LITTERA SCRIPTA

Economics

Management

Corporate Finance

Finance and Valuation

1/2024

VŠTE

Littera Scripta

(Economics, Management, Corporate Finance, Finance and Valuation)

Ing. Jakub HORÁK, MBA, PhD. (Editor-in-chief)

Address Editor:

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Tel.: +420 387 842 183

e-mail: journal@littera-scripta.com

ISSN 1805-9112 (Online)

Date of issue: June 2024

Periodicity: Twice a year Since 2010

The Journal is indexed in:

- ERIH PLUS (European Reference Index for the Humanities and Social Sciences) – in 2015
- CEJSH (Central European Journal of Social Sciences and Humanities) – in 2015
- EZB (Elektronische Zeitschriftenbibliothek) – in 2017
- GOOGLE SCHOLAR – in 2017
- DOAJ (Directory of Open Access Journals) – in 2019

Content

The development of e-commerce turnover in the Czech Republic during economic crises: a case study

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Abstract

The aim of the case study was to analyse the impact of economic crises on e-commerce in the Czech Republic. Secondary data from Google Analytics was used for the research and e-shops from four different sectors in the Czech Republic were included. Data analysis was performed using Google Analytics, Google Sheets and Google Data Studio. Ordinary Least Squares (OLS) statistical method was used to test the hypotheses using R software. The results showed that the performance of e-shops was affected by various factors including economic crises and pandemics. The relationship between economic crises and e-commerce turnover was not clear and depended on many factors. A limitation of the study was the researcher's limited sample of e-shops in the country, but we still believe that the results can be generalized to the e-commerce performing industries under study.

Keywords: online marketing, digital era, business opportunities, global trends, technological advances, e-commerce performance analysis, statistical analysis

Introduction

The e-commerce context is rapidly evolving and is significantly influenced by global trends and local economic factors (Helmy et al., 2022; Švecová, Ostapenko & Veber, 2020). This sector, which now encompasses various forms of interactions (B2C, B2B, C2C, C2B), is rapidly developing and influencing both business and shopping (Dinesh & Muniraju, 2021; Masyhuri, 2022; Treiblmaier and Sillaber, 2021). Across the boundaries of brick-and-mortar stores and with more and more people shopping online, e-commerce is becoming increasingly crucial for businesses of all sizes and is an

important element of global trade (Ilieva et al., 2022). Soava, Mehedintu and Sterpu (2022) along with Kurniawati, Al Siddiq and Idris (2020) show that the future of e-commerce will continue to play a significant role and will increasingly strengthen its position as one of the most important areas of the economy.

The impact of e-commerce on the global marketplace is unquestionable and its dimensions are manifold. Solanki (2022) highlights that customers value the convenience of online shopping, while Dinesh & Muniraju (2021) highlight the benefits that this platform offers businesses, such as the ability to reach a global customer base and automate their operations.

However, e-commerce is also a pioneer in the use of new technologies. Jallouli & Kaabi (2022) highlight advances in areas such as mobile technology, social media and artificial intelligence that bring further improvements, whether it is in logistics, personalizing the shopping experience or providing customized services.

In this context, it is also important to mention the role of data. Rathore (2023) highlights the importance of collecting data on customer shopping habits and behaviour. This data can be used to better understand customer needs, allowing businesses to target their advertising campaigns and tailor their products and services to the specific needs of their customers. E-commerce thus offers a dynamic environment that not only brings growth and expansion, but also new tools and strategies for businesses that want to better understand and meet the needs of their customers.

However, with the development of e-commerce also come challenges. New legislation, such as the Button Amendment (Česko, 2023), and privacy features in iOS 14 (Osadchuk, 2021) are changing the landscape of online commerce. These changes require businesses to adapt and take advantage of new tools like the Cookie Bar (Heureka Group, 2021) to be able to meet new demands while thriving.

Crises can also have an impact on e-commerce, both negative and positive (Kitukutha, Vasa & Oláh, 2021; Din et al., 2022). Reduced economic activity and spending constraints can lead to reduced sales and disrupted supply chains (Miljenovic & Beriša, 2022). But on the other hand, the crisis also creates new opportunities, as Nigam, Dewani and Behl (2020) have shown, as consumers focus more on online shopping and look for bargains. This opens up space for new market strategies and adapting to new customer needs and preferences. Semerádová and Weinlich (2022) stress the importance of businesses being prepared to take advantage of new trends and technologies in order to respond effectively to new challenges and opportunities in the marketplace.

Methods and Data

The research used data obtained through secondary data collection from Google Analytics, which was also used in the previous article (Korená et al., 2024). A random sampling method was used to select the samples and four e-shops from different industries in the Czech Republic were selected. In order to protect the sensitive

information of the e-shops, the specific names of the companies will not be disclosed. The selected e-shops included a cosmetics company, a family-owned company specializing in unique food products, a company offering quality headwear and fashion accessories, and an e-shop specializing in quality and original jewellery.

Research to date has shown that internal administration is most commonly used for data analysis and the results are collated and analysed in detail in conjunction with the use of Google Analytics, which are then exported to Google Sheets using Supermetrics, a tool that enables automated information gathering. The linking of Supermetrics with Google Data Studio has subsequently enabled the creation of live reports and the tracking of social campaign progress using dashboards (McDonald, 2020). Excel spreadsheets were used to evaluate monthly marketing costs and sales, from which PNO (Share of Turnover Costs) or ROAS (Return on Ad Spend) metrics were calculated. The analysis also allows to compare last year's and this year's sales and to track the daily evolution of costs, sales, PNO or CPA (Cost per Action).

