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CONTENTS

The Slovak Insurance Market during COVID-19 Pandemic Times

Miriama Blahušiaková [1]

Abstract

The COVID-19 pandemic has negatively affected the business activities of all economic entities, including insurance companies. Strict measures adopted by governments of individual countries, restrictions on movement, travel bans, and transfer of work to the online environment have also affected the demand for individual types of insurance, the way of signing insurance contracts, settling insurance claims, and at the same time have had an impact on the sum of written premiums, the sum of claims paid out, as well as on the economic results of insurance companies. The aim of the paper is to analyse the impact of the pandemic on the financial position and business processes of nine insurance companies operating in the Slovak insurance market. As our research has shown, during the pandemic there was a decrease in demand for travel insurance and a decrease in claims related to car accident insurance. On the contrary, there was an increase in demand for various types of life insurance, especially risk life insurance. In the context of the travel ban and the negative impact of the pandemic on the tourism sector in particular, a significant new risk has emerged - the risk of insolvency of travel agencies. Several insurers declared in their annual reports that they managed to overcome the challenging lockdown period by digitizing business processes and flexibly transferring their work to an online environment.

Key words

Insurance companies, written premiums, profit or loss, COVID-19 pandemic,

JEL Classification: G22, M41

1. Introduction

Like all areas of business, the insurance industry has been affected by a global pandemic that has become both an opportunity and a challenge for all. The first cases of SARS Cov-2 coronavirus infection were identified in the Chinese city of Wu-chan as early as November 2019, and from there, it quickly spread around the world (Abdulamir and Hafidh, 2020; Cohen, 2020). The pandemic has affected the lives of residents, and the economy, too (Gallego et al., 2020; Fraccascia and Alvarado, 2020; Berger et al., 2020).

The world economy has suffered for several reasons. Curfews, lockdowns of the economy, restrictions on social and economic life, as well as many other restrictive measures taken by national governments to limit and slow the spread of the virus (Shafi, Liu, and Ren, 2020; Leite, Hodgkinson, and Gruber, 2020) have contributed to the deterioration of macroeconomic indicators, but have also had a considerable impact on entities operating at the micro level (Gomes, 2021; Shen et al., 2020; Memon et al., 2021).

The Slovak economy has experienced the negative impacts of the pandemic in an even more pronounced way. The unfavorable development of the pandemic situation in Slovakia due to the low vaccination coverage of the population, and strict measures limiting the economic activities of the population and accounting entities have been reflected in the deterioration of the financial situation of all economic entities (Blahušiaková, 2022).

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The negative impact of the pandemic has also affected the financial sector and, within it, the insurance market. As Landini and Noussia (2023) state, the COVID-19 pandemic has accelerated the pace of evolution of insurance in many aspects and relation to many sectors and insurance lines (health insurance, cargo marine insurance, life insurance, travel insurance, business interruption insurance, etc.). According to Wang and Lee (2023), insurance is an essential financial instrument that can provide financial protection to people who have suffered economic losses due to disasters and diseases. Grzegorz and Alina (2020) discussed the impact of the COVID-19 pandemic on the insurance industry. According to their conclusions, when social risks increase, insurance mitigates them, generating relative public optimism. Balasubramanian et al. (2020) reported that the COVID-19 pandemic decreased living standards and lowered interest rates, which led to higher insurance premiums, thus reducing demand for life insurance. This can lead to the situation when insurance companies may more frequently apply grace periods when taking out insurance contracts for international travel, in particular to countries with a high number of confirmed COVID-19 cases. This is confirmed by Díaz Llavona (2023) who states that health insurance and travel insurance were the two types of non-life insurance most affected by the COVID-19 pandemic.

Ratowska-Dziobiak (2022) investigated the extent to which the COVID-19 pandemic affected the situation in the insurance market, areas, in which its consequences were particularly visible, and the opportunities and threats the pandemic brought to the insurance market. According to her research, insurers have been faced with the need to introduce completely remote customer service. Many insurers had to introduce new tools that in many cases were still in a testing phase and which they had not had the opportunity to use on a large scale. With the onset of the pandemic, they were quickly put in place.

Due to movement and meeting restrictions, the insurance companies shifted providing their services into the online environment. The Customer Service Division´s Activities focused mainly on the fluent provision of all services to customers despite the pandemic, also thanks to activities aimed at attending to customer requests in an electronic form through digitalization, optimization, and robotization of selected administrative processes. This was considerably facilitated by the introduction of electronic communication with customers. According to Pauch and Bera (2022), the COVID-19 crisis has accelerated the need for a digital transformation of insurance companies, which has shifted from being a strategic option to a necessity.

The COVID-19 pandemic also significantly impacted the insurance sector, particularly in the area of new business production, which in turn affected the growth of written premiums, both in life and non-life insurance.

2. Aim and Methodology

The aim of the paper is to analyse the impact of the pandemic on the financial position and business processes of nine insurance companies operating in the Slovak insurance market. We focus on the analysis of the changes in demand for individual types of insurance coverage, the analysis of the nature of insurance claims, as well as on the analysis of the changes that the insurance sector had to undergo in connection with the pandemic. According to Borovcova (2013), the assessment of the level of the insurance market is carried out through qualitative and quantitative indicators of the level of the insurance market. The written premium ratio and the claims cost ratio belong to quantitative indicators, that is why we focus on the development of written premiums, the development of claims costs, as well as on the development of the profit or loss in our paper.

We sampled nine insurance companies operating in the Slovak insurance market, which provide life and non-life insurance products (Table 1). The insurers are arranged according to the sum of written premiums in the 2021 accounting period.

Table 1: List of Insurance Companies

Name of the Insurance Company	SK NACE code	Written premiums in thousands of € in 2021
Allianz – Slovenská poisťovňa, a. s.	65120 – Non-life insurance	690 739
KOOPERATIVA poisťovňa, a. s. Vienna Insurance Group	65120 – Non-life insurance	619 847
NN Životná poisťovňa, a. s.	65110 – Life insurance	136 216
Komunálna poisťovňa, a. s. Vienna Insurance Group	65120 – Non-life insurance	109 351
ČSOB Poisťovňa, a. s.	65110 – Life insurance	93 614
NOVIS Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS Compagnia Di Assicurazioni, NOVIS Poisťovňa a. s.	65110 – Life insurance	80 122
Union poisťovňa, a. s.	65120 – Non-life insurance	65 103
Wüstenrot poisťovňa, a. s.	65120 – Non-life insurance	50 620
BNP Paribas Cardif Poisťovňa, a. s.	65120 – Non-life insurance	34 409

Three insurers declare life insurance as their main line of business, six insurers declare non-life insurance as their main line of business. Nevertheless, all insurers sell both life and non-life insurance products.

Data for the analysis were taken from the financial statements of the analysed insurance companies published in the Register of Financial Statements (www.registeruz.sk), focusing on five accounting periods 2017-2021 (data of some insurance companies for the 2022 accounting period were not available at the time of the paper's preparation, so we worked with data for the 2017-2021 accounting periods in the analyses). In addition to financial statement data, we also analysed data in the annual reports of insurance companies, where we focused mainly on the 2019-2021 accounting periods because of the pandemic.

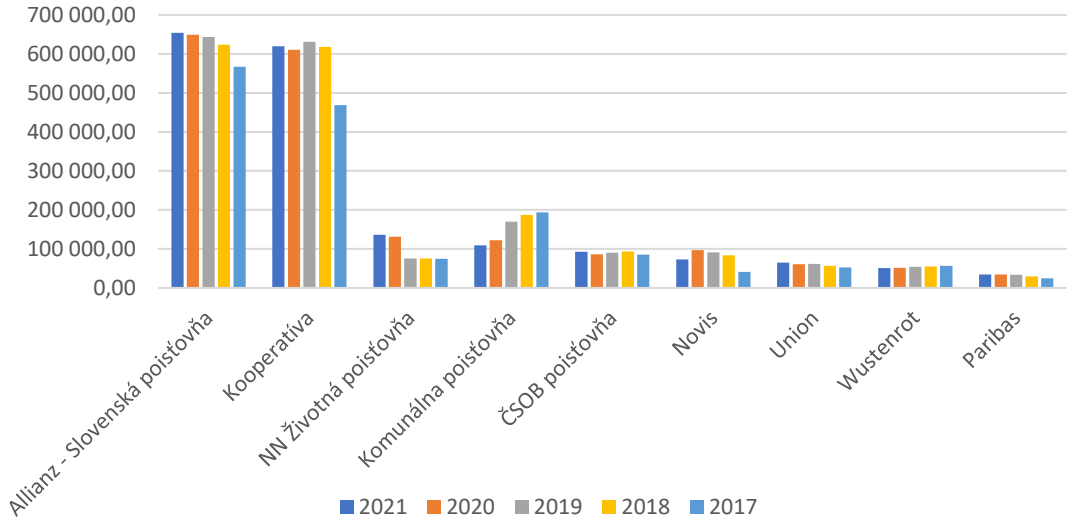
We focused on the trend analysis of income statement items as part of the analysis. In particular, the items were written premiums, written premiums after reinsurance, claims expense after reinsurance, and profit or loss after tax.

3. Trend in written premiums for the 2017 – 2021 accounting periods

According to the Slovak Association of Insurers (hereafter referred to as 'Association'), the Slovak insurance market recorded a decrease in premiums by 1.8% and achieved a written premium amounting to EUR 2.45 billion in 2020, especially due to the difficult situation caused by the COVID-19 pandemic. The decrease was recorded in life insurance (decrease of 4.0%), whilst non-life insurance recorded a growth of 0.5%. The Slovak insurance market, after a challenging year 2020, which was significantly impacted by the pandemic, saw a recovery in 2021, with premiums increasing by 2.4%. Growth was recorded in life insurance (+0.8%) as well as in non-life insurance (+3.9%). The overviews of written premiums and written premiums after reinsurance are shown in Figure 1 and Figure 2.

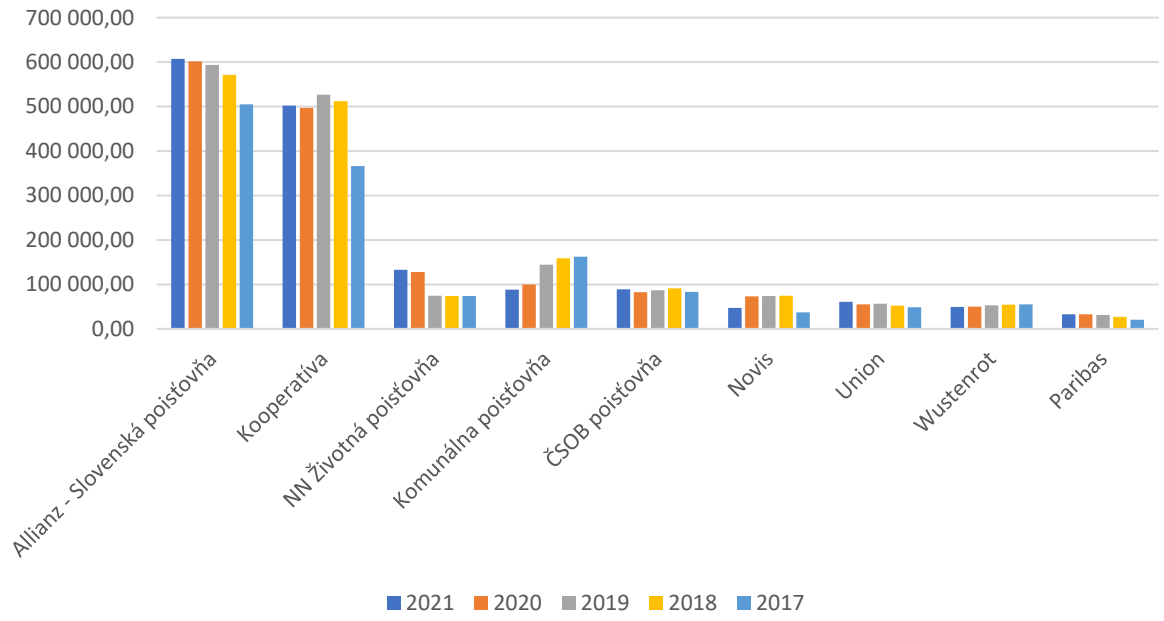
Allianz – Slovenská poisťovňa, a. s., with a market share of 26.8% confirmed the biggest share on the Slovak insurance market in the written premium among the members of the Association in the 2020 accounting period. Its market share in non-life insurance was 33.2%, and in life insurance, it was 19.8%. KOOPERATIVA, a. s. Vienna Insurance Group, confirmed its second position in the Slovak insurance market with a share of 24.95% (22.3% share in non-life insurance, and 27.7% in life insurance). KOOPERATIVA, a. s. Vienna Insurance Group is the market leader in life insurance.

Figure 1: Development of written premiums in thousands of euros



In the 2021 accounting period, the market share in written premium of Allianz – Slovenská poisťovňa, a. s. within the Association's members was 26.5% (32.2% in non-life insurance, and 20.1% in life insurance). KOOPERATIVA, a. s. Vienna Insurance Group was in the second position, with a market share of 24.9% (22.5% in non-life insurance and 27.4% in life insurance).

Figure 2: Development of written premiums after reinsurance in thousands of euros



The percentage change of written premiums in analysed insurance companies in analysed accounting periods is in Table 2.

Table 2: Development of written premiums

Insurance company	2021 vs 2020	2020 vs 2019	2019 vs 2018	2018 vs 2017
Allianz – Slovenská poisťovňa, a. s.	0.74%	0.90%	3.23%	10.01%
KOOPERATIVA poisťovňa, a. s. Vienna Insurance Group	1.59%	-3.33%	-1.65%	3.24%
NN Životná poisťovňa, a. s.	4.04%	73.12%	0.27%	0.88%

Komunálna poisťovňa, a. s. Vienna Insurance Group	-10.50%	-27.96%	-9.40%	-3.18%
ČSOB Poisťovňa, a. s.	7.75%	-4.06%	-4.15%	10.09%
NOVIS Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS Compagnia Di Assicurazioni, NOVIS Poisťovňa a. s.	-24.49	6.28%	9.74%	101.44%
Union poisťovňa, a. s.	7.69%	-1.20%	8.62%	7.18%
Wüstenrot poisťovňa, a. s.	-2.13%	-4.54%	-2.02%	-2.42%
BNP Paribas Cardif Poisťovňa, a. s.	0.45%	2.44%	12.58%	22.75%

According to the annual report of Allianz - Slovenská poist'ovňa, a. s. prepared for the 2020 accounting period, the downturn in the production of new business in the first half of 2020 had an impact on the written premiums, where both life and non-life insurance segments experienced growth (life insurance - growth of 1.5%; non-life insurance - growth of 2.5%), but with a lower growth dynamic compared to the expectations before the pandemic (a decrease of 2.2%). The insurer was only able to maintain profitability by maintaining the size of its portfolio, higher cost efficiency, and a lower frequency of claims during the lockdown (Annual Report, Allianz Slovenská poisťovňa, a. s.).

KOOPERATIVA poisťovňa, a. s. Vienna Insurance Group states in the annual report for the 2020 accounting period that unexpected changes caused a decline in insured events, especially in the area of motor and travel insurance. On the contrary, the company recorded a moderate increase of insured events that occurred in connection with COVID-19 in the number and the sum of disbursed insurance benefits in life insurance. In the life insurance segment, the company recorded a year-on-year decline of 7.01%. The company generated a year-on-year increase of 0.62% in the non-life insurance segment.

KOOPERATIVA poisťovňa, a. s. Vienna Insurance Group states in its annual report for the 2021 accounting period that the risk life insurance is the area in which they saw the highest increase in interest during the year and the company experienced the most dynamic growth in the last five years. The company as the leader in the life insurance market, recorded the highest number of insurance claims related to COVID-19 on the Slovak market. The written premiums in the life insurance segment recorded a year-on-year decrease of 0.3%. The written premiums in the non-life insurance segment recorded a year-on-year increase of 4.76%.

As reported by **Komunálna poisťovňa, a. s.** Vienna Insurance Group in its annual report for the 2020 accounting period, the second wave of the pandemic in the third quarter of 2020 was marked by a decrease in new business, which was mainly reflected in the development of life insurance. Life insurance accounted for 38.6% of total premiums, and non-life insurance 61.4%. In the 2021 accounting period, the non-life insurance market was still affected by the coronavirus pandemic, but there was a slight recovery in the market. The reduction in mobility resulted in a lower number of reported claims, which had a positive impact on the profitability of non-life insurance. According to the Annual report of Komunálna poisťovňa, a. s., there has been an increased demand for covering new types of risks, such as 'COVID' cover under travel insurance. There has also been an increase in demand for life insurance, linked to the improved availability of remote underwriting products as well as concerns about the new coronavirus pandemic. Komunálna poist'ovňa, a. s. Vienna Insurance Group was particularly successful in the risk life insurance segment, the car accident insurance segment, and the home and household insurance segment.

Similar results were also recorded by **Wüstenrot poist'ovňa, a. s.**, where the pandemic was reflected in the consumer behaviour of the insurance company's clients and affected several types of insurance. The development of travel insurance followed the travel restrictions (annual report, Wüstenrot poist'ovňa, a. s.**)**. In the risk life insurance segment, the interest of clients

increased by almost 30.0%. The pandemic also had an impact on the structure of claims, with the largest number of claims in 2020 in the employment sector.

ČSOB Poisťovňa, a. s. states in its annual report for the 2020 accounting period that its written premiums in life insurance for 2020 recorded a slight decrease compared to 2019. In non-life insurance, the company recorded an increase of 15.0% in written premiums. The specific situation experienced in 2020 brought a significant decrease in business production compared to the previous year. In addition to restrictions related to personal (face-to-face) sales, it was mainly a decrease in demand for one-time insurance products. In 2021, the regular life insurance premium recorded a slight increase in comparison with 2020. The growth in life insurance was based mainly on risk insurance, where the company grew above 60.0% in the number of policies. In non-life insurance, the premium achieved a growth of 17.0%. In mandatory motor vehicle third-party liability insurance, the company saw year-on-year growth of gross written premiums by 28.0% in 2021. In 2021, travel insurance was affected by the pandemic situation which had a direct impact on traveling to foreign destinations. Despite the situation, the company saw a slight increase in the written premiums of travel insurance by 9.0% in comparison with 2020 (annual reports, ČSOB Poisťovňa, a. s.).

NN Životná poist'ovňa, a. s. has already mentioned the outbreak of the COVID-19 pandemic in the annual report for the 2019 accounting period in connection with events after the balance sheet date. Following the potential impact of the pandemic on the company, the company's management assessed that the most significant risks faced by the insurance company in this context were related to financial markets (changes in interest rates, stock prices, and spreads), insurance risks (mortality, loss ratio, client behaviour) and operational risk (business process continuity). Consequently, in the 2020 accounting period, the company reports in its annual report an increase in interest in insurance protection related to the financial stability of households, as well as an increase in demand for life insurance products. According to the 2020 annual report, due to the transfer of the traditional personal sales model to the online environment, NN Životná poist'ovňa, a. s. recorded even the best business results in its history in the 2020 accounting period. Written premiums achieved a year-on-year increase of 7.0% in the 2020 accounting period. In the 2021 accounting period, digitalization has optimized and simplified the settlement of insurance claims as well as the changes in insurance contracts. The sale of services has also moved to the online space. The signing of the insurance contract was carried out remotely without the need for a personal visit to the client center.

Novis Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS Compagnia Di Assicurazioni, NOVIS Poisťovňa a.s. discloses in its annual report for the 2019 accounting period, under events after the balance sheet date, information on the expectations and consequences of the COVID-19 pandemic for the next accounting period, with the company expecting a lower number of new insurance contracts, but not less than in the 2019 accounting period. In terms of premium income, the insurer expected a similar or slightly higher level than in the 2019 accounting period. In the 2020 annual report, the insurer reports that, despite the COVID-19 pandemic, gross premium income in this accounting period reached a level comparable to the 2019 accounting period, thus confirming the predictions made in the previous accounting period.

Union poisťovňa, a. s. states in its 2021 annual report that, like the 2020 accounting period, the 2021 accounting period was significantly affected by the pandemic situation, mainly because the insurer has long had a very strong position in travel insurance, which has been one of the most negatively affected areas of insurance. The written premiums in this type of insurance have fallen, even though Union poisťovňa, a. s. was the first to bring to the market a supplementary insurance aimed at covering the risks associated with COVID. In contrast, motor insurance recorded double-digit year-on-year growth, with the highest overall year-on-year growth in retail property insurance.

BNP Paribas Cardif Poisťovňa, a. s. also states in its 2019 annual report information related to a limited number of cases of unknown diseases in China. As the situation was unstable, the insurance company was not able to fully assess the consequences of coronavirus on the future financial position, operations, and results of the company. The expected decline in both the global and domestic economies could have a negative and significant impact on the company's financial results.

In the annual report for 2020, the company BNP Paribas Cardif Poisťovňa, a. s. states that the impact of a pandemic primarily affected the level of new production, the level of claims incurred as well as the area of valuation of the company's assets. Thanks to payment protection insurance, the company established various innovations to provide its clients with the highest protection possible in case of their inability to pay the loans. In 2019, the company launched on the market a unique coverage in the insurance of the ability to repay the loan – family member care. Despite the adverse situation, the company managed to achieve favourable financial results in 2020.

The **claims frequency ratio** belongs to qualitative indicators for assessing the level of the insurance market (Borovcová, 2013). The indicator expresses the relation between the volume of claims provided and the sum of written premiums for the analysed period. An overview of the development of claims costs after reinsurance in the individual insurance companies analysed is shown in Figure 3 and the development of the claims' frequency ratio is shown in Table 3.

Figure 3: Development of claims costs (after reinsurance) in thousands of euros

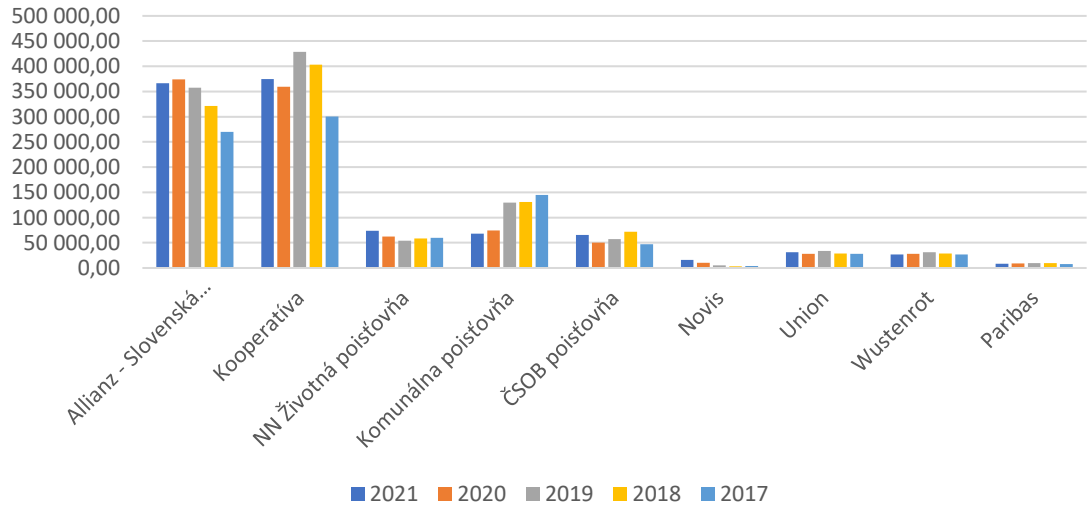


Table 3: Development of claims frequency ratio

Insurance company	2021 in %	2020 in %	2019 in %	2018 in %	2017 in %
Allianz – Slovenská poisťovňa, a. s.	57.38	62.67	56.01	53.76	48.85
KOOPERATIVA poisťovňa, a. s. Vienna Insurance Group	68.08	68.45	76.54	72.75	76.70
NN Životná poisťovňa, a. s.	54.67	48.22	71.11	76.32	79.60
Komunálna poisťovňa, a. s. Vienna Insurance Group	75.37	73.12	87.88	78.92	85.57
ČSOB Poisťovňa, a. s.	66.43	64.92	64.96	76.22	55.41
NOVIS Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS Compagnia Di Assicurazioni, NOVIS Poisťovňa a. s.	22.05	10.66	5.38	3.87	9.77

Insurance company	2021 in %	2020 in %	2019 in %	2018 in %	2017 in %
Union poisťovňa, a. s.	56.31	54.70	56.81	53.08	54.75
Wüstenrot poisťovňa, a. s.	52.47	54.94	58.94	52.39	47.89
BNP Paribas Cardif Poisťovňa, a. s.	24.94	27.26	28.12	31.81	32.59

The aim should be the downward trend in the indicator. A claims' frequency ratio of 100% or more indicates economically unstable insurance. As we can see from Table 3, neither of the insurance companies, except BNP Paribas Cardif Poisťovňa, a.s., has a downward trend in the claims' frequency ratio. The trend is rather fluctuating. Komunálna poisťovňa, a. s. Vienna Insurance Group shows the highest values of this indicator around 80.17%. On the contrary, NOVIS Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS Compagnia Di Assicurazioni, NOVIS Poisťovňa a. s. shows the lowest values of this indicator around 10.35%.

4. Trend in profit or loss for the accounting periods 2017 – 2021

The profit of the individual insurance companies was affected by several factors in the accounting periods analysed. In 2018, new rules came into force, according to which insurance companies in Slovakia started to pay the state an 8% tax on non-life insurance. In the pandemic years 2020 and 2021, several factors had an impact on the profit:

- a lower frequency of claims related to motor and travel insurance, mainly due to lower mobility of the population during lock-down periods;
- digitalization, the implementation of which was accelerated by the pandemic, which had a positive effect on the level of costs, mainly due to the optimization and simplification of internal processes;
- an increase in life insurance claims related to COVID-19, not only in the number but also in the sum of claims paid out;
- the increase of expenses related to the fight against the pandemic and the protection of the staff and clients, such as facial masks, plexiglass protection at all branches, regular disinfection of the work environment, active participation in mass testing for employees to reduce the risk of virus spread. The insurers' excellent business results have also been achieved through strategic partnerships and collaboration with key brokerage partners.

As several insurers state in their annual reports, ensuring the same level of services and economic results has been achieved through the digitalization of most activities, which has contributed to the optimization and simplification of claims settlement, as well as to the possible implementation of changes to contracts. In the online space, the sale of services, and the conclusion of insurance contracts without the need for a personal visit to the client center were also carried out.

Table 4: Development of net profit or loss (earnings after taxes)

Insurance company/ Profit or loss in thousands of euros	2021	2020	2019	2018	2017
Allianz – Slovenská poisťovňa, a. s.	91 726	92 472	85 684	76 255	71 672
KOOPERATIVA poisťovňa, a. s. Vienna Insurance Group	38 801	38 546	36 486	36 114	29 779
NN Životná poisťovňa, a. s.	13 604	4 565	5 420	6 442	5 086
Komunálna poisťovňa, a. s. Vienna Insurance Group	2 646	2 251	1 106	-1 946	5 790
ČSOB Poisťovňa, a. s.	8 093	10 955	10 026	9 130	10 128
NOVIS Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS	-1 163	3 703	6 384	6 395	2 832

Insurance company/ Profit or loss in thousands of euros	2021	2020	2019	2018	2017
Compagnia Di Assicurazioni, NOVIS Poisťovňa a. s.					
Union poisťovňa, a. s.	1 389	325	-1 306	-142	-1 016
Wüstenrot poisťovňa, a. s.	1 948	1 831	2 724	1 521	4 189
BNP Paribas Cardif Poisťovňa, a. s.	416	862	1 367	1 479	2 239

As we can see in Table 4, in the 2020 accounting period, four insurance companies (NN Životná poisťovňa, a. s., NOVIS Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS Compagnia Di Assicurazioni, NOVIS Poisťovňa, a. s.; Wüstentrot poisťovňa, a. s., and BNP Paribas Cardif Poisťovňa, a. s.) recorded a decline in profit in comparison with the previous accounting period, whilst four insurance companies recorded an increase in profit in comparison with the 2019 accounting period. Union poisťovňa, a. s. recorded profit in the 2020 accounting period, whilst in the 2019 accounting period it recorded a loss. In 2021 the profit of Union poisťovňa, a. s. was still growing and was 327.38% higher than in 2020. On the contrary, NN Životná poisťovňa, a. s. after two years of decline in profit (in 2019 and 2020), recorded an increase in the profit by 198.01% in 2021.

Out of the nine analysed insurance companies, several companies recorded a loss in some of the accounting periods analysed. After a very successful 2017 accounting period, Komunálna poisťovňa, a. s. recorded a loss in 2018, when the economic result was more than 133.61% lower than in the previous accounting period. NOVIS Insurance Company, NOVIS Versicherungsgesellschaft, NOVIS Compagnia Di Assicurazioni, NOVIS POisťovňa a. s. recorded the decrease in profit in all accounting periods analysed except for the 2018 accounting period. In the 2021 accounting period, the company even reported a loss. Union Poisťovňa, a. s. reported a loss in the 2017, 2018, and 2019 accounting periods. Since the 2020 accounting period, the company recorded a profit.

5. Conclusion

Based on the results of the analysis of the financial statements and annual reports of nine insurance companies operating in the Slovak insurance market for the financial years 2017 - 2021, we can conclude that the COVID-19 pandemic has significantly affected the insurance sector.

During the pandemic, all insurance companies were forced to transfer their work to an online environment, which meant that the signing of insurance contracts, the settlement of insurance claims, consulting, and advisory services with clients were carried out exclusively in online mode. The COVID-19 pandemic has accelerated the digitization of business processes. The digitization and automation of business processes, which in some insurance companies were only in the preparatory stages of the solution, were immediately put into practice due to the limitation of personal contacts. The digitalization of business processes has optimized and streamlined the operations of individual insurance companies and has been one of the reasons for maintaining a competitive ability and position in the insurance market. In 2021, the insurance companies continued the projects they started to modernize and digitize the insurance company and increased the efficiency of their work in applying new modern solutions. Insurance companies worked on the digitalization of business processes in support of product sales through the implementation of online product calculators with the creation of digital documentation and automatic import into the insurance-technical system. The "distance" sales model continued to be supported.

During the pandemic, the demand for different types of insurance also changed. Due to travel restrictions, demand for travel insurance fell. Conversely, demand for term life insurance

increased, as did demand for travel agency insolvency insurance, which was created in response to the pandemic measures. In 2020, the number of insurance claims, especially those related to car accident insurance, decreased as a result of the curfew and curfew restrictions. Insurance companies providing life insurance recorded the highest number of insurance claims related to the COVID-19 pandemic in the Slovak market during 2020 and 2021.

The pandemic has fully revealed how truly meaningful insurance can be, not only in the most difficult and sad situations in families but also as a source of sufficient financial reserves in the event of longer incapacity for work or hospital stays. The pandemic confirmed the importance of insurance protection and contributed to an increased interest of people in life insurance products.

After the end of the 2021 accounting period, in February 2022, the war conflict in Ukraine arose, which is mentioned by all insurers in their 2021 annual reports. However, given the information available at the time, most insurers were unable to estimate the impact of this conflict on their financial position and the insurance market. Investigating the impact of this conflict on the performance of insurance companies may be a subject for further research.

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Application of multi-criteria decision-making methods in the evaluation of the development of the selected sector in the V4 countries

Martina Borovcová, Dagmar Richtarová [1]

Abstract

The aim of the article is to analyze, compare and evaluate the development in a selected sector of the economy in the V4 countries for the period 2016-2020 using multicriteria decision-making. The chosen sector is the manufacturing industry. The indicators used to compare the manufacturing industry in the V4 countries are obtained from the Eurostat database. These are value added, gross operating surplus to turnover, wage-adjusted labor productivity, average personnel costs and apparent labor productivity. Subsequently, the manufacturing industry in the V4 countries is evaluated based on selected, above-mentioned indicators using a multicriteria analysis. Saaty's Analytic Hierarchy Process method is applied in the article. The results show the final assessment of the manufacturing industry in the V4 countries in individual years and for the analyzed period.

Key words

MCDM, AHP, criteria, alternative, indicators, the manufacturing industry, V4 countries

JEL Classification: C02, C4, G3, G11

1. Introduction

Evaluation of the development and level of business entities, sectors and the economy is one of the basic principles of their proper functioning. Each entity uses different methods to assess the level, which differs in the choice of indicators used.

Historically, accounting ratios based on accounting information have been used to analyze performance. Financial indicators are commonly used in performance evaluation but are unsuitable as a comprehensive measurement tool. Based on these indicators, it is impossible to provide the company's management and shareholders with an accurate picture of its management (Abdoli et al., 2011). Not only accounting but also economic and market indicators can be used to evaluate financial performance; see (Dluhošová, 2021) and (Vernimmen, 2005). Some studies dealt with how the financial performance of non-financial and financial institutions should be adequately evaluated, using, for example, the accounting indicator of return on equity see (Strnadová and Karas, 2014) or an economic indicator, e.g. economic added value - EVA. Economic value added as a performance measure has been described in several publications, e.g. (Rappaport, 1986), (Chen and Dodd, 1997) and (Grant, 2003).

Financial performance analysis methods are usually applied to companies, but these companies are analyzed separately, regardless of the industry in which they operate. Most

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authors have addressed the issue of corporate performance valuation, but few publications have addressed industry performance valuation. For example, (Dluhošová, 2004) applies a pyramid decomposition to the economic added value of selected industries in the Czech Republic, and the value generators were determined using the analysis of deviations. (Richtarová, Ptáčková and Borovcová, 2020) apply pyramid decomposition and analysis of deviations for the quantification of factors affecting economic added value in the evaluation of the performance of the manufacturing industry in the Czech Republic.

The manufacturing industry is the primary sector of the economy. Many authors evaluate the level of this industry; see (Ududechinyere and Mbam, 2018) highlight that the manufacturing industry has traditionally been one of the key drivers in most national economies; (Belgin and Balkan, 2020) focus on evaluating the environmental performance of manufacturing sectors in their study, and (Kotane and Mietule, 2022) evaluate the performance of manufacturing companies in Latvia.

Some authors focus on comparing the development of a selected sector within different economies. The authors (Simionescu et al., 2017) examine the determinants of economic growth in Romania and the V4 countries; (Galgánková, 2020) focuses on the evaluation and comparison of the international competitiveness of the Visegrad countries.

Multi-criteria decision-making methods can also be used to assess the level of individual economies, which use general economic indicators to evaluate the level of respective countries. These indicators can be drawn from, for example, the OECD database or the Eurostat database.

The article is focused on using multi-criteria decision-making methods in evaluating the development and level of the manufacturing industry of the Visegrad Four countries – the Czech Republic, Slovakia, Hungary and Poland, using selected indicators obtained from the Eurostat database. The indicators used for this comparison are value added, gross operating surplus to turnover, wage-adjusted labor productivity, average personnel costs and apparent labor productivity.

According to the Eurostat database, the indicator of value added is defined as the difference between the value of what is produced and the intermediate consumption entering the production, less subsidies on production and costs, taxes and levies. Another indicator used for evaluation is the profitability indicator, which is determined as the share of gross operating surplus on turnover. Gross operating surplus is generated by operating activity after compensating for the input of the labor factor. It can be calculated from the value added in the costs of production factors minus personnel costs. Turnover is the sum of all sales (excluding VAT) for goods and services made by an enterprise in a given sector for the monitored period. The labor productivity indicator adjusted for wages indicates labor productivity derived from structural business statistics. It is defined as added value divided by personnel costs, which is subsequently adjusted by the share of paid employees in the total number of persons employed. The average personnel cost indicator is the total remuneration, in money or kind, paid by the employer to the employee for the work performed, divided by the number of employees. Employees also include part-time workers, seasonal workers, etc., but do not include those on long-term leave. The last indicator is apparent labor productivity. According to the Eurostat database, this indicator is defined as added value in production costs divided by the number of employed persons.

The aim of the article is to analyze, evaluate and compare the development of the manufacturing industry in the V4 countries using multicriteria decision-making methods.

2. Methodology

In order to fulfil the set goal and perform analysis, evaluation, and subsequent comparison of the manufacturing industry of the V4 countries, it is possible to use multicriteria evaluation methods. First of all, it is necessary to determine the weights of the criteria, i.e., the indicators for assessing the level of the manufacturing industry. Subsequently, the variants, i.e., the manufacturing industry of individual countries in individual years, will be compared with each other so that it is possible to evaluate them.

Saaty method AHP will be used in the application part of the study. Therefore, the following description will be focused on this method.

The Analytic Hierarchy Process (AHP) method was developed by Thomas L. Saaty. The method is based on a pairwise comparison of criteria or alternatives for solving a multi-criteria decision-making problem while respecting the structure of the decision-making situation.

Multicriteria decision making (MCDM) is a field that chooses the best of a discrete set of alternatives, (Saaty, 2009). Unlike the usual methods of optimization that assume the availability of measurements, measurements in MCDM are assumed to be derived or interpreted subjectively as indicators of preference and of the strength of preference. One person´s preference is different than another person´s and thus the outcome depends on who is making the decisions and his/her preferences and goals.

Analytic hierarchy process (AHP) is an MCDM method based on priority theory. It deals with complex problems which involve the consideration of multiple criteria/alternatives simultaneously, (Raju and Kumar, 2014). The AHP and its generalization to dependence and feedback, the Analytic Network Process (ANP), are methods of relative measurement of intangibles. They can help bring together a diverse group of people with different perspectives to make the complex decisions required in our time. They offer a structured framework for discussion and debate, a way to include the important intangibles of every major decision together with the tangibles, and a way to resolve conflicts and achieve buy-in to implement the decision at the end of the day.

As with any other MCDM method, the decision maker must first be identified, the decision objective established, and the decision problem structured. Subsequently, it is necessary to establish alternatives and determine criteria. Then, based on pairwise comparisons provided by the user, priorities are ranked. The decision maker does not need to provide a numerical judgment, a relative verbal valuation that is more familiar to our everyday life is sufficient. There are two additional steps that can be taken: a consistency check and a sensitivity analysis. Both steps are optional but recommended to confirm the robustness of the results. Consistency checking is common to all pairwise comparison methods like AHP.

