LogForum

> Scientific Journal of Logistics <

2024, 20 (4), 573-583

https://doi.org/10.17270/J.LOG.001112

http://www.logforum.net p-ISSN 1895-2038 e-ISSN 1734-459X

ORIGINAL PAPER

DETERMINANTS OF THE TREND IN PARCEL VOLUMES IN CROATIA

Ana-Mari Poljičak[1], Zvonko Kavran[2], Borna Abramović[2]

1) Undergraduate Professional Study Traffic, Šibenik University of Applied Sciences, Šibenik, **Croatia**
2) Faculty of Transport and Traffic Sciences, University of Zagreb, Zagreb, **Croatia**

ABSTRACT. Background: The integration of national economies into economic unions, coupled with a digital transition, has driven significant growth in parcel volumes. In recent years, parcel volumes in the Republic of Croatia have risen considerably, along with increased online purchases. This paper aims to establish the determinants influencing trends in parcel volumes to facilitate accurate forecasting of future volumes.
Methods: The study employed a linear multiple regression model, with parcel volume as the dependent variable and GDP and the number of internet customers as independent variables. Model representativeness was assessed using the determination coefficient, while statistical significance was verified through the F-ratio.
Results: The research revealed a consistent increase in parcel volume over the 13 years from 2010 to 2023. The model demonstrated high accuracy, accounting for 97.37% of the sum of the square of the deviation of the dependent variable. Additionally, GDP and the number of internet customers were found to have a statistically significant positive impact on parcel volume trends.
Conclusion: The continued growth in the number of internet customers is a key driver of the increasing parcel volumes, which, in turn, supports the expansion of the courier, express and parcel industry. Gross domestic product (GDP) also plays a crucial role in influencing parcel volumes. Earlier research, which analysed data up to 2018, highlighted these relationships. The current study, spanning 2010 to 2023 and encompassing the COVID-19 pandemic, confirms the model's robustness and reliability for forecasting parcel volumes, even in the face of extraordinary events.

Keywords: parcels, online shopping, gross domestic product (GDP), multiple regression model

INTRODUCTION

An important factor driving the increase in parcel volumes globally is e-commerce, which emerged in the 1990s. Advancements in high-speed internet technologies, a decline in end-user prices, and an increase in product choice have spurred the rapid expansion of the e-commerce market. Furthermore, the growth of e-commerce has been driven by the rising number of web shops, advancements in online payment systems, and more flexible parcel delivery options [Winkelmann et al. 2009].

Over the last decade, the Courier, Express and Parcel (CEP) industry has experienced significant growth, with e-commerce emerging as one of its most important market drivers [Mordor Intelligence 2020; Statista Research Department 2024]. Until recently, the domestic market for parcel delivery was predominantly characterised by B2C (Business to Customer) shipments handled by CEP companies. However, the rise of online shopping has driven an increase in cross-border e-commerce, leading to growth in international B2C parcel volumes worldwide. China and the USA are the two most popular global destinations for cross-border online shopping [Mordor Intelligence 2020].

While most parcels fall under the C2C (Consumer to Consumer) market segment [Miletić 2012], the B2C market primarily consists of parcels from remote sales, where products are ordered via e-mail or online platforms [Winkelmann et al. 2009]. Large business users in the e-commerce segment

Citation: *Poljičak A. M., Kavran Z., Abramović B., 2024. Determinants of the trend in parcel volumes in Croatia. LogForum 20 (4), 573-583,* https://doi.org/10.17270/J.LOG.001112
Received: 16.09.2024, Accepted: 03.12.2024, on-line: 22.12.2024

account for as much as 92% of all parcels sent, while private users primarily send gifts or items sold online C2C [Almqvist 2018]. Notable growth has been recorded in the B2C and C2X (consumer-to-consumer/package returns) segments, which involve parcel exchanges between individuals and returned packages. This growth is directly tied to e-commerce, which has been expanding across all EU countries since 2009 [Statista Research Department 2024].