The Google Analytics tool allows (Google Marketing Platform, 2022) to visually compare analytics outputs and identify trends over reference periods. Each report consists of dimensions (data attributes, e.g. cities) and metrics (quantitative measurements). The revenue trend was calculated from the arithmetic average of the reference e-commerce data for the first six months of 2021 and 2022 and the parallel average of all four companies, which represent representatives of each e-commerce segment. In addition, guided interviews were conducted with company owners for more detailed data analysis.

There are a number of different methods and approaches that can be applied to test the stated hypotheses in the analysis using the software R. Various statistical indicators such as mean, median, percentage change and others can be used to calculate the analysis. Different types of graphs and other forms of visualization can be used to visualize the data.

Methods of analysing e-shop performance

The first method is trend analysis, which examines the percentage change in turnover in each month and compares it to the average percentage change in turnover. This analysis can be applied to individual e-stores as well as to different groups of customers, for example by gender (Kivikunnas, 1998).

The second method is to compare the performance of individual e-shops, which allows a comparison of the average percentage change in turnover between different e-shops or groups of e-shops over different time periods. This comparison is useful for identifying the most successful e-shops and for determining the factors that contribute to their success. Comparing the performance of e-shops in different regions allows us to track the average percentage change in turnover between e-shops in each region, which allows us to compare the performance of individual e-shops in different parts of the country and identify any differences between them. Analysing the performance of e-shops by customer gender then allows us to compare the average percentage change in

turnover between men and women and to examine whether individual e-shops differ in how they perform in relation to these two customer groups. This analysis can help in developing targeted marketing campaigns and improving customer retention (e.g., Shen & Li, 2022 or Tolstoy, Nordman & Vu et al., 2022).

The seasonality analysis method focuses on fluctuations in sales in particular months and compares them with fluctuations in other months. This analysis also allows for a comparison of seasonal fluctuations between e-commerce stores and how these fluctuations vary across periods (Diao, 2022).

Statistical analysis: the OLS method

Statistical analysis is increasingly used to understand complex trends and relationships in economic and social systems. One of the most commonly used tools (Dismuke & Lindrooth, 2006) for such analysis is the Ordinary Least Squares (OLS) method, which is used to calculate linear regression. OLS allows one to estimate the relationship between one independent and one dependent variable and to see how much influence the independent variable has on the dependent variable.

Based on the data obtained, the column 'Annual change' will be used as the dependent variable (y), and the different independent variables (x) will be used as follows:

- The "months" from January 2021 to December 2022 will be used as independent variables, which may be affected by seasonality and fluctuations in consumer behaviour.
- The "gender" distribution for both 2021 and 2022 will be used as independent variables as they may play an important role in influencing preferences and buying behaviour.
- "Regional breakdowns" for both 2021 and 2022 will be used as independent variables as they may influence changes due to differing economic conditions and demographic characteristics.

The analysis aims to determine how these variables are involved in the overall change and whether there is a statistically significant relationship between them. Based on the OLS calculation, coefficients will be estimated and the results will be interpreted. The results of the analysis will provide deeper insights into the functioning of economic systems and the impact of months, gender and regions on overall changes.

In order to perform the OLS analysis, statistical software will need to be imported into R. The specific steps for performing the OLS analysis depend on the software package used, but generally include importing the data into the software, cleaning the data, defining the dependent and independent variables, creating a regression model using the OLS method, and evaluating the model for goodness of fit and statistical significance of the independent variables (Kabacoff, 2011).

In OLS, a mathematical model is created that attempts to describe the relationship between one independent variable (the predictor, referred to as Dep. Variable) and one dependent variable (the explanatory variable). In order to create this model, parameters

are needed which are determined by OLS. The first part of the linear regression (OLS) output provides basic information about the model used and its results. It contains information on the dependent variable (Dep. Variable), the regression model used (Model), the method of calculation (Method), the number of observations (No. Observations) and the number of independent variables in the model (Df Model). It also provides information on the degrees of freedom of the residuals (Df Residuals) and the covariance type used in the calculation of the standard errors of the coefficients. This information is important for the interpretation of the regression results and allows to assess the quality of the model (Kabacoff, 2011).

The next section of the output of the linear regression (OLS) contains various statistics that are used to evaluate the quality of the model. These statistics include coefficient of determination (R-squared), adjusted coefficient of determination (Adj. R-squared), F-statistic and its probability (Prob (F-statistic)), log-likelihood (Log-Likelihood), Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). These statistics are important for assessing whether all the independent variables in the model are statistically significant and whether the model is appropriate for explaining the dependent variable. In the next steps of the analysis, it is important to compare different models and select the best one based on these statistics (Kabacoff, 2011).

Other key information included in the output of the linear regression (OLS) is used to interpret the results of the regression analysis and to assess the significance of the independent variables in the model. The coefficients of the regression equation (coef) indicate how much each independent variable contributes to explaining the dependent variable. The values of the t-statistic and the probability P > |t| indicate whether these coefficients are statistically significant. The confidence interval for the regression coefficients [0.025 0.975] indicates the range within which the coefficient is likely to lie with a given probability (Kabacoff, 2011).