The method of weight determination of the criteria can be divided into two steps. The first step consists of a pairwise comparison when finding the preferential relations of criteria pairs. It is presented as the matrix A. This matrix is symmetric with elements $a_{i,j}$. It is possible to determine also the size of this preference expressed by a certain number of points from the selected point scale in addition to the direction of the preference of pair of criteria. The scale of relative importance recommended by Saaty it is shown in Table 1. The strength of preferences is expressed in the interval $a_{i,j} \in$ [0;9]. This step is resulting in obtaining the right upper triangular part of the matrix A.

$$A = \begin{bmatrix} 1 & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ 1/a_{1n} & \cdots & 1 \end{bmatrix}.$$

The diagonal element has to be $a_{i,i} = 1$, and for the inverse elements (in the lower left triangular part of a matrix) true the following:

$$a_{i,j} = \frac{1}{a_{j,i}}. \quad (1)$$

The elements $a_{i,j}$ matrix are estimated shares of weights of criteria v_i and v_j, so:

$$a_{i,j} \cong \frac{v_i}{v_j}. \quad (2)$$

The scales can be obtained in the following manner:

$$min\, F = \sum_i^n \sum_j^n \left(a_{i,j} - \frac{v_i}{v_j}\right)^2, \quad (3)$$

with the condition $\sum_i^n v_i = 1$.

Because of difficulty, it is possible to obtain the weights using an algorithm based on the geometric average.

$$min\, F = \sum_{i=1}^n \sum_{j>i}^n \left[ln\, a_{i,j} - (ln\, v_i - ln\, v_j)\right]^2, \quad (4)$$

with the condition $\sum_i^n v_i = 1$.

The final solution is based on the geometric mean of rows (Saaty, 2010):

$$w_i = \frac{v_i}{\sum_i^N v_i} = \frac{\left[\prod_j^N a_{i,j}\right]^{\frac{1}{N}}}{\sum_i^N \left[\prod_j^N a_{i,j}\right]^{\frac{1}{N}}}, \quad (5)$$

The numerical judgments use the fundamental scale of absolute numbers (invariant under the identity transformation). From logarithmic stimulus-response theory that we do not go into here, we learn that a stimulus compared with itself is always assigned the value 1 so the main diagonal entries of the pairwise comparison matrix are all 1. We also learn that we must use integer values for the comparisons. The numbers 3, 5, 7, and 9 correspond to the verbal judgments "moderately more dominant", "strongly more dominant", "very strongly more dominant", and "extremely more dominant" (with 2, 4, 6, and 8 for compromise between the previous values). Reciprocal values are automatically entered in the transpose position.

Table 1: Fundamental scale of absolute numbers

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Source: Saaty (2010), (2012), *own processing*

The sign of relevant evaluation is the consistency of Saaty's matrix, in other words when the elements satisfy the condition of transitivity the most. It should be emphasized that in many methods this aspect is not accounted. Consistency can be measured using the coefficient of

consistency C.R. (Consistency Ratio). To calculate C.R. is used C.I. (Consistency Index) and R.I. (Random Index). R.I. values are listed in Table 2. The coefficient for consistent evaluation should be $C.R. \leq 0{,}1$ (Saaty, 2010). The consistency ratio is calculated as follows

$$C.R. = \frac{C.I.}{R.I.}, \tag{6}$$

where,

$$C.I. = \frac{\lambda_{max} - n}{n-1}, \tag{7}$$

where λ_{max} is the maximal eigenvalue (Saaty, 2012).

Table 2: Random Index

Order	1	2	3	4	5	6	7	8	9	10	11	12	13
R.I.	0	0	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49	1.52	1.54	1.56
First Order Differences		0	0.52	0.37	0.22	0.14	0.10	0.05	0.05	0.04	0.03	0.02	0.02

Source: Saaty (2009)

The last necessary step is the synthesis of the local priorities across all criteria in order to determine the global priority. The historical AHP approach adopts an additive aggregation with normalization of the sum of the local priorities to unity. This type of normalization is called the distributive mode as stated by (Ishizaka and Nemery, 2013). This additive aggregation is expressed as

$$P_j = \sum_j w_j \cdot p_{ij}, \tag{8}$$

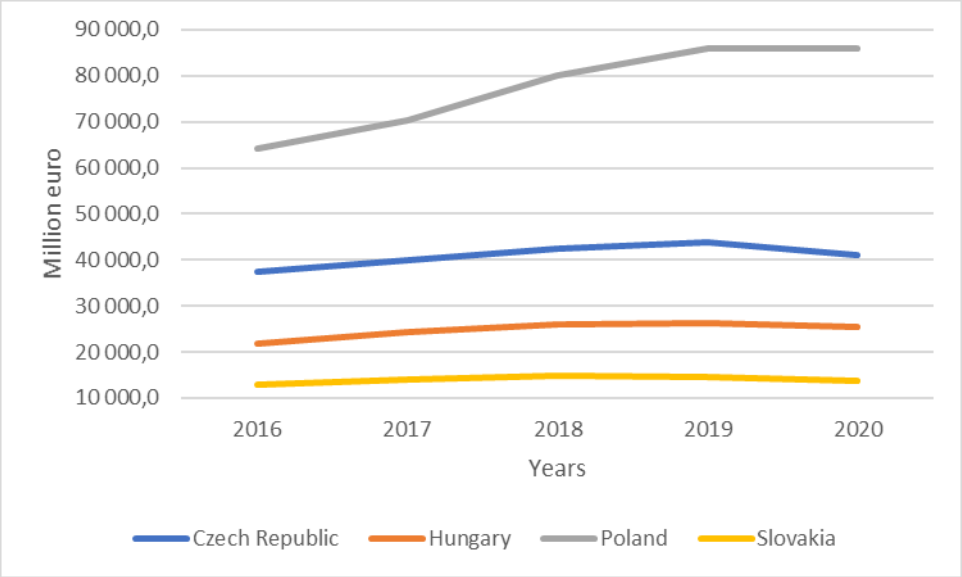
where P_j is the global priority of alternative *i,* p_{ij} is the local priority with regard to criterion *j,* and w_j is the weight of the criterion *j.*

3. Data

Data from the Eurostat database, available on their website, are used to assess the level and development of the manufacturing industry of the V4 countries. The development of the manufacturing industry will be analyzed for 2016-2020 years using selected indicators.

The following figures (1-5) show the development of selected indicators of the manufacturing industry in the V4 countries over the analyzed period. Figure 1 shows the development of added value in the V4 countries.

Figure 1: Value added at factor cost

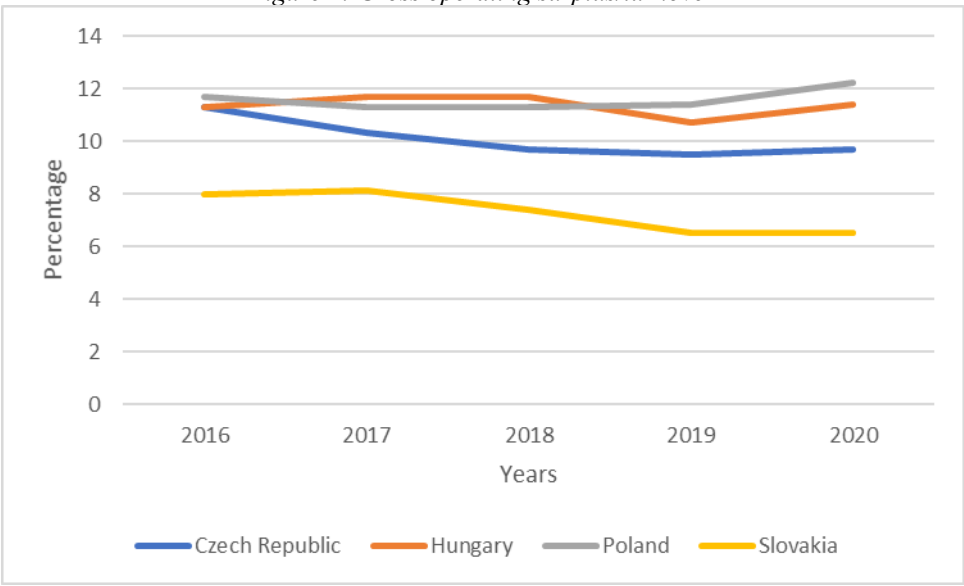


Source: Eurostat database, own processing

All evaluated countries were able to increase value added during the analyzed period. Poland generated the highest value added. Its average annual value was 77.267 million euro. The other V4 countries achieved much lower values. The lowest annual average value added was generated by Slovakia at 14.000 million euro, followed by Hungary at 24.752 million euro, and the Czech Republic reported an annual average added value of 41.000 million euro.

Another indicator that was used to compare the development of the manufacturing industry in the V4 countries was the share of gross operating surplus to turnover. Its development in individual countries is shown in Figure 2.

Figure 2: Gross operating surplus/turnover

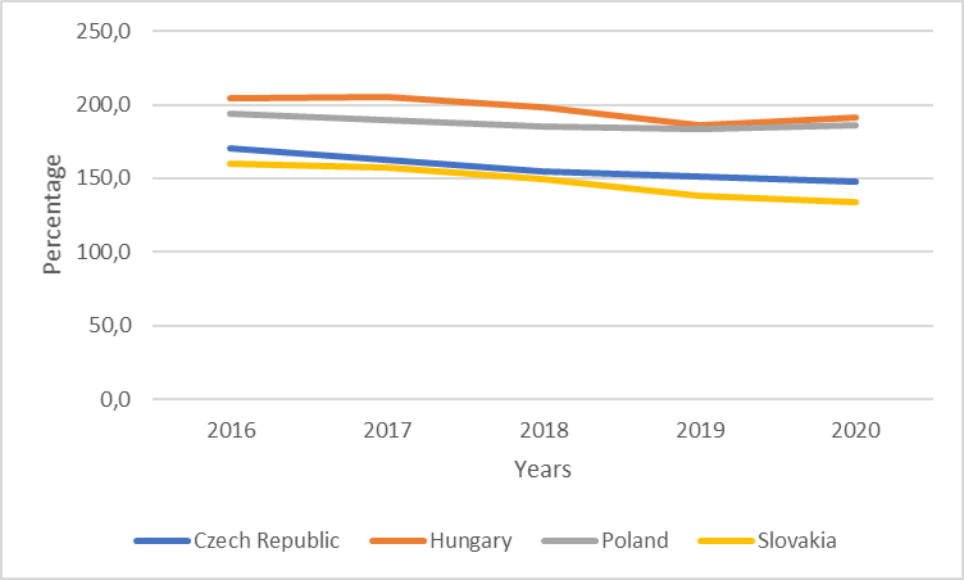


Source: Eurostat database, own processing

From the point of view of the trend, it is desirable that the value of this profitability indicator increases over time. This trend was fulfilled only in Poland and Hungary. On the contrary, the

indicator's value decreased in the Czech Republic and Slovakia. This decrease was caused by falling added value, which significantly affects the size of the gross operating surplus.

Figure 3: Wage adjusted labor productivity

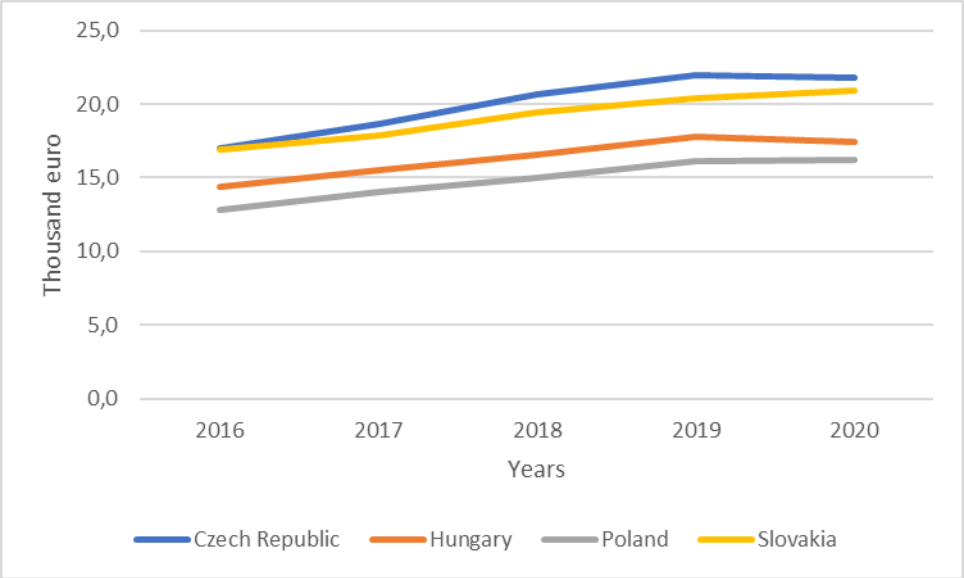


Source: Eurostat database, own processing

Figure 3 shows the development of the labor productivity indicator in the V4 countries during the analyzed period. The wage adjusted indicator of labor productivity is defined as added value divided by personnel costs, which is subsequently adjusted for the share of paid employees in the total number of employed persons. In Poland and Hungary, the development was similar, where from 2016 to 2020 the indicator's value gradually decreased and in 2020 the indicator's value increased. In the Czech Republic and Slovakia, the indicator's value decreased throughout the analyzed period, caused by falling added value and a decreasing number of employees in the manufacturing industry.

The development of average personal costs in the V4 countries is shown in Figure 4. Only in Slovakia did the average personal costs increase over the entire analyzed period.

Figure 4: Average personnel costs

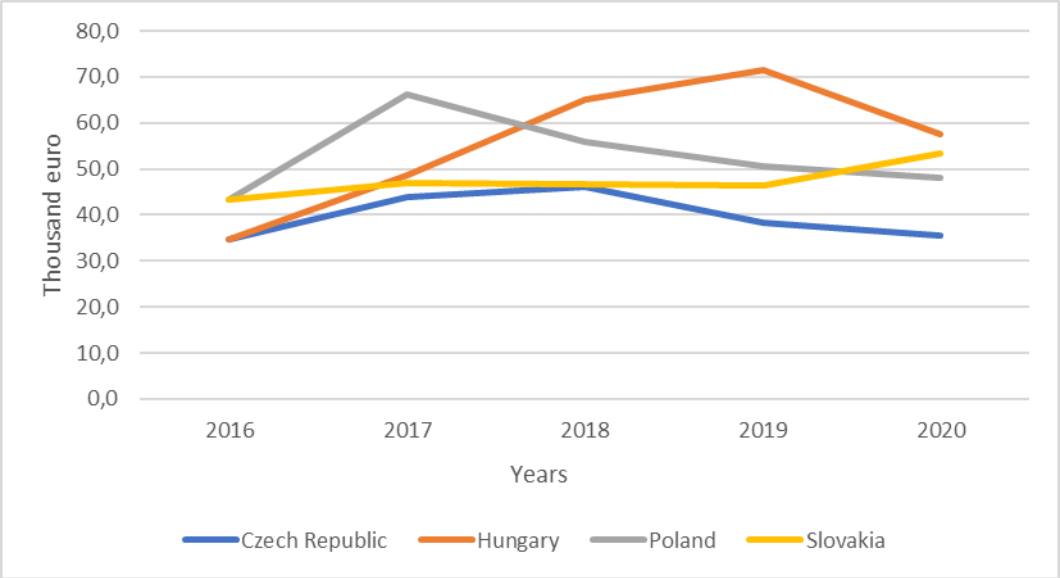


Source: Eurostat database, own processing

In the other countries, the Czech Republic, Hungary and Poland, there was an increase in these costs until 2019, but in 2020 the average personal costs in these countries decreased.

The last indicator used to compare the development of the manufacturing industry in the V4 countries is the apparent labor productivity indicator, see Figure 5.

Figure 5: Apparent labor productivity



Source: Eurostat database, own processing

This indicator is defined as value added at factor costs divided by the number of persons employed. This ratio is generally presented in thousands of euros per person employed. The development of this indicator is significantly different in individual V4 countries.

The Czech Republic reported the lowest value of the indicator for the entire analyzed period. Conversely, in Hungary, this indicator reached its highest value in 2019. The indicator's value gradually increased in Hungary from 2016 to 2019, but in 2020 there was a significant decrease, namely by 13.8 thousand euros. In Poland, the value of the indicator has been decreasing since 2017. Conversely, in Slovakia, the value of the indicator increased in 2020.

4. Results

The manufacturing industry of the V4 countries is evaluated using selected indicators. The following are used for evaluation and comparison: the value added at factor cost indicator, the gross operating surplus to turnover indicator, the wage adjusted labor productivity indicator, the average personnel costs indicator and the apparent labor productivity indicator. The analyzed period is the years 2016–2020.

Since decision-making is carried out by a small group of decision-makers, it has a subjective character. The criteria used are quantitative in nature and will not be normalized.

Using the formula (5), the weights of the indicators are first determined. Indicators, criteria, are marked as C1-C5. Specifically, C1 is an indicator of added value, C2 is gross operating surplus to turnover, C3 is wage adjusted labor productivity, C4 is average personnel costs and C5 is apparent labor productivity.

The matrix consistency is verified using the formulas (6) and (7). The calculation of criteria weights and the verification of matrix consistency are shown in Table 3.

Table 3: Determination of criteria weights

	C2	C5	C3	C4	C1	geomean.	w_i	w_i . A_i	$(w_i$. $A_i)/w_i$
C2	1	3	4	7	9	3,7645	0,5041	2,6110	5,1794
C5	1/3	1	2	5	7	1,8776	0,2514	1,2832	5,1035
C3	1/4	1/2	1	3	4	1,0845	0,1452	0,7332	5,0488
C4	1/7	1/5	1/3	1	2	0,4529	0,0606	0,3085	5,0872
C1	1/9	1/7	1/4	1/2	1	0,2881	0,0386	0,1971	5,1101
						7,4675	1		5,1058
						n = 5		C.I. =	0,0265
						R.I. = 1,11		C.R. =	0,0238

Source: own processing

After calculating the criteria weights, the level of the manufacturing industry of the V4 countries and their development are analyzed and evaluated. First, a matrix of alternatives is constructed for each criterion. These are the values of indicators of individual V4 countries in individual years. For example, the alternative value of the relevant indicator in the Czech Republic in the analyzed year 2016 is marked as CZ16, for the year 2017 then CZ17, and then CZ18, CZ19, and CZ20. The designations of alternatives are also created for Hungary (H16, H17, H18, H19, H20), Poland (P16, P17, P18, P19, P20) and the Slovak Republic (S16, S17, S18, S19, S20).

Most of the criteria have a maximizing character. One of the criteria, specifically C4, is minimization. Since it is also a quantitative criterion, it will not be converted to maximization, but the lowest value of the criterion will be considered the best. The determined values, local priorities, are shown in Table 4.

Subsequently, the utility values are calculated, global priorities of alternatives, are used to compare individual national manufacturing industry and their development. Formula (8) is used for this. The resulting values of the calculations are shown in Table 5.

Table 4: Evaluation of the manufacturing industry of V4 countries (local priorities)

	C1	**C2**	**C3**	**C4**	**C5**
CZ16	0,0345	0,0760	0,0292	0,0345	0,0345
CZ17	0,0345	0,0327	0,0209	0,0222	0,0222
CZ18	0,0345	0,0229	0,0146	0,0119	0,0119
CZ19	0,0345	0,0229	0,0146	0,0086	0,0086
CZ20	0,0345	0,0229	0,0103	0,0086	0,0086
H16	0,0190	0,0760	0,1204	0,1162	0,1162
H17	0,0190	0,0760	0,1204	0,0816	0,0816
H18	0,0190	0,0760	0,1204	0,0544	0,0544
H19	0,0190	0,0475	0,0609	0,0345	0,0345
H20	0,0190	0,0760	0,0852	0,0345	0,0345
P16	0,0920	0,0760	0,0852	0,1594	0,1594
P17	0,1191	0,0760	0,0852	0,1191	0,1191
P18	0,1556	0,0760	0,0574	0,0840	0,0840
P19	0,1556	0,0760	0,0573	0,0564	0,0564
P20	0,1556	0,1190	0,0573	0,0564	0,0564
S16	0,0109	0,0123	0,0209	0,0362	0,0362
S17	0,0109	0,0123	0,0146	0,0362	0,0362

S18	0,0109	0,0093	0,0103	0,0192	0,0192
S19	0,0109	0,0071	0,0076	0,0131	0,0131
S20	0,0109	0,0071	0,0076	0,0131	0,0131

Source: own processing

Table 5: Evaluation of the manufacturing industry of V4 countries (global priorities)

	C1	**C2**	**C3**	**C4**	**C5**	P_j	P_j (global priorities of country)
w_i	0,0386	0,5041	0,1452	0,0606	0,2514		
CZ16	0,0013	0,0383	0,0042	0,0021	0,0087	0,0546	
CZ17	0,0013	0,0165	0,0030	0,0013	0,0056	0,0278	
CZ18	0,0013	0,0115	0,0021	0,0007	0,0030	0,0187	
CZ19	0,0013	0,0115	0,0021	0,0005	0,0022	0,0177	
CZ20	0,0013	0,0115	0,0015	0,0005	0,0022	0,0170	0,1358
H16	0,0007	0,0383	0,0175	0,0070	0,0292	0,0928	
H17	0,0007	0,0383	0,0175	0,0045	0,0205	0,0820	
H18	0,0007	0,0383	0,0175	0,0033	0,0137	0,0735	
H19	0,0007	0,0240	0,0088	0,0021	0,0087	0,0443	
H20	0,0007	0,0383	0,0124	0,0021	0,0087	0,0622	0,3548
P16	0,0036	0,0383	0,0124	0,0097	0,0401	0,1040	
P17	0,0046	0,0383	0,0124	0,0072	0,0299	0,0924	
P18	0,0060	0,0383	0,0083	0,0051	0,0211	0,0789	
P19	0,0060	0,0383	0,0083	0,0034	0,0142	0,0703	
P20	0,0060	0,0600	0,0083	0,0034	0,0142	0,0919	0,4375
S16	0,0004	0,0062	0,0030	0,0022	0,0091	0,0210	
S17	0,0004	0,0062	0,0021	0,0022	0,0091	0,0200	
S18	0,0004	0,0047	0,0015	0,0012	0,0048	0,0126	
S19	0,0004	0,0036	0,0011	0,0008	0,0033	0,0092	
S20	0,0004	0,0036	0,0011	0,0008	0,0033	0,0092	0,0719

Source: own processing

From the values calculated above, the development of the manufacturing industry in Poland can be evaluated as the best. Lower values are achieved by the manufacturing industry of Hungary and the Czech Republic. The lowest values are archived by the manufacturing industry of the Slovak Republic.

5. Conclusions

The aim of the article was to analyze, compare and evaluate the situation and development in the processing industry of the V4 countries in 2016-2020. To compare the manufacturing industry of individual countries, the indicator's value added, gross operating surplus to turnover, the wage adjusted labor productivity, average personnel costs and apparent labor productivity, were used. Their values for the monitored period were obtained from the Eurostat database. Subsequently, the manufacturing industry was evaluated based on selected indicators using multicriteria analysis methods.

By applying the Saaty and AHP methods, the preferences of the selected indicators were determined. The most significant indicator with the highest preference was the indicator of gross operating surplus and sales with a weight of 0.5041. For the indicator of the share of

added value to the number of employed persons, a weight of 0.2514 was calculated, and for the indicator of the share of added value to personal costs, a preference of 0.1452 was determined. The indicator of the share of personnel costs to the number of employees with a weight of 0.0606 and the indicator of added value with a weight of 0.0386 were determined as the least important. Based on applying the AHP method, the development of the manufacturing industry in Poland can best be evaluated. The second best-developing manufacturing industry was in Hungary, followed by the Czech Republic and, according to the calculated values, the development in the Slovak Republic was the worst.

At the same time, according to the calculated values, none of the monitored countries achieved the desired development in the analyzed period. In the case of all, there is a decrease in the annual values of the calculated utility. The exception is 2020 in Poland when the value of the calculated annual utility is increasing.

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Economic Modelling - a Method for Determining the Transfer Price of Loan Interest

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Abstract

Setting a transfer price (i.e. the price of a transaction between related parties) is one of the most challenging tasks in the tax area. The problem is made more complex due to the lack of data available free-of-charge, meaning the CUP method (Comparable Uncontrolled Price) is unlikely to give good results. This is a particularly difficult problem for financial transactions carried out by micro, small and medium-sized enterprises (SMEs), which cannot afford to purchase external consulting services, or buy access to commercial databases in order to set a transfer price. This paper presents concepts and approaches for the determination of market interest rates by applying economic modelling using publicly-accessible data, available free-of-charge.

Key words

Arm´s Length Principle, Economic Modelling, Financial Transactions, OECD Transfer Pricing Guidelines

JEL Classification: H25, K34.

1. Introduction

Transfer pricing is currently perceived as one of the most problematic tax areas (Harst et al., 2021) for a number of reasons. Transfer pricing is not purely a tax issue for which there exists clear and unambiguous rules. The determination of the transfer price or price range needs to be preceded by a number of analyses and assessments (e.g. analyses of the macroeconomic environment, industry environment, competition, description of existing risks and functional analysis) (see OECD, 2022). It should also be noted that the overall understanding and role of the transfer pricing issue has evolved in recent decades (see Kumar et al., 2021). It remains an area that many studies consider to be related to base erosion and profit shifting activities, i.e. tax avoidance (or even tax evasion) (see, Sebele-Mpofu, 2021; Sikka and Willmott, 2010; Kumar et al., 2021). This is the reason the OECD has paid extra attention to transfer pricing in its action plans to tackle BEPS (*Base Erosion and Profit Shifting*) (OECD, 2013, 2015). Extensive amendments to the OECD Transfer Pricing Guidelines (OECD, 2022) are one of the outcomes of this project. The new Chapter X (OECD, 2020) gives guidance on transfer pricing rules for financial transactions. While this extension of the standard undoubtedly represents a beneficial change, the high level of

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generality of the rules creates many application problems (see, Lang and Petruzz (eds.), 2022).

Chapter X of the OECD Transfer Pricing Guidelines (OECD, 2022) defines the framework and principles for the following financial transactions: loans, cash-pooling, hedging, financial guarantees and captive insurance (OECD, 2020, 2022). The key indicator (determinant) when determining the transfer price for financial instruments, as follows from the contextual and content analysis of the standard, is the credit rating (Kalová, 2023). This aspect is highly problematic for a number of reasons - the costs connected with rating determination, the absence of fully publicly accessible methodologies (missing partial indicators and specification of qualitative data taken into consideration), and subjectivity as regards the credit rating determination (see Kalová, 2023; Ištok, 2023; Caplinska and Tvaronavičiene, 2020). However, if a credit rating is known, or can be accurately estimated, the comparable independent price (CUP) method is the most suitable for setting the transfer price. This method is recommended due to its advantages: the relative simplicity of its use (if relevant data is available), and the possibility of corrections within the comparative analysis. On the other hand, there are a number of limitations associated with the application of the CUP method – primarily data availability and the costs of using commercial databases, which are too high for most SMEs. As a consequence, the use of the economic modelling method would seem to be more appropriate for SMEs, as it makes use of publicly accessible data, available free-of-charge.

2. Goal of the paper and methodology

The goal of this paper is to propose an economic model applicable for setting a transfer price for intra-group loans using publically accessible data, available free-of-charge. The paper looks at the possibilities of setting a risk-free rate and methods for setting risk premiums. The paper is based on qualitative analysis and takes into consideration limits set in OECD standards and the expert literature. When analysing the risk-free rate, the scientific and expert literature on investing, banking, risk and taxes (transfer pricing) is primarily used. The risk premium analysis is primarily based on annual default studies, which are regularly published by the three most renowned rating agencies: Moody's (2022), Fitch (2022) and Standard & Poor's (2022).

3. Results and discussion

Chapter X (OECD, 2020) deals with economic models in section *C.1.2.5. Economic modelling.* Certain industries rely on economic models to value intra-group loans by building an interest rate as a proxy for the arm's length principle (OECD, 2020, item 10.104.). The most common variants of economic models construct an interest rate using a combination of a risk-free rate and a risk premium associated with different aspects of the loan (default risk, liquidity risk, expected inflation or maturity). Some economic models also include elements to compensate for the operational expenses of the lender (OECD, 2020, item 10.105.). The outcomes of the economic models, however, do not represent actual transactions between independent parties, therefore, comparability adjustments are necessary as a rule. Economic models may be usefully applied when identifying an arm's length price for intra-group loans in a situation where reliable comparable uncontrolled transactions cannot be identified (OECD, 2020, item 10.106).

There are two main types of economic models that are used in transfer pricing area. The first one is the “build-up model”, which is based on a financial analysis of a company - debtor (e.g. Damodaran, 2023). The second type are based on the valuation of capital assets (*CAPM* -

Capital Asset Pricing model) and these make more extensive use of industry data (an extended model based on consumption is used, e.g. Valckx, 2001).

3.1 Risk-free rate

The risk-free rate is a key value (building blocks) used for determining interest rates between related parties. Damodaran (2008) defines the risk-free rate as the position where the actual return is always equal to the expected return (the investment is risk-free, as there is no variance around the expected return). The professional and scientific literature offers an extensive list of articles and studies on the risk-free rate. Damodaran (2008) considers the government bond rate (long-term loans) or the state treasury bill rate (short-term loan) as the basis for stating the risk-free rate, and emphasises the country risk premium should also be taken into consideration. In this respect, Kitanov (2015) stresses that government bonds are not completely risk-free due to the risk of default (credit), inflation and currency risks. On the other hand, Napoletano (2022) states that US government bonds may be considered risk-free investments, as the US federal government has never defaulted on its debt. Gremm (2016) concludes that bonds are not completely risk-free, but hedged options and a very extensively diversified portfolio can be considered risk-free. The author defines the risk-free rate as the return from a very extensively diversified portfolio, rather than as an arbitrary external parameter. Some key points on the application of the CAPM when determining a risk-free interest rate are specified by Yandiev (2021). A study by Fernandez et al. (2022) concluded that many respondents use risk-free rate yields that are higher than 10-year government bond for European countries: the risk-free rate is calculated as the government bond yield, plus the premium for an expansionary monetary policy. A study by Ištok et al. (2022) analysed the concepts of safe harbours for intra-group loans and concluded that the risk free rate is frequently determined by the loan maturity and currency; the risk-free rate for a short-term loan is often linked to the interbank offered rate.

It follows from the above that there are several opinions as regards the determination of the risk-free interest rate in the professional and scientific literature. In general, three main groups (categories) can be identified.

Group 1: The authors refer to the use of government bonds (long-term loans) and to the relevant interbank offered rates or state treasury bills depending on the loan currency (short-term loans). The availability of free data and simple application as regards setting the market interest rate are the main benefits, but the authors also highlight some problematic issues. They also draw attention to the fact that the risk-free rate should be a realistic (easily accessible) alternative for taxpayers.

Group 2: The yield on government bonds is considered to be a starting point, but a default by the state where the company (debtor) has its official seat needs to be considered, i.e. the country's risk premium needs to be deducted from the relevant government bond risk rate.

Group 3: The yield of government bonds is again the starting point, but inflation (usually as the result of expansionary monetary policy) is included in the calculation. This opinion group is not so extensive, as such a determination of the risk-free rate in a period of high inflation is very problematic.

Whichever position is taken, determining a risk-free rate is crucial especially in situations when debtors are in an investment rating zone, as default rates are low (e.g. Standard & Poor's, 2022) and so the risk-free rate has a significant impact on determining the resulting market interest rate (transfer price for the loan provided).

3.2 Risk premium

According to Kučera and Mašková (2021), the easiest way for Czech and foreign investors to determine the risk premium is to use the company's rating, which is a problematic issue (see above). The authors refer to the use of the Damodaran methodology, which has some problematic aspects. In connection with the use of this methodology for transfer pricing of financial transactions in Europe, it is possible to identify three main weak points (also in relation to OECD rules (OECD, 2022):

a) the methodology is derived from US data,

b) the credit rating estimation is fully dependent on a single indicator (interest coverage), and

c) the criterion of loan maturity is not taken into account.

Table 1 below presents the risk premiums (default spreads) for selected types of companies as provided by Damodaran (2023). Estimated default spreads are set for three types of companies (large non-financial service firms, smaller and riskier firms, and financial service firms).

Table 1: Determination of credit rating and default spread of borrower according to Damodaran methodology

For large manufacturing companies				**For smaller and riskier firms**			
If interest cover				**If interest cover**			
>	**≤**	**Rating**	**Default spread**	**>**	**≤**	**Rating**	**Default spread**
-100000	0.199999	D2/D	20.00%	-100000	0.499999	D2/D	20.00%
0.2	0.649999	C2/C	17.50%	0.5	0.799999	C2/C	17.50%
0.65	0.799999	Ca2/CC	15.78%	0.8	1.249999	Ca2/CC	15.78%
0.8	1.249999	Caa/CCC	11.57%	1.25	1.499999	Caa/CCC	11.57%
1.25	1.499999	B3/B-	7.37%	1.5	1.999999	B3/B-	7.37%
1.5	1.749999	B2/B	5.26%	2	2.499999	B2/B	5.26%
1.75	1.999999	B1/B+	4.55%	2.5	2.999999	B1/B+	4.55%
2	2.2499999	Ba2/BB	3.13%	3	3.499999	Ba2/BB	3.13%
2,25	2.49999	Ba1/BB+	2.42%	3.5	3.999999	Ba1/BB+	2.42%
2.5	2.999999	Baa2/BBB	2.00%	4	4.499999	Baa2/BBB	2.00%
3	4.249999	A3/A-	1.62%	4.5	5.999999	A3/A-	1.62%
4.25	5.499999	A2/A	1.42%	6	7.499999	A2/A	1.42%
5.5	6.499999	A1/A+	1.23%	7.5	9.499999	A1/A+	1.23%
6.5	8.499999	Aa2/AA	0.85%	9.5	12.49999	Aa2/AA	0.85%
8.50	100000	Aaa/AAA	0.69%	12.5	100000	Aaa/AAA	0.69%

Source: Damodaran (2023)

Considering the above conclusions, it can be observed that smaller and companies facing higher risks must achieve better interest cover ratio values to be assigned the same rating as large manufacturing companies. Such a conclusion appears to be valid, as SMEs do not have such strong protection in the event of problems, mistakes and waste, as is often the case for large, capital-rich enterprises (Duffy, 2004). The indisputable advantage of this methodology is its simplicity of application and the availability of data on the Damodaran website. According to Ištok (2023), the risk premium should be calculated as the *default rate of the debtor (according to the statistics of the three largest rating agencies) multiplied by (1 - recovery rate).* Moody's (2022), Fitch (2022) and Standard & Poor's (2022) publish annual default studies on a regular basis, from which it is possible to extract information on the default rates of debtors according to the rating assessment over a given time horizon. This approach is, therefore, in line with the standards in OECD Chapter X (2020), according to which a longer loan maturity period brings a higher risk for the creditor and this consequently results in a higher required (expected) risk premium. Another factor in favour of using the

methodological materials of rating agencies is that in some cases the average cumulative default rates are also provided separately for the Europe. A slightly problematic aspect is the availability of data for the recovery rate. In the Slovak Republic, data is published on an annual basis by the Ministry of Justice (2023), but the number of completed bankruptcies (for companies) is very low (usually less than 10 a year). The most recent data available free of charge for the Czech Republic is from 2019 (Advokátní deník, 2019), which cannot be considered adequate and will not correspond to the current situation.

It should be stated that OECD Chapter X (2020) considers credit default swaps (section *C.1.2.4. Credit Default Swaps*) as a possible method for determining the risk premium. This method is difficult to use in the Czech and Slovak Republic due to the unavailability of the relevant data.

3.3 General observations and justification for application of economic modelling

Given the current conditions as regards the transfer pricing of financial transactions in the Czech and Slovak Republic, economic modelling can be considered a suitable method for determining the market interest rate. Most publicly accessible, free of charge methodologies are based on a build-up model, in which it is necessary to determine the risk-free rate and the risk premium. It must be said that this method does not fully correspond with the primary intention of the OECD Guidelines (OECD, 2022) to set up a rate for an instrument (loan). On the other hand, the OECD (2022) stresses that expenses connected with setting the correct transfer price should be reasonable and should take into consideration the result and price paid to undertake this. The above is supported by the case-law of the Czech Supreme Administrative Court. In its judgment of 20 February 2020, file No. 7 Afs 472/2018, the Czech Administrative Court (2020b) states that it is not permissible for the tax authority to determine the amount of the transfer price only by applying its preferred method. The tax authority is obliged to provide a justification as to why the method used by a taxpayer is not suitable for a particular case. Further, the selection of the method should be based on economically rational reasoning (see the judgment of the Supreme Administrative Court of the Czech Republic of 27 January 2011, file No. 7 Afs 74/2010 (Czech Supreme Administrative Court, 2011) in connection with conclusions as stated in the judgment of the Supreme Administrative Court of 29 January 2020, file No. 9 Afs 232/2018 (Czech Supreme Administrative Court, 2020a) and of 23 January 2013, file No. 1 Afs 101/2012 (Czech Supreme Administrative Court, 2013).

3.4 Recommendations for SMEs – economic modelling

The use of the risk-free rate depends primarily on the maturity and the currency of the loan. As for short-term loans (maturity period - max. 12 months), the relevant interbank offered rates (or average overnight rates) would appear to be an appropriate option (e.g. PRIBOR or CZEONIA for loans denominated in CZK, EURIBOR or ESTER for loans in EUR, SARON for loans in CHF, and SONIA for loans in GBP). The long-term risk-free rate should be determined according to the yield of the government bond with the relevant maturity. The Czech National Bank (2023) publishes monetary and financial statistics on a monthly basis (information on bond yields with maturities of 2, 5 and 10 years is also available). If necessary, companies can also use information about the issuance of sovereign bonds.

A similar structure of information is also provided by the Slovak National Bank (National Bank of Slovakia, 2023).

When determining the risk premium, the credit rating of the borrower and the maturity period of the loan are the most significant factors. When determining the risk premium, it is

possible to use statistics on company defaults (default rates) as provided by rating agencies. Table 2 contains a proposal for the use of specific statistics in the Czech and Slovak Republic.

