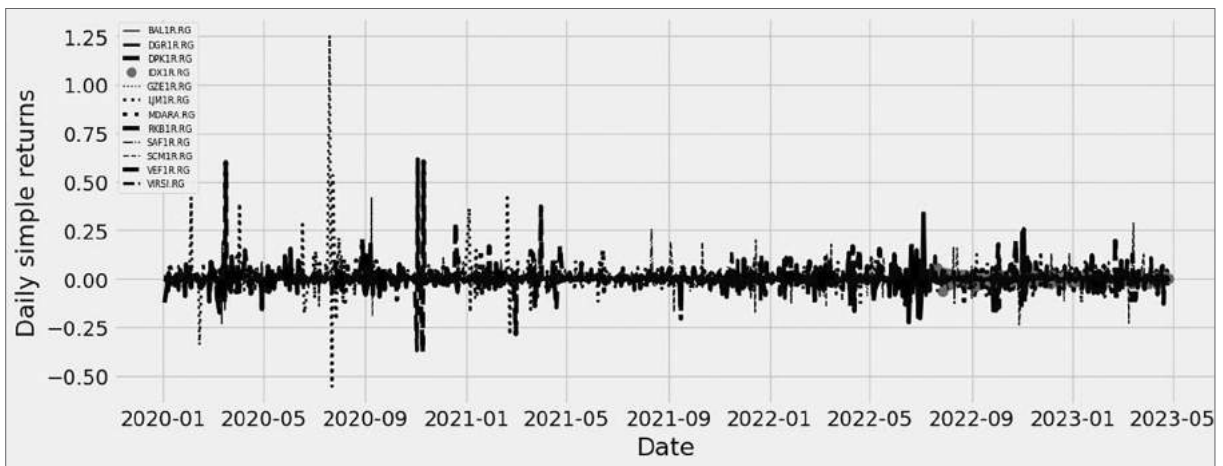

Fig. 5. Daily simple returns dynamics in Latvia
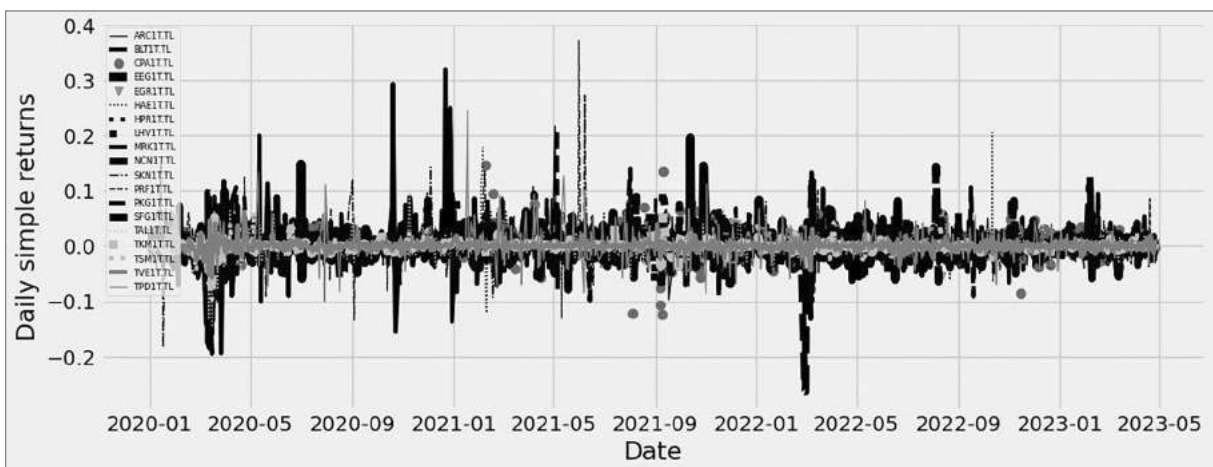*Source:* own elaboration

Fig. 6. Daily simple returns dynamics in Estonia
Source: own elaboration

turned out to be the most risky (SKN1T.TL). But even for this company, the biggest disturbance was short-term, which can be explained by business reorientation.

Portfolio optimization. The overall analysis of the selected portfolios gave us a separate assessment of profitability and risk, but we need a more comprehensive assessment. This is, for example, portfolio optimization based on the Sharpe ratio. More criticism of this approach focuses on the issue of not involving qualitative risk characteristics but exclusively quantitative ones. But we believe that for the markets of the small Baltic countries, the quantitative estimates are sufficient.