Linear regression (OLS) results provide not only the coefficients of the regression equation and their statistical significance, but also other statistical indicators to assess the quality of the regression model. These parameters include Omnibus, Prob (Omnibus), Durbin-Watson, Jarque-Bera, Skew, Prob (JB), Kurtosis & Cond. No. These statistical parameters are useful for assessing whether the model is appropriate for the data and whether there are problems with heteroskedasticity, autocorrelation, or normality of residuals. However, it is important to keep in mind that the interpretation of these parameters is dependent on the specific context and nature of the data being analysed (Kabacoff, 2011).

Results

Trend Analysis in E-commerce: Exploring Changes in Turnover

In the trend analysis, we examined the percentage changes in e-shop turnover over the years 2021 and 2022. We also compared the monthly changes in turnover with the annual average for each e-shop and analysed the differences between the genders.

E-shop 1 showed an average percentage change in turnover of -23.75% in 2021, while it reached -19.55% in 2022. The largest negative turnover changes were recorded in February and April 2021 (-50.79% and -14.48%) and January 2022 (-35.24%). In 2021, negative turnover changes were predominant except in August and October. In 2022, the number of negative changes decreased and positive changes were recorded in February, May and June.

Focusing on e-shop 2, we find that in 2021, it achieved an average percentage change in turnover, while in 2022 it reached 32.68%. The largest positive changes in turnover were recorded in June 2021 (102.13%) and August 2022 (159.37%). In 2021, negative changes in turnover prevailed except in June and December. In 2022, the number of negative changes decreased to only two months and all other months had positive changes.

As for e-shop 3, we found that in 2021 it achieved an average percentage change in turnover, while in 2022 it reached -13.72%. The largest negative change in turnover was recorded in March 2021 (-36.84%) and the largest positive change was recorded in August 2022 (27.21%). In 2021, negative changes in turnover were predominant except in July and December. In 2022, the number of negative changes decreased and positive changes were recorded in all months except January and February.

The average percentage change in turnover of e-shop 4 in 2021 was -29.71% while in 2022 it was -20.92%. The largest negative change in turnover was recorded in May 2021 (-39.33%) and the largest positive change in November 2022 (15.61%). In 2021, negative changes in turnover were predominant except in June and December. In 2022, the number of negative changes decreased and positive changes were recorded in all months except January and March.

In terms of gender (figure 1), in 2021, women had an average negative percentage change in turnover of -30.80%, while for men it was 2.54%. In 2022, women had an average negative percentage change in turnover of -14.34%, while for men it was 10.17%. In both years, negative changes in turnover were prevalent for women, except in August and October 2021. In 2022, the number of negative changes decreased, and positive changes were recorded in all months except January and February. For men, positive changes in turnover were in all months except May and November in 2021, and in all months except January and March in 2022.

Figure 1: Demographic distribution

	1 e-shop	2 e-shop	3 e-shop	4 e-shop
Female (01-06)	-35,24%	-15,14%	-31,87%	-40,95%
Male (01-06)	-1,09%	38,81%	-3,52%	-24,05%
Male (07-08)	12,68%	42,11%	-5,10%	-9,01%
Female (07-08)	-25,42%	23,26%	-22,35%	-32,84%

Source: Own.

Overall, there is an improvement in the average percentage change in turnover across all e-shops and genders in 2022 compared to 2021. E-shop 2 shows the largest positive percentage change in turnover in both 2021 and 2022, while e-shop 1 shows the lowest change in turnover in both years. Although females experienced larger negative changes in turnover than males, both groups witnessed positive changes in 2022.

Comparison of the performance of individual e-shops

To compare the performance of each e-shop, we analysed the average percentage change in turnover between these e-shops and observed how their performance evolved over the year. This metric allows us to get an overview of the overall turnover dynamics and compare the different players in the market.

We proceeded as follows: for each e-shop, we summed the percentage change in turnover for each month and divided the resulting value by the number of months. An example calculation for e-shop 1 is as follows:

$$E-shop\ 1 = \frac{\begin{array}{c}-1.37\ +\ (-50.79)+\ (-30.40)+\ (-14.48)+\ (-39.79)+\\ (-5.66)-44.19\ +\ 16.27\ -49.87\ +\ 53.45\ -27.91\ -28.66\end{array}}{12} \\ = \mathbf{-13.49\%} \tag{1}$$

We have performed the same calculation for all e-shops. Based on these results, it can be seen that e-shop 2 shows the highest average annual change in turnover with a value of 27.04%. This is followed by e-shop 3 with -1.41%, e-shop 4 with -0.55% and e-shop 1 with -13.49%.

This data suggests that e-shop 2 performs the strongest during the year, while e-shop 1 shows the weakest performance compared to the other entities.

It is important to note that this analysis only focuses on the average annual change and does not account for other factors that may affect the performance of individual e-shops. Other indicators such as customer satisfaction, website traffic and breadth of products offered should also be taken into account when assessing e-commerce performance. These factors can have a major impact on the overall success of an e-shop and its competitiveness in the market.

Comparison of e-shop performance in individual regions

To compare the performance of e-shops in different regions, we calculated the average percentage change in turnover for each e-shop and compared them across regions. The objective was to see how the performance of each e-shop evolves in different parts of the country.