Table 2: Proposed statistics of average cumulative default rates by rating

Rating agency	Proposed statistics on default rates
Moody's	• Average cumulative issuer-weighted global rates by letter rating (1983 – 2021) • Average cumulative issuer-weighted global rates by alphanumeric rating (1983 - 2021)
Fitch	• Fitch global non-financial corporate average cumulative default rates (1990 – 2021) • Fitch EMEA corporate finance average cumulative default rates (1990 – 2021)
Standard & Poor's	• Global corporate average cumulative default rates (1981 – 2021) • Average cumulative default rates for corporates by region – Europe (1981 – 2021)

Source: own processing of the authors based on Moody's (2022), Fitch (2022) and Standard & Poor's (2022)

In general, the statistics are linked to the company's credit rating, either on the alphanumeric scale, or on the group credit rating scale. For this reason, it is necessary to apply the statistics that are connected to the specific credit rating, or the applied methodology, to determine the credit rating.

Conclusion

Economic modelling can be considered a suitable method for determining the market interest rate, especially for SMEs in countries where there is no available methodological guideline for financial transactions. Given that OECD Chapter X from 2020 is relatively vague in this respect, different methodologies can be applied by taxpayers. Most publicly accessible, free of charge methodologies are, however, based on determining/estimating the borrower's credit rating and the resulting market interest rate is subsequently calculated as the sum of the risk-free rate and the risk premium. When determining the interest rate, the characteristics (terms and conditions) of the loan should be considered, especially the maturity period and the currency, which are parameters that can be reflected in economic modelling. Assuming free of charge data is accessible, the scientific and professional literature recommends using the relevant interbank interest rates as the short-term risk-free interest rate and government bonds with a similar maturity for long-term loans. This also supports the possibility of using the economic modelling method.

To give a broader and more systematic picture, financial transactions are a very specific type of transaction, which is reflected in the fact that they have their own chapter in the OECD Guidelines (OECD, 2022). As such, they are subject to a number of specific rules in addition to the general transfer pricing rules. This also applies to potentially applicable transfer pricing methods. Although the OECD materials do not explicitly establish a hierarchy, it is clear that the CUP method remains the preferred and appropriate method also for financial transactions. In this case, especially for micro, small and some medium-sized enterprises, the cost of determining the transfer price in the form of the interest rate is inevitably disproportionate (access to databases and/or securing external consultancy services for this purpose is usually costly - which makes the effect obtained more expensive at lower loan denominations). Even the use of an internal CUP in terms of the interest rate required by the bank for the existing loans does not seem appropriate, given the necessity and difficulty of making the necessary adjustments. Moreover, a bank is a completely different type of entity with specific functions and risk profile. The other recommended method of determining the transfer price in the form of the interest rate - the use of credit default swaps - is also not a realistic and rational option for the above categories of entities, although, like the CUP method, it is more closely linked to the underlying financial asset (it is more targeted). It is also burdened by a very high level of volatility. Therefore, after the CUP method, economic

modelling seems to be the most appropriate method, taking into account the limits and rules established by the case law of the administrative courts. Economic modelling is not specified in detail (see OECD, 2022, chapter X, point C.1.2.5.): the OECD manual is really very sparse in this respect. It is therefore possible to rely on the requirements set out in the case law of the administrative courts, which emphasise the rationality of the justification and the verifiability of the calculation method used. In addition, it should be stressed that the economic modelling is also subject to reasonable and logically justifiable adjustments (notch-up, notch-down).

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Research on mixed price forecasting model based on time-frequency recursion and non-recursive decomposition

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Abstract

The purpose of this paper is the improvement of the prediction accuracy for commodity future prices. Particularly, the historical data of kerosene aviation fuel price of Mexico Gulf as the modelling time series data are used to develop a dynamic forecast model. The paper is organized as follows. In theoretical part necessary mathematical background is provided. In the empirical analysis, first, the recursive and non-recursive time-frequency analysis of the time series is performed. Secondly, a new composite model of traditional ARMA model and emerging neural network is developed for prediction purposes. At last, the predicted prices are compared with the true values. The results show that variational mode function (VMF) and empirical mode decomposition (EMF) in combination with long- and short- term memory neural network (LSTM) improve prediction accuracy than a single prediction model.

Key words

kerosene aviation fuel price, combined forecast, empirical mode decomposition, Variational Mode Decomposition, artificial neural network, LTSM model, ARMA model,

JEL Classification: C13, C45, C58

1. Introduction

Sufficiently accurate and reliable price prediction of future prices has always been a crucial and challenging activity for the analysists and risk managers in companies, whose financial performance is affected by market risks. Market risk is defined as the risk of price change in the future and usually includes the exchange rate risk, commodity risk, interest rate risk and equity price risk. Accurate prediction enables to act the risk managers in an appropriate manner in order to mitigate the possible losses or alternatively increase the protentional profits.

The airline industry is one of the sectors, where the profits/losses and cash flows are significantly affected by market risks, particularly commodity risk and exchange rate risk. While revenues (and inflows) are given by the number of passengers and price of service and may fluctuate seasonally, the operating expenses (and outflows) are partly fixed over a certain period (labor cost, parking and hangar fees, insurance, etc.) or can vary (costs on jet fuel, landing fees, maintenance).

The crucial expenses affecting the most the total operating expenses (and resulting operating income) are labor costs and jet fuel costs. Whereas labor costs are largely fixed (at least in the short-term period, while fuel costs can swing wildly based on the price of oil.

For this reason, analysts pay more attention to fuel costs in the near term. Two-thirds of the costs of flying an airplane are fixed, so changes in fuel costs can swing a flight from profit to loss depending on how many people are on the flight.

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On the basis of forecasting aviation fuel prices, airlines can buy or sell corresponding fuel futures in advance to help them reduce their operating fuel costs and increase their profit margins. In addition, it avoids operational risks caused by fluctuations in fuel prices.

It is inevitable to use the time series of historical data for analysis in price forecasting, because time series data is the carrier of all historical information of the research object.

In the current common price forecasting research, most of them directly put historical data into the model for forecasting. The advantage of this is that it is simple and fast. However, due to the inevitable interference of noise and the information contained in different trends in the same sequence during the prediction process, the prediction accuracy is poor, and the error exceeds the expected result.

The objective of this paper and research performed here is to improve the prediction accuracy of models for kerosene aviation fuel prices forecasting. Particularly, variational modal decomposition based on time-domain analysis is used to pre-process the time series signal and then predict the data, so as to suppress noise and mutual interference between different frequencies and improve the prediction accuracy. On this basis, the more commonly used empirical mode decomposition is also introduced for comparison. Variational modal decomposition is a new adaptive and completely non-recursive signal decomposition method. After decomposing the data, the article will use the long-short-term memory neural network and the traditional autoregressive moving average model to form a new composite prediction model to predict the decomposed data group separately on the prediction model.

2. Research review

In the previous research on time series forecasting, more research results focused on the improvement of the forecasting model itself. For example, Fang Lan *et al.* (2010) used the ARMA model to analyse the trend of asset prices of mineral resources, and also used related neural networks to predict prices; Zhang Pinyi *et al.* (2018) simulated the gold price prediction based on the GA-BP neural network model. The results showed that the neural network model can better predict the price trend of gold in terms of error level and convergence accuracy. However, in many literatures, few scholars have improved the disadvantages of a single model. For example, in the traditional autoregressive moving average model, there may be interference between different historical information, which affects the prediction accuracy. With the development of computer science, the calculation speed of complex calculations is rapidly increasing. A large number of computationally cumbersome but high-precision models are gradually being adopted in the financial field, especially in the field of time-frequency analysis and forecasting of time series. Generally, for time series analysis, although time-domain analysis theoretically has a greater accuracy advantage in time positioning, it is often unable to obtain more information on the signal in practical applications, and it is difficult to overcome inherent shortcomings to achieve adaptability. For this reason, Huang (1998) proposed the empirical mode decomposition method, which adaptively analyses the local time-frequency characteristics of the signal through the self-characteristics of the time series signal. Huang et al. believe that any continuous signal is composed of multiple intrinsic mode functions with different frequencies. Simply selecting a specific basis function for decomposition cannot cover the complete signal curve, which will increase the error. In this case, Huang et al.'s method of decomposing the original signal into different intrinsic mode functions based on the composition of the signal and frequency classification has high adaptability. It is especially suitable for the processing of non-stationary time series signals. In the use of empirical mode decomposition to pre-process the time series, Zhu *et al.* (2015) used the empirical mode decomposition hybrid backpropagation algorithm neural network to predict the price of gold and get the conclusion:

compared with the single backpropagation algorithm, after data pre-processing through empirical mode decomposition, the accuracy of the price trend predicted by the simulation is higher, and the deviation is smaller. In the separation of different frequencies of the signal, Rao *et al.* (2015) used empirical mode decomposition to denoise the blasting vibration signal and the results showed that EMD is better than traditional wavelet decomposition.

With the widespread use of empirical mode decomposition, its inherent shortcomings are gradually revealed. First of all, empirical mode decomposition has some details in mathematics that cannot be deduced and proved. Therefore, it lacks strict mathematical theoretical support and belongs to the method of engineering practicality prior to theoretical research. In addition, the results of empirical mode decomposition also have modal aliasing. At the same time, the model also has the disadvantages of being sensitive to noise and sampling. Some scholars have proposed some improved methods of empirical mode decomposition based on Huang et al.'s theory. For example, a more accurate constrained optimization method is used to replace the local mean decomposition of envelope interpolation, which effectively reduces the end effect that often occurs in empirical mode decomposition; In addition, there is also collective empirical mode decomposition, which introduces white noise for auxiliary decomposition on the basis of empirical mode decomposition. It effectively solves the modal aliasing problem of the original model. The above improvements have optimized some of the defects to a certain extent, but they are still in the recursive decomposition method of time domain analysis. Dragomiretskiy *et al*. (2014) developed a new variational modal decomposition based on Fourier transform after empirical modal decomposition designed. Compared with the existing empirical modal decomposition, its performance is better in theory. In particular, the variational modal decomposition model is more robust to sampling and noise. Variational modal decomposition has been widely used in the engineering field. Zhang *et al.* (2018) proposed a signal noise reduction method based on variational modal decomposition. The results show that the use of variational modal decomposition method in the process of microseismical signal noise reduction shows a good noise reduction effect.

At the same time as it is widely used in the field of engineering, so far, few scholars have used variational modal decomposition in the financial field. This article will use variational modal decomposition and empirical modal decomposition mixed long-short memory neural network and traditional autoregressive moving average model to predict jet fuel prices. The calculation results show that the results obtained by using time-frequency analysis to pre-process the time series signal and then predict the results are better than a single model in terms of motion trend and prediction accuracy. The hybrid model solves the problem of mutual interference in the historical information group to a certain extent, effectively improve the accuracy of prediction calculations, and ensure the scientific, timeliness and effectiveness of predictions.

3. Theoretical background

3.1 Theory of Empirical Mode Decomposition (EMD)

Empirical Mode Decomposition (EMD) is an adaptive signal decomposition method that can filter the trends of different features existing in the original sequence step by step to obtain the intrinsic modal components with the same feature scale. The idea of EMD decomposition is to decompose the signal into several relatively stationary, uncorrelated intrinsic mode functions (IMFs). The intrinsic mode function's function should satisfy the following two conditions, see (Cui *et al,* 2015):

1. In the entire data sequence, the number of extreme points should be equal to the number of zero-crossing points, or at most one difference.

2. At any point in time, the local mean defined by the local maxima and local minima of the signal should be zero.

Briefly, IMF is a time series with a mean close to zero and no obvious trend. The nature of IMF is exactly in line with the needs of traditional time series analysis, so non-stationary time series can be decomposed by EMD to obtain a series of IMFs, and then to analysed. Meanwhile, for non-stationary time series, the residual amount produced by EMD decomposition generally contains a certain trend, so it called trend term. The trend term reflects the overall trend of the original time series, the problem is well-known (Zhu *et al.,* 2013) which eliminates minor events and short-term effects. The decomposition process is as follows:

Search for the extreme point of the original signal $x(t)$, and connect all the maxima and minima points with the cubic spline function to obtain the upper and lower envelopes of $x(t)$,. Expressed as $x_{max}(t)$, and $x_{min}(t)$, respectively.

Calculate the mean of the envelope $w_1(t)$,

$$w_1(t) = \frac{[x_{max}(t) + x_{min}(t)]}{2}. \quad (1)$$

Calculate the difference between the signal $x(t)$ and the envelope mean $w_1(t)$ get $d(t)$,

$$d(t) = x(t) - w_1(t). \quad (2)$$

Determine whether $d(t)$ satisfies the two conditions of IMF. If $d(t)$ satisfies the condition, $d(t)$ is the first component of signal $x(t)$, which is IMF_1; if the condition is not met, then use $d(t)$ as the new original signal and repeat the above steps until the condition is met.

Calculate the residual signal r_1,

$$r_1 = x(t) - IMF_1. \quad (3)$$

Using r_1 as a new signal source, repeat step 1 to 3 and continuously decompose the signal to obtain the IMF_i that satisfies the condition until the residual r_n is a monotonic function and stop the decomposition. At this time, the original signal $x(t)$ can be expressed as the sum of i IMFs and a residual value r_n.

$$x(t) = \sum_{i=1}^{n} IMF_i + r_n. \quad (4)$$

The EMD decomposition is based on three assumptions: 1) any signal can be decomposed into several IMF components; 2) each IMF component could be linear or non-linear, the number of local zero and extreme points are the same, and the upper and lower envelopes are locally symmetric about the time axis; 3) a signal can contain several IMF components. When the sequence extreme points are not obvious, it is necessary to find the extreme points by several differences as Liu *et al.* (2018) points out.

3.2 Theory of Variational Mode Decomposition (VMD)

Variational mode decomposition VMD is a new non-stationary signal adaptive decomposition estimation method proposed by Dragomiretskiy (2014), which can decompose the original signal into certain K frequency band sub-signals. It abandons the recursive solution mode of EMD, and the decomposition result is less affected by noise. The key to Variational mode decomposition lies in solving variational problems. Let the original price series be f, assuming that f can be decomposed into K modal quantities, each modal has a limited bandwidth with a different centre frequency, and the constraint to be satisfied is that the sum of each modal is equal to the original signal. The objective function for solving the variational problem is to minimize the sum of the bandwidth estimates of each mode.

Unlike traditional recursive mode decomposition such as EMD and LMD, VMD converts signal decomposition into non-recursive, variational modal decomposition. Its overall framework is a variational problem, which minimizes the sum of the bandwidth of each component after decomposition.

In order to estimate the bandwidth of each modal component, we first need to perform Hilbert transform on each modal function to obtain its single-sided spectrum;

$$\left(\delta(t)+\frac{j}{\pi t}\right)\cdot\mu_k(t),\ \ \delta(t)=\begin{cases}0, & t\neq 0\\ \infty, & t=0\end{cases}, \tag{5}$$

Then, by adding an estimated centre frequency $e^{j\omega_k t}$t, the frequency spectrum of each modal component is transformed to baseband;

$$\left[\left(\delta(t)+\frac{j}{\pi t}\right)\cdot\mu_k(t)\right]e^{j\omega_k t}. \tag{6}$$

Finally, the square L^2 norm of the analytical signal gradient is calculated to estimate the bandwidth of each modal component.

Assuming that after the VMD decomposition, the original signal is decomposed into k modal components, the variational constraint model is：

$$\begin{cases}\min\limits_{\mu_k,\omega_k}\left\{\sum_k\left\|\partial_t\left[\left(\delta(t)+\frac{j}{\pi t}\right)\cdot\mu_k(t)\right]e^{-j\omega_k t}\right\|^2\right\},\\ s.t\sum_k\mu_k=f\end{cases} \tag{7}$$

among them：$\{\mu_k\}$——Collection of modal components, $\{\mu_k\}=\{\mu_1,\mu_2,\dots,\mu_k\}$;

$\{\omega_k\}$——Collection of centre frequencies, $\{\omega_k\}=\{\omega_1,\omega_2,\dots,\omega_k\}$;

$\delta(t)$——Unit pulse function.

The VMD algorithm introduces the second penalty term α and Lagrange multiplier L to solve the above variational constraint model, that is:

$$L(\mu_k,\omega_k,\lambda)=\alpha\sum_k\left\|\partial_t\left[\left(\delta(t)+\frac{j}{\pi t}\right)\cdot\mu_k(t)\right]e^{-j\omega_k t}\right\|_2^2+\|f(t)-\sum_k\mu_k(t)\|_2^2+\langle\lambda(t),f(t)-\sum_k\mu_k(t)\rangle \tag{8}$$

The specific implementation steps of VMD are as follows:

Initialize $\{\hat{\mu}_k^1\}$, $\{\omega_k^1\}$, $\{\hat{\lambda}_k^1\}$ and n;

Make $n=n+1$, perform loop process;

Make $k=0, k=k+1$, update $\{\mu_k\}$, and $\{\omega_k\}$;

$$\hat{\mu}_k^{n+1}(\omega)=\frac{\hat{f}(\omega)-\sum_{i\neq k}(\omega)+\frac{\hat{\lambda}(\omega)}{2}}{1+2(\omega-\omega_k)^2}, \tag{9}$$

$$\omega_k^{n+1}=\frac{\int_0^\infty\omega|\hat{\mu}_k(\omega)|^2d\omega}{\int_0^\infty|\hat{\mu}_k(\omega)|^2d\omega}, \tag{10}$$

Update λ:

$$\hat{\lambda}^{n+1}(\omega)\leftarrow\hat{\lambda}^n(\omega)+\tau[\hat{f}(\omega)-\sum_k\hat{\mu}_k^{n+1}(\omega)], \tag{11}$$

where τ represents the noise tolerance parameter.

Repeat steps 2 to 4, until the condition of:

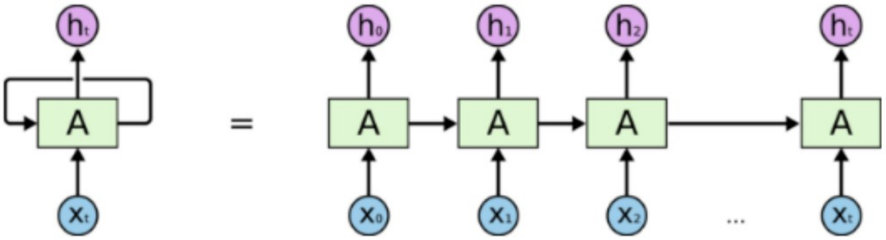
$$\frac{\sum_k\|\hat{\mu}_k^{n+1}-\hat{\mu}_k^n\|_2^2}{\|\hat{\mu}_k^n\|_2^2}<e, \tag{12}$$

constraint is satisfied, the iteration is stopped.

3.3 Principle of Recurrent Neural Network (RNN)

The difference between the structure of RNN neuron and standard neuron is that it has a recursive structure, which can transfer the information of the previous state to the current state. As shown in Figure 1, when the input is a time series, it can be expanded into a series of interconnected standard neurons.

Figure 1. RNN neural network (source: GitHub)



Assuming that the input sequence is $X = (x_1, x_2, \dots, x_t)$, the algorithm of the hidden unit sequence $A = (a_1, a_2, \dots, a_t)$ and the output sequence $H = (h_1, h_2, \dots, h_t)$ is:

$$A_t = \sigma(W_{xa}x_t + W_{aa}x_{t-1} + b_a), \quad (13)$$

$$h_t = W_{ah}x_t + b_h, \quad (14)$$

where σ is the nonlinear activation function, W_{xa} , W_{aa} and W_{ah} are weight matrix from input to hidden unit, hidden unit to hidden unit, hidden unit to output respectively, b_a and b_h are the offset term of hidden unit and the output respectively.

The basic consideration of RNN is that you can use the previous information to enhance the understanding of the current information, such as using the first few frames of a complete video to help identify the content that appears in the next few frames. As another example, use the first half of the group time series to predict the following series. However, ordinary RNNs can only deal with close links in time, such as using the information of the previous moment to predict the information of the next moment, but they cannot handle long-term links, such as using information from a long time ago to predict the current information. This is because the gradient will quickly disappear as the number of layers deepens.

3.4 Principle of Long Short Term Memory networks (LSTM)

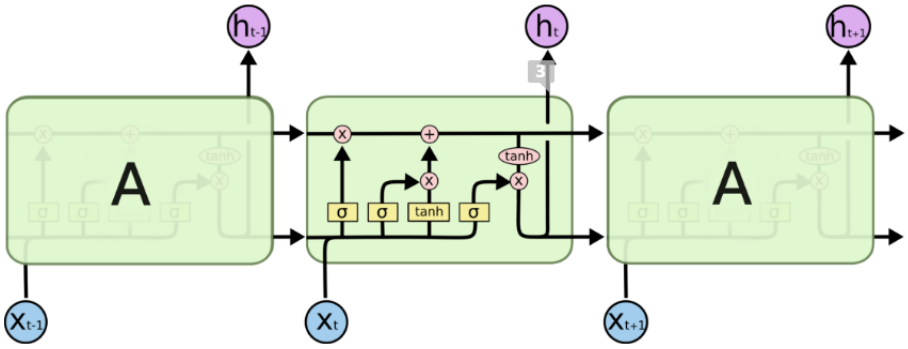
The LSTM network is an RNN applied in the field of deep learning. It was proposed by Hochreiter and Schmidhuber (1997) to overcome the difficulty of RNN training and gradient disappearance. It can learn long-term dependencies and has been continuously improved by the academic community.

Each layer of the LSTM network is composed of multiple memory blocks with the same structure. Each memory block contains an "input gate", an "output gate" and a status node. The input gate controls the proportion of input information received by the memory block, the output gate controls the proportion of output information transmitted from the memory block to the outside world, and the state node contains all historical information received by the memory block, forming a "memory" of the input information. With the structure of memory blocks, the LSTM network can memorize information with an interval of more than 1000-time units, see for more details Zhou (2016).

Although the LSTM structure proposed by Hochreiter and Schmidhuber (1997) can memorize information at long intervals, there is a problem of "memory explosion". Because the state node in the memory block accumulates all historical information, the internal value of the state node grows infinitely over time, and the state node fails due to saturation. Gers et al. solved the problem of node saturation failure by introducing "Forget Gate". In Hochreiter's LSTM structure, the information of the state node at this moment is completely transferred to the information of the next moment of the node, that is, the state node will not "forget" its historical information. Gers et al. Added a "forget gate" structure to the state node, allowing the historical information of the node at this moment to be passed to the next moment at a certain ratio. This modification completes the basic structure of LSTM. Now the LSTM models used by people all contain the structure of "forgotten gate".

The difference between the LSTM network and the standard RNN is that the structure of the hidden unit of the RNN is replaced by a memory block by a long-short-term memory network. The most important structure in the memory block is its three gate structures and a cell structure. Its specific structure is shown in Figure 2.

Figure 2: LSTM neural network

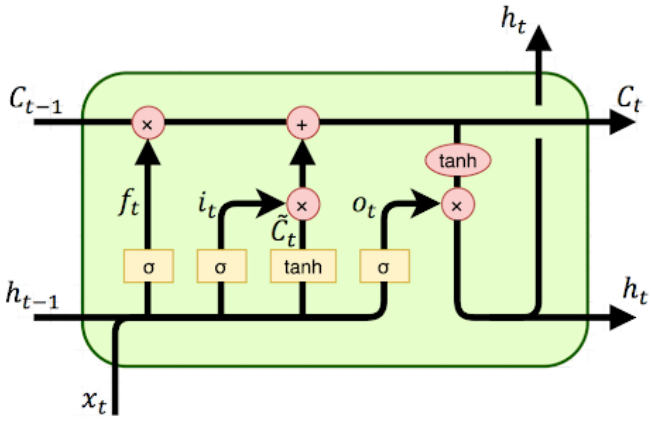


Memory blocks are the basic building blocks of long short-term memory networks. Memory blocks, like neurons in the brain, have the function of memorizing information and connecting peripheral neurons. The structure of the memory block is shown in Figure 3.

The memory block is related to time sequence. At time t, the input is x_t, the output is h_t, and the historical information of the memory block "memory" is C_t. Each memory block has three gates, namely the input gate i_t, the forget gate f_t and the output gate o_t. The input gate controls the proportion of input information at time t, the forget gate controls the proportion of historical information stored at time t, and the output gate determines the proportion of information output from the memory block to the next layer.

The memory block has a time series state. C_t contains all input information from time 0 to time t, which is the state of the memory block at time t.

Figure 3: Memory block of LSTM



The forget gate f_t is determined by the input information $x_t$and the output information $h_t - 1$ at the last moment of the memory block. After the sigmoid function (The sigmoid function maps the real number interval R to the interval (0,1), generally expressed by the symbol σ, $\sigma(x) = 1/(1 + e^{-x})$)transforms, the value of the forget gate is between 0 and 1, as shown in formula (14). f_t indicates how much of the state of the memory block at the previous time C_t is retained until the current time t. When the value of f_t is 0, it means that the state of the previous moment is completely forgotten, and the value of f_t is 1 means that the state of the previous moment is completely remembered.

The input information x_t and the output of the previous moment $h_t - 1$, after being transformed by the tanh function (The tanh function is the hyperbolic tangent function, which maps the real interval R to the interval (-1,1), $tanh(x) = (e^x - e^{-x})/(e^x + e^{-x})$), become the state increment at the current moment $\tilde{C}_t$, as shown in formula (15). The value of the state increment $\tilde{C}_t$ is in the interval (-1,1), which represents the increment size that the input information x_t can cause to the state of the memory block.

Similar to the forget gate, the value of the input gate i_t is determined by the input information x_t and the output information $h_t - 1$ at the previous moment, as shown in equation (16). The input gate controls the proportion of the state increment $\tilde{C}_t$ received by the memory block. If the value of the input gate i_t is 0, then the state increment $\tilde{C}_t$ will be completely ignored; if the input gate i_t value is 1, then $\tilde{C}_t$ will be fully counted into the state C_t.

$$f_t = \sigma(W_f \cdot [h_{t-1}, x_t] + b_f) \quad (15)$$

$$\tilde{C}_t = \tanh(W_c \cdot [h_{t-1}, x_t] + b_c) \quad (16)$$

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i) \quad (17)$$

Now let's take a look at how the status of the memory block is updated. The state value C_t consists of two parts, one part is the state at the previous moment $C_t - 1$, this part is controlled by the forget gate. The other part is the state increment $\tilde{C}_t$. This part is determined by the input gate and determines the proportion of the increment received. The state value $\tilde{C}_t$ update formula with time is shown in (18). The symbol "⊗" in formula (17) represents a bitwise multiplication between vectors (Bitwise multiplication means that each dimension of the vector is multiplied, and the result is a vector of the same dimension, for example $(1,2,3) \otimes (4,5,6) = (4,10,18)$), that is, in a memory block, a gate is a kind of scaling of information.

$$C_t = f_t \otimes C_{t-1} + i_t \otimes \tilde{C}_t \quad (18)$$

The output gate o_t is similar to the forget gate and the input gate, and its value is synthesized from the input information x_t and the output information h_{t-1} at the previous moment, as shown in equation (18). The size of the output gate o_t determines the state of the memory block C_t as a probability of being output and captured by other neural network layers.

The symbol h_t represents the output of the memory block at time t. This output is based on the state of the memory block C_t, but it needs to be filtered by the output gate. The state C_t is first transformed by the tanh function to compress the state to the interval (-1, 1). and then the output gate o_t determines the output ratio, as shown in equation (19).

$$o_t = \sigma(W_o \cdot [h_{t-1}, x_t] + b_o) \quad (19)$$

$$h_t = o_t \cdot \tanh(C_t) \quad (20)$$

The LSTM memory block is a function transformation in time series, which transforms the input time series into another time series. Because the memory block has a built-in state unit and has a special structure of the input gate and the forget gate, the memory block has the ability to associate long interval information, see Yang (2019).

The characteristics of the price change in the running process can be regarded as a time series. The price change during a period of time has n closing prices, and the price at the current time t is related to the k prices before this time, that is, the input vector is:

$$X = \{x_1^{t-1}, x_1^{t-2}, \ldots, x_1^{t-k}, x_2^{t-1}, x_2^{t-2}, \ldots, x_2^{t-k}, \ldots, x_n^{t-1}, x_n^{t-2}, \ldots, x_n^{t-k}\} \quad (21)$$

3.5 The Autoregressive Moving Average model (ARMA)

The ARMA (p, q) model is one of the most widely used time series prediction models due to its simplicity, feasibility and flexibility. The modelling and forecasting consist of four steps:

1. Sequence smoothing processing. If the sequence is non-stationary, it can be made to satisfy the stationarity condition by differential variation.
2. Model identification. Mainly determining the lag order p and q of the model by the autocorrelation coefficient and the partial autocorrelation coefficient.
3. Parameter estimation and model diagnosis. Estimating the parameters of the model, and testing (including the significance test of the parameters and the randomness test of the residuals), and then judging whether the model is desirable.
4. Forecasting using a model of the appropriate parameters selected and test.

If the time series X_n satisfies:

$$X - \phi_1 X_{n-1} - \cdots - \phi_p X_{n-p} = \varepsilon_n - \theta_1 \varepsilon_{n-1} - \cdots - \theta_q \varepsilon_{n-q}. \quad (22)$$

then the time series X_n obeys the $p, q \in (1,2,3\ldots)$ order and $\varepsilon_n \sim N(0, \sigma_\varepsilon^2)$ autoregressive moving average model $ARMA(p,q)$, where $\phi_1 \ldots \phi_p$ is the autoregressive regression coefficient and $\theta_1 \ldots \theta_q$ is the moving average coefficient. When p or q are 0, the model degenerates into MA or AR, see Mehrmolaei *et al.* (2016).

4. Empirical Analysis of Composite Models

In this paper, data from the U.S. Gulf Coast Kerosene jet fuel price data from Index Mundi will be cited, from 01.01.2010 to 06/04/2020 (total 2578 data), the last close of jet fuel price as the research object. From the 2578 data, the max data is 3.375, and the minimum data is 0.65 and other statistical indicators seen in Table 2, and first, it is necessary to perform Augment Dickey-Fuller (ADF) test, see in Figure 4 on the data to verify that the data is non-stationarity.

Table 1. U.S. Gulf Coast jet fuel price statistic description (Source: MATLAB calculation)

	MAX	MIN	AVE	SD	MEDIAN	KURT	SKEW
DATA	3.375	0.65	2.185	0.6724	2.061	-1.2431	0.0391

Figure 4. ADF test of signal (Source: Calculate by Matlab)

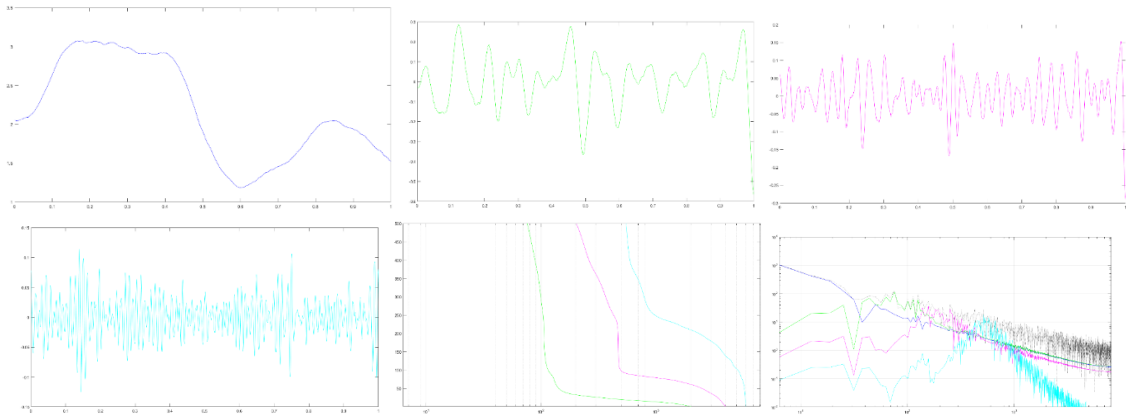
Null Rejected	P-Value	Test Statistic	Critical Value	Lags	Model	Test Statistic	Significance Level
false	0.3254	-0.8916	-1.9416	0	AR	t1	0.0500
false	0.3254	-0.8916	-2.5688	0	AR	t1	0.0100
false	0.3254	-0.8916	-1.6168	0	AR	t1	0.1000

It can be clearly seen from the figure that the t-statistic is -0.8916 and the P-value is 0.3254 which greater than the significance level of 5%. Therefore, the original hypothesis cannot be rejected at 95% confidence, based on this, the data signal is non-stationary. Finally, EMD and VMD decomposition of the price series is required for subsequent research.

4.1 Prediction by applying Variational mode decomposition and empirical mode decomposition

The following results in Figure 5 can be obtained after the variational modal decomposition of the original data signal.

Figure 5: Results of variational mode decomposition



In the upper chart group, the charts from left to right and top to bottom are: vmf1, vmf2, vmf3, vmf4, the evolution of the centre frequency Omega and the structural decomposition.

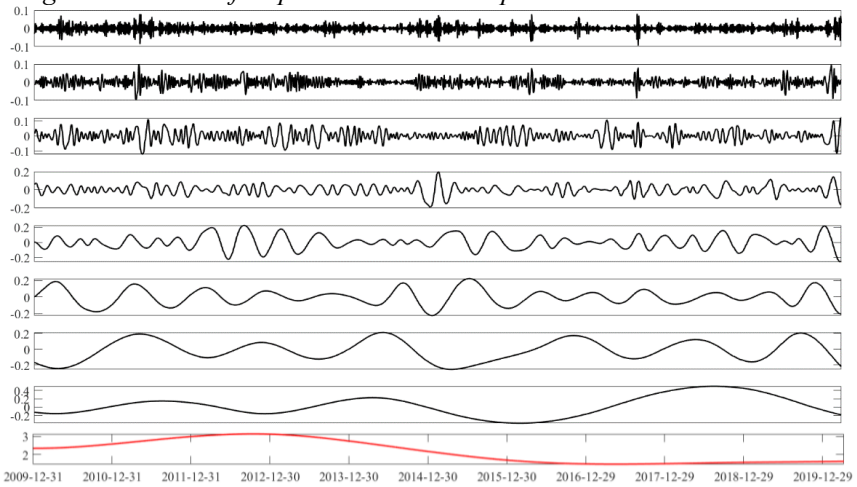
Due to the significant difference between the calculation method and the currently commonly used empirical mode decomposition method, there are also significant differences in the output form and quantity of the variational mode function (VMF) under the variational mode decomposition method. The fluctuation frequency of VMF1 to VMF4 gradually increases, which is completely opposite to the result obtained by the EMD method. Following Table 4 shows the Pearson correlation coefficient (PCC), variance, and the maximum and minimum values of each VMF of the decomposition results.

Table 2: Statistical description of variational modal decomposition results

	PCC	variance	maximum	minimum
VMF1	0.970329	0.402696	3.073313	1.185070273
VMF2	0.324355	0.016476	0.287215	-0.56576
VMF3	0.162744	0.0033	0.153077	-0.29027
VMF4	0.080162	0.001112	0.114505	-0.12526

In the variational modal decomposition, a larger input parameter K value (the number of VMF obtained by the decomposition) will cause the resultant signal data to be incoherent. This article will use the parameter value K=4, that is, the decomposition calculation is performed when the number of VMF outputs is 4. As a comparison, the article will also use empirical mode decomposition to decompose the original data signal.

Figure 6. Results of empirical mode decomposition-IMFs and residuals



From the results of the empirical mode decomposition method in the above figure, it can be clearly seen that as the decomposition proceeds, the fluctuation frequency of the IMF gradually decreases.

Table 3. Statistical description of empirical mode decomposition results

	PCC	variance	maximum	minimum
IMF1	0.031715	0.000413	0.080607	-0.09433
IMF2	0.031047	0.000495	0.099576	-0.09572
IMF3	0.030596	0.001277	0.11998	-0.12106
IMF4	0.123715	0.002378	0.197358	-0.18903
IMF5	0.18684	0.007409	0.22283	-0.2584
IMF6	0.125477	0.008448	0.221652	-0.22509
IMF7	0.277749	0.016725	0.210875	-0.25649
IMF8	0.301471	0.056186	0.500847	-0.38472
r	0.870421	0.369298	3.126265	1.475747

4.2 Predicition by appling long- and short-term (LSTM) memory neural network

The original data contains a total of 2578 time points. In this article, the latest 515 of the 2578 time points (about 20% of the total data volume) are selected as the test set, and the remaining 2063 data will be used as the training set. There are currently a variety of widely used standards for evaluating model predictions, such as mean absolute distance (MAD), sum of squared errors (SSE), mean square error (MSE) and root mean square error (RMSE). This article will use MSE and RMSE as the standard for model evaluation.