If the separation of profitability and risk puts Lithuania exclusively on the path of agrarian business and related activities, such an aggregated approach (Tabl. 1) allows us to immediately reveal the fact of the prevalence of one of the modern industries, namely telecommunications (46% in the portfolio). The same is true for the Latvian market (65% for networking) and the Estonian case (21% for telecommunication and 14% for networking). At the same time, we must emphasize the important role of farming in these portfolios while keeping in mind the certain imbalance of the family business issue. The optimal portfolio for the three states demonstrates rather

Table 1

Optimal portfolios

Lithuania Expected annual return: 29.0% Annual volatility: 13.0% Sharpe Ratio: 2.08 Ranking of industries in optimal portfolio: wireless communication services ('TEL1L.VS, 0.46414), farming (LNA1L.VS, 0.3101), food products (VLP1L.VS, 0.07303), investment advisors (IVL1L.VS, 0.0841), lease of agricultural land (INL1L.VS, 0.03999), real estate services (INR1L.VS, 0.02853)	[('AMG1L.VS', 0.0), ('APG1L.VS', 0.0), ('AUG1L.VS', 0.0), ('GRG1L.VS', 0.0), ('IGN1L.VS', 0.0), ('IVL1L.VS', 0.08418), ('INL1L.VS', 0.03999), ('INR1L.VS', 0.02853), ('INC1L.VS', 0.0), ('KNR1L.VS', 0.0), ('KNF1L.VS', 0.0), ('LNA1L.VS', 0.31013), ('LGD1L.VS', 0.0), ('NTU1L.VS', 0.0), ('PTR1L.VS', 0.0), ('PZV1L.VS', 0.0), ('RSU1L.VS', 0.0), ('SNG1L.VS', 0.0), ('TEL1L.VS', 0.46414), ('UTR1L.VS', 0.0), ('VLP1L.VS', 0.07303), ('VBL1L.VS', 0.0), ('ZMP1L.VS', 0.0)]
Latvia Expected annual return: 48.9% Annual volatility: 26.6% Sharpe Ratio: 1.76 Ranking of industries in optimal portfolio: networking (SAF1R.RG, 0.65), personal care products (MDARA.RG, 0,206), farming (SCM1R.RG, 0.05), real estate developers (VEF1R.RG, 0.04731), healthcare provision (LJM1R.RG, 0.0380)	[('BAL1R.RG', 0.0), ('DGR1R.RG', 0.0), ('DPK1R.RG', 0.0), ('IDX1R.RG', 0.0), ('GZE1R.RG', 0.0), ('LJM1R.RG', 0.03806), ('MDARA.RG', 0.20622), ('RKB1R.RG', 0.0), ('SAF1R.RG', 0.65769), ('SCM1R.RG', 0.05073), ('VEF1R.RG', 0.04731), ('VIRSI.RG', 0.0)]
Estonia Sharpe Ratio: 1.81 Expected annual return: 35.3% Annual volatility: 18.4% Ranking of industries in optimal portfolio: Banking(LHV1T.TL, 0.28418), real estate developers (TPD1T.TL, 0.16016), renewable energy generation (EGR1T.TL, 0.18277), forestry and wood products('SKN1T.TL', 0.1195), publishing (EEG1T.TL, 0.11875), construction (MRK1T.TL, 0.05397)	[('ARC1T.TL', 0.0), ('BLT1T.TL', 0.0), ('CPA1T.TL', 0.08068), ('EEG1T.TL', 0.11875), ('EGR1T.TL', 0.18277), ('HAE1T.TL', 0.0), ('HPR1T.TL', 0.0), ('LHV1T.TL', 0.28418), ('MRK1T.TL', 0.05397), ('NCN1T.TL', 0.0), ('SKN1T.TL', 0.1195), ('PRF1T.TL', 0.0), ('PKG1T.TL', 0.0), ('SFG1T.TL', 0.0), ('TAL1T.TL', 0.0), ('TKM1T.TL', 0.0), ('TSM1T.TL', 0.0), ('TVE1T.TL', 0.0), ('TPD1T.TL', 0.16016)]
Baltic countries Expected annual return: 35.8% Annual volatility: 13.0% Sharpe Ratio: 2.60 Ranking of industries in optimal portfolio: wireless telecom services (TEL1L.VS, 0.21657), Farming (LNA1L.VS, 0.21506), networking (SAF1R.RG, 0.14227), real estate developers (TPD1T.TL, 0.07717), investment advisors (IVL1L.VS, 0.05728), forestry wood products (SKN1T.TL, 0.04427), publishing (EEG1T.TL, 0.04372), lease of land stock (INL1L.VS, 0.03584), real estate developers (VEF1R.RG, 0.02036), personal care products (MDARA.RG, 0.01553), farming (SCM1R.RG, 0.01272), healthcare provision (LJM1R.RG, 0.01278)	[('LJM1R.RG', 0.01278), ('MDARA.RG', 0.01553), ('SAF1R.RG', 0.14227), ('SCM1R.RG', 0.01272), ('VEF1R.RG', 0.02036), ('TEL1L.VS', 0.21657), ('LNA1L.VS', 0.21506), ('VLP1L.VS', 0.01117), ('IVL1L.VS', 0.05728), ('INL1L.VS', 0.03584), ('INR1L.VS', 0.03794), ('LHV1T.TL', 0.05732), ('TPD1T.TL', 0.07717), ('EGR1T.TL', 0.0), ('SKN1T.TL', 0.04427), ('EEG1T.TL', 0.04372), ('MRK1T.TL', 0.0)]