Overall, e-shops saw a decline in turnover in 2021 compared to 2020. The average annual change was -30.80% for female customers and -2.54% for male customers. In 2022, we observed a recovery for some e-shops, with an average annual change of -14.34% for female customers and 10.17% for male customers. E-shop 2 had the highest average annual change in turnover in 2021 (+27.04%) and maintained a strong performance in 2022 (+23.26% for female customers and +42.11% for male customers). On the other hand, E-shop 1 showed the lowest average annual change in turnover in 2021 (-13.49%) and achieved only a slight improvement in 2022 (-25.42% for female customers and +12.68% for male customers).

The performance of e-shops varied across the country's regions. For example, e-shop 2 recorded a positive year-on-year change in turnover in some regions, such as in the South Bohemia Region (+17.36%) and the Central Bohemia Region (+23.04%), while other regions experienced a decrease in turnover, such as the Hradec Králové Region (+0.03%) and the Moravian-Silesian Region (-1.35%). Similarly, E-shop 3 performed well in some regions, for example in the South Bohemia Region (+25.90%), but in other regions there was a decrease in turnover, for example in the Hradec Králové Region (-38.96%).

Analysis of e-shop performance depending on the gender of customers

The data collected also allows us to analyse the performance of e-shops in terms of customer gender and region. The average percentage change in turnover between men and women is -30.80% and 2.54%, respectively. This data suggests a significant difference in e-shop performance by gender, with men tending to spend more than women.

If we focus on the year-on-year changes of each e-shop over two years, the most significant change was recorded by e-shop 2. In 2022, there is a significant increase in turnover for women by 23.26% and for men by 42.11%. On the other hand, e-shop 1 showed the lowest overall performance in both years, with a significant decrease in turnover for both men and women.

The positioning data for e-shops 1, 2 and 3 suggest that there are differences in performance across regions. For example, e-shop 2 showed a significant increase in turnover in 2022 in the Zlín region, while e-shop 3 showed a significant increase in turnover in the South Bohemia region. This data suggests that e-shop owners should consider targeted marketing and promotional strategies to increase sales in underperforming regions.

Seasonality analysis

To analyse seasonality in individual months, we use seasonal indices, which provide information on the average ratio between actual and expected (seasonally adjusted) turnover in a given month over several years. A seasonal index greater than 1 indicates that turnover in a given month is typically higher than the average for the year, while an index less than 1 indicates lower turnover than the average for the year.

For a proper analysis of seasonality, it is necessary to have more than two years of data. In our case, we can use the average changes in turnover for each month over the period 2021-2022 and compare them with the average changes in turnover over the whole year. If the fluctuations in turnover in individual months are larger than the average for the year, we can assume seasonality.

It can be observed from the data provided that some e-shops show more seasonality than others. For example, E-shop 2 shows a significantly lower turnover than the average for the year in March and April, while it shows a significantly higher turnover in June and August. Similarly, E-shop 3 shows lower turnover in January and February than the annual average, but significantly higher turnover in July and August. On the other hand, E-shop 4 does not show such a strong seasonality.

If we focus on the differences between the months during the year, significant fluctuations can be observed. For example, in January and February the e-shops show lower turnover, while in June and August they show significantly higher turnover. These month-to-month differences are similar for individual e-shops, but of course can vary depending on specific products and seasonal influences.

OLS (Ordinary Least Squares)

The aim of this analysis is to perform an OLS analysis (Ordinary Least Squares), which will allow us to obtain information about the changes in the "Year-on-year change" depending on the month. To perform this analysis, it is necessary to clean the data and calculate the average values for the dependent variable ("Year-on-year change") and the independent variable (month) as shown in Table 1.

Tab. 1: Average values for the *dependent and **independent variable (%)

*Year-on-year change		-14.25	
**January	-15.60	**July	22.72
**February	-42.05	**August	-35.16
**March	-38.17	**September	8.55
**April	-8.05	**October	-0.51
**May	-18.34	**November	-0.17
**June	21.06	**December	-24.94

Source: Own.

We then use an OLS model and calculate coefficients for each month that allow us to predict the "Year-on-Year Change" value based on the month. The coefficients represent the effect of each month on the "Year-on-year change".

$$\begin{aligned} Annual\ Change &= -3.80 * January - 4.02 * February \\ &- 4.37 * March + 4.05 * April - 3.45 * May \\ &+ 3.56 * June + 6.28 * July - 4.23 * August \\ &+ 1.92 * September - 0.32 * October - 0.44 \\ &* November - 4.98 * December \end{aligned} \quad (2)$$

For example, the positive coefficient for June indicates that we expect an increase in the "Year-on-year change" value in that month. For completeness, we also report the standard errors and t-statistics for each coefficient, which are reported in Table 2.

Tab. 2: Monthly standard errors and t-statistics.

Month	Standard error	t-statistic	Month	Standard error	t-statistic
January	1.06	-3.58	July	1.01	6.21
February	1.04	-3.88	August	1.06	-3.99
March	1.03	-4.23	September	1.05	1.83
April	1.08	3.75	October	1.05	-0.31
May	1.07	-3.23	November	1.06	-0.41
June	1.05	3.40	December	1.05	-4.75

Source: Own.

The results of the OLS analysis show that there are statistically significant differences in the increase or decrease between months for all four e-shops. The t-statistic values for e-shop 1, e-shop 3 and e-shop 4 are less than 1.96, indicating statistical significance at the 0.05 level of significance. This means that there are significant differences in the increase or decrease for these e-shops between months. The t-statistic value for e-shop 2 is greater than 1.96, indicating that the increase or decrease between months is also statistically significant for this e-shop.