Figure 7: Forecasting fitting result of LSTM

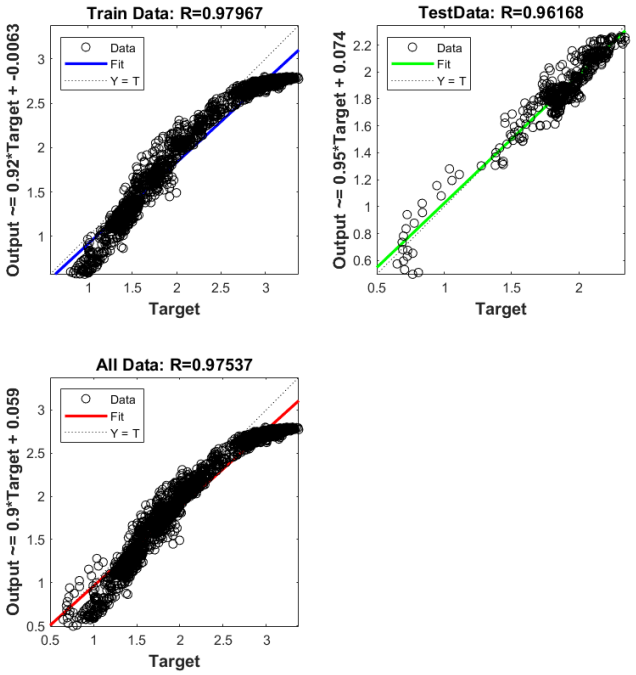
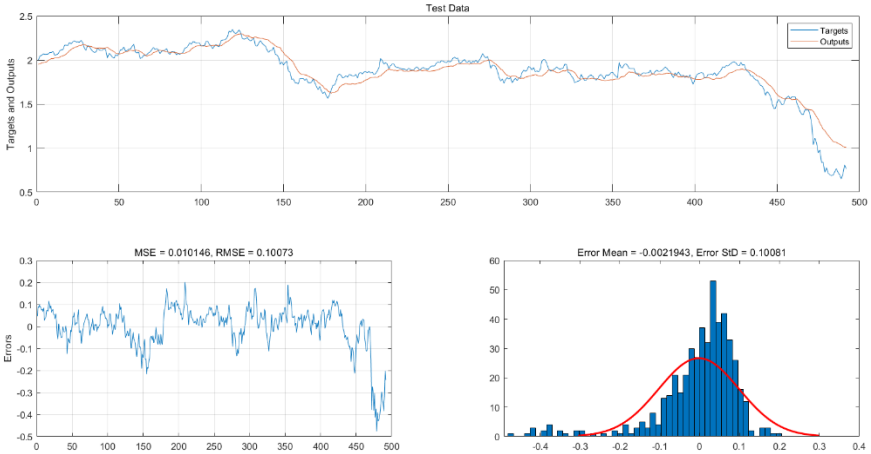


Figure 8. Forecasting fitting result of LSTM

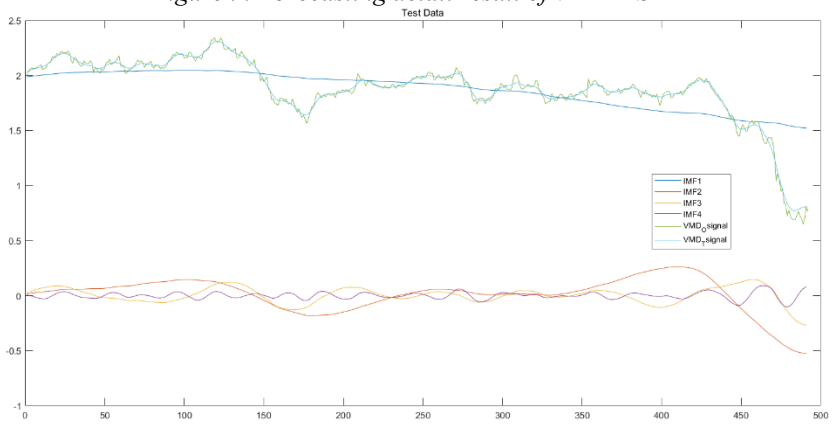


From the training results shown in the figure above, it can be seen that the LSTM neural network has good prediction results for time series signals. The fitted value R of the test data is 0.96168, and the RMSE of the test data is 0.101. At the same time, the curve of the forecast result is more in line with actual data fluctuations.

The VMD method is based on Fourier transform and considers that the signal is composed of sub-signals controlled by different frequencies. Its purpose is to decompose the signal into sub-signals of different frequencies. The different sub-signals obtained by decomposition

represent different information that affects the time series changes. The following figure shows the predicted value curve of the modal function and the final price prediction curve obtained by variational modal decomposition. The horizontal axis is the date and the vertical axis is the price. In the figure, VMD Osignal is the original signal, and its prediction result VMD Tsignal fits the trend of the target set well. After calculation, the RMSE of the prediction result is 0.365.

Figure 9. Forecasting detail result of VMD-LSTM



For comparison, after using the empirical mode method to decompose the original data signal, the prediction result is shown in the figure below. The horizontal axis in the picture represents the number of days (the length of the test set), the vertical axis represents the price, and the curves from IMF1 to IMF8 and r represent the prediction results of the modal function decomposed from the original model. The Osignal curve represents the original model, and the Psignal curve represents the final prediction result. From the RMSE of the different models in the table below, it can be seen that using empirical mode decomposition and variational mode decomposition to pre-process the data on the basis of the LSTM model can effectively improve the prediction accuracy of the data.

Figure 10: Forecasting detail result of EMD-LSTM

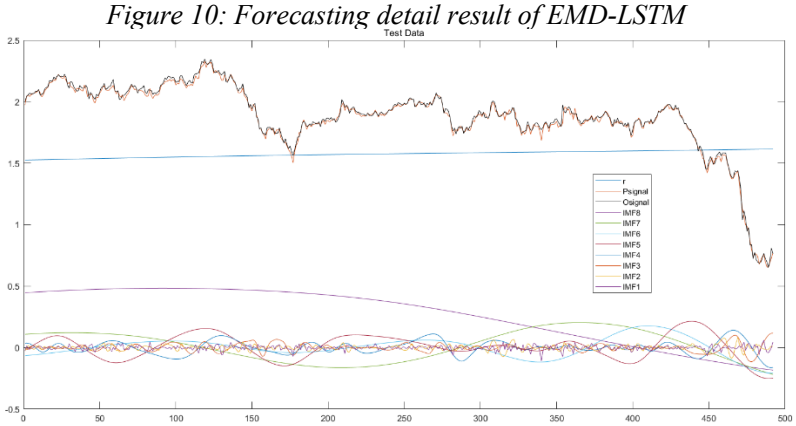


Table 4: Comparison of prediction errors of different models.

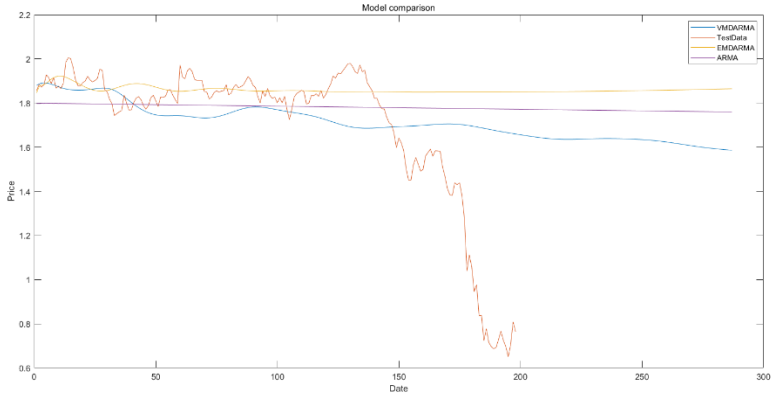
	LSTM	EMD-LSTM	VMD-LSTM
RMSE	0.101	0.0556	0.0365

4.3 Prediction by appyling Autoregressive moving average model

Similarly, this article introduces the traditional autoregressive moving average forecasting model for comparison. It can be seen from the forecast results in the figure below that a single

ARMA model has a poor long-term forecasting effect. In the case of abnormal fluctuations, the accuracy of the short- and medium-term trend forecast is still not high.

Figure 11. Comparison of different models



In addition, this article will also use EMD and VMD hybrid ARIMA model for forecasting. In the forecasting process of about 30 days of taking the forecast result, the fluctuation trend of the forecast result of the EMD-ARIMA and VMD-ARIMA mixed model is better than that of the single ARIMA model. This can also be seen from the RMSE of the predicted fitted value. Under the EMD-ARIMA model, the 35-day predicted fit value is 0.057, and under the VMD-ARIMA model, the 35-day predicted fit value is 0.062. However, in a single ARIMA model with unrepressed data, the RMSE of the 35-day predicted fitted value is 0.109. It can be seen that in the traditional econometric statistical forecasting model, pre-processing the data can greatly improve the forecasting results.

5. Conclusion

In practical financial market price forecasting, the analysis and accurate prediction of prices has great importance. In this paper, the empirical mode decomposition of recursive decomposition and the variational mode decomposition of non-recursive decomposition in time-frequency analysis are applied to signal pre-processing. Then use autoregressive moving average model and long short-term memory neural network to predict the price of jet fuel. In the financial sector, due to the extremely high volatility of the market, there is great uncertainty. Combining more rigorous mathematical models with higher requirements for computational accuracy with forecasting models in finance can effectively improve the accuracy of forecasts and reduce unnecessary risks. Empirical analysis shows that empirical mode decomposition and variational mode decomposition can be used to separate high frequency fluctuation components and low-frequency trend components implicit in time series, effectively reducing the prediction errors caused by internal information interference. The processing of data through time frequency analysis fully reduces the non-stationarity of the original signal, and builds a good external platform for traditional prediction models and emerging neural network models. Compared with a single prediction model, the new combined data pre-processing algorithm provides higher prediction accuracy to a certain extent in both short term and long-term predictions. Therefore, the new data pre-processing algorithm for price prediction based on recursive empirical mode decomposition and non-recursive variational mode decomposition in time-frequency analysis has application value in aviation price prediction.

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Impact of the COVID-19 Pandemic on the Financial Situation of Companies in the Construction Sector: A Case Study in Slovakia

Marek Durica[1], Nikola Opoldikova[2], Lucia Svabova[3]

Abstract

The COVID-19 pandemic has brought unprecedented challenges to industries worldwide, including the construction sector. This study aims to assess the impact of the pandemic on the financial situation of companies in the construction industry in Slovakia. By analysing financial data from a selected group of companies and comparing their pre-pandemic and pandemic period performance, key financial ratios were examined to evaluate profitability, liquidity, activity, and indebtedness changes. The study utilised autoregressive time series models to forecast the financial ratios in the absence of the pandemic, enabling a comparison with actual values during the pandemic. The findings revealed a negative pandemic impact on the profitability, liquidity, activity, and indebtedness of companies in the construction sector.

Keywords

financial stability, financial-economic analysis, COVID-19 pandemic impacts, construction sector

JEL Classification: C22, C5, E37, L74

1. Introduction

COVID-19 was declared a pandemic by the World Health Organization in early 2020. Since then, more than six million people have lost their lives to this disease, and its impact has been felt in various aspects of society, including the economies of many countries and the daily lives of individuals. The extent of the global shock caused by this pandemic is now well-known. Numerous companies have gone bankrupt, while others have accumulated significant debts, experienced decreased profitability or remain completely paralysed for a while. (Belas et al., 2021; Gajdosikova et al., 2022). Besides that, several studies highlight the crucial role of small and medium-sized enterprises as the driving force behind the economy. Consequently, governments should be motivated to aid in their recovery and seek solutions to improve the business environment. While some states have returned to normalcy, others continue to face persistent crises resulting from the pandemic (de Granda-Orive & Martinez-Garcia, 2023).

The COVID-19 pandemic necessitated specific measures in every country to reduce the probability of the disease spread. Almost every business was affected; some experienced a positive impact, while others faced negative consequences. This situation not only impacted the functioning of enterprises but also significantly influenced the cities, towns and the daily lives of ordinary people. The enterprises have faced numerous challenges throughout the pandemic,

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with some enduring while others have managed to expand their operations (Blazek et al., 2023; Michalkova, 2023). Companies have had to address problems related to sourcing the necessary resources for their production. While it can be said that the pandemic is now under control, the recovery of the business environment remains an ongoing process.

Although the complete extent of the pandemic's impacts remains uncertain even three years after its onset, this paper focuses on analysing its effects on the financial situation of companies within the selected construction sector. This study aims to quantify the pandemic impact by examining companies' financial results during the pandemic and comparing them to the pre-pandemic period. The analysis utilises real financial data from the companies' published financial statements, which are then compared with statistical prognoses.

The structure of the remaining section of the paper is as follows. The Literature review section provides an overview of existing perspectives on the pandemic as documented in published studies. The Methodology and Data section briefly outlines the method employed in this study and provides a description of the data utilised for the quantitative analysis. In the Results section, the main findings of the analysis are presented and discussed. The Discussion section offers an overview of the situation in Slovakia during the pandemic crisis and references some studies published in other countries. Lastly, the Conclusion section summarises the key results drawn from the study.

1.1 Literature review

Publications of various authors on the consequences of the COVID-19 pandemic present diverse opinions and perspectives on this issue.

From the point of view of the economy, the pandemic is regarded as a crisis that has significantly impacted the functioning of economies in subsequent periods. This disease has altered statistics macroeconomic situation and has led to a recession. The uncertainty surrounding future developments is apparent but difficult to predict (Ladani et al., 2021). In their publication, COVID-19: The greatest reset, Schwab and Malleret (2020) emphasise the opportunity for people to harness their ingenuity, take control of the future and explore new possibilities within the pandemic-affected economy, encouraging them to „*Think outside the box*".

In Slovak literature, the impacts of the pandemic on enterprises have acquired increasing attention from authors. In his publication, Bednár (2020) expresses a strong opinion that relying on the state, employers, or any other entity is unreasonable. Additionally, the author criticises policymakers and the European Union, citing the example of psychologist Nathaniel Bradnen, having a poster in his office with the words „No one is coming to save you". The author highlights the lack of systematic solutions, insufficient aid, and numerous crisis within the Slovak parliament during the pandemic.

Zakaria (2021) identified ten lessons learned for the post-pandemic world. The author emphasises that COVID-19 has significantly constrained our lives, necessitating global isolation, remote work and restricted contact with loved ones. Furthermore, the author asserts that although the pandemic will subside, the world will never be the same again. Even as the economy rebounds, enterprises will face a crucial test that can either destroy or strengthen them. Consequently, companies must consider stability, adaptability and crisis management as essential factors.

On the other side of the spectrum, an opinion is worth mentioning: „We should have foreseen it". While the COVID-19 pandemic is a novel occurrence, previous events such as the plague, the Spanish flu, various SARS or MERS epidemics, and last but not least, bird and swine flu have impacted the world, resulting in economic and social consequences (Borja & Dieringer, 2023). In 2015, during the TED Talk conference, Bill Gates stated, „If something has the potential to kill more than 10 million people in the coming decades, it is likely to be a highly

contagious virus“. Later, in 2017, during the safety conference, he further specified that the pandemic would likely occur within the next ten or fifteen years (Zakaria, 2021).

Even three years after its onset, opinions among authors and experts from practice regarding the COVID-19 pandemic remain highly diverse. Many entrepreneurs did their best in that situation but were ultimately compelled to end their businesses. A similar situation can be observed among analysts and within scientific studies. However, given the nature of the issue, this divergence is expected since the impact of the pandemic varied from person to person, and individuals dealt with the consequences in their unique ways.

2. Methodology and Data

Since the impacts of the pandemic vary across industries, this study focuses on the Construction industry, which we considered interesting to analyse. Construction production has continued since the beginning of the pandemic. However, there was a slight decrease during the pre-pandemic period in 2019 compared to 2018. Since 2020, production has been increasing at an average rate of 9,69 % per year, indicating that the pandemic may have either no effect or even a positive effect on production in this industry. The average wage of employees in the construction sector has been steadily increasing since 2017. In 2020, when the pandemic began in Slovakia, the pace of increase slowed, and the average wage only rose by 2 €, representing a mere 0.3 % increase. However, in 2021 the growth rate accelerated to 3.46 %. These facts highlight that the year 2020 was crucial for companies, and coping with the situation was challenging for some or even led to liquidation for a few.

The companies' financial situation in selected industries will be assessed using financial ratios. From each group of ratios, the most relevant ones were selected to evaluate the situation of the companies comprehensively. These ratios are listed in Table 1.

Table 1: Financial ratios selected for analysis

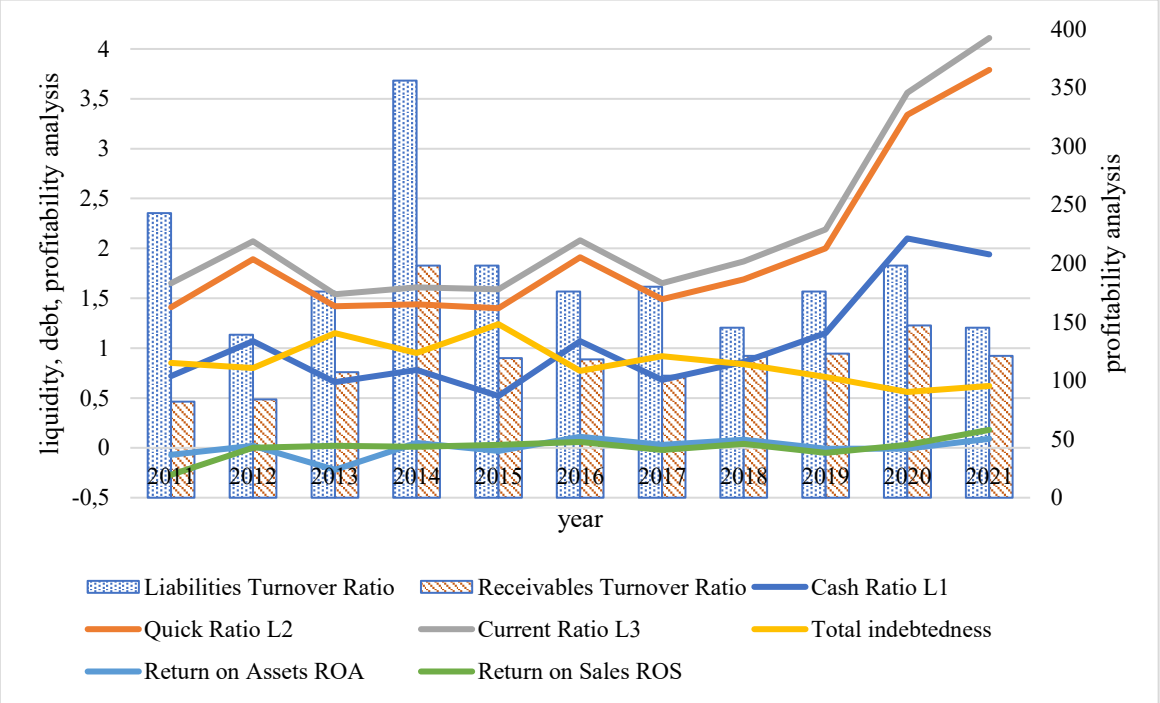
Group	Indicators	Formula for calculation
Liquidity ratio analysis	Cash ratio	$L1 = \frac{Cash + Marketable\ Securities}{Current\ Liabilities}$
	Quick ratio	$L2 = \frac{Currnet\ Assets - Stocks}{Current\ Liabilities}$
	Current ratio	$L3 = \frac{Current\ Assets - Long - term\ Receivables}{Current\ Liabilities}$
Activity analysis	Liabilities turnover ratio	$Liabilities\ turnover\ ratio = 360 \cdot \frac{Current\ liabilities + Long - Term\ Liabilities}{Sales}$
	Receivables turnover ratio	$Receivables\ turnover\ ratio = 360 \cdot \frac{Short - term\ Receivables + Long - term\ Receivables}{Sales}$
Debt Analysis	Total indebtedness	$Total\ indebtedness = \frac{Debts}{Total\ Assets}$
Profitability Analysis	Return on Assets	$ROA = \frac{EBIT}{Total\ Assets}$
	Return on sales	$ROS = \frac{EBIT}{Sales}$

In selecting companies for the analysis, we focused on ensuring comparability based on key parameters such as location, legal form, number of employees and active status. A total of 50

companies were chosen for the analysis, all established before 2010 and have publicly available financial statements covering the period from 2010 to 2021.

Figure 1 illustrates the development of the mean values of the chosen financial ratios throughout the specified period to describe the database of companies selected for the analysis.

Figure 1: Mean values of selected financial ratios during the period under review



The pandemic period covers the years 2020 and 2021, during which certain changes in the trajectory of the financial ratios are more or less noticeable.

While bankruptcy prediction models are frequently employed for forecasting the future financial situation of a company, they may not be suitable for estimating the development of financial ratios. This is because they do not provide an overview of the ratios‘ development but rather focus on the overall company’s situation. Consequently, in this case, mathematical-statistical predictive methods will be employed instead, specifically regression time series models.

To predict the selected financial ratios (listed in Table 1), we constructed autoregression models using the time series values from 2010 to 2019. These models aim to describe the situation of companies in the construction sector during the pre-pandemic period. Subsequently, these models will be utilised to estimate the future trajectory of these ratios during the COVID-19 pandemic period, assuming that the pandemic had not occurred and the development of the financial ratios would have continued in a similar manner. The forecasts will be generated for the years 2020 and 2021. These prognoses will then be compared with the actual values of the ratios during these pandemic years. The differences between the predicted and actual values will reflect the pandemic impact on the financial situation of companies in the selected industry.

In practice, autoregressive (AR) models are commonly used for a simple prediction of future values in time series analysis. These models forecast future values based on the historical development of the time series (Haykin, 1998). In general, the autoregressive model of order p $AR(p)$ can be written

$$y_t = \beta_0 + \delta_1 x_{1_t} + \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + \cdots + \gamma_p y_{t-p} + \varepsilon_t$$

where γ denotes the parameters of the lagged dependent variables, the index of this parameter means the number of lagged periods, x_1 is the explanatory variable included in the model except

for the lags of the given time series (there can be several such explanatory variables in the model) and ε_t is an error term.

The most commonly used is the first-order autoregressive model denoted $AR(1)$ without additional explanatory variables:

$$y_t = \beta_0 + \gamma_1 y_{t-1} + \varepsilon_t \quad (1)$$

or the second-order autoregressive model $AR(2)$ without additional explanatory variables:

$$y_t = \beta_0 + \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + \varepsilon_t. \quad (2)$$

To determine the appropriate order of the AR model, we utilised the partial autocorrelation functions (PACF) for each individual ratio. From an economic perspective, we deemed only the first two lags (equivalent to two years) of the time series, creating the model given by (1) or (2). Additionally, to achieve more accurate predictions, we incorporated the time variable and lags of the other financial ratios in the models. Thus, we get the following model with $AR(1)$ component of the dependent variable

$$y_t = \beta_0 + \gamma_1 y_{t-1} + t + \delta_1 x_{1_{t-1}} + \cdots + \delta_8 x_{8_{t-1}} + \varepsilon_t \quad (3)$$

or model with $AR(2)$ component of the dependent variable

$$y_t = \beta_0 + \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + t + \delta_1 x_{1_{t-1}} + \cdots + \delta_8 x_{8_{t-1}} + \varepsilon_t \quad (4)$$

where $\delta_1, \ldots, \delta_8$ are the coefficients of lagged time series of financial ratios listed in Table 1.

Since our focus is on predictions rather than interpreting the found relationships among variables, we did not assess the statistical significance of the variables in the constructed models. The quality of capturing the variability of the dependent variable is assessed by the coefficient of determination R^2.

3. Results

Regression time series models were created to model the development of the selected financial ratios and predict their values in 2020 and 2021 in the absence of the pandemic. These models were built using the average values of companies in the construction industry from 2010 to 2019. Subsequently, the value of the financial ratio in 2020 was predicted using the values of other variables in 2019, and similarly, the value in 2021 was predicted using the actual values in 2020. The quality of the models, the predicted values and their comparison with actual values during the COVID-19 pandemic are presented in Table 2. To quantify the pandemic impact, the differences between the predicted and actual values are measured as a percentage of the predicted value.

Table 2: Comparison of predicted and actual values of financial ratios

Financial ratio	R square	2020			2021		
		predicted	actual	comparison [%]	predicted	actual	comparison [%
Cash ratio L1	0.29	1.30	2.1	+ **61**	0.84	1.94	+ **131**
Quick ratio L2	0.55	0.58	3.34	+ **475**	0.43	3.79	+ **788**
Current ratio L3	0.59	2.09	3.56	+ **70**	1.63	4.11	+ **153**
Liabilities turnover ratio	0.93	180	198	+ **10**	177.80	145	**- 18**
Receivables turnover ratio	0.96	132	147	+ **12**	66.20	121	+ **83**
Total indebtedness	0.98	0.04	0.56	+ **1,300**	0.11	0.62	+ **463**
Return on Assets ROA	0.82	0.16	-0.01	**- 107**	0.20	0.09	**- 55**
Return on sales ROS	0.99	0.11	0.03	**- 73**	0.25	0.18	**- 28**

All three liquidity ratios (L1, L2 and L3) exhibited higher actual values during the pandemic than what was predicted by the models based on the previous development of companies in this sector. We can assume that during the pandemic, the share of short-term liabilities included in the calculation of liquidity ratios decreased at all levels, at the expense of long-term liabilities, which, although not directly included in the calculations, significantly changed the structure of liabilities. Since the Ministry of Finance of the Slovak Republic provided business loans with 0% interest during the pandemic, we can assume that their use was the reason for higher liquidity during the pandemic compared to expected (predicted) values. However, despite that, it is still possible to conclude that the impact of the pandemic was negative. This conclusion is drawn based on the fact that these ratios can be optimised or maintained within ideal ranges.

The analysis of activity ratios does not allow for the generalisation of the results. The pandemic had predominantly negative impacts, as liabilities were repaid over a longer period than predicted in a scenario without the pandemic. However, in 2021, the turnover period of liabilities had a higher predicted value than the actual value. This indicates that during the pandemic, debtors were able to repay their liabilities in fewer days than predicted.

The total indebtedness ratio reflects a clear negative impact of the pandemic in both years analysed. Therefore, it can be concluded that in the absence of the pandemic, the majority of the companies in the construction sector would have had significantly lower levels of indebtedness.

Finally, the profitability analysis revealed a negative impact of the pandemic, as the companies achieved lower actual values than predicted. This outcome, particularly the generation of a loss in EBIT, is considered a negative consequence of the pandemic.

4. Discussion

The two-year period of the COVID-19 pandemic posed significant challenges for the entrepreneurial sector, with only a small part of the industries able to benefit from the situation. A prompt reaction and effective crisis management were crucial at the beginning of 2020, as supplier relationships were disrupted, and society as a whole experienced a period of paralysis. Analysts have attempted to assess the impacts of the pandemic, not only in the construction sector, by various aspects. However, many authors agree that only a small fraction of companies were able to take advantage of the opportunity and implement changes in their costs and revenue structure to adapt to the circumstances. Iqbal et al. (2021) collected data on the negative impacts of the pandemic in the construction sector in their publication and proposed crisis management strategies to enhance the sector's ability to handle measures during and after the COVID-19 pandemic. Leontie et al. (2022) summarised the main effects of the COVID-19 pandemic on the Romanian construction sector and highlighted the role of digitalisation in mitigating the negative influences. The study revealed that, in general, the Romanian construction sector was only slightly affected, with delays and cost increases due to safety and health issues being the most significant negative impacts. Companies with a higher level of digitalisation were found to navigate the pandemic situation better. Turhan and Ari (2021) focused on the macroeconomic perspective of the pandemic's impacts on the construction sector in Turkey. The authors analysed the establishments and closures of enterprises in this industry. Alsharef et al. (2021) examined the viewpoints of managers, engineers and designers in various industries in the USA. Through interviews, they assessed the early effects of the pandemic on the construction industry in the USA in its early beginning.

Slovakia is considered one of the countries within the European Union that has experienced a slower recovery after the pandemic. (SITA Financie, 2021). The Slovak Business Agency (2022) emphasises in their publication that, based on historical data, all industries except for information technologies have recorded a decrease in profits due to the pandemic. This

conclusion aligns with the finding of our study where, which concluded that the economic result of the selected companies in this industry decreased significantly.

According to the Institute of financial policy, companies in Slovakia have managed the crisis better than in 2009, but it is unlikely that most of them will be able to return to the pre-2020 situation. A persistent issue is that the surviving enterprises now have higher debt levels than ever before. Furthermore, today after some time, it can be observed that the situation a few months after the pandemic crisis did not contribute to their recovery. The war conflict in Ukraine has resulted in a rapid increase in energy prices and a sharp rise in inflation, which are important factors that have an even greater impact on the entrepreneurial environment than the COVID-19 pandemic in various aspects.

An immediate transition to remote work was feasible in the information technology or education sectors. However, in the construction sector that we analysed, remote work was not a viable option. Therefore, the Slovak government implemented the "kurzarbeit" scheme, which provided support to companies whose operations were forced to close, limit or interrupt or whose sales decreased directly due to the pandemic. This was the case for many companies in the construction sector, which were eligible to receive a lump sum of allowance for their employees. After that, the scheme underwent some modifications and became a relatively effective measure, providing the companies with almost complete financial aid.

5. Conclusion

The primary objective of this study was to quantify the impact of the COVID-19 pandemic on the financial situation of companies in the construction sector. This was achieved by analysing their financial results during the pre-pandemic period and comparing them with the pandemic period. Additionally, we aimed to provide an overview of the overall impact of the pandemic on this industry and the development of the financial ratios of these companies over the 12 years. To quantify the impact, eight financial ratios were selected. The pandemic impact was assessed by modelling the development of these financial ratios during the pre-pandemic period, using these models to estimate the future development in the absence of the pandemic and subsequently, comparing the predicted and actual values of these indicators in 2020 and 2021. In summary, the COVID-19 pandemic had a negative effect on companies in the construction sector in terms of their profitability, liquidity, activity and indebtedness.

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Requirements for the reporting of a group of business entities in the present

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Abstract

The requirements for the reporting of a group of entities result from the conditions from Act no. 431/2002 on accounting, as amended in the Slovak Republic. A group of accounting units consists of the parent accounting entity and all its subsidiary accounting entities. A group of accounting entities is referred to by the Accounting Act as a consolidated whole. The requirements in the Accounting Act concern financial reporting, but also non-financial reporting of a group. The basic source of financial information is the consolidated financial statements. An important source of information is the consolidated annual report, which contains financial and non-financial information.

Key words

Group, parent, subsidiary, financial reporting, non- financial reporting

JEL Classification : M40, M41

1. Introduction

By a group of entities, we generally understand the business of several capital-linked entities based on ownership shares. In connection with the definition of groups of entities, it is customary to use the designation holding or concern in the professional economic literature (for example, Majdúchová and at all, 2018). In accounting legislation, the concept of concern or holding is not used. A group of business entities consists of business entities that are separate legal entities. These separate legal entities are economically interconnected. The group as a whole has no legal personality.

Groups of business entities can function in different organizational structures, in a horizontal structure, in a vertical structure, when multi-level groups of companies can even be created. Often, complex organizational structures are created, in which horizontal and vertical structures are combined. Interconnections can arise within these structures. Business groups can act as national groups, or as transnational groups if they have an international reach.

The economic connection of business entities in the group affects the achieved financial and non-financial results of business of the each entity in the group. The group has its own business model, where individual entity fulfill their function and contribute to the realization of this business model. Mutual customer-supplier relations are carried out between entities in the group, for example in the form of purchase and sale of property, financial relations, for example the provision of loans in the group, payment of profit shares. In the Slovak Republic, groups of entities operate in various sectors of the economy and also in the financial sector.

For reporting purposes, a group of entities means a consolidated whole defined by Act no. 431/2002 Coll. on accounting as amended (hereinafter referred to as the "Accounting Act"). A consolidated whole represents a group of accounting entities regardless of their headquarters.

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A group of accounting entities consists of the parent accounting entity and all its subsidiary accounting entities.

According to the Accounting Act (§ 22, provision 3), the parent accounting entity has a prescribed legal form, namely: company, state enterprise, cooperative, or entity in public interest, it must be a shareholder in another accounting entity that is a company and must have a decisive influence directly or indirectly in the subsidiary accounting entity. A subsidiary accounting entity is an entity in which the parent accounting entity has decisive influence directly or indirectly through another subsidiary accounting entity. The definition of decisive influence (control) is based on the de jure concept, which means that the existence of a right establishing decisive influence (control), most often the majority of voting rights (there may be other rights) is assessed. The actual exercise of this right is not required, what is important is the existence of the right, the ability to exercise it.

Accounting entities in the group are independent business entities that keep their own accounting and prepare financial statements. At the same time, the entities in the group are also tax subjects and file a tax declaration for corporate income tax and are also tax subjects for taxes other than income tax.

The parent accounting entity is the accounting entity at the top of the group and has decisive influence over the accounting entities in the group (Galimberti, C.-Marra, A.-Prencipe A. 2013). Reporting for a group is handled by the parent accounting entity (parent company, parent entity). The parent accounting entity is the reporting accounting entity for the group (Lubbe, I., Modack G., Herbert, S., Hyland A., 2014).

Reporting requirements arise from the legal framework that applies to groups. The legal framework that regulates the reporting of the groups in the conditions of the Slovak Republic is Act No. 431/2002 Coll. on accounting as amended. Accounting legislation in the Slovak Republic, which is a member state of the European Union, is influenced by the legislation of the European Union (Lovciová, K., Pakšiová, R., 2018).

2. Aim and Methodology

The research object of the paper is the requirements regarding the reporting of groups of business accounting units in the Slovak Republic. Reporting for the group is carried out by the parent accounting entity, which has decisive influence in the group.

The aim of the paper is to present and analyse the requirements for the reporting of groups at the present in the conditions of the Slovak Republic. The article does not analyse data for a specific group. The article is based on Slovak legislation and international legislation valid as of January 1, 2023 and in professional articles and professional publications in this area.

In the post, we analyse the consolidated financial statements for a group, a statement of selected data from the consolidated financial statements, a report with information on income tax and a consolidated annual report. All these documents are a source of financial and non-financial information about the group for their users.

The paper uses a theoretical analysis of the requirements related to the reporting of the group with subsequent derivation of the reporting outputs that result from them.

3. Analysis of the group reporting requirements

The analysis of the group's reporting requirements showed that the reporting requirements of the group currently relate to financial reporting and also non-financial reporting. Part of financial reporting is primarily accounting reporting, the output of which is consolidated financial statements and other financial information obtained on the basis of data from consolidated financial statements. Non-financial reporting is focused on reporting social

responsibility, currently sustainability. Based on the reported data for the group, it is possible to obtain financial and non-financial information about the group.

The requirements for financial and non-financial reporting of a group are listed in the following table (table 1):

Table 1: Reporting of a group

Financial reporting of a group	Consolidated financial statements Other reports that are not part of the consolidated financial statements, but contain financial data: statement of selected data from the consolidated financial statements, income tax information report Consolidated annual report
Non-financial reporting of a group	Consolidated annual report

Source: Own processing based on Act No. 431/2002 Coll. on accounting as amended.

The main source of financial data is data from accounting, or from the financial statements. In the case of a group, this source is the consolidated financial statements. The main source of non-financial data of a group is consolidated annual report.

3.1 Group financial reporting requirements

The obligation to present consolidated financial statements is regulated in the Accounting Act (§ 22). The definition of the obligation to present consolidated financial statements is based on Directive 2013/34/EU of the European Parliament and of the council of 26 June 2013 on the annual financial statements, consolidated financial statements and related reports of certain types of undertakings, amending Directive 2006/43/EC of the European Parliament and of the Council and repealing Council Directives 78/660/EEC and 83/349/EEC (hereinafter referred to as the "Financial Statements Directive"). Under certain circumstances, the parent accounting entity may be exempt from the obligation to present consolidated financial statements if it meets the conditions of one of the exemptions according to Accounting Act (exemption at the intermediate level of the group with precisely defined conditions, exemption based on size criterias, exemption based on the insignificance of the subsidiary and exemption relating to defined subsidiary accounting entities).

In the conditions of the Slovak Republic, the consolidated financial statements of business entities are prepared exclusively according to IFRSs adopted by the European Union in accordance with Regulation no.1606/2002 on the application of international accounting standards since 2005. The Ministry of Finance of the Slovak Republic also adjusts other statements that are not part of the consolidated financial statements, but contain financial data (for example, a statement of selected data from the consolidated financial statements, a report with information on income tax).

3.1.1 Consolidated financial statements prepared for a group

The main source of financial information about a group is the consolidated financial statements. According to IFRS 10 *Consolidated financial statements*, must be prepared in such a way that assets, liabilities, equity, expenses, income and cash flows of a group are recognised as a single economic entity. A group that has a share in a joint venture and in an associate applies the standard IFRS 11 *Joint Arrangements* and IAS 28 *Investments in Associates and Joint Ventures*.

The consolidated financial statements are prepared for the accounting period, which is the accounting period of the parent accounting entity. Consolidated financial statements, like any financial statement according to IFRSs, must contain data for at least two accounting periods. We present the components of the consolidated financial statements in the following table:

Table 2: Structure of consolidated financial statements

Consolidated financial statements	Consolidated statement of financial position (balance sheet) Consolidated statement of profit and loss and other components of comprehensive income Consolidated statement of changes in equity Consolidated statement of cash flows Notes Consolidated balance sheet at the beginning of the earliest comparable period, if the group changed the accounting policy, or the items in the financial statements were reclassified

Source: Own processing based on IAS 1 *Presentation of financial statements*.

The consolidated statement of financial position (balance sheet) is prepared as of the last day of the accounting period. The consolidated balance sheet shows assets, liabilities and equity for the group. The investment of the parent accounting entity and the share of the parent accounting entity in a subsidiary equity are excluded from the consolidated statement of financial position. The ownership of other shareholders in the group is expressed by the item non-controlling interests. Mutual receivables and liabilities are excluded from the consolidated statement of financial position and the valuation of assets that were the subject of intragroup transactions is adjusted. Goodwill is recognised in the consolidated statement of financial position if it arises during the acquisition of a subsidiary. The consolidated statement of financial position provides information on the financial position of the group.

The consolidated statement of profit and loss and other components of comprehensive income is prepared for the accounting period of the group. In the consolidated statement of profit and loss and other components of comprehensive income, expenses and revenues are recognised for the group. Mutual intragroup expenses and income are excluded. In the consolidated statement of profit and loss and other components of comprehensive income, the share of non-controlling shareholders in the operating result and in other comprehensive income is reported separately. The consolidated statement of profit and loss and other components of the comprehensive income provides information on the financial performance of the group of enterprises.

The consolidated statement of cash flows is prepared for the accounting period of the group and contains recognised cash flows from the group from operating, financial and investment activities. Intragroup cash flows are excluded from the consolidated statement of cash flows. The consolidated statement of cash flows provides information on the change in cash and cash equivalents of the group between the first day of the accounting period and the last day of the accounting period.

The consolidated statement of changes in equity includes recognised changes in the group's equity as a result of the correction of an error, a change in accounting policy and ownership transactions. Equity is recognised divided into equity attributable to the parent accounting entity and to the non-controlling interests. The consolidated statement of changes in equity provides information on changes in the group's equity for two accounting periods.

The notes in the consolidated financial statements contain supplementary and explanatory data to the data in the consolidated statements, as well as non-financial data. The general framework of notes is governed by IAS 1. At the same time, reporting requirements are also specified in other standards, for example IFRS 3, IFRS 12 and in others.