Notes: ranking is based on the weights coefficients

Source: own elaboration

Table 2

Fama — French analysis

Ticker	Available features of the models
TEL1L.VS	Prob (F) = 0.347. Model is not working
LNA1L.VS	Prob (F) = 0.06, HML = −0.9(0.04), CMA = 1.55(0.008), D-W=1.841
SAF1R.RG	Prob (F) = 0.1. Model is not working
TPD1T.TL	Prob (F) = 0.05, SMB = 1.45(0.02), D-W=2.05
IVL1L.VS	Prob (F) = 0.06, Mkt-RF=0.57(0.02), D-W=1.8
SKN1T.TL	Prob (F) = 0.967. Model is not working
EEG1T.TL	Prob (F) = 0.07, Mkt-RF=0.49(0.03), SMB=1.13(0.06), D-W=1.947
INL1L.VS	Prob (F) = 0.017, Mkt-RF =0.6(0.001), D-W=2.27
VEF1R.RG	Prob (F) = 0.868. Model is not working
MDARA.RG	Prob (F) = 0.05, Mkt-RF=0.47(0.03), RMW= −1.67(0.049), D-W=1.86
SCM1R.RG	Prob (F) = 0.781. Model is not working
LJM1R.RG	Prob (F) = 0.959. Model is not working

Source: own elaboration

serious diversification, mutual satisfaction of the markets, and mutual complementarity. The absence of pronounced individual leaders that completely absorb a significant part of investment funds (as in the case of some South American countries, for example) is definitely a good sign of the presence of competition and the stable development of the stock market.

Strategy. For both developed and emerging markets, Fama-French analysis is a good tool for identifying a company's long-term strategy. Such a strategy includes choices regarding risk, investment timing, conservative or aggressive behavior, etc. A possible disadvantage of this model is its linearity. In the case of the Baltic countries for 50% ingredients of optimal portfolio this model is not working because of the unsatisfactory significance of F-criterion (Tabl. 2).

At the same time, some of these businesses can be said to be less risky compared to the market,

conservative, having low profitability. In case of having "working status" the proper model has an accepted level of multicollinearity. Obviously, on the basis of this, it is possible to draw a conclusion about the presence of a strategy in 50% of cases, but it is impossible to describe it. In described case it was used Fama — French factors for emerging markets. In case of developed market factors the situation is much worse. Such model is working only for 2 companies from the proposed list. It means the status of emerging markets is still working for the proper countries stock markets.

So, given the Fama-French factor table, we need to use a tool that will build non-linear relationships between the company's share price and these factors. This can be done using neural networks.

Suppose that each of the crises (pandemic, war) can be represented in our model as an additional hidden layer with more neurons than at the ini-

Table 3

Neural networks based analysis

Ticker	Hidden =2			C(6,2)			C(6,6,2)		
	Acc.	Error	Steps	Acc.	Error	Steps	Acc.	Error	Steps
TEL1L.VS	0.917	0.734	5	0.917	0.732	20↑	0.922	0.734	17↑
LNA1L.VS	0.945	0.382	19	0.945	0.383	26↑	0.945	0.383	14↓
SAF1R.RG	0.903	1.599	26	0.901	1.599	30↑	0.901	1.599	2↓
TPD1T.TL	0.893	2.054	23	0.888	2.050	13↓	0.893	2.053	7↓
IVL1L.VS	0.961	2.596	17	0.960	2.599	16↓	0.961	2.6	19↑
SKN1T.TL	0.402	79.19	19	0.40	79.1	13↓	0.40	79.2	16↓
EEG1T.TL	0.957	1.305	13	0.954	1.305	19↑	0.953	1.3	23↑
INL1L.VS	0.969	0.092	10	0.969	0.093	15↑	0.967	0.094	15↑
VEF1R.RG	0.672	18.6	10	0.673	18.6	22↑	0.669	18.6	4↓
MDARA.RG	0.378	16.89	13	0.381	16.89	9↓	0.38	16.89	19↑
SCM1R.RG	0.745	1.46	19	0.75	1.46	14↓	0.733	1.442	18↓
LJM1R.RG	0.803	1.243	20	0.792	1.243	9↓	0.785	1.243	11↓