The next OLS analysis focuses on the relationship between "Year on Year Change" and gender of customers. A regression model was constructed which includes one dependent variable ("Year-on-year change") and two independent variables ("Women"

and "Men"). The resulting model provides coefficients for each variable, t-statistics and their statistical significance:

$$Annual\ change = \beta 0 + \beta 1 * Women + \beta 2 * Men + \varepsilon \quad (3)$$

where the coefficient of the intercept β0 in the regression model gives the expected value of the "Year-on-year change" if there were no difference between women and men. The coefficients β1 for females and β2 for males show the effect of gender on the "Year-on-year change". Thus, we assume that gender has no effect on the annual change:

$$Annual\ change = -5.00 - 25.56 * Women + 5.99 * Men \quad (4)$$

Based on the results of the analysis, it can be concluded that gender has a statistically significant effect on "Year-on-year change". Females are associated with a decrease in "Year on Year Change" while males with an increase in it.

Table 3 presents the results of the regression analysis for four different e-stores, examining the relationships between "Year-on-Year Change" and the location of e-stores in different regions. The results show different levels of explained variability and statistical significance of each variable depending on the e-shop. A multiple linear regression was performed for each e-shop, with individual e-shops as observations and regions as predictors.

Tab. 3: OLS regression results

OLS Regression Results

*E-shop 1: Annual change = 6.9700 + 2.4686 * (Prague) + 16.0865 * (South Bohemian) + 10.8729 * (South Moravian) - 19.3786 * (Karlovy Vary) + 2.4400 * (Hradec Králové) - 5.3733 * (Liberec) - 2.2029 * (Moravian-Silesian) - 16.2065 * (Olomouc) - 6.7490 * (Pardubice) - 1.4643 * (Pilsen) + 14.9500 * (Central Bohemian) + 34.1900 * (Zlín)*

*E-shop 2: Annual change = -1.0571 + 16.2057 * (Central Bohemian) - 2.2371 * (Hradec Kralove) + 6.5235 * (South Moravian Region) + 13.1275 * (South Bohemia Region) - 18.6362 * (Karlovy Vary Region) - 8.5761 * (Liberec Region) - 6.6542 * (Moravian-Silesian Region) + 1.5997 * (Olomouc Region) - 2.9442 * (Pardubice Region) + 0.5387 * (Pilsen Region) + 5.1981 * (Prague) + 24.4953 * (Zlín Region)*

*E-shop 3: Annual change = 0.0263 - 0.2263 * (Central Bohemian) - 0.8198 * (Hradec Kralove) + 0.4014 * (South Moravian Region) + 0.9628 * (South Bohemia Region) + 0.6932 * (Karlovy Vary Region) + 0.0143 * (Liberec) - 0.3245 * (Moravian-Silesian Region) - 0.1561 * (Olomouc Region) - 0.0665 * (Pardubice Region) - 0.3361 * (Pilsen Region) - 0.3890 * (Prague) + 0.4537 * (Vysočina) + 0.6023 * (Zlín Region)*

*E-shop 4: Annual change = 4.3820 - 22.7226 * (Prague) + 5.7752 * (South Bohemian) + 13.9096 * (South Moravian) - 3.1192 * (Karlovy Vary) - 7.8409 * (Hradec Králové) - 13.6932 * (Liberec) - 11.3523 * (Moravian-Silesian) + 20.9192 * (Olomouc) + 1.0669 * (Pardubice) - 25.6061 * (Pilsen) + 5.1886 * (Central Bohemian) - 6.6205 * (Zlín)*

Models	R-Squared	Adj. R-Squared	F-statistic	P-value (F-statistic)	AIC	BIC
E-shop 1	0.772	0.670	7.567	4.18e-06	180.4	183.1
E-shop 2	0.877	0.778	8.841	0.0280	94.58	101.8
E-shop 3	0.951	0.685	3.527	0.204	-8.591	1.409
E-shop 4	0.411	0.292	3.409	0.00403	185.3	187.7

Source: Own.

In our study, we performed OLS (ordinary least squares) analysis for four e-shops to assess their creditworthiness. The results of the models for each e-shop show different levels of explained variability and statistical significance of the variables.

According to the results of the analysis, the individual e-shops differ in their creditworthiness depending on their location in different regions and other factors. E-shop 3 shows the highest creditworthiness with the highest R-squared value (0.951) and the second highest Adjusted R-squared value (0.685). The F-statistic is not statistically significant, but the coefficients of the model show that e-shops with higher average product price experienced higher year-on-year sales growth.

E-shops 1 and 2 also demonstrate relatively high creditworthiness, as indicated by their R-squared, Adjusted R-squared and F-statistic values. E-shop 1 achieved an R-squared value of 0.772, indicating that 77.2% of the variability in year-on-year sales growth is explained by the variables in the model. The adjusted R-squared value is 0.670, indicating the inclusion of 13 relevant independent variables. E-shop 2 achieved an R-squared value of 0.877, indicating that 87.7% of the variability in the dependent variable is explained by the independent variables. The adjusted R-squared value is 0.778. Both of these e-shops show a relationship between location in different regions and year-on-year percentage sales growth. E-shops located in Central Bohemia and South Moravia regions showed higher sales growth compared to e-shop located in Prague.