3.1.2 Statement of selected data from the consolidated financial statements

The obligation to present a statement of selected data from the consolidated statements is imposed on the parent accounting entity by the Accounting Act (§ 22, provision 18). The scope,

method, place and dates of filing the statement of selected data from the consolidated financial statements are regulated by the Measure of the Ministry of Finance of the Slovak Republic no. 29928/2011-74. This statement is prepared by the parent accounting entity based on data for the group. The statement of selected data from the consolidated financial statements has a mandatory prescribed structure and content, which the parent accounting entity must comply with. This structure and content is given by the selected data report template. The structure of the statement of selected data is presented in the following table:

Table 3: Structure of the statement of selected data from the consolidated financial statements

Statement of selected data from the consolidated financial statements	General information Selected data from the consolidated statement of financial position Selected data from the consolidated statement of comprehensive income Other selected data

Source: Own processing based on Measure of the Ministry of Finance no. 29928/2011-74.

The statement of selected data from the consolidated financial statements is prepared on the same date as the consolidated financial statements. General information consist information of the identifying of the parent accounting entity (date of creation, business name, seat, ID number, VAT number, SK NACE code) and information identifying the consolidated financial statements (accounting period, regular or extraordinary consolidated financial statements).

Data from the consolidated statement of financial position provide an overview of the structure of assets, equity and liabilities of the group for the current accounting period and the immediately preceding accounting period. The data from the consolidated statement of comprehensive income provide an overview of selected expenses and income of the group for the current accounting period and the immediately preceding accounting period. Other selected data refer to an overview of the structure of shareholders of the parent accounting entity in the current accounting period and an overview of the consolidated entity for the current accounting period and the immediately preceding accounting period.

3.1.3 Reporting on income tax information relating to the group

The Accounting Act establishes the obligation regarding groups to prepare a report with information on income tax. This obligation may arise to the ultimate parent accounting entity. The ultimate parent accounting entity is a company that prepares consolidated financial statements for the largest group of accounting entities, regardless of their headquarters.

This obligation was introduced into the Accounting Act by the transposition of the Directive (EU) 2021/2101 of the European parliament and of the Council of 24 November 2021 amending Directive 2013/34/EU as regards disclosure of income tax information by certain undertakings. This directive was issued with the aim of increasing the transparency (country-by-country reporting). Member states have the obligation to incorporate this directive into their legislation by June 22, 2023. The obligation to prepare a report with information on income tax has (Accounting Act, §21-§21f) ultimate parent accounting entity, if its consolidated revenues in each of two last consecutive accounting periods exceeded EUR 750 000 000 on the balance sheet day. The content of income tax report is presented in the following table:

Table 4: Content of income tax information report

Information provided in the income tax report	Name of the ultimate parent accounting entity Presentation currency List of all subsidiary accounting entities Brief description of the nature of their activities Number of employees based on full-time equivalent basis Revenues (including revenues between related parties) The amount of the profit or loss before income tax The amount of income tax that is calculated as an expense for the current accounting period (deferred taxes are not included) The amount of income tax paid in the current accounting period The amount of retained earnings at the end of the accounting period

Source: Own processing based on Directive (EU) 2021/2101 (Country-by-country directive)

The report on income tax information will include information for each member state. If a Member State comprises multiple tax jurisdictions, this information will be combined at the level of each member state tax jurisdiction. The content of the report with information on income tax was modified by the Ministry of Finance by its measure no. 006455/2023-74 on the report with information on income tax. The income tax information report will be prepared for the first time for the accounting period starting on June 22, 2024.

In addition to the obligation to prepare a report with information on income tax related to the ultimate parent accounting entity, the provisions of the Accounting Act also result from the obligation of a large subsidiary accounting entity of a foreign entity and the affiliated branch of a foreign entity to submit a report with information on income tax for its foreign entity.

Subsidiary accounting entity submits of the income tax information report of the foreign parent accounting entity, if it is a large accounting entity that is a company, has a foreign ultimate parent entity whose consolidated revenues exceeded the amount in each of the two last consecutive accounting periods EUR 750 000 000 or the equivalent of this amount on behalf of a state that is not a member state of the EU on the balance sheet day.

Affiliated branches of the foreign parent entity submits the income tax report of this parent entity, if in each of the two last consecutive accounting periods its net turnover exceeds the amount of 8 000 000 EUR and the foreign parent entity that established the affiliated branches has consolidated revenues that exceeded the amount of EUR 750 000 000 or an equivalent amount in each of the two last consecutive accounting periods.

3.2 Requirements for non-financial group reporting

Some non-financial information are presented in the notes of the consolidated financial statements, but the main source of non-financial information is the consolidated annual report (Accounting Act § 22, paragraph 2). The consolidated annual report also contains specified financial information, for example consolidated financial statements.

The parent accounting unit prepares a consolidated annual report. The content of the annual report is regulated by the Accounting Act (§ 20 - § 20 b) and these provisions also apply appropriately to the consolidated annual report. The provisions of the Accounting Act are based on the Financial statements directive.

Information from the individual annual report and the consolidated annual report can be combined into one consolidated annual report. The annual report contains financial information and non-financial information. The content of the consolidated annual report is presented in the following table:

Table 5: Content of consolidated annual report

Consolidated annual report	Consolidated financial statements for the period for which the consolidated annual report is prepared Auditor's report on these consolidated financial statements Other information defined by the Accounting Act Consolidated Report on Payments to Governments (parent accounting entity that is a company and public interest entity and operates in the extracting industry or in the primary forests) Corporate governance statement (parent accounting entity that issued securities and they were accepted for trading on the regulated market of a member state of the European Union) Explanatory report of the board of directors (the parent accounting entity that issued the securities and they were accepted for trading on the regulated market of the member state and are concerned by the takeover offer) Non-financial information (parent accounting entity that is a subject of public interest and the average number of employees of the group has exceeded 500 employees) A description of the diversity policy it applies in its bodies

Source: Own processing based on Act No. 431/2002 Coll. on accounting as amended and Directive 2014/95/EU

The requirements for the content of the annual report established by the Accounting Act are quite extensive and are based on the on Financial Statements directive. The requirements for the content of the annual report generally consist of requirements that relate to all accounting units preparing the annual report, requirements of defined accounting units, for example, an accounting entities that issued securities on the regulated markets of a member state, an entity of public interest.

The consolidated annual report of all parent accounting entities must contain consolidated financial statements for the accounting period for which the annual report is prepared, the auditor's report and other information defined by the Accounting Act.

The principle of faithful and true representation also applies to the content of the annual report, and therefore also the consolidated annual report. The consolidated annual report is subject to verification by an auditor. The auditor must verify the consolidated annual report within one year after the end of the accounting period.

When verifying the consolidated annual report, the auditor must express an opinion in several areas, namely: whether the consolidated annual report is in accordance with the consolidated financial statements, express an opinion on some information defined by the Accounting Act (for example, on the description of the main internal control and risk management systems in relation to the financial statements and others), express an opinion on whether the consolidated annual report contains information according to a special regulation (if it is a parent accounting entity where such information must be published) and express an opinion on whether the annual report contains information according to the Accounting Act. On the basis of knowledge about the group and the financial situation of the group obtained during the audit, the auditor must state whether he found material misstatements in the consolidated annual report and state the nature of each such material misstatement (§ 20, provision e) - new provision effective from 01/01/2023).

Other information defined by the Accounting Act that must be provided by all parent accounting entities is in particular:

- information about the development of the group, the state in which it is located, and the significant risks and uncertainties to which the group is exposed,
- information on events of special importance that occurred after the end of the accounting period for which the annual report is prepared,

- information on the expected future development of the group's activities,
- information on the costs of research and development activities in the group,
- information on the acquisition of own shares, business shares of the parent accounting entity according to § 22,
- proposals for the distribution of the profit or settlement of the loss of the parent accounting entity,
- information required according to special regulations,
- whether the parent accounting entity has a branch.

The obligation to prepare an annual report on payments to governments belongs the parent accounting unit, which is a large company and an entity of public interest and has activities in the extractive industry or in the area of logging of primary forests, or has subsidiary accounting entities that carry out these activities. The provisions of the Accounting Act relating to the report on payments also apply proportionately to the consolidated report on public authority payments. These payments are divided by type: payment for the mining right, corporate income tax and similar tax, dividend, license fee, entrance fee and other remuneration from the lease agreement, premium for signing the contract for discovery and mining, payment for infrastructure improvement. Payments are shown in the payment report divided according to the states in which it has a mineral extraction operation or a primary forest clearing operation. A payment of one type, the aggregate value of which in one country is lower than 100 000 EUR, does not need to be reported in the payment report.

The parent accounting entity that issued the securities and they were accepted for trading on the regulated market of the member state must also include a corporate governance report as part of the annual report. The corporate governance report contains information related to the governance of the company, such as the governance code, information on governance methods, a description of the main internal control and risk management systems in relation to the financial statements, and more.

The members of the board of directors of the parent accounting entity that issued the securities and they are accepted for trading on the regulated markets of a member state submit an explanatory report regarding the securities to the general assembly. This report provides information regarding, for example, the structure of the share capital, including data on securities not admitted to trading on a regulated market in any member state, restrictions on the transferability of securities, qualified participation in the share capital, and more.

Non-financial information is provided by a public interest entity that is the parent accounting unit of a large group whose average calculated number of employees on a consolidated basis exceeded 500 employees for the accounting period. This non-financial information relates to the impact of the group's activities on the environmental, social and employment matters and information regarding the respect of human rights and the anti- corruption and bribery matters. Such a parent accounting entity shall state in its annual report:

- a brief description of the group's business model,
- a description and results of the use of the policy applied by the group in the area of social responsibility, including the application of due diligence procedures, a description of the main risks of the group's influence,
- a description of the main risks of the group's influence on the area of social responsibility arising from the activity of the accounting entity, which could have adverse consequences, and, if appropriate, also a description of business relationships, products or services that are related to the risks of this influence and a description of the way in which the group manages the risks,
- significant non-financial information about the group's activities by individual activities,

- reference to information on the amounts reported in the consolidated financial statements and an explanation of these amounts in terms of impacts on the area of social responsibility, if possible.

Non-financial information may also be provided from the framework of the European Union, or from another international framework that regulates non-financial information. However, the annual report must state the framework under which this information was provided.

This non-financial information does not have to be provided by a subsidiary accounting entity that is a subject of public interest, if information about it and all its subsidiary accounting entities is included in the annual report or in a similar report of the parent accounting entity. If the public interest entity does not disclose this non-financial information, it shall state why this information was not disclosed.

A description of the diversity policy it applies in its administrative bodies, management bodies and supervisory bodies, especially in relation to the age, gender, education and professional experience of the members of these bodies, the objectives of such policy, the way it is implemented and the results achieved in the reporting period, if on the day on which the financial statements are prepared and for the immediately preceding accounting period, it fulfilled at least two of the specified conditions regarding the amount of net assets (higher than EUR 20 000 000), the amount of net turnover (higher than EUR 40 000 000), the average recalculated number of employees (exceeded 250).

The parent accounting entity that does not provide a description of the diversity policy in the consolidated annual report shall state in the annual report the reasons on the basis of which it decided not to apply the diversity policy.

4. Conclusion

The consolidated financial statements, statement of selected data from the consolidated financial statements, income tax information report, annual report and auditor's report are stored in the register of financial statements. They are an important source of information for an external user of information for the group (for example, a potential investor, bank, public, government) and a person interested in information about the group (auditor, financial analyst). An external user of information for a group does not have access to internal information related to the group. Managers and current owners of the group have access to internal information.

Consolidated financial statements provide information about the financial position, financial performance, cash flows and changes in the financial position of the group as if it were a single economic entity. On the basis of financial information, it is possible to evaluate the financial health of a group.

Considering that the financial statements according to IFRSs do not have a precisely defined format, the statement of selected data provides financial data in a precisely defined format and structure. The statement of selected data also contains non-financial information, for example information on the consolidated entity.

Consolidated financial statements are tax ineffective. The corporate tax is not assessed for the group. In order to increase transparency and public interest, an obligation was introduced for an ultimate parent accounting entities that exceed the set limit of consolidated revenues to prepare a report with information on income tax.

In order to better protect the tax bases of the EU Member States, Directive (EU) 2022/2523 of 14 December 2022 on ensuring a global minimum level of taxation for multinational enterprise groups and large-scale domestic groups in the Union was issued. The aim of the directive is to ensure a global minimum level of taxation of multinational corporate groups and large national groups in the Union. The member states should incorporate it into their national legislation by 31.12. 2023.

The consolidated annual report contains financial information and non-financial information and contributes to the usefulness of the information recognised in the consolidated financial statements. On the basis of non-financial information, the user of the information can assess the impact of the group's activities on society in the economic, social and environmental areas. In the area of reporting non-financial information, changes will occur through the transposition of Directive (EU) 2022/2464 of the European Parliament and of the Council regarding the reporting of information on corporate sustainability. This directive must be incorporated into the legislation of the Member States in several specified periods of time.

The present time is influenced by the socio-economic consequences of the Covid-19 pandemic. The economic situation of business entities and groups of business entities is also affected by other risks, such as the war in Ukraine, rising prices and the energy crisis. At the same time, issues related to the sustainability of businesses are becoming more and more relevant. All these facts will affect the reporting of not only individual companies, but also groups of companies in the future.

Acknowledgments

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[11] Directive (EU) 2022/2464 of the European Parliament and of the Council regarding the reporting of information on corporate sustainability.

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Comparing Active and Passive Approaches in Portfolio Optimization Models

Aleš Kresta[1], Terezie Krestová[2], Michael Slovák[3]

Abstract

The paper deals with the comparison of the performances of selected portfolio optimization models. Unlike other studies, we do not consider fixed parameters of individual optimization strategies but consider these models as a group of strategies with different parameter settings. Specifically, we consider different values for the length of input time series and maximum weight of the stock in a portfolio. In such a setup we consider the set of 180 specific parametrizations of the selected models and we compare the active and passive approaches to investing. Empirical results are based on stocks included in the Standard & Poor's 100 index and the out-of-sample results are compared by means of different performance measures. Based on the results, we conclude that the passive approach outperforms the active approach. Comparing the different portfolio models, there is no clear outperformer, however, it is clear that all the models outperform the benchmark (the Standard & Poor's 100 index).

Key words

Portfolio optimization models; risk measures; performance measures; mean-variance; mean-CVaR; mean-semivariance.

JEL Classification: G11

1. Introduction

In today's dynamic and ever-changing financial world, the composition of investment portfolios plays a crucial role in achieving optimal returns while managing risk. Diversification, in particular, holds significant importance as it helps mitigate the risk. By appropriately distributing investments across various assets, investors aim to maximize their investment potential.

The aim of the paper is to compare the performance of selected portfolio optimization models over a selected period, with an emphasis on a comprehensive analysis. This is achieved by constructing a large number of portfolios based on two different input parameters. Specifically, we consider different lengths of the in-sample time series needed for parameter estimation and the maximum weight restriction.

Our empirical analysis is based on stocks included in the Standard & Poor's 100 index, which consists of 100 major US companies. These companies are predominantly blue-chip firms with substantial market capitalization, making the index a representative benchmark for evaluating portfolio performance. By using this dataset, we aim to provide insights that are relevant and applicable to real-world investment scenarios.

The performances of the selected portfolio optimization models are compared using different performance measures, providing a comprehensive evaluation of their effectiveness. Our analysis includes well-known models such as the mean-variance model, mean-CVaR model,

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and mean-semivariance model. These models employ different risk measures and optimization techniques to construct efficient portfolios.

By comparing the active and passive approaches to investing, we aim to shed light on the trade-offs between active portfolio management and a passive buy-and-hold strategy. The active approach involves continuous monitoring and adjustments to portfolio composition, while the passive approach focuses on creating a portfolio and holding it for the whole period without rebalancing.

In summary, this paper contributes to the existing literature on portfolio optimization by providing a comprehensive comparison of selected models. Our analysis takes into account various parameter settings, including the length of input time series and maximum weight restrictions. Based on our empirical results, we draw conclusions regarding the relative performance of active and passive approaches, as well as the effectiveness of different portfolio models.

The paper is structured as follows. In the second section, we provide a brief introduction to the methodology with emphasis on applied portfolio optimization models and performance measures. In the third section, we provide the results of the empirical analysis. The last section provides the conclusion of the paper.

2. Methodology

In this section, we briefly introduce the portfolio optimization models and performance measures applied in the empirical part of the paper.

2.1 Portfolio optimization

The problem of portfolio optimization can be generally understood as a process whereby given the risk and expected return of the various admissible portfolios an investor tries to select a portfolio that has the minimum risk at a given level of expected return. This optimization problem can be written mathematically as:

$$\min_x \rho(x), \tag{1}$$

under the constraints:

$$E[\omega(x)] \geq r_{min}, \tag{2}$$
$$1^T \cdot x = 1, \tag{3}$$
$$x \geq 0, \tag{4}$$
$$x \leq x_{max}, \tag{5}$$

where $\rho(x)$ is the chosen risk measure, $E[\omega(x)]$ is the expected return of the portfolio, and the constant r_{min} represents the minimum return expected by the investor, see Rachev et al. (2005). Constraint (4) expresses that no short-selling is possible. By imposing the constraint (5) we can limit the maximum possible weight and thus assure a given level of diversification.

The risk measure $\rho(x)$ can be chosen arbitrarily with respect to the investor's preferences, although in case of some measures, there is a problem with the optimization itself, where the resulting optimization problems are hard to solve (e.g. VaR) and the knowledge of nonlinear programming is required.

2.1.1 Mean-variance model

This is probably the most known approach to portfolio optimization. The model was introduced in the 1950s by Markowitz (1952, 1959). As the name suggests, the variance (or standard deviation) of return is used as a measure of risk.

The mathematical formulation of the optimization problem that minimizes portfolio risk is as follows:

$$\min_x \sigma_p = \sqrt{x^T \cdot \mathrm{Q} \cdot x}, \tag{6}$$

under constraints:

$$x^T \cdot E(R) \geq r_{min}, \quad (7)$$
$$1^T \cdot x = 1, \quad (8)$$
$$0 \leq x \leq x_{max}, \quad (9)$$

where Q is the covariance matrix and $E(R)$ is the vector of expected returns.

2.1.2 Mean-CVaR model

Having *S* random scenarios of the return vector, $y_s = \left(y_{1,s}, y_{2,s}, \ldots, y_{N,s}\right)^T$, e.g. historically observed returns, the linear programming model to minimize the CVaR of a portfolio is as folows:

$$\min_{x,\gamma,z} \gamma + \frac{1}{(1-\beta)\cdot S}\sum_{s=1}^{S} z_s, \quad (10)$$

under constraints:

$$x^T \cdot E(R) \geq r_{min}, \quad (11)$$
$$z_s \geq -x^T \cdot y_s - \gamma, s \in \{1, 2, \ldots S\} \quad (12)$$
$$z \geq 0, \quad (13)$$
$$1^T \cdot x = 1, \quad (14)$$
$$0 \leq x \leq x_{max}, \quad (15)$$

where β is the CVaR probability level, z and γ are auxiliary variables. A full derivation of this model can be found in the original work of Rockafellar and Uryasev (2000).

2.1.3 Mean-semivariance model

The optimization problem that minimizes the semivariance of a portfolio was addressed by Ballestero (2005). It is analogous to the Markowitz mean-variance model, see (6) - (9), except that instead of covariance matrix Q a semivariance matrix Q^{down} of asset returns is utilized.

In order to calculate the semivariance matrix, it is necessary to define a vector of betas of individual assets: $\beta = (\beta_1, \beta_2 \ldots, \beta_N)$, where betas are calculated in line with the CAPM model, $\beta_i = \frac{\sigma_{i,MT}}{\sigma_{MT}^2}$. The upper semivariance of the market portfolio (*MT*) returns, which is the right-hand side of the density function, is then calculated as:

$$(\sigma_{MT}^{up})^2 = \frac{1}{M}\sum_{t=1}^{M}\{\max\left[R_{t,MT} - E(R_{MT}), 0\right]\}^2. \quad (16)$$

The semivariance matrix Q^{down} is then calculated as follows:

$$Q^{down} = Q - (\sigma_{MT}^{up})^2 \cdot \beta \cdot \beta^T, \quad (17)$$

where Q is the covariance matrix.

2.2 Performance measures

In the same way as there are different approaches to measuring the risk, there are also different approaches to measuring the performance of individual stocks or portfolios. A performance measure can be thought of as a ratio of reward per unit of risk taken. The reward is typically the return of the asset or portfolio over a certain period, usually adjusted for the return of the risk-free asset (obtaining excess return). Depending on the choice of the risk measure in the denominator, different performance measures are then derived. Below we define three commonly applied performance ratios: Sharpe ratio, Calmar ratio, and Sortino ratio.

2.2.1 Sharpe ratio

The Sharpe ratio was introduced by Sharpe (1966) for measuring and comparing fund performances. This metric measures the return per unit of risk in terms of its standard deviation. The formula for calculating the Sharpe Ratio is as follows:

$$SR = \frac{R_p^{p.a.} - R_f^{p.a.}}{\sigma_p}, \tag{18}$$

where σ_p represents the standard deviation of the portfolio return and $R_p^{p.a.}$ represents the average portfolio return, which for the purposes of this paper will be understood as the compound annual growth rate (CAGR). The risk-free rate $R_f^{p.a.}$ is subtracted from the portfolio return, although it is also possible to encounter variants where this rate is not subtracted or other chosen benchmark is utilized (Sharpe, 1994).

2.2.2 Calmar ratio

As stated by Magdon-Ismail and Atiya (2006), the Calmar ratio is a risk-adjusted measure of return, where the maximum drawdown (henceforth MDD) is taken as the measure of risk. The formula for calculating the Calmar ratio is as follows:

$$CR = \frac{R_p^{p.a.} - R_f^{p.a.}}{MDD_p}. \tag{19}$$

2.2.3 Sortino ratio

As with previous measures of return, it is the ratio of the excess return to the level of risk, specifically using the semideviation σ_p^{down}. The Sortino ratio (Sortino and Price, 1994) can thus be calculated using the following formula:

$$SoR = \frac{R_p^{p.a.} - R_f^{p.a.}}{\sigma_p^{down}}. \tag{20}$$

3. Empirical results

Portfolio optimization is performed on stocks included in the Standard & Poor's 100 index (henceforth SP100), which is composed of 100 major US companies. These are mostly blue-chip companies that have the largest market capitalization. It is a capitalization-weighted index, which means that the weight of each company is determined by the ratio of its capitalization to the total market capitalization. Figure 1 shows the evolution of the Standard & Poor's 100 index over the in-sample period from January 1, 2015, to December 31, 2015, and the out-of-sample period from January 1, 2016, to December 31, 2022. As is obvious in both periods the general trend is upward, however, there are some market crashes and periods with downtrends. Out of 100 stocks included in the index we excluded 13 due to the incomplete data. Thus, we work with only 87 components of the index.

Two approaches are used in this paper, namely passive and active. In the case of the passive approach, portfolios are constructed as of January 1, 2016. Different time series lengths are used for the parameter estimation, specifically, the time series starting from January 1, 2005, to January 1, 2012, and always ending on December 31, 2015, see Table 1 for description. As can be seen, the distributions of returns are usually negatively skewed and with excess kurtosis, which leads to the rejection of the normality by the Jarque-Bera test for all 87 stocks. We can also notice, that the shorter the in-sample period, the lower the kurtosis. For passive investments, the created portfolios are held over the whole out-of-sample period without rebalancing.

In the active approach, we proceed in the same way as in the case of the passive approach, but in the out-of-sample period, we rebalance the portfolio at the beginning of each year, i.e. on January, 1. For rebalancing purposes, the length of the in-sample time series stays constant.

Figure 1: Standard & Poor's 100 index evolution in in-sample and out-of-sample periods

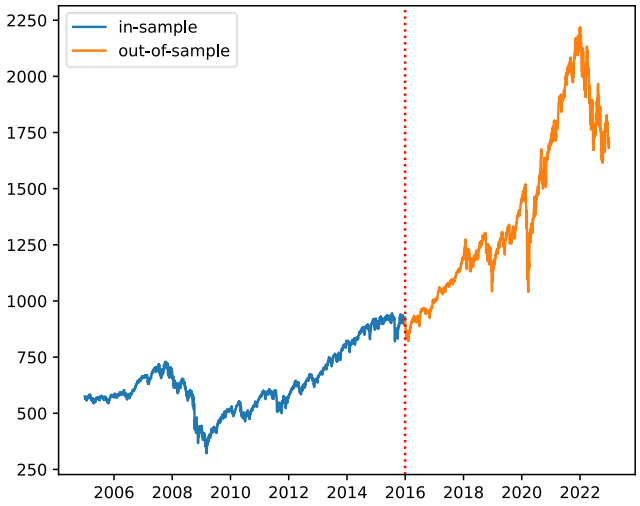


Table 1: Basic descriptive characteristics of the applied time series

Start of time series	Number of observations	Average return	Median return	Average skewness	Average kurtosis	JB P-value lower 0.05
1.1.2012	1005	5.21E-04	5.84E-04	-0.14	5.04	87/87
1.7.2011	1132	4.23E-04	4.91E-04	-0.22	5.39	87/87
1.1.2011	1257	4.27E-04	4.53E-04	-0.22	5.32	87/87
1.7.2010	1385	5.61E-04	5.48E-04	-0.20	5.19	87/87
1.1.2010	1509	4.52E-04	4.57E-04	-0.20	5.04	87/87
1.7.2009	1637	5.64E-04	5.78E-04	-0.15	5.93	87/87
1.1.2009	1761	5.22E-04	4.78E-04	-0.07	8.01	87/87
1.7.2008	1889	3.20E-04	3.70E-04	-0.08	11.53	87/87
1.1.2008	2014	2.58E-04	2.91E-04	-0.08	11.02	87/87
1.7.2007	2141	2.39E-04	2.80E-04	-0.09	10.93	87/87
1.1.2007	2265	2.71E-04	2.91E-04	-0.09	11.23	87/87
1.7.2006	2391	2.96E-04	3.23E-04	-0.10	11.53	87/87
1.1.2006	2516	2.94E-04	3.02E-04	-0.10	11.68	87/87
1.7.2005	2643	3.19E-04	3.23E-04	-0.09	11.88	87/87
1.1.2005	2768	3.09E-04	3.19E-04	-0.13	12.97	87/87

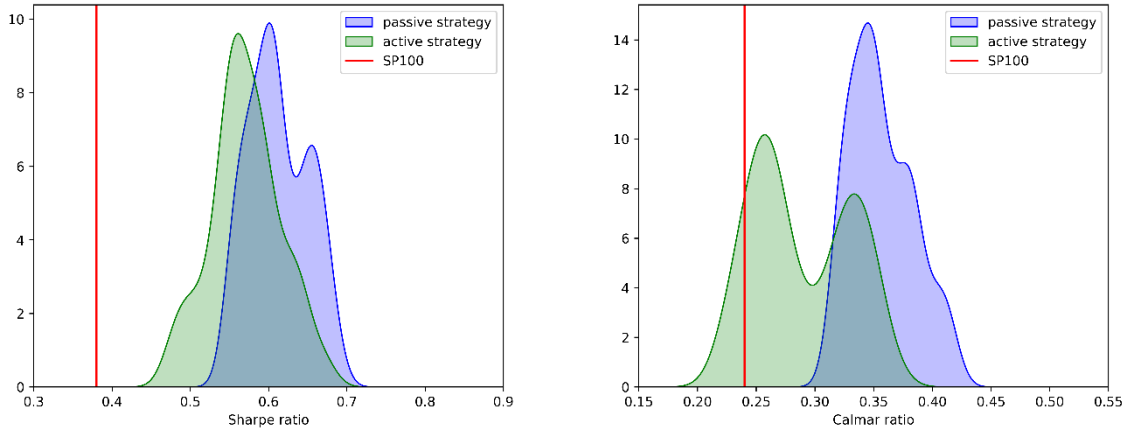
For both approaches, we optimize the portfolios by the risk minimization models described in section 2.1, i.e. mean-variance, mean-semivariance, and mean-CVaR models, setting the minimum required expected return r_{min} to be 9% p.a. We also consider the requirement of minimum diversification, and apart from the length of the in-sample time series we vary the value of the maximum weight, x_{max}. The maximum weight varies between 4% and 9.5% with the step of 0.5%. Thus, for each optimization model a total of 180 portfolios were constructed, differing in the degree of diversification (12 variants) and the length of the time series used (15 variants). It should be also noted that the transaction costs and taxes are not assumed.

3.1 Comparison of active and passive strategies

In this subsection, we compare the results from active and passive strategies under different optimization models. Figure 2 shows a comparison of the histograms of Sharpe and Calmar ratios under the mean-variance optimization for the active and passive strategies. The resulting values are above the chosen benchmark, except for a small part of the active approach under the Calmar ratio. It can be noticed that the values of the Sharpe ratio for the active approach are in the interval between 0.42 and 0.71 and for the passive approach in the interval between 0.5 and 0.71. Values of the Calmar ratio range from 0.17 to 0.4 for the active approach, while for the passive approach, they range from 0.29 to 0.45. These values show that if a portfolio was

constructed on January 1, 2016 and then held for seven years (passive approach), it would be more likely to achieve higher Sharpe and Calmar ratios than in the case of the portfolio rebalancing every year (active approach). Also, in the case of an active approach, the resulting value would be probably lower due to the transaction costs and taxes, which are neglected in our analysis and would be higher for the active approach.

Figure 2: Comparison of passive and active approaches under the mean-variance approach



The histograms of the values of Sharpe and Calmar ratios under the mean-CVaR optimization models are shown in Figure 3. The resulting values are well above the chosen benchmark. At first glance, it is clear that for the Sharpe ratio, the individual histograms are more "overlapping" than in the case of the mean-variance model. If we judge performance based solely on the Sharpe ratio, the active approach would outperform the passive investment on average. For the Calmar ratio, we can again notice that the passive approach outperforms the active approach. Considering the neglected transaction costs and taxes, in general, the passive approach would probably outperform the active approach.

Figure 3: Comparison of passive and active approaches under the mean-CVaR approach

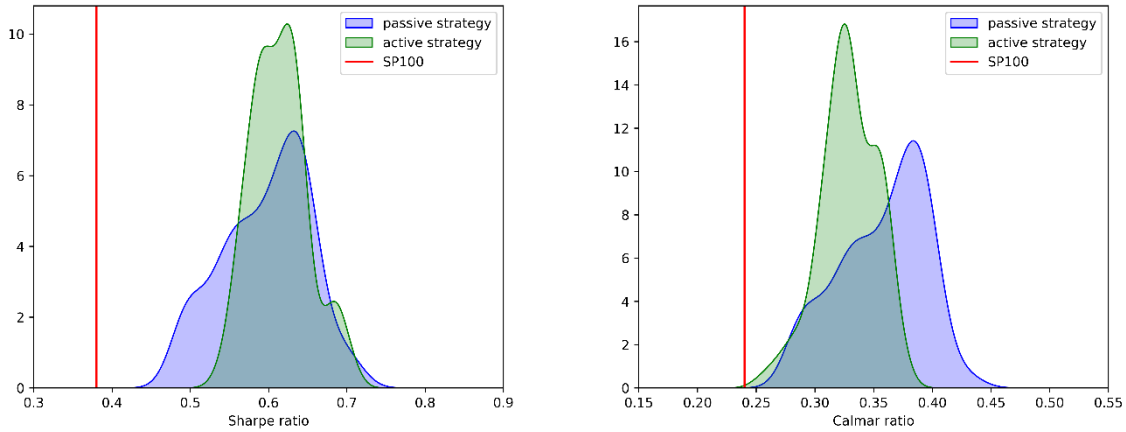


Figure 4 shows a comparison of the histograms of the Sharpe and Calmar ratios under the mean-semivariance optimization for the active and passive strategies. It is noteworthy that the histograms of passive approach are significantly shifted to the right for both ratios, which is desirable. In the case of the active approach, some of the values of the Calmar ratio are even below the chosen benchmark.

We further compare the results of the models in terms of the worst-performing and the best-performing portfolios. In Table 2 we list the performances of the worst portfolio (in terms of

achieved average annual return p.a.) for each strategy. As can be seen, for mean-variance and mean-semivariance models, the passive approach outperforms the active approach in all analyzed risk and performance measures. For mean-CVaR model, the results are mixed.

In Table 3 we list the performances of the best portfolio (in terms of achieved average annual return p.a.) for each strategy. As can be seen, the differences between the passive and active approaches are much smaller. From the results, there is no clear interpretation of whether the active approach outperforms the passive or vice versa as the results are mixed.

Figure 4: Comparison of passive and active approaches under the mean-semivariance approach

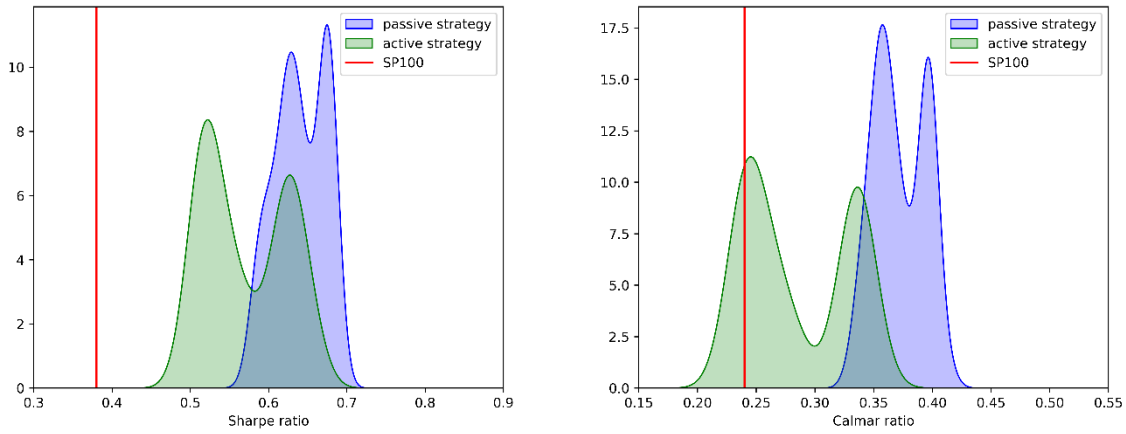


Table 2: Basic descriptive characteristics of the worst-performing strategies

	SP100	mean-variance		mean-CVaR		mean-semivariance	
		passive	active	passive	active	passive	active
Time series length	-	9 years	5.5 years	9 years	11 years	11 years	5.5 years
Maximum weight	-	5.00%	4.00%	4.50%	4.50%	5.00%	4.00%
Average annual return p.a.	9.41%	10.35%	9.65%	9.37%	10.45%	10.93%	10.00%
Standard deviation p.a.	19.46%	15.23%	16.03%	15.27%	15.39%	15.51%	16.33%
Semideviation p.a.	14.03%	10.77%	11.55%	10.82%	10.86%	10.97%	11.80%
Daily VaR(0.05)	1.89%	1.33%	1.40%	1.33%	1.32%	1.38%	1.46%
Daily CVaR(0.05)	3.06%	2.27%	2.43%	2.29%	2.29%	2.33%	2.51%
MDD	31.53%	26.37%	33.52%	26.05%	27.78%	27.01%	34.30%
Sharpe ratio	0.38	0.55	0.48	0.48	0.55	0.58	0.49
Sortino ratio	0.53	0.78	0.66	0.68	0.78	0.81	0.68
Calmar ratio	0.23	0.32	0.23	0.28	0.3	0.33	0.23

Table 3: Basic descriptive characteristics of the best-performing strategies

	SP100	mean-variance		mean-CVaR		mean-semivariance	
		passive	active	passive	active	passive	active
Time series length	-	5.5 years	8.5 years	4 years	7 years	6 years	8.5 years
Maximum weight	-	4.50%	9.50%	8.50%	9.50%	4.00%	9.00%
Average annual return p.a.	9.41%	12.84%	12.52%	13.07%	13.27%	12.97%	12.36%
Standard deviation p.a.	19.46%	15.64%	15.53%	15.55%	15.87%	15.93%	15.65%
Semideviation p.a.	14.03%	10.98%	10.93%	11.00%	11.18%	11.22%	11.10%
Daily VaR(0.05)	1.89%	1.36%	1.29%	1.33%	1.28%	1.41%	1.35%
Daily CVaR(0.05)	3.06%	2.33%	2.27%	2.31%	2.32%	2.39%	2.34%
MDD	31.53%	25.75%	28.89%	28.05%	30.70%	26.45%	29.97%
Sharpe ratio	0.38	0.69	0.68	0.71	0.71	0.69	0.66
Sortino ratio	0.53	0.99	0.96	1.01	1.01	0.98	0.93
Calmar ratio	0.23	0.42	0.36	0.39	0.37	0.41	0.35

4. Conclusion

In this empirical analysis, we examined the performance of different portfolio optimization strategies using stocks from the Standard & Poor's 100 Index. Two approaches were considered: passive and active. We employed three optimization models: mean-variance, mean-semivariance, and mean-CVaR models. Comparing the passive and active strategies under different optimization models, we analyzed the histograms of the Sharpe and Calmar ratios. For the mean-variance model, both strategies yielded values above the chosen benchmark, except Calmar ratio under active approach, with the passive approach tending to achieve higher ratios. The mean-CVaR model showed mixed results, while the mean-semivariance model favored the passive approach, as its histograms were more shifted to the right. Further comparison of the worst-performing and best-performing portfolios revealed similar results.

Overall, the findings suggest that a passive investment approach may be more favorable in achieving higher Sharpe and Calmar ratios. However, the performance of the active approach varied depending on the optimization model employed.

It is important to note that these conclusions are based on the specific dataset and period analyzed in this study. Different market conditions, additional factors, and the inclusion of transaction costs and taxes could influence the relative performance of passive and active strategies. Further research is recommended to validate these findings and explore other factors that may impact portfolio performance.

Acknowledgments

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Assessment of the development of the personal income tax burden in the Czech Republic

Karolina Lisztwanová, Iveta Ratmanová [1]

Abstract

Individual income tax has been amended many times in the Czech Republic since its introduction in 1993. Changes in the individual income tax legislation impact the disposable income of individual taxpayers. It is possible to quantify and analyze the taxation extension by applying, for example, the tax burden. This paper aims to analyze the evolution of this measure at selected taxpayers in the Czech Republic from 1993 to 2023.