Source: own elaboration

tial level. We will use the case with one additional hidden layer with 2 neurons (hidden = 2, no crisis involvement), the case with one crisis with a bigger amount of factors than on the initial layer (c(6,2)), and the case with two crises (c(6,6), 3 hidden layers).

Abandoning linearity in favor of algorithms using neural networks made it possible to achieve significant accuracy in prediction models and assert the existence of long-term non-linear strategies in all businesses of the optimal portfolio (Tabl. 3).

We determine the appropriateness of introducing two additional hidden layers in our analysis based on the reduction of the required steps of the model. It means that proper companies' strategies are affected by one or two crises. Only in the case of critical changes in the business it was possible to see the obvious confirmation of the impact of crises in the form of a significant improvement in the accuracy of the model.

There are only 3 such companies in our portfolio, when involving one or two crises in model has critically improved the model accuracy (TEL1L. VS, MDARA.RG, SCM1R.RG). At the same time, there is an exception as a result of the insignificant impact of crises. That is, in this case, it would be possible to operate with only one hidden layer and two neurons.

It is worth noting that such a model is a very good tool for predicting the price based on its level of accuracy (coincidence of the model and real value). At the same time, the analysis of individual coefficients requires additional research.

Below is a graphic presentation of the distribution of layers for the company Telia Lietuva (Fig. 7).

As our analysis showed, only for a part of the participants in the optimal portfolio of the region of the Baltic countries, the impact of the pandemic and the war unleashed by Russia changed the long-term strategy of these companies. Our applied analysis using the table of Fama-French factors and neural networks allowed us to give an affirmative answer to this question. At the same time, there is a significant problem with the lack of possibility to interpret factors in such a model. On the other hand, it became possible to test the behavior of the model based on the influence of additional layers
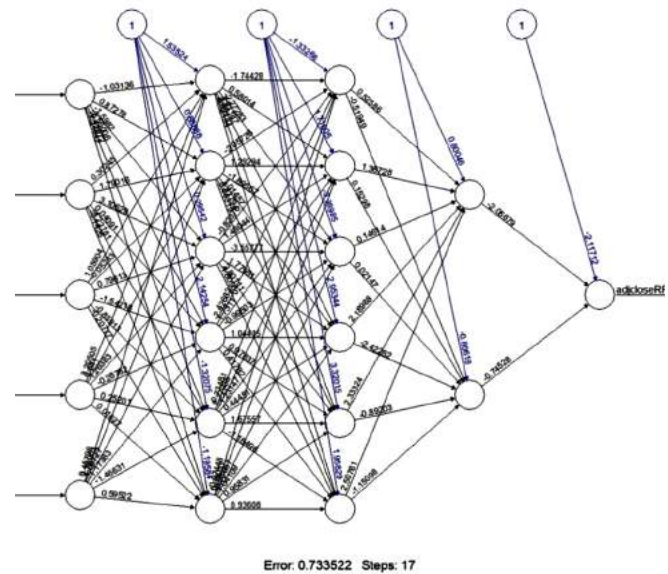

Error: 0.733522 Steps: 17

Fig. 7. Telia Lietuva (TEL1L.VS) prediction NN model
Source: own elaboration

(opportunities, crises) and the manipulation of the number of factors (neurons).

Conclusions. The stock markets of the Baltic countries are a reflection of social problems, which is characteristic of developed markets. Despite not having a whole range of industries that prevail in developed markets, at the same time, there is a special role for telecommunications and the IT sector. The farming and banking sectors highlight the traditional commitment of individual markets to these industries. The business that preferred the Russian market successfully reoriented its activities.

On the basis of the 5-factor Fama-French model, the presence of long-term strategies in at least half of the participants in the optimal portfolio is demonstrated. This approach turned out to be insufficient and uninformative.

With the help of the modernization of the method based on neural networks, an acceptable model of price prediction and analysis of the impact of crisis phenomena on the company's strategy was formed. For half of the companies, the absence of a significant impact of the pandemic and Russian aggression on the long-term strategy has been revealed.

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