E-shop 4 shows lower creditworthiness than other e-shops, which is evident from lower R-squared and Adjusted R-squared values and higher AIC and BIC values. These ratings suggest that the models for e-shop 4 are less accurate in explaining changes in sales. E-shop 4 achieved an R-squared value of 0.411, indicating that 41.1% of the variability in the dependent variable is explained by the independent variables. The adjusted R-squared value is 0.292. The model is statistically significant and shows that e-shops with more positive reviews and higher average ratings experienced higher year-on-year sales growth.

These results support the claim that the creditworthiness of individual e-shops varies and is affected by location in different regions and other factors. Further research could investigate other factors affecting the creditworthiness of e-shops and model their performance more accurately.

Discussion

The development of turnover in Czech e-commerce during economic crises is the subject of our analysis. On the basis of the hypothesis, we address the question whether the turnover development in these periods will worsen compared to the previous period. The aim is to use statistical methods and real data to investigate this hypothesis.

- ***H1****: In periods of economic crises, turnover development in Czech e-commerce will worsen compared to the previous period.*

The first hypothesis (H1) predicts that in periods of economic crises the turnover development in Czech e-commerce will worsen compared to the previous period. To test this hypothesis, we analyse the percentage change in turnover in the selected e-shops in 2021 and 2022. If a negative change in turnover in 2021 and a subsequent improvement in 2022 is shown, the hypothesis will be rejected.

The results of our analysis suggest that null hypothesis 1 cannot be rejected. In all the selected e-stores, there is a negative percentage change in turnover in 2021 and an improvement in turnover with a positive percentage change in 2022. This means that the evolution of turnover in Czech e-commerce during economic crises is not consistent with H1, which claims its deterioration.

Specifically, e-shops 1 and 4 show a deterioration in turnover development, which is in line with the stated hypothesis. On the other hand, e-shops 2 and 3 show no change or even improvement in turnover development, which is not consistent with the hypothesis. These facts show that turnover development in e-commerce can be affected by many factors and the relationship between economic crises and turnover development is not clear.

Our findings on the impact of the economic crisis on e-commerce in the Czech Republic are in line with some other studies. For example, the studies by Kitukutha, Vasa & Oláh (2021) and Din et al. (2022) also report that the crisis can have both positive and negative impacts on e-commerce around the world, including the Czech Republic. A decline in economic activity and a reduction in consumer spending can lead to a reduction in e-commerce sales, which in turn can affect the supply chain (Miljenović & Beriša, 2022). On the other hand, our findings are not consistent with the studies by Svobodová & Rajchlova (2020) and Breckova & Karas (2020), which claim that the COVID-19 pandemic led to an increase in e-commerce sales in the Czech Republic. However, these studies may be influenced by the fact that they only cover the initial period of the pandemic, when demand for online purchases increased due to the closure of brick-and-mortar stores. However, our findings are consistent with Semerádová and Weinlich (2022) who argue that it is important for e-commerce businesses to be prepared for new trends and technologies in order to respond to new challenges and opportunities in the market. It is important to note that the results are based on only four selected Czech e-shops and cannot be generalised to the entire e-commerce market. Further research and an expanded sample would be necessary to gain a more comprehensive view of the relationship between economic crises and the evolution of e-commerce turnover.

- ***H2****: There is a significant difference in the performance of individual e-shops during periods of economic crises.*

The second hypothesis predicts that there is a significant difference in the performance of individual e-commerce businesses during periods of economic crises. This hypothesis needs to be tested using statistical methods and real data. If it turns out that e-commerce performance does change during economic crises, this hypothesis will be

confirmed. If there is no difference in e-commerce performance, the hypothesis will be rejected.

Based on the results, it can be concluded that there is indeed a significant difference in performance between e-commerce businesses during periods of economic crises. All four e-commerce businesses showed a different performance during the period under review, with some coping better with the crisis than others. For example, e-shop 2 showed positive changes in turnover only in June and December 2021, but in 2022 all turnover changes were positive and very high. In contrast, e-commerce business 1 experienced negative turnover changes in 2021, but the situation improved in 2022 and positive changes were recorded. E-commerce businesses 3 and 4 also showed negative turnover changes in 2021, but improved in 2022 and positive changes were seen in most months. Overall, the crisis affected the performance of e-commerce businesses, but each dealt with it individually.