Key words

Personal income tax, total tax liability, tax burden

JEL Classification: H24, K34

1. Introduction

Tax is an obliged payment to the public budget determined by legislation without generating liability to finance a specific public project. Tax can be described as a payment regularly recurring in an interval or thanks to particular circumstances. Moreover, tax is assessed as a non-equivalent payment not entitled to compensation. Finally, tax is an irreversible payment without a claim to repay the amount already paid. One of the most basic tax classifications is classification according to the taxpayer's income - direct and indirect tax. The taxpayer pays direct tax, and there is no risk of tax incidence. Property taxes, income taxes, or lump sum tax can be included in this type of tax. In the case of indirect tax, a taxpayer does not pay tax according to his income, and tax can be transferred to the other subject, as it can be seen in the case of consumption taxes.

Today's taxation ideas are derived from the historical development of economic and political opinions. The main pillar of taxation is influenced by the individual's freedom as the economic theory's basic resource. The exchange tax theory argues that taxes are considered for payments of public services provided to individuals. The benefit principle is evident in the case of property tax. Over time the principle of payment ability added to the benefit principle. This fact eliminates the risk of regressive taxation. Currently, the principle of the same victim (the same loss) reacts to the fact that everyone should have the same or marginal loss, even if they don't have the same income. (Kubátová, Vítek, 1997)

The tax functions contain fiscal, stabilization, redistribution, and allocation functions. (Vančurová, Zídková, 2022) These functions can be identified in individual types of taxes. In the case of personal income taxation, these functions are visible. The paper aim is to describe and assess the development of individual income taxation in the case of selected taxpayers with employment income during the period between 1993-2023, when progressive taxation

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was substituted with linear taxation. Assessing will be made by calculating the final tax burden, and the values of the gross average monthly wage will be used as input data.

In the Czech Republic, researchers in the field of personal income tax focus on researching the progression of fictitious incomes (mostly multiples of the average wage) and the interval progressiveness is measured [see e.g. Krajňák (2020, 2021), Krajňák et al. (2022), Široký and Maková (2009), Ratmanová (2011)].

Široký and Maková (2009) analyzed the effect of replacing the nominal progressive tax rate with a nominal linear tax rate in the Czech Republic in 1993 - 2007. Dušek et al. (2014) also mention that the reform of the personal income tax in 2008 led, in some cases to a reduction in the tax burden, but that income tax remains a progressive tax. According to Tepperová and Pavel (2016) these reforms significantly affected the amount of tax revenues and the distribution of the tax burden personal income tax in the Czech Republic. All mentioned authors found out that this reform reduced the tax burden of personal income tax, especially for a taxpayer with children or taxpayer with the average level of wage.

2. Personal Income Tax in the Czech Republic

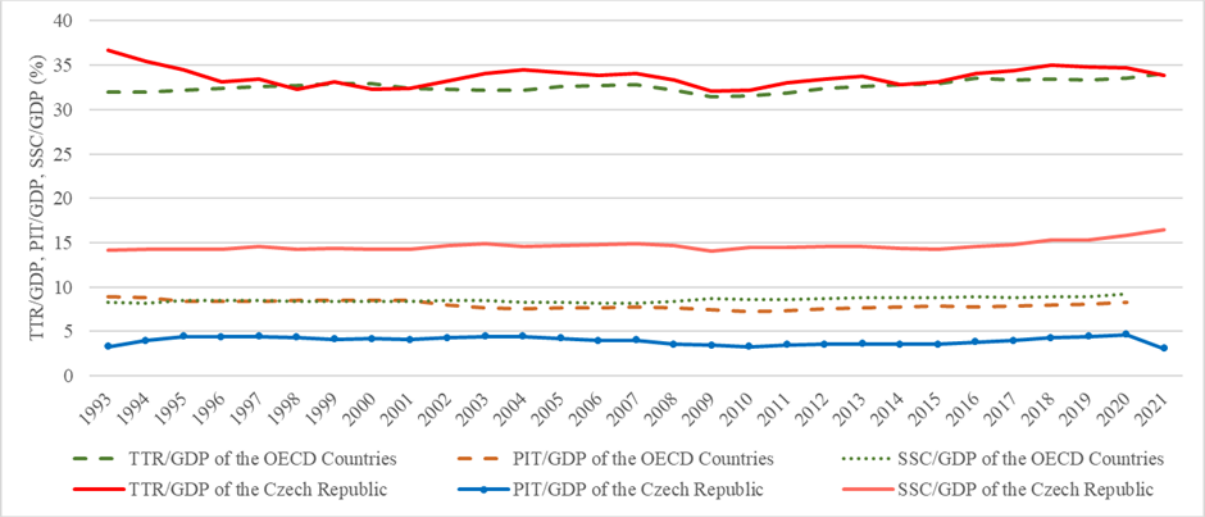
Personal income tax is a relatively young tax, it was used for the first time in 1799 for financing The Napoleonic wars in the United Kingdom. (Kubátová, 2018) The rates of this tax were very low when it was created, and only high incomes were subject to this tax. After the Second World War, its rates increased, however, in the 1980s efforts to reduce them began to be seen. The taxation of individual income, as it is known today in the Czech Republic, dates back to 1993.

The role of taxation in the economy can be described via the tax quota. Tax quota is the ratio between total tax revenues and GDP. (Široký, 2008) Concerning data mentioned in Figure 1, it is clear that the observed period declares a stable level of this ratio without a fatal decrease or increase in the reality of the Czech Republic. Comparing the Czech data with OECD data, essential differences are not detected. Regarding the development of this ratio, it can be generally concluded that changes in tax revenues are similar to changes in GDP in the case of the Czech Republic and OECD countries.

The development and the value of the tax quota, in the case of personal income tax, declare the position of this tax in tax systems. According to the details of Figure 1, it is clear that significant changes were not detected in its development. Nevertheless, the difference is clear from the value of the tax quota. This indicator reaches a higher value in the case of OECD data. It shows the more important role of personal income tax revenues in the tax systems of OECD countries. Moreover, it must be pointed out, that the last year of the observed period is connected with the decrease of the Czech tax quota, which influences the higher gap in observation.

Income taxation can be described as a tax that influences the income of individuals. To be precise, it decreases their incomes. The income of individuals is not reduced only thanks to income tax, but also to the impact of social security contributions. In this point of view, social security contribution can also be described as a tax. An important conclusion can be made by assessing the data of Figure 1 devoted to developing the ratio of social security contribution to GDP. The development of both observed subjects (the Czech Republic and OECD) is stable, but the value is different. The percentage is higher in the case of the Czech Republic, and a little increase can be observed in the last two years.

Figure 1: Total tax revenues, tax revenues of PIT and social contributions to GDP of the OECD Countries and the Czech Republic

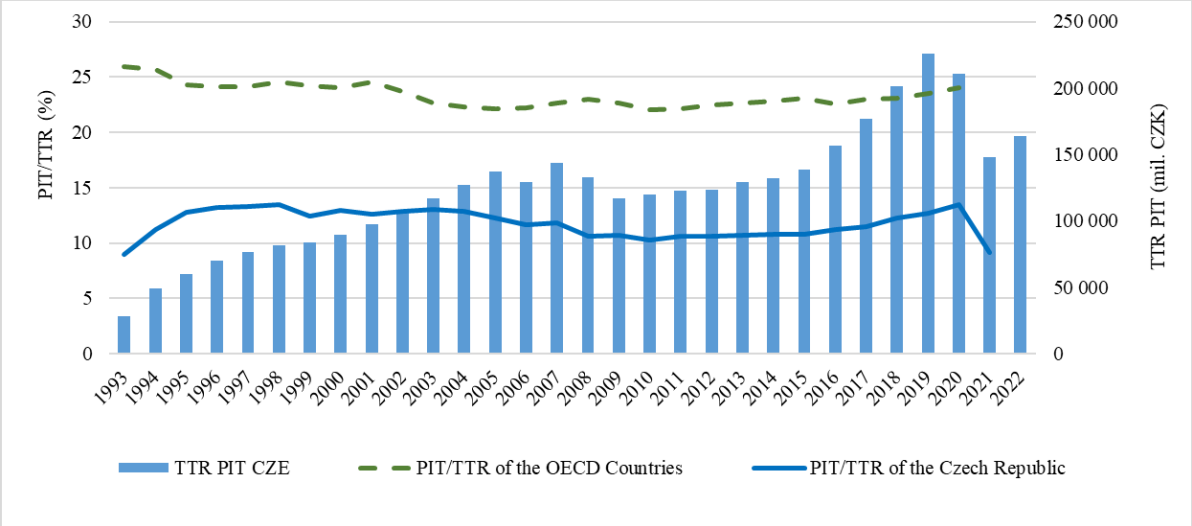


Source: Authors' processing according to OECD

The individual income taxation is responsible for creating tax revenues for public budgets. Making a comparison of the Czech and OECD data, the weaker position of personal income tax in the Czech Republic is clear. Assessing the development of total individual income tax revenues, it can be observed that every year is not connected with the growth of this kind of tax.

The following Figure 2 provides details of the development of tax revenues of individual income tax of the Czech Republic. According to the data in Figure 2, two times important decreases in personal income tax revenues were observed for the first time in 2008 and the second time in 2021. These facts reflect essential changes in the tax policy of individual income taxation.

Figure 2: Personal income tax revenues in the Czech Republic and OECD



Source: Authors' processing according to OECD and the Financial Administration

Individual income taxation in the case of the Czech Republic is similar to the individual income taxation of the developed countries. It means that this taxation covers different kinds of income as employment income, investment income, rental income, and other income.

The individual income tax system generally works not only with the determination of tax base but final tax liability is moreover influenced by certain reductions of tax base or final tax

liability is decreased thanks to tax reliefs. Reductions and reliefs may react to the individual circumstances of every taxpayer or can be used for all taxpayers. This paper concentrates only on the impact of basic tax reductions or reliefs obtainable to all taxpayers or tax reductions or tax reliefs applicable to taxpayers with two children.

Individual income tax of the Czech Republic has used a progressive tax system with more tax rates and several tax brackets respecting the certain value of taxpayers' income since 1993. The following table 1 shows the marginal tax rates of individual tax brackets. The table contains data about changes in the number of tax brackets between 1993 and 2007, when this system was used.

Table 1: Numbers of tax brackets and marginal tax rate

Year	Number of tax brackets	Marginal tax rates of the tax brackets (%)					
		1	2	3	4	5	6
1993	6	15	20	25	32	40	47
1998	5	15	20	25	32	40	
2003	5	15	20	25	32	40	

Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

The tax base was defined as a sum of all kinds of incomes and could be declined by the value of the tax-deductible item in the case of every taxpayer. The value of the tax-deductible item (item reducing tax base) has been changed several times, as shown in Table 2. This item started at 20 400 CZK in 1993 and finished at 38 040 CZK in 2005, the last year of application of this system, as it is clear from the tables 1 – 3 of the Appendix. Every item reducing the tax base generally decreases the tax base, consequently, it cuts down tax liability, and, in this way, tax saving is created. Table 2 provides information about tax savings for every tax bracket. All taxpayers have been influenced by the same value of the item-reducing tax base in individual years. Still, the values of the tax savings varied thanks to including their incomes in the appropriate tax brackets.

Table 2: Tax deductible item and tax savings of taxpayer (CZK)

Years	Tax deductible item	Tax savings					
		1	2	3	4	5	6
1993	20 400	3 060	4 080	5 100	6 528	8 160	9 588
1998	32 040	4 806	6 408	8 010	10 252	12 816	
2003	38 040	5 706	7 608	9 510	12 172		

Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Concerning the later changes in individual income taxation, it is important to point out that the payment of the social security contribution decreased the value of the tax base. As mentioned, this system was used for the last time in 2007.

The year 2008 brought changes in taxation. The tax base is defined in the same way. Still, its value is increased by the value of the social security contribution of the employee paid by the employer and the tax base is not reduced by the social security contribution of the employee. Additional change can be observed in the case of tax rates. A linear tax rate replaces tax progression and only one tax rate (15 %) is used. Instead of an item-reducing tax base, tax relief begins to be used and the same value of basic tax reliefs is used for all taxpayers. It means that tax relief decreases by the same value the tax liability to all individuals. Moreover, if incomes exceeded 48 times the average monthly wage, the principle of solidarity was applied as an additional tax rate of 23 % for the first time in 2013 and for the last time in 2020. This solidarity tax rate was used only in the case of employment income and business income, and only the income value exceeding the specified limit was applied.

The next important change in individual income taxation can be observed in 2021. The tax base in the case of employment income has been changed. The requirement to add social security contributions paid by employers has been lifted and the possibility to decline tax base of employees with paid social security contributions has been stopped. Moreover, this linear system of taxation uses a basic tax rate of 15 % and a second tax rate of 23 % for all the value of an income if the income exceeds the value of 48 times the average wage.

3. Determination of tax burden in the case of personal income tax

As has already been mentioned, the paper's main aim is to judge the impact of changes in individual taxation on selected types of taxpayers with only employment income during observed periods.

For expressing the impact of changes in tax policy of individual income taxation, two kinds of taxpayers were selected. A first taxpayer with only income from employment and a second taxpayer with only income from employment and with two children. The impact of taxation on the incomes of these two selected taxpayers is judged through the indicator of the tax burden (TB). The formula for calculation of it is following:

$$TB = \frac{PIT}{GW}, \tag{1}$$

PIT is the value of the personal income tax liability and *GW* is the value of the gross wage.

The effective tax rate is able to give the impact of items reducing tax base or tax reliefs on final tax liability. As input data, the annual average monthly wage information is used for the observed period that starts in 1993 and finishes in 2023. So as to find out the changes in the effective tax rate with the changes in the value of taxpayers' income, the multiplication of the annual average monthly wage is used. Table 3 provides information about the values of the average wage in the selected period. The average monthly wage of the first quarter is used for the year 2023.

Table 3: Average monthly wage in the selected years (CZK)

	1993	1998	2003	2008	2013	2018	2023
AW	5 904	11 801	16 905	22 653	25 051	32 097	41 265

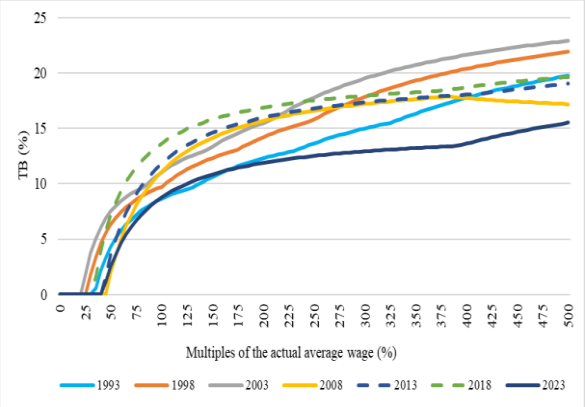
Source: Authors' processing according to the Czech Statistical Office

Considering the changes during 1993 and 2023, the observed period was separated into individual time periods and the effective tax rate was calculated only for the first year of every period. Figure 3 describes the situation of the effective tax rates of the childless taxpayer. According to the data, it is clear that taxpayers with the very low wage do not pay any tax. Comparing data between 1993 and 2023 it can be claimed that the wage up to 45 % of the average wage generates zero tax liability in 2008. Interestingly, the level of non-taxable wages varies during the observed period. Still, in no case, it cannot be claimed that its level continuously increases during the period. Considering this fact, it can be stated that the level of non-taxable wage is not the highest in the year 2023. The highest level of non-taxable wage was reached in 2008, when the value was 45 %. The main reason for generating certain values of non-taxable wages is the basic item reducing the tax base and basic tax relief. Even fact that the system of taxation was importantly changed, generating non-taxable wage remained preserved.

The following conclusion can be made when it comes to the development of TB with increasing taxable income. Taxpayers' income growth generates a lower intensity of TB growth, in spite of the fact that at the beginning of the observed period, progressive tax rate and later linear tax rate were used. The explanation is the impact of the item reducing the tax

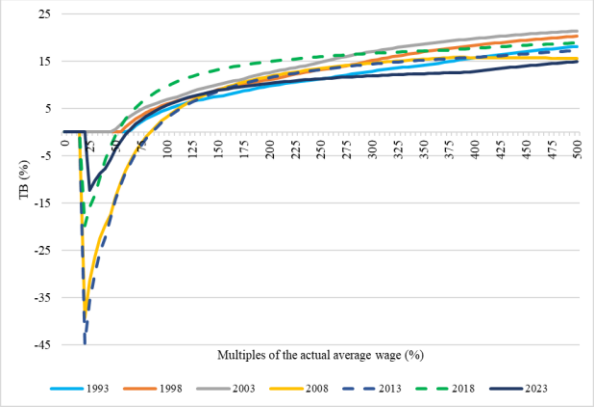
base and, later the impact of the basic tax relief. According to the lines of Figure 3, it can be concluded that if the tax burden of the average wage exceeds two times of the average income, the growth rate of TB has been slowing down since 2008 and the last change of the taxation in 2021 caused further slowing down of it. With regard to data for the year 2023, it can be observed that the tax burden of almost tested levels of the average wage is lower than the nominal tax rate of 15 %.

Figure 3: TB of childless taxpayer



Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Figure 4: TB of taxpayer with 2 children

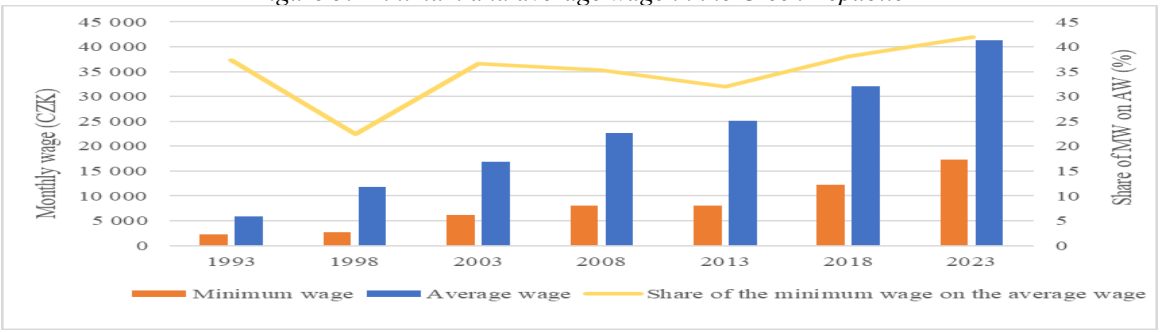


Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Figure 4 describes the situation of the taxpayer with two children. From the data, it is clear that between 1993 and 2008, this fact only generates non-taxable wages, if the income value does not exceed 65 % of the average wage. Since 2008 the tax system has been changed and taxpayers' tax liability may reach negative values. It means taxpayers do not have to pay taxes but receive tax bonuses from the tax administration. According to the data, it is clear that in 2021 the tax system stopped the limit value of the tax bonus and, importantly, scaled up the value of minimum wage, which influenced the value of the income entitled to the right to a tax bonus. An interesting fact is comparing the value of the tax bonus between the years 2013 and 2023. The amount of the tax bonus for low-income entities is reduced, and not only its absolute value but also the amount of income that is capable of contributing to the creation of the right to a tax bonus. The main reason is increased pressure to raise the minimum wage in the last years, as is visible in Figure 5. The system of tax bonus can only be used if the taxpayer's annual income exceeds six times the minimum wage. Therefore, if the minimum wage increases, low-income taxpayers can no longer claim the tax bonus.

Also, the TB with increasing taxable income is lower than the value of the nominal tax rate if taxable income does not reach five times the value of the average wage.

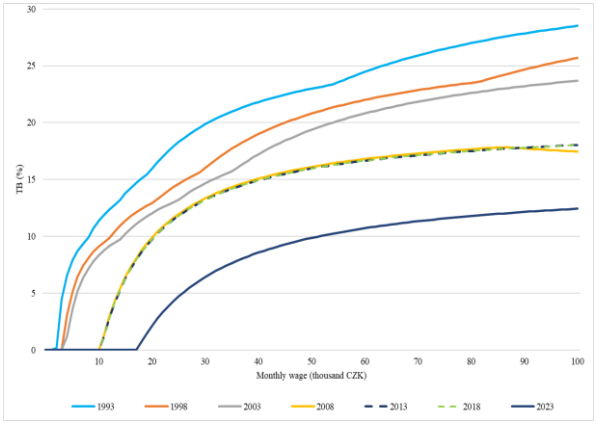
Figure 5: Minimum and average wage in the Czech Republic



Source: Authors' processing according to the Czech Statistical Office and the Ministry of Labour and Social Affairs

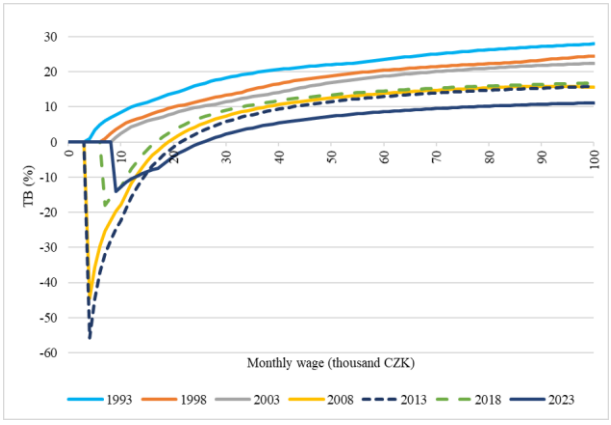
The observed period covers a long period of 30 years. Regarding data from Table 3, the values of the average monthly wage gradually increased during this period. So as to improve the comparison of selected taxpayers in the observed period, the constant value of the average monthly wage was used. The following Figure 6 gives more clearly the differences among individual periods. In the case of the childless taxpayer, it can be concluded that the gradual reduction of the tax burden with regard to all selected amounts of income. Also, it can be stated that an important decrease in tax liability was observed in 2008 and for the second time in 2023 after the last important changes of taxation of individual income made in 2021. The changes in taxation this year also increased the value of non-taxed income the most in the compared period.

Figure 6: TB of childless taxpayer



Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Figure 7: TB of taxpayer with 2 children



Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Figure 7 provides information about changes in the taxation of the taxpayer with two children assuming that the value of the average monthly wage is 20 000 CZK. Interesting is the decresae of the pretension to tax bonus visible in 2018 and 2023. The comparison thus reveals that the entitlement to a tax bonus was the highest in the conditions of 2008 and 2013. (The conditions of individual income taxation of the previous years 1993-2004, the possibility to use tax bonus did not offer at all.) However, with the minimum wage growth, its amount decreases in 2018. This fact continues in 2018 as well. However, it is possible to see the extension of the possibility of applying the tax bonus up to an income of 26 000 CZK.

When it comes to the total development of taxation, it is again visible that the last 30 years brought a gradual reduction of tax burden, and since 2003 the value of TB has not reached the value of the marginal tax rate.

4. Conclusion

The scope of taxation of the selected taxpayer's personal income taxes in 1993 – 2023 was determined and assessed using the effective tax rate indicator. The assessed taxpayer was a taxpayer with income only from employment. These incomes were considered in the range of 0-500% of the average salary. The values of the effective tax rate indicator were calculated both for the actual average salary of the given year and subsequently also for the constant income level, always respecting the legislative regulation in force in the given year.

The selected taxpayer was always assessed in two social situations: a childless taxpayer and a taxpayer with two supported children. The determined values of the indicator were assessed first from the point of view of the amount of the taxpayer's income and then from the point of view of the development of the scope of taxation over time. Based on the established values of the total amount of taxation of a childless taxpayer and a taxpayer with dependent

children, it can be stated that the extent of taxation of a taxpayer always increases with the growth of his income (the only exception is the situation of a taxpayer with dependent children in the case of payment of a tax bonus) in a given period. A comparison of the effective tax rate indicator values for a taxpayer without children and a taxpayer with dependent children shows that the scope of taxation is always lower for a taxpayer with dependent children.

In order to assess the development of the scope of taxation over time, it was necessary to clean the values of the indicator by the changes caused by the different amounts of the actual average wage of the given year. For this reason, the indicator values were also calculated for a constant income level. From the determined values of the indicator of the average personal tax rate for a childless taxpayer, it follows that for a given income level, the range of taxation in the entire interval of tested income decreases over time. For a taxpayer with dependent children, it can be similarly stated that for a given income level, the range of taxation decreases in the entire interval of tested income, or the right to a tax bonus increases. The exception is the period between 2018 and 2023, when the increase in the value of the minimum wage caused a limitation of the claim to the tax bonus.

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Appendix

Table 1: Deductible item and tax relief of taxpayer (CZK)

	1993	1998	2003	2008	2013	2018	2023
Deductible item	20 400	32 040	38 040				
Tax relief				24 840	24 840	24 840	30 840

Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Table 2: Deductible item and tax credit for child (CZK)

	1993	1998	2003	2008	2013	2018	2023
Deductible item	9 000	18 000	23 520				
Tax credit – 1st child				10 680	13 404	15 204	15 204
Tax credit – 2nd child				10 680	13 404	19 404	22 320

Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Table 3: Value of tax bonus (CZK)

	1993	1998	2003	2008	2013	2018	2023
Minimum				100	100	100	100
Maximum				52 200	60 300	60 300	

Source: Authors' processing according to The Act no. 586/1992 Coll., on Income Taxes

Assessing Behavioral Biases in the Banking Sector: Evidence from a Questionnaire Survey

Martina Novotná, Kateřina Kořená, Barbora Lehmanová [1]

Abstract

This paper is focused on the behavior of people, with a particular emphasis on examining behavioral biases. The main aim of this study is to verify the existence of behavioral biases of selected banking institution employees, which can lead to distorted perceptions, wrong estimates, and illogical interpretations. The partial goal is to determine whether different categories of employees show different or similar tendencies to these biases. The main findings are based on the independence tests and logistic regression analysis, suggesting the tendency toward behavioral biases. Our results support the main findings of other studies and show that the occurrence of biases depends on age, education, and financial literacy. Alongside the results of this work can help to understand better behavioral biases and their possible influence on human thinking in the working environment.

Key words

Bank, behavioral economics, biases, independence tests, logistic regression, questionnaire survey

JEL Classification: G 40, G 41

1. Introduction

Behavioral finance is an important part of behavioral economics. One of the crucial elements of behavioral finance studies is the influence of biases - behavioral finance proposes that psychological biases can affect behavior of people in financial markets. This means that within behavioral finance, the participants of these markets can be influenced in their decision-making process.

Behavioral finance is a relatively new and developing field whose popularity increased sharply in the 1980s. As Pompian (2012) argues, behavioral finance explains the actual behavior of market participants, thus distinguishing them from traditional finance, which is based on how these participants should rationally behave. Within traditional finance, a man is considered a rational person who can process all unbiased information and aims to optimize the expected return (Kamoune and Ibenrissoul, 2022). The main introduction of psychology to economics can be attributed to Daniel Kahneman and Amos Tversky and their Prospect Theory (Kahneman and Tversky, 1979). This theory generally describes how people evaluate gains and losses and is a fundamental building block for behavioral finance. The results of their research provided behavioral economists with the foundations of psychological models for studying how individuals make their economic decisions. The key figures in this field are

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Robert Shiller, Richard Thaler, Meir Statman, Daniel Kahneman, and Vernon Smith (Pompian, 2012).

The aim of this paper is to verify the existence of behavioral biases among the employees of the selected banking institution in the Czech Republic. The research is based on an online questionnaire survey. According to the employees' answers in this survey, the authors want to assess their tendency to behavioral biases. The paper is also focused on examining the differences between selected categories of these employees, namely gender, age, education, experience with investing in financial markets, and financial literacy. It means the aim is to determine whether different categories of employees show different or similar tendencies to chosen biases. As mentioned below, this tendency to biases can lead to distorted perception, wrong estimates, and illogical interpretations. Therefore, the results of this work will help better understand behavioral biases and their possible influence on human thinking in the working environment of the selected banking institution.

The paper is divided into four sections as follows. The first part deals with the general description of the selected biases, and then the methodology is described. Next, the findings are presented and discussed. Finally, the main results are summarized in the conclusion.

2. Behavioral biases

In behavioral finance, a large number of psychological characteristics have been identified – we can call them behavioral biases. Pompian (2012) defined behavioral biases similarly to systematic errors in decision making, and he argues that only through the identification of these biases is it possible to save clients from possible financial failures. The following biases have been selected for this paper and the empirical study.

Conservatism bias is a process in which people lean towards original opinions and information; it is the tendency to prefer existing evidence over new evidence. As Veselá (2019, p.638) states, "most people are not willing to often change their opinions, positions and attitudes and easily accept opinions fundamentally different from their own."

Confirmation bias is the tendency of people to look for evidence or interpret information in a way that confirms existing beliefs (Baker et al., 2019). Conversely, information that contradicts our beliefs is ignored and challenged. As Baker et al. (2019) reported, people tend to believe what they want to believe, so prejudice is challenging to avoid. Therefore, confirmation bias can impact how we gather, interpret and recall information.

Representativeness bias is a behavioral bias that Veselá (2019, p. 637) describes as "a mental shortcut when a person's mind compares an unknown decision-making process as closely as possible to a similar process that it has already experienced in the past." People often make the mistake of believing that two similar processes are more closely correlated than they actually are. This described simplification appears beneficial, as one does not have to analyze known tasks in a complex manner, thereby saving time. However, according to Baker et al. (2019), it can make the investor make bad choices and mistakes, as they tend to ignore all other things except those immediately coming to mind. When making quick decisions, he compares a process, person, or event he has experienced.

Availability bias refers to a bias when people estimate the probability of an outcome based on how familiar the outcome is in their lives. As Kahneman (2012, pp. 142-143) argues, "the availability of exemplars of a certain category will temporarily increase some dramatic event. Personal experiences, images, and living examples are more readily available in the memory than things that have happened to them or other people than mere words or statistics." It is easier for a person to recall significant events that caught his attention.

Self-attribution is defined as the process in which people comprehend the outcomes and consequences of their behaviors. *Self-attribution bias* occurs when a person attributes success

to his skills but blames negative results on bad luck or other external factors. According to Veselá (2019), people tend to overestimate themselves when reporting successes; on the contrary, admitting a mistake is very difficult to accept.

Recency bias causes people to remember recent events more than those that happened in the distant past. As Baker et al. (2019) suggest, people tend to incorrectly believe that recent events will occur again. For example, investors tend to evaluate their portfolios based on recent performance, and thus judgment can be subconsciously biased. The recency bias is often reinforced by the media and the publication of up-to-date information.

Loss aversion bias was described by Daniel Kahneman and Amos Tversky in 1979 as a part of their Prospect Theory. This is perceived as their most significant contribution (Malkiel, 2012). Individuals subject to this bias think in terms of gains and losses that the same amount of loss brings more pain in comparison with gain and joy. Kahneman and Tversky found that if given a choice between definitely getting $1000 or having a 50% chance of getting $2500, people are more likely to accept the $1000. According to a number of studies, a general rule emerged when from a psychological point of view, the possibility of loss is up to twice as strong a motivator than the possibility of achieving a profit of the same size.

According to Pompian (2012), *overconfidence bias* is defined as a situation when persons overestimate their abilities and the information provided to them, which leads to emotionally excessive behavior and risk-taking. People think they are smarter and better informed than they really are. Therefore, they tend to overstate their knowledge, understate risks, and exaggerate their ability to control events. As applied to investments, overconfidence may lead to excessive risky trading.

Regret aversion bias is a concept within the Prospect Theory (Kahneman and Tversky, 1979) that says people anticipate regret if they make a wrong choice and take this anticipation into consideration when making decisions. Fear of regret can play a significant role in dissuading or motivating someone to do something. As Veselá (2019, p. 646) claims, "investors are afraid to make any important and substantial decision that will have visible consequences."

3. Data and methodology

The survey was carried out in the period 8/2/2023 – 21/2/2023. The questionnaire was created in the Microsoft Forms program, and the respondents were approached mainly through the Outlook e-mail service or the Facebook social network. In total, 109 completed questionnaires were obtained. The population sample based on the total number of bank employees at the end of 2022 was 649. Respondents who participated in the survey were asked to answer 40 questions. The first 28 questions (see Annex) were about behavioral finance biases. These questions were followed by seven demographic or supplementary questions, and five focused on knowledge of fundamental economic indicators.

3.1 Data description

One hundred nine respondents participated in the survey, providing information regarding gender, age, marital status, the highest education level, and experience with investing in the financial markets. Overall, almost the same number of men and women participated. The most numerous categories are respondents aged 26-35, followed by respondents aged 36-45, and no respondents older than 60. The highest number of respondents with a university education reflects specific educational requirements for the employees of the selected banking institution. Most respondents have investment experience in the financial markets, namely 71%. The used variables and categories are described in Table 1.

Table 1: Variable description

	Category	Multicat.	Binary	Abs. freq.	Rel. freq. (%)
Gender	Male	1	1	50	45.9
	Female	2	2	59	54.1
Age	18-25	1	1	15	13.8
	26-35	2		41	37.6
	36-45	3	2	31	28.4
	46-60	4		22	20.2
Education	Secondary	1	1	38	34.9
	Post-Secondary	2		3	2.8
	University	3	2	68	62.4
Investment experience	Yes	1	1	77	70.6
	No	2	2	32	29.4
Knowledge	5 points	5	1	28	25.7
	4 points	4		31	28.4
	3 points	3	2	27	24.8
	2 points	2		18	16.5
	1 point	1		5	4.6

The empirical study investigates the relationship between respondents' answers and their gender, age, education, investing experience, and economic knowledge. These categories were chosen based on existing literature that links behavioral biases to biological traits, education, and experiences. For analysis, some variables were converted into binary categories (age, education, knowledge).

Regarding gender, the respondents were categorized as men, women, or other (though no respondent selected this option). This division aimed to identify potential gender differences in investing, supported by studies such as Hsu et al. (2021), who reported variations in risk attitudes and preferences between genders. Previous research by Lundberg et al. (1994) indicates that men tend to be more self-confident, particularly in male-dominated fields like finance. Barber and Odean (2001) also found significant gender disparities in overconfidence. Concerning risk aversion, Powell and Ansic (1997) discovered that women tend to be less risk-seeking than men.

The age category was divided into respondents under and over 35 years. This differentiation was based on numerous studies highlighting distinctions between older and younger individuals. For instance, Gonzalez-Equal et al. (2021) noted that younger investors are more susceptible to cognitive and emotional biases. Aging often leads to a decline in cognitive abilities, as described by Korniotis and Kumar (2011), who observed that older investors tend to have poorer investment skills despite greater experience. However, Gamble et al. (2014) found no correlation between aging and confidence in managing personal finances. In terms of trading preferences, Lin et al. (2010) discovered that younger individuals, particularly males, are inclined toward online trading, which is associated with more active trading and overconfident behavior.

The remaining three variables focused on respondents' education, investing experience, and knowledge of current economic indicators, which serve as measures of financial literacy. Recent literature, as highlighted by Hsu et al. (2021), has emphasized the influence of education on financial behavior. Financial literacy significantly affects risk-taking, asset allocation, and the demand for financial advisors. It is widely accepted that individuals with higher education, knowledge, and financial literacy tend to manage their finances more effectively. Additionally, Hibbert et al. (2012) found that educated individuals are less susceptible to behavioral biases, reinforcing the importance of financial literacy in investing. The questionnaire included five knowledge-based questions about the current inflation rate, minimum wage, unemployment, deposit insurance, and withholding taxes. Each correct

answer carried one point, while incorrect answers deducted one point from the total possible score of five.

The survey included 28 questions focusing on nine specific biases outlined in Chapter 2 as follows: *Conservatism* (Q1-Q3), *confirmation* (Q4-Q6), *representativeness* (Q7-Q9), *availability* (Q10-Q12), *self-attribution* (Q13-Q15), *recency* (Q16-Q19), *loss aversion* (Q20-Q21), *overconfidence* (Q23-Q25), and *regret aversion* (Q26-Q28). The questions are based on the research by Kahneman (2012), Pompian (2012), Malkiel (2012), Cherry (2022, 2023), and dwassetmgmt.com (2018), yourdictionary.com (2020), practicalpie.com (2022), thedecisionlab.com (2023).

Each biased response was assigned one point. Participants' scores were calculated by summing the points, indicating the extent of their tendency towards behavioral biases. The median bias score was 15, and the mean score was 14.76, with a relatively symmetrical distribution indicated by skewness of 0.35 and kurtosis of 3.11. For analysis purposes, two binary variables were created based on two discriminating values: the 25th percentile and the mean value (Table 2).

Table 2: Bias score variables

	Discriminating value	**Category**	**Frequency**
bias_cat1	13 (25th percentile)		
	≤13	0 (lower tendency to biases)	35 (32.1 %)
	>13	1 (higher tendency to biases)	74 (67.9 %)
bias_cat2	15 (mean value)		
	<15	0 (lower tendency to biases)	52 (47.7 %)
	≥15	1 (higher tendency to biases)	57 (52.3 %)

3.2 Methodology and measurement of behavioral biases

In the empirical study, we will investigate whether the answers to the questions (Q1-Q28) within the biases relate to the respective categories of variables specified in the previous section (see Table 1). The approach used in this study is based on a nonexperimental method, where the relationships are examined using observations and measures of the variables. As Cozby and Bates (2017) suggest, a relationship is established by finding that the two variables vary together, or in other words, the variables covary and correlate with each other.

Since the results of a given study are based only on data from a sample of participants, inferential statistics are essential for the survey analysis. Cozby and Bates (2017) propose using this approach to determine whether results match what would happen if the survey was conducted repeatedly with multiple samples. In other words, we test if the difference in the sample means reflects a true difference in the population means. Then, inferential statistics give the probability that the difference between means reflects random error rather than a real difference. Statistical inference involves setting the null and research hypotheses as follows (Cozby and Bates, 2017):

H_0 (null hypothesis): The population mean of the no-model group is equal to the population mean of the model group.

H_1 (research hypothesis): The population mean of the no-model group is not equal to the population mean of the model group.

The null hypothesis is rejected when the obtained results could be due to random error with a very low probability (statistical significance). The decision to reject or accept the null hypothesis is made based on various statistical tests, most often the *t* test, the *F* test (the analysis of variance), and the chi-square test (χ^2). Cozby and Bates (2017) advise that the chi-square test is used when dealing with nominal scale data, and the data consist of frequencies. The test examines the extent to which the study' differ from the expected

frequencies if the null hypothesis is correct. Then, the null hypothesis states no relationship between the two variables. The chi-square is computed as

$$\chi^2 = \sum \frac{(O-E)^2}{E}, \tag{1}$$

where O is the observed frequency in each cell, and E is the expected frequency in each cell. The expected frequency is calculated as follows,

$$E = \frac{row\ total \times column\ total}{N}, \tag{2}$$

N is the total number of observations. The significance of the obtained χ^2 is evaluated based on the critical values of χ^2. They depend on degrees of freedom *(df)* that can be found as

$$df = (R-1)(C-1), \tag{3}$$

where R is the number of rows and C is the number of columns in the table (Cozby and Bates, 2017). In our study, we use Stata software that allows for the analysis of survey data. The test of independence is based on Pearson χ^2 corrected for the survey design with the second-order correction of Rao and Scott (1984). It is converted into an F statistic (Stata Press, 2017, p. 159).

In addition to the tests of independence, we will assess whether the used variables may be related to the tendency of behavioral biases. The relationship between variables and the bias score will be examined by the binary logistic regression analysis. There is a vast literature on logistic regression methods; for example, Menard (2010), Hosmer et al. (2013), Harrel (2015), Hair et al. (2018) and Tabachnick and Fidell (2019).

The main purpose of binary logistic models is to predict cases into one of two dependent variable categories by one or more independent variables. The conditional distribution of the outcome variable follows a binomial distribution, and the conditional mean gives the probability $\pi(x)$. We estimate the parameters to maximize the probability of obtaining the observed data set to fit the logistic regression model. We must first construct the function that describes the observed data's probability as a function of the unknown parameters. This function is called the likelihood function, and the values of parameters that maximize this function are called maximum likelihood estimators. We assume a collection of p independent variables denoted by the vector $\mathbf{x}' = (x_1, x_2, \ldots, x_p)$, where each of these variables is at least interval scaled. If we denote the conditional probability that the outcome is present by the expression $\Pr(Y=1|\mathbf{x}) = \pi(x)$, then the logit of the multiple logistic regression model has the following form,

$$g(x) = \ln\left[\frac{\pi(\mathbf{x})}{1-\pi(\mathbf{x})}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p, \tag{4}$$

and the multiple logistic model is given by:

$$\pi(x) = \frac{e^{g(\mathbf{x})}}{1+e^{g(\mathbf{x})}}. \tag{5}$$

4. Empirical results from a survey

Hypotheses for individual categories will first be tested using tests of independence. Next, the effect of used variables on biases will be examined using the logistic regression models.

4.1 The relationship between variables and biases

Firstly, it will be assessed whether there are statistically significant relationships between the variables and the answers to the questions according to individual biases. The data sample contains 109 (*n*) observations from employees of the selected bank, where the sample population based on the total number of employees is 649 (*N*). Thus, the base weight, *N/n* = 5.954, and finite selection factor, $fnp = \frac{n}{N} = 0.168$. We can say that the sampled person represents approximately six persons in the population.

Table 3 shows 26 cases of statistically significant dependencies between variables and answers to questions from 140 measurements. Dependence was most often confirmed for the variables gender and knowledge, followed by age, education, and investment experience. Furthermore, it can be summarized that the dependence between a bias and one of the variables was proven in all cases. We identify three considerable dependencies based on two confirmed tests per a bias: Overconfidence prevails in men, representativeness for people under 36 years, and self-attribution is evident in those with more than one incorrect answer in the knowledge test.

Table 3: Independence tests

Bias	*Quest.*	*Gender*	*Age*	*Education*	*Investing*	*Knowledge*
Conservatism	Q1	0.00	1.37	4.50**	5.55**	0.35
	Q2	0.64	1.22	0.06	1.56	0.51
	Q3	0.07	0.04	1.22	0.24	1.49
Confirmation	Q4	6.18**	1.46	2.02	1.86	1.66
	Q5	0.15	1.03	1.56	0.48	1.54
	Q6	0.09	4.30**	0.11	0.34	1.09
Representativeness	Q7	1.00	2.13*	0.96	0.15	0.42
	Q8	1.60	2.78**	0.51	0.07	2.16*
	Q9	1.02	1.10	0.15	1.28	0.30
Availability	Q10	0.29	1.18	0.69	0.16	1.77
	Q11	1.80	7.71**	1.80	10.33**	0.87
	Q12	2.09	1.35	0.14	0.50	0.93
Self-attribution	Q13	4.44**	1.06	0.84	0.03	2.81**
	Q14	0.18	0.86	7.51**	0.55	5.13**
	Q15	0.87	0.71	1.78	0.05	0.75
Recency	Q16	1.59	1.03	0.58	0.50	1.47
	Q17	0.46	1.40	1.06	0.00	1.71
	Q18	3.08*	0.90	0.84	1.13	1.25
	Q19	0.22	1.97	1.14	0.72	2.19*
Loss aversion	Q20	0.21	1.32	1.78	1.93	1.28
	Q21	0.21	0.08	0.45	0.00	3.43**
	Q22	10.41**	0.74	3.28**	1.38	1.58
Overconfidence	Q23	2.93*	1.65	0.89	0.08	1.89*
	Q24	0.03	0.34	2.22	0.78	1.06
	Q25	11.32**	1.53	1.96*	2.94*	1.62
Regret aversion	Q26	2.65	2.09*	1.15	0.96	1.60
	Q27	0.34	1.49	0.97	8.88**	0.72
	Q28	0.68	0.82	2.57*	0.31	1.54

Pearson design-based statistics, F (1, 108); *p<0.10, **p<0.05

Finally, logistic regression models are estimated to assess the effect of variables on the general tendency to bias behavior. Table 4 presents the results of five models according to the considered variables. Independent variables were used as multi-categorical or binary, as

defined in Table 1. The dependent variable reflects the tendency to bias measured as a score, with two different discriminating values (see Table 2).

Table 4: Estimated coefficients

Variable	Model 1 (multi) bias_cat1	Model 2 (multi) bias_cat2	Model 3 (binary) bias_cat1	Model 4 (binary) bias_cat2	Model 5 (adj. binary) bias_cat1
2.gender	0.5444	0.0001	0.3690	-0.1766	X
2.age	0.3513	1.4530**	-0.7728*	-0.3765	-0.8325**
3.age	-0.5822	0.3393	X	X	X
4.age	-0.6320	1.1139	X	X	X
2.educ	-0.8737*	-0.7530*	-0.8769*	-0.6102	-0.9999**
2.invest	0.3575	0.5550	0.2647	0.3315	X
2.knowscore	0.5827	0.7192	0.6435	0.1362	0.6856*
3.knowscore	2.0062*	1.4392	X	X	X
4.knowscore	0.2608	0.6080	X	X	X
5.knowscore	0.7649	0.8251	X	X	X
Constant	0.3760	-1.3108	1.2005*	0.5970	1.5643**

*p<0.10, **p<0.05

The models incorporating multi-category variables (Model 1 and Model 2) reveal the impact of age and education on the propensity for behavioral biases. These findings are further supported by including only binary variables in the model and a score measured bias_cat1 (Model 3). Eventually, the adjusted model (Model 5) was developed, encompassing three statistically significant binary variables. It has also been found that the 25th percentile can be considered a suitable discriminating value for the bias score.

Based on the results, we suggest that age, education, and economic knowledge significantly affect the tendency to bias behavior. This relationship can be better interpreted using odds ratios from model 5 as follows: the odds of biased behavior is 0.43 times lower for respondents older than 35 years than younger ones, 0.37 times lower for university educated than lower-educated, and two times higher for those who made more than two incorrect answers in the knowledge test.

4.2 Discussion

After conducting tests of independence, it was established that there exist connections between the variables and specific responses related to the nine biases under examination. These findings were further confirmed through the bias score analysis, which gauges overall participants' inclination towards biases in the survey.

The results based on particular questions affirm the conclusions reached in previous studies. For example, for loss aversion, a statistically significant dependence between gender and answers to Q22 was demonstrated, where a significant number of women decided to refuse the game. This result is consistent with Powell and Ansic (1997), who claim that women are less willing to take risks than men. In addition, the results for the overconfidence bias support the conclusions of Barber and Odean (2001), who noted significant gender differences, and Lundeberg et al. (1994), suggesting that men are generally more confident than women. This behavior can be observed in Q23 and Q25, where more men than women tend to have excessive self-confidence.

The conclusions of Gonzalez-Equal et al. (2021) that biases more influence younger investors were demonstrated in Q11, where all respondents who chose an answer indicating a tendency towards the availability bias were younger than 35 years.

As previously mentioned, there is a general assumption that people with higher education and better financial literacy are more watchful in control of their finances. Hibbert et al. (2012) also support this idea and argue that these individuals are less prone to behavioral

biases. Our research confirms that most respondents with a tendency towards availability bias do not invest in financial markets, as indicated in Q11. Furthermore, the biases are related to knowledge test results and the education level of the employees. For example, based on Q13, Q14, and Q21, those with more mistakes in the knowledge test tend to self-attribute and loss aversion biases. Finally, based on Q22, we suggest that secondary school graduates show a tendency towards loss aversion bias.

5. Conclusion

The aim of this paper was to examine the behavioral biases that can influence the investment decision-making process of the employees of the selected banking institution. Alongside, the authors wanted to find out whether different categories of employees show different or similar tendencies towards biases according to the selected points of view. Specifically, differences between gender, age, education, experience with investing in financial markets, and financial knowledge were investigated.

First, based on tests of independence, it was proven that there are dependencies between the variables used and some responses within the nine considered biases. These findings were subsequently verified based on the bias score measuring the tendency to biases of each participant in the survey. Based on logistic regression analysis, it was found that age, education, and knowledge test results mainly influence the bias score's value. Our results support the main findings of other studies and show that younger employees, individuals with less than a university education, and those with lower financial literacy have a greater tendency to behavioral biases.

As an additional topic, testing of individual departments could be possible in this selected banking institution to identify specific tendencies towards behavioral biases or conduct a questionnaire survey in other banking institutions and compare results. Alternatively, the research could focus on whether employees are aware of behavioral biases and whether they are able to recognize and minimize their influence on their investment decisions.

Generally, studying behavioral finance and understanding behavioral biases can help investors minimize risk and create effective investment strategies. It is important to remember that investment decision-making is not only about numbers and facts but also about psychology and emotions. Therefore, it is necessary to be aware of possible behavioral biases and try to eliminate them actively. Knowledge of this field can help raise awareness of behavioral biases. It can also help investors achieve better results in the financial markets because they can make more rational investment decisions.

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Annex

Q1: *Imagine you hear negative news that affects the price of your stock. What is your natural reaction?*
a) I ignore this message as I have already invested. I am convinced that this investment will be successful.
b) I'll think about my investment, but I'll probably stick to my convictions because that's what I usually do.
c) I consider my investment and decide what to do next based on objective consideration.

Q2: *If you hear the news that has a negative impact on the price of the shares you own, how quickly will you react to this news?*
a) I usually wait how market will respond and then I decide.
b) Sometimes I wait how market will respond, but other times I react immediately.
c) I react without thinking.

Q3: *Imagine that you book a luxury vacation at a bargain price a month in advance. As your departure date approaches, you will learn that a hurricane may occur in the area during your vacation date. What will be your reaction?*
a) I will immediately cancel the holiday reservation due to this new information.
b) If the situation does not look terrible, I will go on vacation.

Q4: *After careful research, you have invested in a security. Now you read that the company you invested in may have a problem with its product line. However, the following article describes a new product that the company could present at the end of the year. What will be your natural reaction to this situation?*
a) I will note the new product announcement and research this item more.
b) I will notice a problem with the product line and investigate the situation further.

Q5: *You decide to invest in a bond fund for some reason. After a few months, you will find that the company is doing well, but not because of the intention with which you decided to invest. How will you react?*
a) I will continue to invest in the fund anyway. The reason why the investment is profitable is not important, but the fact that I have invested well.
b) I will research why the fund is doing well, and based on that, I will decide whether I will continue to invest.

Q6: *Imagine you send a text message to a specific person. However, you will not receive any answers. What are you more likely to think?*
a) The person concerned is busy.
b) The person in question does not like me.

Q7: *Which sequence will be more likely in a coin toss?* (H=heads, T=tails)
a) H H T T H T.
b) H H H H T T.

Q8: *Tomáš is an opera fan who likes to visit art museums. Growing up, he enjoyed playing chess with family members and friends. Which situation is more likely?*
a) Tomáš plays the trumpet for a large symphony orchestra.
b) Tomáš is a farmer.

Q9: *Linda is thirty-one years old, single, straightforward, and very intelligent. In the past, she studied philosophy and, as a student, was intensively concerned with issues of discrimination and social justice and was also a participant in anti-nuclear demonstrations. Which situation do you think is more likely?*
a) Linda is a bank clerk.
b) Linda is a bank clerk and, at the same time, active in the feminist movement.

Q10: *Imagine that you have money that you would like to invest. You know about a good stock investment from your friend, an excellent investor. What do you do in this situation?*
a) I would like to buy shares because my friend is good at investing, and usually, his investments are very profitable.
b) Before making a final decision, I will think about, research, and analyze a possible future investment in these shares.

Q11: *Imagine that you repeatedly hear about suicides in the TV news. Suicides will begin to be justified by the negative situation in the world, which was also helped by the disease of COVID-19 and the war in Ukraine. What do you think more people died of in the last two years?*
a) Suicide.
b) Cancer.

Q12: *Imagine that you wish to buy shares. Your friend will recommend shares to you. However, in a professional magazine focused on finance, you will read about other stocks that "flew up" by 10%. Which investment will you choose?*
a) I will buy shares that a friend advised me.
b) Before buying a stock recommended by a friend, I thoroughly analyze the stock from a professional magazine.

Q13: *Imagine that you have made an investment that you are earning, but it is not because of the intention with which you decided to invest. You feel good about making this investment. Which of the following examples best describes your feelings?*
a) I have a reasonable estimation of profitable investments.
b) Although the investment is profitable for a different reason than I thought, it is still good.
c) I don't feel that good even though I made money. The reason I thought I would make money on the investment did not materialize. I was lucky.

Q14: *If the profitability of your portfolio increases, what do you think is the most likely cause of this situation?*
a) Your investment skills.
b) By combining investment skills and luck.
c) Luck.

Q15: *Imagine that you failed the exam. How will you feel about this situation?*
a) I did not devote enough time to preparation.
b) I failed the exam because the teacher did not explain the material to us sufficiently.

Q16: *Read the names and, without counting them, answer whether there are more male or female names: Anna, Matěj, Barbora, Aneta, Tadeáš, Sandra, Šimon, Daniel, David, Lenka*.
a) There are more female names.
b) There are more male names.
c) There are the same number of female and male names.

Q17: *Do you remember what you had for dinner yesterday?*
a) Yes.
b) No.

Q18: *Do you remember what you had for dinner last Monday?*
a) Yes.
b) No.

Q19: *You have heard good reviews about a particular product and consider buying it. You hear a bad review about it right before you buy it. How do you decide?*
a) I will buy the product.
b) I will not buy the product.

Q20: *You plan to invest CZK 100,000. Which scenario would you rather choose?*
a) I want to be sure I get all my money back, even assuming I don't earn any extra money.
b) I want a 50% chance that I will get back CZK 150,000 and a 50% chance that I will only get back CZK 50,000 from my investment.

Q21: *Choose one of the two results:*
a) Certain profit CZK 100,000.
b) 25% chance of a profit of CZK 500,000 and a 75% chance of no profit.

Q22: *Imagine that you are offered a game of coin toss. If tails fall, you pay 100 CZK. If heads fall, you get CZK 150. Will you play such a game?*
a) Yes.
b) No.

Q23: *Imagine you are asked to answer this question: Russia is the largest country in the world by area. Do you agree or disagree? Now choose how sure you are that your answer is correct.*
a) I strongly disagree.
b) Disagree.
c) I don't know.
d) Agree.
e) I strongly agree.

Q24: *Do you think you have your finances under control?*
a) Definitely yes.
b) Rather yes.
c) Rather not.
d) Certainly not.

Q25: *Looking at other drivers, how good a driver is you?*
a) Below average.
b) Average.
c) Above average.
d) Very above average.
e) I don't drive.

Q26: *It is Friday evening, and you are at home. You have decided to watch a movie. A friend unexpectedly calls you to ask if you want to attend a party. You are already quite tired and satisfied. How do you decide?*
a) I will go to the party. I might later regret not going to the party and missing out on something interesting.
b) I won't go to the party. I‘ve already planned to watch a movie.

Q27: *You hear about a good investment. Many acquaintances will realize it. How do you behave?*
a) I will also decide to implement this investment if many acquaintances have done so. I would regret it later. I may make money from it.
b) I will not invest. It could put me at risk.

Q28: *You have purchased a car that you are taking to the service for the third time during the year, as it has frequent faults. What will you do?*
a) I will keep the car.
b) I will sell the car and buy another one. I made the wrong choice when buying a car.

Identifying Key Determinants of Unemployment in Slovakia: A Time Series Econometric Modelling Approach

Matus Senci[1], Lucia Svabova[2]

Abstract

Unemployment is an important issue that needs to be addressed in every country. In Slovakia, it is also necessary to comprehensively examine the underlying determinants of unemployment. This study employs an econometric time series approach to identify the key factors influencing unemployment in Slovakia. By constructing an econometric model, we analyse the period from 2013 to 2020 and explore the relationships between unemployment and various potential determinants. Our findings highlight the key factors with the strongest associations with unemployment, and the interpretations from the created model explain the direction of this relationship. The study results can be valuable for policymakers and stakeholders in designing targeted interventions to reduce unemployment in Slovakia by influencing other macroeconomic indicators.

Keywords

unemployment, determinants of unemployment, econometric modelling, time series analysis

JEL Classification: J64, E24

1. Introduction

Unemployment is a factor that has a significant impact on the entire economy. It is a complex socio-economic problem with far-reaching consequences for individuals, society and the economy. The unemployment rate itself influences the seriousness of the consequences of unemployment, so its optimisation is very important. However, unemployment is a common phenomenon in a market economy and occurs practically everywhere worldwide (Gregova, 2017). Therefore, it makes no sense to talk about its occurrence but rather its rate. With the increasing rate of unemployment, the output of the economy decreases. In the case of long-term unemployment, the consequences also affect the health of individuals and society. Kapuvari (2011) even writes about physical health issues which might be caused by stressors, including unemployment.

It is important to note that lowering the unemployment rate is not always desirable. Unemployment rate lower than the natural unemployment rate might increase inflation (Maximova, 2015). The natural unemployment rate is the rate at which long-term equilibrium occurs in the labour market. Unemployment will always return to the long-run NAIRU (non-accelerating inflation rate of unemployment) corresponding to the natural rate of unemployment (Cross & Lang, 2011).

In this article, we performed an analysis based on which we determined what factors impacted the unemployment rate in Slovakia during the period under review. In doing so, we

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focused not only on finding significant determinants of unemployment but also on interpreting the established relationships between the investigated factors and unemployment. Knowing these factors and the extent of their influence is crucial for optimising the unemployment rate and formulating measures by the government.

Potential predictors were chosen according to previously confirmed relations. Motyovszki (2013) states that a low unemployment rate will inevitably increase wages, thus leading to increased prices. Papik et al. (2022) have demonstrated that GDP per capita is one of the determinants of unemployment. In their study, King and Morley (2007) examined the determinants of the natural unemployment rate and concluded that higher interest rates in the market make capital more expensive for companies, reducing profitability and consequently slowing down recruitment, which can increase the natural unemployment rate. Additionally, we have included other factors in the analysis that are expected to influence the unemployment rate.

The following sections of the article are as follows. The literature review section provides an overview of the current state of the art by referencing relevant studies that focus on the topic addressed in this study. The methodology and data section briefly outlines the econometric approach used in the study and characterises the data used for analysis. The result section highlights the main outcomes of the analysis, including the developed econometric model. In the discussion section, the coefficients of the unemployment determinants are interpreted, and a possible continuation of the research is suggested. The last section presents the conclusions drawn from the study.

1.1 Literature review

The study by Lee (2014) analysed the determinants of unemployment in Great Britain during the economic recession of 2088 and 2009. One key determinant found was the level of education. The study observed that regions with higher qualifications of their citizens experienced a lower increase in unemployment. Another significant factor influencing unemployment was the industry sector to which the region was oriented. Cities primarily oriented to financial services and the production sector experienced the highest increase in unemployment during the period under review.

Benazic and Uckar (2017) also analysed the determinants of unemployment. The authors focused their study on unemployment in Croatia, which experienced significant increases from 2010 to 2013, probably due to the global recession. The study examined factors such as work productivity, prices, and level of real wages as the factors influencing unemployment. Furthermore, they demonstrated the inverse relationship between unemployment and inflation, the Philips curve.

Logarusic and Kristic (2019) conducted an extensive study to identify significant determinants of unemployment in the EU. They analysed data from all 28 EU member countries from 1995 to 2016 using panel analysis. The study revealed a relatively homogeneous character of the unemployment rate in the EU member states. The authors also confirmed the existence of Okun's law which suggests the inverse relationship between unemployment and economic growth. A similar study was conducted by Munoz (2010), examining the Philips curve and Okun's law in the Colombian context. Similarly, Baah-Boateng (2013) confirmed Okun's law in the labour market of Ghana.

Bordonaro and Rodriguez-Oreggia (2002) analysed the determinants of unemployment in Mexico, considering both individual and regional factors of individual genders affecting unemployment rates. The study focused on periods of economic crisis and periods of economic stability.

The Canadian determinants of unemployment during the period from 1967 to 1991 were analysed by Fortin et al. (2001). The authors considered the variables such as interest rate, tax policy, minimum wages, demographic development and unemployment insurance. The study

found that higher interest rates and unfavourable demographic changes were key factors contributing to a long-term increase in unemployment in Canada.

Gorry (2013) conducted a study investigating the relationship between minimum wage and youth unemployment in France and America from 2007 to 2009. The study results indicated that an increase in minimum wages could impact the unemployment rate among young people.

2. Methodology and Data

In this study, econometric modelling was the main tool for exploring the relationship between the unemployment rate and other macroeconomic factors. Given our assumptions of the autoregressive nature of the unemployment rate time series, we employed the autoregressive (AR) model. This model incorporates time lags of the time series, with the appropriate lag order determined based on the partial autocorrelation function (PACF) of the time series. The PACF depicts the correlation between the time series and its lags. Analysis of the PACF revealed a significant correlation between the unemployment rate time series and its first lag, indicating that the appropriate model is AR(1).

In addition to the time series lag, the model incorporated several macroeconomic factors mentioned below, as the main aim of this study was to explore their impact on the unemployment rate in Slovakia during the monitored period. Consequently, the model included several explanatory variables alongside the autocorrelation component. Furthermore, to account for potential seasonal variations in the unemployment rate, we introduced a set of dummy variables representing the months of the year to capture the seasonal fluctuations.

The model was evaluated using evaluation measures such as the coefficient of determination R^2. The regression assumptions were verified through appropriate tests and graphical analysis of residuals.

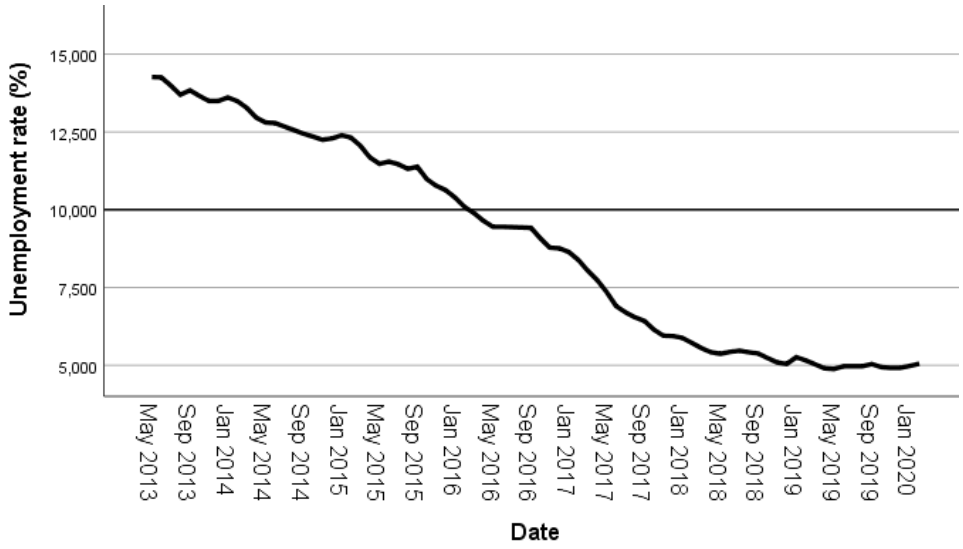
The data for the analysis were obtained from various sources, including the websites of the National Bank of Slovakia, the Central Office of Labour, Social Affairs and Family (COLSAF) of the Slovak Republic (SR), the World Bank, the World Trade Organization, the Statistical Office of the SR, Transparency International, and Trading economics. Data on selected factors, including unemployment, were available for the period 2000-2022. The unemployment rate exhibited a predominantly downward trend throughout this period, with temporary reversals during crises. Specifically, around 2009 (during the global financial crisis) and 2020 (during the COVID-19 pandemic), unemployment experienced temporary increases, likely due to these crises.

It is important to note that the presence of such crises could potentially impact the quality of the regression model. During times of crisis, the unemployment rate may respond differently to certain factors compared to normal conditions, and we may not have sufficient data to capture these effects accurately. Therefore, in this study, we limited the regression model to the period without any crisis, focusing on capturing the development of the registered unemployment rate in Slovakia under normal circumstances.

Another important aspect to consider for the analysed period is the change in the methodology used for calculating the registered unemployment rate in Slovakia in May 2013. To ensure objectivity, our analysis will only include data from May 2013 to February 2020, as this was when the impact of the COVID-19 pandemic on unemployment started to be felt in Slovakia.

Figure 1 illustrates the trend of the unemployment rate during the monitored period.

Figure 1: Unemployment rate. Source: own elaboration



The following factors were considered in the analysis as potential determinants of unemployment, serving as explanatory variables in the model creation:

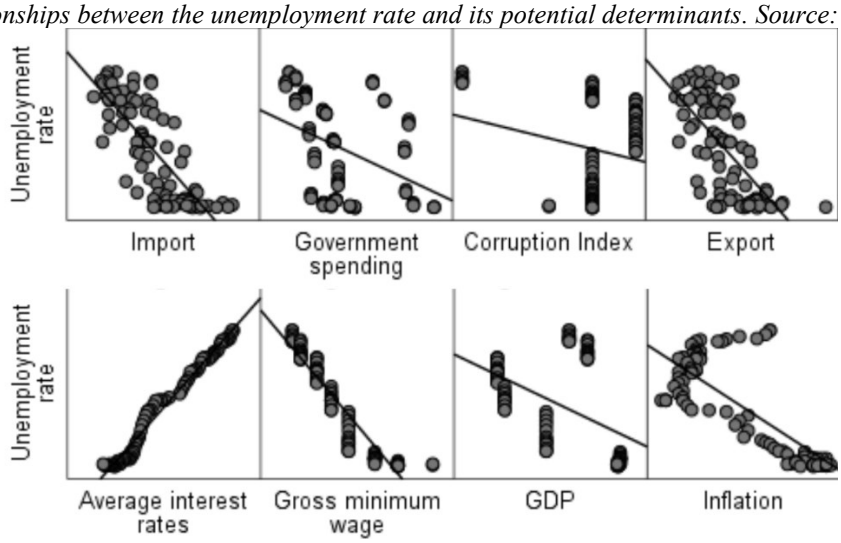
- Average interest rates on loans from commercial banks: We expect a direct relationship with the registered unemployment rate. Increasing interest rates signify higher costs of foreign capital, which may cause some entrepreneurs to lay off employees in order to reduce personnel expenses.
- Gross minimum wage: We expect an inverse relationship, as the gross minimum wage has consistently increased while the recorded unemployment rate has largely decreased. However, it is important to note that raising the minimum wage stimulates the labour market supply while simultaneously reducing the demand for work. This can lead to varying effects in different periods.
- GDP: We anticipate an indirect relationship whereby as GDP grows, we expect a decrease in unemployment.
- Inflation rate: The inflation rate primarily decreased during the analysed period, coinciding with the decrease in the recorded unemployment rate, indicating a direct relationship. However, the Philips curve suggests an opposite relationship. Therefore, predicting the relationship between inflation and unemployment during the selected period is challenging.
- Export and import: Export and import serve as important indicators of the performance of the economy and international trade functioning. A stronger economy with well-functioning international trade should facilitate job availability, implying an indirect relationship between exports and imports and the registered unemployment rate.
- Government spending: Government spending is expected to stimulate both the demand for and the supply of work in the market as required, thus suggesting an indirect relationship with unemployment.
- Corruption Index: Data on the Corruption Index was obtained from the website of Transparency International Agency, which annually assigns this index to 180 countries worldwide. A value of 0 indicates the highest possible level of corruption, while 100 represents the absolute absence of corruption. We anticipate an indirect relationship between the corruption index and the registered unemployment rate.

All calculations were performed using IBM SPSS software. A significance level of 0.05 was used for statistical hypothesis testing.

3. Results

This study aimed to identify significant determinants of unemployment and create an econometric model that captures their impact on the unemployment rate. The directions of these dependencies are illustrated by the matrix of scatter plots depicting the relationships between the selected factors and unemployment, as shown in Figure 2.

Figure 2: Relationships between the unemployment rate and its potential determinants. Source: own elaboration



The graphs depicting the relationship between the unemployment rate and individual factors confirm the assumed directions of dependences. The relationship between unemployment and inflation is indirect, thereby confirming the functionality of the Philips curve. Additionally, by examining the graphs, we can estimate the strength of the dependence. Points that cluster closely around the trend line indicate a stronger expected dependence. The strength of the correlation is quantified by the correlation coefficients listed in Table 1.

Table 1: Correlations between the unemployment rate and other factors

Correlation coefficient	average interest rates	gross minimum wage	GDP	inflation	import	government spending	corruption index	export
Pearson correlation	0.990	-0.947	-0.478	-0.763	-0.657	-0.790	-0.403	-0.246
Spearman correlation	0.994	-0.984	-0.504	-0.674	-0.808	-0.546	0.016	-0.661

Source: own elaboration

In the regression model for the relationship between unemployment and its potential determinants, as mentioned above, we included all selected explanatory variables, along with dummy variables representing individual months of the year, to account for possible seasonality. After analysing the multicollinearity between the explanatory variables using variation inflation factors (VIF), we observed a high degree of dependence between exports and imports and between the gross minimum wage and average interest rates. For this reason, with regard to the substantive meaning, gross minimum wage and import factors were subsequently removed from the model.

Considering the assumed autoregressive nature of the unemployment rate, we included time series lags into the model. Analysis of the partial autocorrelation function indicated that the AR(1) model was the appropriate choice for the lag order.

Subsequently, we constructed a model that excluded all dummy variables representing the months of the year and the corruption index. It was visible even from the graphical and correlation analysis that its relationship with the unemployment rate is weak. Even though it had a very low statistical significance (p-value = 0,95) and minimal impact on the overall model quality, its removal from the model did not significantly affect the result. Other variables are retained in the model even though their significance is higher than the 0.05 level, as we intended to emphasize their relationship with the unemployment rate irrespective of the statistical tests results. The regression model is presented in Table 2.

Table 2: Regression model for the unemployment rate

Factor		Lag	Estimate	SE	t	Sig.
Unemployment rate	*Constant*		3,13	1,75	1,79	0,08
	AR	Lag 1	0,99	0,02	66,05	0,00
Average interest rates	Numerator	Lag 0	1,80	0,32	5,67	0,00
GDP	Numerator	Lag 0	-0,14	0,11	-1,36	0,18
Inflation	Numerator	Lag 0	-0,10	0,08	-1,35	0,18
Government spending	Numerator	Lag 0	-0,37	0,13	-2,83	0,01
Export	Numerator	Lag 0	-0,009	0,02	-0,42	0,68

Source: own elaboration

The coefficient of determination of the created model is 0.996, indicating that the model explains 99.6% of the variability in the registered unemployment rate.

4. Discussion

Based on the developed regression model, it can be claimed (ceteris paribus) that the following effects would occur on the registered unemployment rate in the monitored period:

- A one percentage point increase in interest rates would, on average, lead to a 1.80 per cent increase in the registered unemployment rate.
- A one billion USD increase in GDP would, on average, result in a 0.14 percentage point decrease in the registered unemployment rate.
- A one percentage increase in inflation would, on average, cause a 0.10 percentage point decrease in the registered unemployment rate.
- A one billion € increase in government spending would, on average, lead to a 0.37 percentage point reduction in the registered unemployment rate.
- A one billion € increase in exports would, on average, result in a 0.009 percentage points decrease in the registered unemployment rate, although this variable is the least significant in the model.

The econometric time series model developed in this study indicated that the unemployment rate in Slovakia does not exhibit a seasonal pattern. According to our knowledge, there may be a seasonal component in the number of newly registered jobseekers, but it does not translate directly to the unemployment rate itself. These findings were confirmed by this study.

We would like to emphasise that these conclusions are valid only under normal circumstances, as the analysis focused on a period without any crisis. The emergence of the COVID-19 pandemic in 2020 had a significant impact on the unemployment rate in Slovakia,

thus altering the situation during and after this crisis. It would be appropriate to conduct further in-depth analysis to determine the validity of the relationships found in this study within the changed conditions during or after the pandemic. We consider this a potential suggestion for further research.

Furthermore, the results of the study can be further expanded by incorporating additional factors as potential determinants of the unemployment rate in Slovakia. It would also be appropriate to create a regression model that assesses the impact of macroeconomic factors lagged by at least one period on the unemployment rate. Such a model would not only facilitate interpretations but also enable predictions. From an econometrical point of view, it would be appropriate to test the suitability of logaritmic transformations of the variables in the model.

5. Conclusion

This study focused on examining the relationship between the unemployment rate and its several potential determinants. The study aimed to analyse data from May 2013 to January 2020, ensuring consistency in the methodology used to calculate the unemployment rate in Slovakia. The end of the period under review was set as the month prior to the start of the COVID-19 pandemic in Slovakia. Therefore, the findings of this study primarily reflect the relationships between the unemployment rate and other factors under normal circumstances.

The study revealed that the unemployment rate in Slovakia exhibits an autoregressive nature, indicating a strong correlation with the unemployment rate from the previous month. Additionally, we identified several factors that have a significant relationship with the unemployment rate, including inflation, GDP, interest rates, government spending, and exports. The regression model largely confirmed most of the assumptions regarding these relationships.

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Evaluating the financial performance of intermediary companies: a comparative analysis before and after the COVID-19 pandemic

Branislav Slobodník

Abstract

The COVID-19 pandemic has affected all sectors of the financial services industry and left profound effects on their operations. Various European institutions have stated that the COVID-19 pandemic has caused significant disruption to the economy, businesses and people's lives. In addition to insurance companies and banks, the intermediary sector is also disrupted. There has been little analysis of the financial performance of intermediary companies during this period in the literature. The aim of this study is to measure the financial performance of the four largest intermediary companies operating in the Slovak Republic, with an emphasis on the impact of the COVID-19 pandemic on the business of the investigated intermediary companies. The study examines key company indicators such as, profitability, liquidity and capital structure over the period 2018-2021. Return of assets, return on equity, Profit Margin, Current Ratio, Debt/assets ratio, Debt to equity ratio were observed. The findings show a generally high degree of stability in the profitability indicators of the intermediary companies. The analysis concludes that during the COVID-19 pandemic, intermediary companies were more profitable than before the COVID-19 pandemic. In terms of liquidity and capital structure indicators, the companies showed lower levels of variability and volatility in all areas.

Key words

Intermediary companies, financial stability, financial performance, COVID-19

JEL Classification: G23

1. Introduction

The COVID-19 pandemic was a major event that significantly affected the relationship between the consumer and the financial institution in the context of the provision of financial services. These events have brought with them significant changes and have caused communication to shift to a digital environment.

The financial performance of intermediary firms is a critical factor in assessing their efficiency, stability, and competitiveness in the financial markets. The analysis of financial ratios provides valuable information on their operational efficiency, risk management and overall market position. In the context of the Slovak Republic, a comparison of the financial performance of intermediary companies between 2018 and 2021 is important to assess their resilience and adaptability in a dynamic economic environment, in particular the impact of the COVID-19 pandemic.

A well-developed intermediary services sector is the backbone of the country's economic development. The financial performance of intermediary firms has a direct impact on the public, from consumers directly to financial institutions, from the employees of these firms to the intermediaries themselves, and from regulators to potential investors. The insolvency as well as the delivery of financial services during the COVID-19 pandemic in the intermediation industry has created a state of concern as the dysfunction of the intermediation

industry can cause serious financial instability within the economic sector and can affect the functioning of banks and insurance companies negatively.

The aim of this research study is to conduct a comparison of the financial performance of intermediary companies operating in the Slovak Republic between 2018 and 2021. By examining key financial ratios such as profitability ratios, liquidity ratios, capital structure ratios, this study seeks to provide a comprehensive analysis of the performance trends, strengths, and weaknesses of these companies within the Slovak intermediary industry.

2. Literature review

A well-developed intermediation sector is essential for the development of the national economy. The intermediation industry encompasses complex processes ranging from contracting and intermediation to the selection of financial products in insurance, banking and other industries. which ultimately advances the financial system. Without the proper set up and regulation of this sector, economic growth would be disrupted and this would cause financial instability within the functioning of the market. Aras and Muslamov [1] present a positive relationship between financial intermediation and economic growth. As countries grow economically, the demand for investment and capital increases, leading to a corresponding expansion in the supply of and demand for intermediary institutions within financial markets.

The COVID-19 pandemic has not only affected people's lives, but also the functioning of financial institutions. No research has been carried out in the Slovak Republic to compare the financial performance of intermediary companies. There are many studies that have measured the financial stability of European insurance companies and banks during the COVID-19 pandemic. (Pulawska, 2021 [2], Boot et al, 2020 [3]. Pulawska [2] analysed the financial statements for the years 2010 to 2020 using regression analysis. Their analysis showed a demonstrable and negative impact on the performance of the insurance sector, which the authors attribute to a significant reduction in the average return on assets of the insurer. This may undermine the financial stability of the economy. Also, from the perspective of the insurance industry, it is also possible to find studies that have analysed financial stability after the financial crisis. Baluch et al. [4] conducted a comprehensive assessment of the repercussions of the financial crisis on insurance markets. The study scrutinized the performance of various insurance markets and banks over the period spanning from 2007 to 2009. The findings indicate that the influence of the crisis on insurance markets exhibited heterogeneity, with varying degrees of impact observed. Furthermore, a significant number of banks failed to meet their solvency capital requirements during the crisis period, whereas the majority of insurance companies maintained satisfactory solvency ratios. This divergence between distinct banking and insurance markets can potentially undermine overall financial stability.