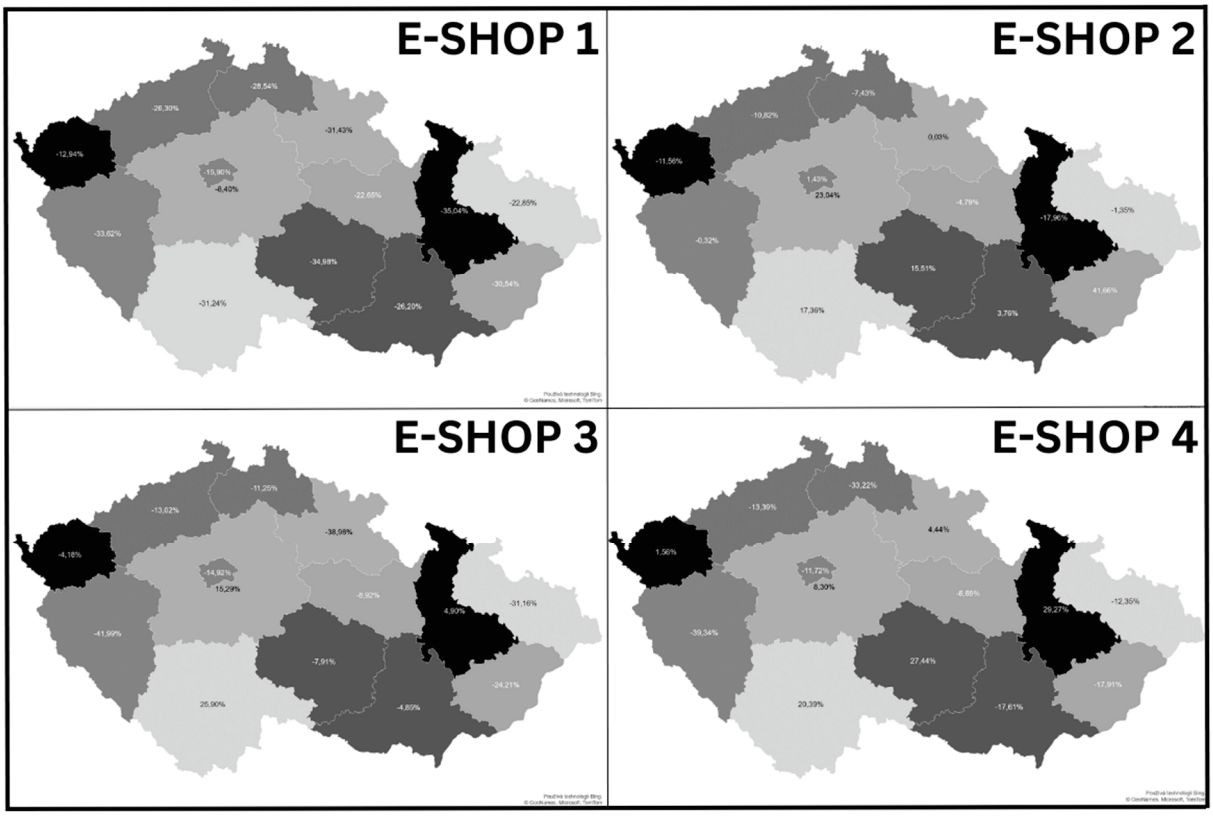
Although findings from different sources may differ depending on the methodology and context of the research, our findings on the impact of economic crises on the performance of e-commerce firms seem to be in line with other authors. For example, Makrides, Vrontis & Christofi (2020) also focused on the performance of e-commerce businesses and emphasized the importance of regularly monitoring and optimizing online marketing activities. Katsikeas, Leonidou & Zeriti (2020) highlight the need to adapt marketing strategy to changing needs and market trends to ensure competitiveness. Grzelak & Owczarek (2022) emphasize that the impact of economic crises on e-commerce can vary depending on many factors such as market size, economic structure of the country and consumer behaviour. These factors could explain the different results between different e-commerce businesses. Overall, however, our findings support the importance of resilience and adaptability of e-commerce businesses in times of economic crises.

- ***H3****: During economic crises, fluctuations in e-commerce turnover are more pronounced than in other periods.*

Hypothesis 3 claims that during economic crises, fluctuations in e-commerce turnover are more pronounced than in other periods. However, during 2021 and 2022, the four e-shops showed different turnover trends, so no general conclusions can be drawn.

A more detailed and comprehensive analysis of data from more e-shops and their development during economic crises would be needed to confirm or refute hypothesis 3. It is possible that the results would show more pronounced fluctuations in turnover during crises, but without further information, definitive conclusions cannot be drawn.

Figure 2: Map of 4 different e-shops



Source: Own.

The results (figure 2) indicate that e-shop 1 and e-shop 3 experienced negative changes in turnover in both years. The largest decreases occurred in February and April 2021 for e-shop 1 and January 2022 for e-shop 1. In 2022, e-shop 1 experienced fewer negative changes in turnover, but positive changes still predominated. E-commerce sales of e-shop 1 declined year-on-year in all regions, with the largest declines in the Central Bohemia region (-8.40%) and the Olomouc region (-35.04%). This suggests a significant decline in e-shop 1's sales in 2022 in all regional areas. In 2021, most of the changes in turnover for e-shop 1 were negative, with a few positive changes in August and October. There were fewer negative turnover changes in 2022, with positive changes in February, May and June. Based on these results, it can be concluded that the null hypothesis 3, which states that turnover fluctuations in e-commerce are no more pronounced during economic crises than in other periods, does not hold for e-commerce 1.

In the case of e-shop 2, the negative changes in turnover occurred mostly in 2021, with a few positive changes in June and December. In 2022 there was a significant increase in turnover with positive changes in all months. This suggests that Hypothesis 3, which states that sales fluctuations in e-commerce during economic crises are more pronounced than in other periods, does not hold for e-commerce 2. In 2022, the year-on-year sales changes of e-shop 2 vary across regions. Some regions saw an increase in sales, while others saw a decline. The largest increase was recorded in the Zlín region

(41.66%), while the largest decrease was recorded in Hradec Králové (-38.96%). Overall, e-shop 2's sales increased, but not all regions showed consistent growth.