In recent years, there has been a significant increase in the correlation between financial intermediation and economic development, which is mainly attributed to the growing dominance of the banking, insurance, and investment markets within the financial sector. From an insurance industry perspective, Ostrowska-Dankiewicz and Simionescu [5] posit that this phenomenon finds support in empirical evidence, which demonstrates a persistent expansion of the global insurance market since 1950, with an annual growth rate surpassing 10 %. Notably, this growth rate significantly exceeds the pace of global economic growth, underlining the substantial divergence between the two. From an investment capability perspective, FIs are crucial to the securities market and the broader economy. According to Levine [6], financial intermediaries engage in a variety of core financial functions, including mobilizing savings, allocating resources efficiently, exercising corporate control, managing risk, and facilitating trade in goods and services. Moreover, research conducted by Levine [6],

has shown a positive correlation between the exogenous aspect of financial intermediary development and economic growth.

Assessing the development of financial intermediation involves factors such as the overall scale of financial intermediaries, the level of involvement of commercial institutions in intermediation, and the extent to which financial products are transferred to private sector activities [7]. In addition to these factors, Diamond [7] emphasized the critical role of financial intermediaries in mitigating the information asymmetry that leads to adverse selection problems.

The examination of financial institutions' performance assumes paramount significance as their effective functioning serves as a foundational assurance for robust growth within the real sector. The advent of the global financial crisis in 2008 compelled financial institutions and their managers, acting as pivotal entities within the system, to undertake excessive risks driven by short-term financial goals. Consequently, substantial financial burdens were borne by the overall economy [8]. In a financial system reliant on trust, any erosion in trust yields adverse consequences for the operation of the financial intermediation system [9].

The literature on the mediation period is very limiting. The assessment of the financial stability of this sector is very important for the functioning of institutions. Therefore, it is pertinent to examine the financial stability of intermediary companies.

3. Method and methodology

The aim of this study is to measure the financial performance of the four largest intermediary companies by largest turnover in the Slovak Republic between 2018 and 2021, with an emphasis on comparing their financial performance before the COVID-19 pandemic in 2018-2019 and during the 2020-2021 crisis. Three groups of financial performance evaluation indicators, namely liquidity, profitability, capital structure, will be used to make the comparison. The financial performance data relating to the financial statements in the form of balance sheet and income statement for the years 2018 to 2021 have been taken from the publicly available Register of Financial Statements [10,11,12,13]. and from finstat.sk, which are also available on their website.

Among the first observed group of financial performance we consider profitability. The indicators used to calculate the profitability of the intermediary companies were Return of assets (ROA), Return of Equity (ROE) and Profit Margin.

Return of assets (ROA) in observation will be calculated in % as:

$$ROA = \frac{Net\ Income}{Total\ assets}$$

Return of equity (ROE) in observation will be calculated in % as:

$$ROE = \frac{Net\ Income}{Total\ equity}$$

Profit Margin in observation will be calculated in % as:

$$Profit\ Margin = \frac{Gross\ Profit}{Net\ Sales}\ x\ 100$$

The second observed group of financial performance we rank liquidity. For measuring liquidity, we use two Current Ratio and Ratio Financial Accounts to Total Assets.
The Current ratio in observation of liquidity will be calculated as follow:

$$Current\ ratio = \frac{Current\ Assets}{Current\ Liability}$$

Another indicator that measures the liquidity of observed intermediary companies is the ratio of financial accounts to total assets. The ratio of financial accounts to total assets is calculated as:

$$Ratio\ Fin.Account = \frac{Net\ Financial\ Account}{Total\ Assets}$$

The third observed group of financial performance is capital structure. For calculating the capital structure, we selected two ratios, namely Debt-asset ratio and Debt to Equity Ratio.

First indicator which measure capital structure is Debt to Equity Ratio. Debt to Equity Ratio shows how much debt a company has compared to its assets. It is found by dividing a company's total debt by total shareholder equity. A higher D/E ratio means the company may have a harder time covering its liabilities. Debt to Equity Ratio is calculated as:

$$Debt\ to\ Equity\ Ratio = \frac{Total\ liability}{Total\ equity}$$

Second indicator measuring capital structure is debt/asset ratio. Debt/asset ratio is calculated by dividing total debt by total assets. When a debt ratio is greater than 1 or 100%, it means that company has more debt than assets while a debt/asset ratio of less than 100% indicates that a company has more assets than debt. Debt/asset ratio is calculated as:

$$Debt/Asset\ Ratio = \frac{Total\ liability}{Total\ assets}$$

Coefficient of variation is a relative measure of dispersion that is used to determine the variability of data. It is expressed as a ratio of the standard deviation to the mean multiplied by 100. We use coefficient of variation of observation of three indicators liquidity, profitability and capital structure, especially calculating variation between observed period of ratio. The coefficient of variation is calculated as:

$$Variance\ coeficient = \frac{Standard\ Deviation}{Mean}\ x\ 100$$

The first part of the analysis of the financial performance of the intermediary companies measures the stability of each financial ratio using the coefficient of variation. Results of ratios are being compared from period 2018-2021. Subsequently, statistical methods are applied which is used to determine the variability.

In the second part of the financial performance analysis, we compare the descriptive analyses to analyse the performance of each indicator and examine the behaviour of financial institutions using these indicators over 2018-2021.

Before presenting the results of each intermediary company, it is necessary to introduce the companies that will be compared. In Table 1, we present the 5 largest intermediary companies operating in Slovakia from 2018 to 2021. In our analysis, we excluded Fingo.SK from the observation, as the company entered the Slovak intermediary market only in 2020.

Table 1: Intermediary companies in Slovakia according to revenues in 2021-2018

Name of intermediary company	Revenue in 2018	Revenue in 2019	Revenue in 2020	Revenue in 2021
Partners Group	34 399 717	40 288 808	44 508 070	49 561 210
OVB Allfinanz Slovensko	37 773 021	41 043 790	41 142 785	43 721 061
Respect Slovakia	41 766 167	38 238 429	37 633 005	37 743 002
Finportal	17 718 310	21 108 281	25 477 522	35 672 277
Fingo.SK	-	-	1 012	2 267 953

Source: own elaboration based on the accounts of individual intermediary companies

4. Data analyse

In the next section, we compare three basic financial ratios namely profitability, liquidity, and capital structure. We express the correlations using the coefficient of variation and descriptive comparisons. The data was taken from the financial statements and the results of the ratios were manually calculated.

4.1 Profitability analysis

In Table 2 we can see four selected intermediary companies operating on the Slovak intermediary market. The value of the individual coefficients of variation of the profitability of the observed intermediary companies reflects the instability of the intermediary market.

Analysing the profitability based on results presented in Table 2 of Partners Group's largest company [10], it can be observed that all three indicators are not volatile. The ROE ratio increased by 2.6 percentage points between 2021 and 2019. This was due to higher net profit compared to before the COVID-19 pandemic. When comparing ROA, it can be observed that this indicator visibly decreased during the COVID-19 pandemic. By deeper analysis, it can be argued that such a reduction is due to the increase in the company's assets when compared to the previous years. In our view, the impact of the COVID-19 pandemic does not affect ROE. The coefficient of variation values is low. Partners Group's profit margin ratio was lower during the COVID-19 pandemic than before the COVID-19 pandemic. Apart from Partners Group's visibly higher profits, the COVID-19 pandemic did not have a significant impact on the business of the country's largest intermediary company.

Based on results presented in Table 2, OVB Allfinanz Slovensko [11] the COVID-19 pandemic helped to improve all three indicators examined. Even during the COVID-19 pandemic, both ROE and ROA indicators increased significantly. Rapidly, when analyzing the financial performance of this company, we see an increase in the ROE indicator, up to 7.8%. This is due to the increasing profitability during the COVID-19 pandemic. Also, the ROA ratio has been caused due to the significant increase in the profit of this company during the COVID-19 pandemic. According to calculations, between 2018 and 2021, OVB Allfinanz Slovensko, a.s. increased its profit by 15%. Profit margins were stable compared to the period before and after the COVID-19 pandemic.

Comparison based on results in Table 2 of Respect Slovakia s.r.o. [12] in the period before the pandemic COVID-19 and after the pandemic COVID-19 we observe low values of the coefficient of variation, which reflects stability. The values of the ROE indicator were approximately the same, but we see a significant increase in the ROA indicator in the

comparison between 2018 and 2021. This is also due to the significant decrease in the profit of Respect Slovakia s.r.o., which also affected the indicators. Also, in 2021 there was a decrease in the company's equity, which increased the value of the ROE indicator. This may be the result of management's decision around business strategy. In 2020, the intermediary company Respect Slovakia had a significantly increased profit margin. Also, a significant decrease in Respect Slovakia's assets can be seen in Table 2 for 2021 year. Compared to 2018 (before the COVID-19 pandemic), this is an approximate decrease of 10%. In our opinion, the COVID-19 pandemic has affected Respect Slovakia s.r.o. negatively compared to the other intermediary companies under review.

The fourth largest intermediary company Finportal a.s. [13] shows high values of coefficients of variation. Comparing the years 2018-2021, we can see a doubling of the profits of this company. It is also possible to observe a rapid increase in equity of EUR 4 690 413. In terms of profitability, this company has experienced rapid development and growth, especially during the COVID-19 pandemic. This is probably due to the relatively high use of digital services by consumers during the COVID-19 pandemic. A significant increase can also be seen in the profit margin. The COVID-19 pandemic had a positive impact on this company compared to the other companies studied.

Table 2: Profitability of intermediary firms

Partners Group					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
ROE	91,6	93,2	93,0	94,2	11,51
ROA	62,0	58,0	54,9	61,3	55,38
Profit margin	18,6	20,0	17,4	19,1	57,75
OVB Allfinanz Slovensko a. s					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
ROE	61,3	62,2	67,1	69,1	58,12
ROA	22,9	23,1	24,7	24,4	38,14
Profit margin	7,8	7,4	7,6	7,8	25,14
Respect Slovakia s.r.o.					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
ROE	97,7	97,6	97,7	97,2	0,24
ROA	60,3	65,1	64,0	66,0	3,92
Profit margin	18,5	19,3	21,0	17,0	8,79
FINPORTAL					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
ROE	10,8	19,0	6,9	39,0	75,57
ROA	2,0	-2,8	3,8	23,0	174,57
Profit margin	0,6	-0,7	0,9	6,1	173,80

Source: based on the register of accounts and own processing

4.2 Liquidity analysis

The coefficient of variation measures the stability and variability of an indicator. A higher coefficient means a higher level of instability and variability of the variable. Current ratio is defined as a liquidity ratio that measures a company's ability to pay short-term liabilities or obligations due within one year.

In Table 3, lower values of Current Ratio can be seen, except for Finportal a.s.. It achieves a good level of stability and indicate similar changes in the components of current assets and current liabilities.

For Partners Group, comparing the Current Ratio values between 2018 and 2021, the value presented in Table 3 has decreased significantly during the COVID-19 pandemic, especially in 2019 and 2020. Current ratio presented in Table 3 increased in 2021. This is due to the emergence of current receivables, which were significantly higher in 2021 compared to 2018, 2019 and 2020, by approximately 3 million. After Finportal, the company had the second highest Current Ratio value, indicating that the company had a good level of stability during the pandemic. The company experienced increased liabilities during the COVID-19 pandemic, which also caused a higher coefficient of variation in the analysis.

Based on results presented in Table 3, OVB Allfinanz a.s. also recorded higher Current Ratio values, especially during the COVID-19 pandemic from 2019 to 2021. The increase was mainly seen in current receivables in 2021, but current liabilities were not significantly increased after 2018. The coefficient of variation shows a lower value, which indicates a positive result for OVB Allfinanz a.s. and speaks of its stability during the COVID-19 pandemic.

Respect Slovakia s.r.o. has seen a significant reduction in Current Ratio values after 2018 to 2021, which are being interpreted in Table 3. A deeper analysis can argue that relatively the Current Liabilities values were the same. Current receivables when comparing 2018 and 2021 were lower, which caused the Current ratio to decrease. The coefficient of variation of this company is 19.16, which can be considered as a higher value and speaks of not favourable liquidity of the company.

The current ratio of the intermediary company Finportal a.s. based on result in Table 3 has the largest value of all observations. We argue that this is due to the company's rapid growth in revenues, assets, and profits. Short-term receivables have increased by 254.4% between 2018 and 2021, as evidenced by the high value of the coefficient of variation. On the other hand, a decrease of 110% can be seen in current liabilities. These significant changes are due to the high Current Ratio as the company experienced rapid growth during the COVID-19 pandemic.

If we compare the current ratio and the ratio of financial accounts to total assets presented in Table 3 for Partner Group we can see that slowly by half this value is lower in 2021 than in 2018, which means that the liquidity position of this company has worsened during the pandemic COVID-19. Based on results presented in Table 3, OVB Allfinanz a.s. has worsened its liquidity position after the pandemic in 2021. We can see interesting observations when we measure the financial performance of Respect Slovakia s.r.o. and Finportal a.s. For both companies, there has been a significant growth in the financial accounts to total assets ratio when comparing 2019 and 2020. Subsequently as it can be seen from Table 3, in 2021, a rapid decline in this ratio can be seen for both companies. This change is mainly due to the improvement in the financial performance of both companies from 2020 to 2021.

Table 3: Liquidity of intermediary firms

Partners Group					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
Current ratio	2,484	1,830	1,36	2,152	24,48
Financial accounts to total assets	21,2	23,6	25,3	12,2	28,34
OVB Allfinanz Slovensko a. s					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**

Current ratio	1,106	1,171	1,463	1,411	13,64
Financial accounts to total assets	36,4	32,8	27,1	28,6	13,48
Respect Slovakia s.r.o.					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
Current ratio	3,077	2,001	2,609	2,211	19,16
Financial accounts to total assets	4,5	27,3	20,0	15,2	57,09
FINPORTAL					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
Current ratio	0,596	0,710	1,388	2,079	57,50
Financial accounts to total assets	50,6	20,6	32,1	22,8	43,32

Source: based on the register of accounts and own processing

Comparing the liquidity ratios, we can argue that for all companies, liquidity deteriorated significantly during the COVID-19 pandemic, as evidenced by the two ratios examined, namely Current Ratio and Financial Accounts to Total Assets Ratio. Some of the companies showed good liquidity, indicating that they are stable.

4.3 Capital structure analysis

Capital structure analysis measures the financial strength of an organization. A higher Debt assets ratio indicates a higher risk because it reveals that the company is using a higher proportion of external foreign resources to finance its business operations.

Analyzing the capital structure of Partners Group a.s., which is being interpreted in Table 4, we could see a significant decrease in the debt/asset's ratio in comparison from years 2018 to 2020. This means that the company used less external foreign resources for its financing before COVID-19 pandemic. When we analyse the debt-equity ratio, we see a rapid increase in 2019 and 2020, followed by a decline in 2021. This is mainly due to the growth in equity during the COVID-19 pandemic. During the pandemic, Partners Group increased its equity value.

As it can be seen in result in Table 4, coefficient of variation of intermediary company OVB Allifinanz a.s. is at a low value by monitoring Debt/assets ratio. The results are similar for each of the years under review. This is since the value of assets, liabilities and equity did not change during the period under review. The change can be observed in the assets of the company in 2021, where the previous year increased by 10%. In terms of capital structure, we consider OVB Allifinanz a.s. to be stable. On the other hand, the company avoids financial risks, as evidenced by the higher value of the debt/asset's ratio.

The coefficient of variation presented in Table 4 for intermediary company Respect Slovakia s.r.o. shows a low value of 3,73 for the value of the debt/asset's ratio and for debt-to-equity ratio 10,32, which also shows the stability of the company in terms of capital structure. From the analysis of the financial statements interpreted in Table 4, it is possible to observe a decrease in Debt-to-equity ratio in 2021 caused by decreasing Equity as well as in total assets which influenced both observed ratios presented in Table 4. The company's liabilities did not change their values rapidly in the period under review. We can consider this company to be stable before and during the COVID-19 pandemic.

As it can be seen in Table 4, intermediary company FINPORTAL shows high values of the coefficient of variation for both observed ratios. This is due to the fact that in 2018 and 2019, the firm showed high liabilities and the firm has multiplied its assets by a multiple of 91% from 2019 onwards, more specifically between 2018 and 2021. FINPORTAL has grown and expanded its business significantly during the COVID-19 pandemic, which can be seen in

their capital structure as in Debt assets ratio and Debt-to-equity ratio, which are being interpreted in Table 4. The year 2021 was favourable for all companies since these companies managed to strengthen their financial structure by reducing debt in relation to total assets and equity, resulting in a low level of financial risk.

Table 4: Capital structure analysis of intermediary firms

Partners Group					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
Debt asset ratio	31,25	26,43	24,45	28,86	10,63
Debt-to-equity ratio	47,3	60,8	69,3	53.2	16,53
OVB Allfinanz Slovensko a. s					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
Debt asset ratio	62,6	62,8	63,1	64,6	1,43
Debt-to-equity ratio	1,83	1,71	1,69	1,67	4,17
Respect Slovakia s.r.o.					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
Debt asset ratio	67,6	65,55	66,66	62,0	3,73
Debt-to-equity ratio	2,083	1,902	1,997	1,630	10,32
FINPORTAL					
Indicator %	**2018**	**2019**	**2020**	**2021**	**Coefficient of variation**
Debt asset ratio	81,1	85,0	44,9	31,2	43,97
Debt-to-equity ratio	4,366	5,667	0,816	0,531	90,18

Source: based on the register of accounts and own processing

5. Conclusion

The objective of this study was to measure the financial performance of the four largest financial intermediary companies operating in Slovakia between 2018 and 2021, with a particular focus on the impact of the COVID-19 pandemic on their performance in relation to profitability, liquidity, and capital structure. A few key findings that emerged from the analysis.

The findings show conclusively that the crisis had a clear and definitive impact on the profitability of these companies in 2021. The COVID-19 pandemic brought additional profits to the 4 largest intermediary firms. It can even be argued that FINPORTAL has doubled its profits thanks to its digitalisation and preparedness for the COVID-19 pandemic. The COVID-19 pandemic did not affect the profitability of the firms, and even helped them to increase their share of the intermediary market.

In terms of liquidity ratio, they examined two indicators namely Current Ratio and Financial Accounts to Total Assets. The COVID-19 pandemic has worsened the liquidity of the largest intermediary companies. The latter has adjusted in 2021, mainly by increasing profits and assets. Short-term receivables during the COVID-19 pandemic were increased, this caused lower liquidity of intermediary companies.

When analysing the capital structure, the most significant results can be observed in the fact that intermediary companies in the Slovak Republic do not avoid capital risks. Intermediary companies show stability based on their financial statements. Interesting is the expansion of the business of the intermediary company FINPORTAL, which has achieved a high coefficient of variation and high values of total liabilities to total assets. This is due to the fact that prior to the COVID-19 pandemic, the company did not make as much profit and did not own assets to the extent that they acquired during the COVID-19 pandemic.

From the analysis of the financial performance of the four largest financial intermediary companies, it can be said that intermediary companies in the Slovak Republic were more profitable than before the COVID-19 pandemic. A comprehensive comparison of indicators shows that the profitability, liquidity and capital structure of a company depends to a large extent on the internal business policy of a given company.

The results of this study showed that the pandemic had a major impact on the financial performance of intermediary companies in the Slovak Republic. Some companies have shown resilience and have been able to cope effectively with the crisis by adopting digital technologies, introducing remote working and adapting their business strategies to changing market conditions. These companies showed strong financial indicators including liquidity, profitability and risk management despite the challenging economic environment.

The study contains limitations. The limitation can be seen in the short time period after the COVID-19 pandemic. It is therefore necessary for more accurate results to observe a period of approximately 5 to 7 years after the pandemic to see if the effects of the pandemic do not reach the intermediary companies over a longer period. For further research, it would be useful to track financial stability indicators over a longer period of time.

In conclusion, this research has demonstrated the different impact of the COVID-19 pandemic on intermediary companies in the Slovak Republic. While some firms showed resilience and adaptability, others faced significant challenges. Technological innovation, digitalisation and a supportive regulatory environment emerged as key factors that determined the performance and resilience of intermediary companies during the crisis. It is imperative that firms continue to embrace digital transformation, improve risk management practices, and respond to market dynamics in order to thrive in an ever-evolving financial environment.

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Impact of a New Czech Act on Accounting (2025+) on Financial Performance of Czech Companies

Jiří Strouhal [1]

Abstract

This research is focused on a proposed new Czech Act on Accounting which is planned to be valid since January 2025. There is analysed a level of harmonisation between current and new Czech accounting practices and International Financial Reporting Standards (IFRS) when applying Jaccards' coefficient being commonly used tool for a harmonisation level measurement. Results proof a significantly higher similarity between new Act and IFRS. The case study focusing on major differences between current Czech accounting and IFRS proof that new Act will bring more comparable results while testing liquidity and turnover ratios, however profitability and debt ratios behave a bit fuzzy.

Key words

financial reporting, financial performance, IFRS, Czech accounting legislature

JEL Classification: M41, G30

1. Introduction

This research is motivated by a proposed new Act on Accounting which shall be eventually valid since January 2025. Act is promoted to be more harmonised with international referential (IFRS – hereinafter International Financial Reporting Standards) providing definitions of a basic elements (assets, liabilities, equity, expenses, income), accounting principles and to reflect the current impacts of ICT (hereinafter information and communication technologies) and digitisation onto accounting.

The reminder of this paper is as follows: firstly, there would be provided an up-to-date literature review focused on accounting harmonisation and testing of the harmonisation level and would be described the current stage of the preparation process. Within the practical part would be tested a harmonisation of current and new Act on Accounting with IFRS and presented a sample study on an impact of this legislature shift on corporate financial performance.

2. Literature Review

A literature review will focus on an accounting harmonisation in general, from a perspective of de iure and de facto harmonisation, fair value versus cost measurement and impact of the IFRS on earnings management. Second part of the review would be focused on a measuring of the level of harmonisation between local GAAP (hereinafter generally accepted accounting practices) and referential standards. Last part of this chapter will provide an insight into a preparation of a brand-new Czech Act on Accounting.

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2.1 Accounting Harmonisation

Capital markets are increasingly integrated. Until 2005 and mandatory use of IFRS, the subject of most de iure harmonization research was the description of the development of international and national financial reporting regulatory frameworks with emphasis on the International Accounting Standards Board (Garrido et al., 2002), identification and measurement of differences in national accounting regulations, i.e. legislation, capital market regulations, national accounting standards (Adhikari and Tondkar, 1992; Rahman et al., 1996; Brown and Tarca, 2005; Brown and Tarca, 2007) and examining the impact of European Union Directives and regulations on the national regulatory framework for financial reporting (Larson and Street, 2004; Haller and Eierle, 2004; Delvaille et al., 2005; Strouhal et al., 2009; Albu et al., 2013). Researchers have become aware that a basic legal framework is not enough; enforcement is crucial for companies to follow the rules (Carvajal and Elliott, 2009).

The mandatory adoption of IFRS in the European Union represents one of the largest regulatory experiments ever undertaken (Christensen et al., 2007). Some studies posit that countries with accounting standards with higher divergence from IFRS benefit more from IFRS adoption (Ashbaugh and Pincus, 2001; Biddle et al., 2015; Cai et al., 2014). In this sense Czech Republic is a perfect case whose accounting standards have been considered divergent from IFRS. Many of studies find that IFRS companies exhibit less earnings management, less earnings smoothness, more timely recognition of losses and greater value relevance (Chua et al., 2012; Daske, 2006; Nouri and Abaoub, 2016). Other studies believe that IFRS reduce the cost of capital, improve market liquidity and equity valuations, encourage international investments, increase analyst following and reduce analyst forecast dispersion (Cormier, 2013; Daske et al., 2008; Landsman et al., 2012).

Widely discussed topic is a spread of mark-to-market (or fair value) accounting, i.e. whether also other assets and liabilities (not only financial assets or financial liabilities) shall be measured at fair value as opposed to historical cost model.

Ball (2006) study points out what fair value accounting provides accurate and comprehensive financial statements information. Also, fair value accounting allows lower managerial manipulation especially if appraisals were conducted by external appraisers (Dietrich et al., 2000). On the other hand, the fair value opponents argue that fair value accounting increases information asymmetry as it combines realized and unrealized gains and losses and as well, it has the potential for redistributing of capital as dividends exceed realised earnings (Abdel-Khalik, 2008). Rodriguez-Perez et al. (2011) argue that although switching from historical cost to fair value accounting might alter the perception of analysts regarding few firms, it will not affect the appraisal of the firm. The study finds a significant change in profitability, asset turnover and profit margin ratios, when contrasted with historical cost ratios.

2.2 Harmonisation Measurement

A distinct positioning and importance must be given to the studies focusing on different aspects of the international accounting harmonization process since this research field represents the major objective of research activities being developed by many accounting professionals and universities during the last 40 decades (Baker and Barbu, 2007). They identified three main research periods and a series of major topics of studies developed during the 1965-2004 period.

The objective of analysing research literature's main trends in terms of measuring accounting harmonization is also undertaken by Mustata et al. (2011). Mustata et al. (2011) document that two major periods can be dimensioned in the evolution of studies on formal harmonization measurement as follows: the initial period can be placed in time beginning with 1981, until 1985; and the mature period, starting in 1996 until now.

We can observe that instruments measuring the compatibility degree of accounting practices and of different sets of accounting regulation record a convergent time evolution towards the common point given through measurement instruments based on similarity. Moreover, a clearer dimensioning of the accounting harmonization degree is obtained when using either association coefficients or correlation coefficients.

Jaccard's Coefficients are mostly known in the form being used by Fontes et al. (2005), as follows:

$$S_{ij} = \frac{a+d}{a+b+c+d} \quad (1)$$

and

$$D_{ij} = \frac{b+c}{a+b+c+d} \quad (2)$$

where:

S_{ij} represents the similarity degree between the two sets of analyzed accounting regulations or practices; D_{ij} represents the degree of dissimilitude or diversity between the two sets of analyzed accounting regulations or practices; a – the number of elements which take the 1 value for both sets of regulations or practices; b – the number of elements which take the 1 value within the j set of regulations or practices and the 0 value for the i set of regulations or practices; c – the number of elements which take the 1 value within the i set of regulations or practices and the 0 value for the j set of regulations or practices; d – the number of elements which take the 0 value for both sets of regulations or practices.

The values that can be recorded by these coefficients go from 0 to 1, where 1 represents a maximum level of harmonization when considering the similarity coefficient. Also, the sum of the two Jaccard's Coefficients, Jaccard S_{ij} and D_{ij}, is obviously always equal to 1.

2.3 Preparation of a New Czech Act on Accounting

The currently valid Czech Act on Accounting is from year 1991 and is widely accepted by current practice. In 2019 was prepared a draft of a Substantive Intent for a Preparation of a New Act on Accounting which shall reflect all new trends, i.e. the higher level of harmonisation with International Financial Reporting Standards (IFRS) and the impact of digitisation and ICT on accounting. This Substantive Intent was accepted by professional accountants just with a reserved attitude and heavily criticised from a Legislative Council of a Government of the Czech Republic. Despite the legislative council criticized this intent, paradoxically recommend it for an approval by Czech government, what happened in October 2020.

Since October 2020 the brand-new Act on Accounting has its already 6th version which was opened for public comments till November 2022. Within a new Act there is visible a significant shift towards IFRS approach, there are defined some basic elements and accounting methods, however the current stage is still quite fuzzy and for certain paragraphs it still offers two or more alternative (and sometimes contradictory) versions. The comments from relevant bodies are available on a government website[2] - the major comments were provided by Chamber of Auditors (Březinová et al., 40 p.), Association of SMEs (Strouhal et al., 6 p.) and Chamber of Tax Advisors (13 p.). Up till June 2023 all those comments have not been settled by a Ministry with a quote that those shall be settled together when an underlying legislation would be announced as well.

Ministry of Finance initially expected that this new Act would be valid since January 2024, currently (as of June 2023) the validity is not expected sooner but in January 2025, which is from author's point of view too optimistic and risky. Considering the shift in measurement bases (instead of costs and nominal values would be widely spread amortised costs and fair values) it shall be followed the approach of IFRS 1 (A First Adoption of IFRS) and set the

[2] https://odok.cz/portal/veklep/material/pripominky/KORNCKKHGM1N/

validity not sooner but in January 2027 in case that all other relevant legislature would be prepared. There arose the problem with changes of accounting standards, but up till now there is no relevant information about the works on standards or another regulation, insider information says that this shall be done by professional accountants and not by a Ministry of Finance. However, this will delay the adoption process even more.

3. Research Design

This paper will focus on a harmonisation measurement between current and new Czech Act on Accounting with International Financial Reporting Standards (IFRS) from a perspective of applied measurement bases and the adoption of substance over form rule. For a measuring of a statistical distance would be applied Jaccards' methodology as described within a subchapter 2.2.

The impact of a new legislature on financial performance would be tested on a sample (and simple) case study which is focusing on major differences between current Czech Act on Accounting and IFRS aiming to proof how the shift towards a New Act on Accounting will bring a higher compatibility level with IFRS or not.

4. Results

4.1 Harmonisation Measurement

For the purposes of a harmonisation measurement there were analysed following areas in terms of measurement bases: (i) intangible assets, (ii) property, plant and equipment, (iii) investment properties, (iv) biological assets – animals, (v) inventories, (vi) receivables, (vii) shares, (viii) bonds, (ix) provisions, and (x) liabilities. There was also analysed who recognize finance and operating leases and the possibility of the functional currency usage.

The results of the harmonisation measurement tests applying Jaccards' coefficients are visible from Table 1. Underlying data are described within Appendix 1.

Table 1: Level of Similarities and Dissimilarities between Current and Proposed Czech GAAP and IFRS

	CZ_0/CZ_1	CZ_0/IFRS	CZ_1/IFRS
S_{ij}	53.57%	35.71%	82.14%
D_{ij}	46.43%	64.29%	17.86%

Source: own analysis based on Czech GAAP (current and proposed), IFRS – underlying data in Appendix 1

There is visible a significant shift in comparability between Czech GAAP and IFRS in case of the adoption of a new Act on Accounting (from current 36% towards 82%) while keeping a reasonable comparability between current and a new one (54%). The major difference is given by a wider spread of amortised costs concept and the shift in reporting of leases where shall be newly followed IFRS approach (substance-over-form, when a lessee is a party who recognises an object of a finance lease).

4.2 Impact of a New Accounting Act on Financial Performance

To be able to provide a practical impact of a proposed new Czech Accounting Act we will introduce here a simple case study focusing on a major difference between the current and a new legislature.

The initial balance sheet was as follows:

Balance Sheet at the Year-Beginning			
Property, plant and equipment	5 000 000	Registered capital	1 000 000
Goods	1 500 000	Retained earnings	4 000 000
Current receivables	2 500 000	Non-current liabilities	2 000 000
Cash	1 000 000	Current liabilities	3 000 000
TOTAL ASSETS	10 000 000	EQUITY AND LIABILITIES	10 000 000

This means that at the beginning of the year the selected ratio results were as follows:

current ratio	1.67	debt ratio	50.00%
quick ratio	1.17	finance leverage	2.00

Within the period there were realised just these four transactions (all on 1st January 20X2):

1. An invoice for a purchase of an investment property for 1 000 000 CU[3] (expected useful life is 5 years, a straight-line depreciation is assumed; for IFRS treatment is applied a fair value model => fair value at the year-end is 1 200 000 CU)
2. A company entered into a 5-years finance lease with annual instalments of 300 000 CU (payable at the year-end). Incremental interest rate of lessee is 10% p.a., there is expected a straight-line depreciation throughout the lease term.
3. A sale of goods on a 3-years credit for 1 400 000 CU (costs of goods sold were 1 000 000). In case of an immediate settlement, company will accept 1 200 000 CU only.
4. A purchase of a PPE (property, plant and equipment) item on a 3-years credit for 1 000 000 CU. In case of an immediate settlement the supplier would accept 900 000 CU only. There is expected a 3-years useful life and a straight-line depreciation method.

Appendix 2 provides financial statements and important data at the year end after accounting for these four transactions according to a current Czech accounting legislature, proposed new Czech accounting legislature and according to IFRS.

Based on the data the major financial ratios would be as follows – see Table 2 and Appendix 2:

Table 2: Ratio analysis

		CZ GAAP$_0$	CZ GAAP$_1$	IFRS
return on assets	$\frac{EBIT}{Assets}$	-3.75%	-3.78%	-0.51%
return on equity	$\frac{EAT}{Equity}$	-9.49%	-13.90%	-4.39%
profit margin	$\frac{EBIT}{Sales}$	-30.95%	-38.68%	-5.35%
current ratio	$\frac{Current\ assets}{Current\ liabilities}$	0.92	0.90	0.90
quick ratio	$\frac{Cur.assets - Inventories}{Current\ liabilities}$	0.80	0.78	0.78
assets turnover	$\frac{Sales}{Assets}$	0.12	0.10	0.09
debt ratio	$\frac{Debts}{Assets}$	60.52%	64.23%	62.20%

[3] currency units

interest cover	$\frac{EBIT}{Interest\ charges}$	n/a	-3.18	-0.44
finance leverage	$\frac{Assets}{Equity}$	2.53	2.80	2.65

Source: own analysis based on Czech GAAP (current and proposed) and IFRS – underlying data in Appendix 2

Results show the comparability between new Czech GAAP and IFRS while testing liquidity ratios and assets turnover. When measuring profitability and debt position, new Czech GAAP (based on this elementary study) proves the worst results (both compared to IFRS or a currently valid Czech GAAP).

5. Conclusions and Limitations

The shift to a new Act on Accounting will bring a better comparability between Czech accounting practices and International Financial Reporting Standards. Based on a performed analysis, there is expected an 82% compatibility between new Czech Act and IFRS while keeping 53% compatibility between old and new Czech Act. However, the shifts in measurement bases will bring a new demand on professional accountants and their quality, what may bring an interesting challenge for professional chambers. The major challenge for professional accountants would be a determination of a proper effective interest rates and other relevant discount factors and a proper determination of fair values.

The new Act will also bring some positive shifts alike reporting of leases and the possibility of a functional currency usage.

As a limitation of this paper shall be mentioned the current stage of the legislature process where was published only the version of a new Accounting Act, however without ANY relevant underlying legislature, so there is possible to comment just a detail without knowing the whole frame.

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Appendix 1: Measurement under current and proposed Czech GAAP and IFRS

	CZ GAAP$_0$	CZ GAAP$_1$	IFRS
Intangibles			
• cost model	yes	yes	yes
• revaluation model	no	no	yes
Property, plant and equipment			
• cost model	yes	yes	yes
• revaluation model	no	no	yes
Investment properties			
• cost model	yes	yes	yes
• fair value model	no	no	yes
Biological assets (animals)			
• cost model	yes	no	no
• fair value model	no	yes (ZOO only)	yes
Finance leases			
• recognised by a lessor	yes	no	no
• recognised by a lessee	no	yes	yes
Operating leases			
• recognised by a lessor	yes	yes	yes
• recognised by a lessee	no	no	yes
Inventories (other than biological assets)			
• cost model	yes	yes	yes
Receivables			
• nominal value	yes	no	no
• amortised costs	no	yes	yes
Shares			
• cost model	yes	yes	yes
• equity method	yes	yes	yes
• FVTPL	yes	yes	yes
• FVOCI	yes	yes	yes
Bonds			
• nominal value	yes	no	no
• amortised costs	no	yes	yes
• FVTPL	yes	yes	yes
• FVOCI	yes	yes	no
Provisions			
• nominal value	yes	no	no
• amortised costs	no	yes	yes
Liabilities			
• nominal value	yes	no	no
• amortised costs	no	yes	yes
Functional currency	no	yes	yes

Appendix 2: Underlying Financial Statements and Dataset for a Case Study

Current Czech GAAP Balance Sheet at the Year-End			
Property, plant and equipment	6 466 666	Registered capital	1 000 000
Goods	500 000	Retained earnings	4 000 000
Non-current receivables	1 400 000	Profit/loss of the period	-433 334
Current receivables	2 500 000	Non-current liabilities	3 000 000
Cash	700 000	Current liabilities	4 000 000
TOTAL ASSETS	11 566 666	EQUITY AND LIABILITIES	11 566 666

Proposed Czech GAAP Balance Sheet at the Year-End			
Property, plant and equipment	6 400 000	Registered capital	1 000 000
Right-of-the-use assets	909 789	Retained earnings	4 000 000
Goods	500 000	Profit/loss of the period	-610 069
Non-current receivables	1 263 272	Non-current liabilities	3 788 034
Current receivables	2 500 000	Current liabilities	4 095 096
Cash	700 000		
TOTAL ASSETS	12 273 061	EQUITY AND LIABILITIES	12 273 061

IFRS Statement of Financial Position (AKA Balance Sheet) at the Year-End			
Property, plant and equipment	5 600 000	Registered capital	1 000 000
Investment properties	1 200 000	Retained earnings	4 000 000
Right-of-the-use assets	909 789	Profit/loss of the period	-210 069
Goods	500 000	Non-current liabilities	3 788 034
Non-current receivables	1 263 272	Current liabilities	4 095 096
Current receivables	2 500 000		
Cash	700 000		
TOTAL ASSETS	12 673 061	EQUITY AND LIABILITIES	12 673 061

	CZ GAAP$_0$	CZ GAAP$_1$	IFRS
EAT	-433 334	-610 069	-210 069
interest charges	0	145 894	145 894
EBIT	-433 334	-464 175	-64 175
sales	1 400 000	1 200 000	1 200 000
assets	11 566 666	12 273 061	12 673 061
equity	4 566 666	4 389 931	4 789 931
debts	7 000 000	7 883 130	7 883 130
current assets	3 700 000	3 700 000	3 700 000
inventories	500 000	500 000	500 000
current liabilities	4 000 000	4 095 096	4 095 096

THE DEPARTMENT OF FINANCE IS SUPPORTED BY