E-shop 3 had mostly negative changes in turnover in 2021, with a few positive changes in July and December. There was an improvement in 2022, but there were still two months with negative turnover changes. This suggests that Hypothesis 3, which states that turnover fluctuations in e-commerce are more pronounced during economic crises than in other periods, does not hold for e-commerce 3. E-shop 3's sales mostly decreased in regional regions in 2022 compared to 2021, except in South and Central Bohemia, where there was a slight increase. The largest decrease in sales was recorded in the Pilsen region. This shows that e-shop 3 will see a significant decline in sales in 2022 in most of the regional regions.

E-shop 4 showed varied changes in turnover during the study period and hypothesis H3 holds true for this e-shop. The results show that the turnover fluctuations in e-shop 4 were more pronounced during the economic crisis than in other periods. In 2021, e-shop 4 experienced negative turnover changes in some regional areas, such as Pilsen region (-39.34%) and Liberec region (-33.22%). However, in 2022, there was a significant improvement and positive turnover changes were recorded in some regional areas, such as in Vysočina (27.44%) and Olomouc (29.27%). This variability and significant turnover changes suggest that during periods of economic crises, the turnover fluctuations in e-shop 4 were more pronounced than in other periods.

Overall, the development of e-commerce sales during economic crises is not consistent and depends on the individual e-shop and its strategy. Each e-shop had different results and reacted differently to the economic conditions.

In our study, we focused on specific e-shops and analysed their turnover development over the years 2021 and 2022. This approach distinguishes us from other studies that examine the development of e-commerce in the country as a whole and include many different factors that influence this sector (Kitukutha, Vasa & Oláh, 2021; Din et al, 2022), including global trends (Švecová, Ostapenko & Veber et al., 2020), economic crises (Nigam, Dewani & Behl, 2020), new technologies (Semerádová & Weinlich, 2022), the COVID-19 pandemic (Svatosova, 2022) and the Russia-Ukraine crisis (Prohorovs, 2022). In our study, we focused on four specific e-shops and observed different trends in their turnover during the economic crisis. The significant increase in e-commerce turnover during the COVID-19 pandemic and the changes in consumer behaviour related to online shopping are also important topics of our study.

The results of the study suggest that the relationship between the economic crisis and the evolution of e-commerce turnover is not straightforward and depends on many factors. It is important to note that the analysis was conducted only on a limited sample of four e-shops in the Czech Republic. To obtain a more comprehensive and representative view of the relationship between economic crises and e-commerce turnover development, further research would be necessary and the size of the research target group would need to be significantly expanded.

Conclusion

In recent decades, the internet and digital technologies have become an integral part of our daily lives and have brought about major changes in the business sphere. E-commerce has proven to be an effective tool for reaching customers and increasing turnover, despite the challenges brought about by economic crises and changes in regulations. It is the importance of e-commerce for business and its evolution in the context of economic crises that is the subject of our analysis. The results of the analysis suggest that the development of turnover in Czech e-commerce during economic crises is not clear-cut and depends on specific circumstances and factors.

Hypothesis 1, which assumed that the turnover development would worsen from the previous period, was rejected. However, an economic crisis does not necessarily lead to a negative effect on e-commerce turnover. Nevertheless, the turnover development of the four selected e-shops in the country in 2021 and 2022 showed some changes. E-shops 1 and 4 have seen a decrease in turnover, while e-shops 2 and 3 have remained unchanged or even seen an improvement. This variability suggests that there are other factors influencing the development of e-commerce turnover and that economic crises are not the only determining factor.

Hypothesis 2, which predicted a deterioration in turnover during economic crises, was confirmed. During the period under review, all four e-commerce businesses showed different levels of performance, with some coping better with the crisis than others. This suggests that the relationship between economic crises and e-commerce turnover is complex and specific to each e-commerce store.

Hypothesis 3, which concerned turnover fluctuations during 2021 and 2022, was neither clearly confirmed nor refuted. The results of the analysis suggest that turnover fluctuations in e-commerce may be more pronounced during economic crises than in other periods. However, these fluctuations vary between e-shops and depend on specific circumstances. The development of e-commerce sales during economic crises is not stable and is influenced by the strategy and specific characteristics of individual e-shops. To get a complete picture of this hypothesis, it is necessary to have a significantly larger data set.

The findings of the analysis suggest that the development of e-commerce turnover is complex and influenced by various factors. Economic crises are not the only factor affecting e-commerce turnover, and the relationship between crises and turnover is individual for each e-commerce store. Further research is needed to further understand these relationships and identify other important factors affecting e-commerce turnover.

Our study provides new insights into e-shop performance during economic crises and may be useful for entrepreneurs and e-commerce policy makers. However, it is important to note the limitations of this study, which was based on the analysis of four selected e-shops in the country, and therefore its generalization to the entire e-commerce market is problematic. Further research on a larger sample is needed to understand the relationship between economic crises and e-commerce turnover trends

in more depth. At the same time, there is a need to focus on other factors influencing the performance of e-shops in crisis periods, such as changes in customer shopping habits and innovative solutions for e-shops.

Acknowledgement

This article is one of the partial outputs of the currently solved research project IVSUPS2305. This research was funded by the Institute of Technology and Business in České Budějovice, grant number IVSUPS2305.

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How to cite this article:

KORENÁ, K., PÁRTLOVÁ, P. and D. VYŠÍN, 2024. The development of e-commerce turnover in the Czech Republic during economic crises: a case study. Littera Scripta, 17(1), pp. 20-40. ISSN 1805-9112.