The COVID-19 pandemic significantly accelerated e-market adoption. Individuals who had never used e-commerce in the past or had used it sparingly began to make online purchases during this time [Czerwinska et al. 2023]. According to the 2022 CEP market report, the Asia-Pacific market saw the largest growth, with revenue increasing by 15.1% and parcel volumes by 13.4%, amounting to 143.56 billion parcels. In North America, revenues rose by 3.7%, but parcel volumes declined by 1.5%, totalling 21.177 billion parcels. Similarly, the European market experienced a decline in parcel volumes, (2.3%), but revenues grew by 2.1% due to higher prices. In 2022, the European market handled 18.216 billion parcels [Effigy Consulting 2024].

According to Mordor Intelligence [2020], CEP service demand was projected to grow strongly from 2019 until 2024 in the Asia-Pacific region—a trend that continues [Statista Research Department 2024].

Croatia ranks at the lower end of EU countries when analysing internet usage and online orders by individuals. Despite this, Croatia follows European trends, with more than 50% of its online purchases originating from China, followed by the United Kingdom, USA and Germany [Kalevi Dieke et al. 2019]. Research by Kalevi Dieke et al. [2019], comparing online B2C purchases in the EU-28 from 2013 to 2017, revealed growth in online purchases both domestically and across borders. By 2017, Croatia's e-commerce activity was below the EU-28 average [Poljičak 2021].

Across Europe, internet usage and online shopping continue to grow. Although a slowdown in e-commerce was anticipated after COVID-19 mitigation measures were lifted, this did not occur. Research across 37 European countries showed B2C turnover growth in 2021, even as some countries reported lower e-commerce sales. Western Europe accounted for 63% of total e-commerce traffic in 2021, followed by Southern Europe (16%), Central Europe (10%), Northern Europe (9%), and Eastern Europe (2%). Western Europe also led in e-GDP (the percentage of GDP derived from e-commerce sales) with 4.28% in 2021[Lone and Weltevreden 2022a].

In 2022, Western Europe, with 67%, continued to dominate the total B2C e-commerce turnover among European regions. Consequently, Western Europe still had the highest e-GDP compared to other regions, at 5.2%. E-commerce is projected to contribute 5% to GDP in 2023 [Lone and Weltevreden 2023b].

The percentage of internet users in Europe who purchased goods or services online grew from 65% in 2017 to 73% in 2021 [Lone and Weltevreden 2022a]. In 2022, this percentage increased further to 76%**,** with growth predicted to continue by an additional 2% in 2023 [Lone and Weltevreden 2023b]. In 2021, the Netherlands had the highest percentage of internet customers, at 94%**,** while Montenegro recorded the lowest, at 32% [Lone and Weltevreden 2022a]. By 2022, the United Kingdom led with 95%**,** while Montenegro remained last, with 31% [Lone and Weltevreden 2023b].

When analysing the EU-27 market, it is evident that it serves as the centre of B2C commerce. Neither the lifting of COVID-19 mitigation measures nor the United Kingdom's exit from the EU affected B2C e-commerce turnover significantly. In 2021, 90% of the population were internet users, of whom 74% purchased goods or services online [Lone and Weltevreden 2022a]. By 2022, 91% of the population were internet users, with 75% making online purchases. Both the number of internet users and the percentage purchasing online were predicted to grow by 1%, as stated in [Lone and Weltevreden 2023b].

Regarding the European CEP market, parcel volumes increased steadily year-on-year between 2015 and 2021, according to Statista Research Department [2024].

The Croatian postal market is part of the EU postal market, and trends in Croatia mirror those in the EU. Traditional postal services are increasingly being replaced by electronic communication, which has led to a downward trend in the number of letters sent in recent years. Conversely, parcel volumes have risen due to the growth of e-commerce, as parcels are a critical link in the delivery chain [Croatian Regulatory Authority for Network Industries 2024, Naletina et al. 2019]. This growth in parcel volumes has significantly impacted revenue growth [Croatian Regulatory Authority for Network Industries 2024].

Between 2013 and 2022, there was a decline in the total number of postal services, with slight recoveries in 2014 and 2019. Transactions involving letters (except 2019) and printed matter (except in 2014) decreased, while parcel volumes showed continuous growth [Croatian Regulatory Authority for Network Industries 2024]. The COVID-19 outbreak led to an increase in demand for parcel services as online shopping surged during periods of physical purchasing restrictions [Croatian Regulatory Authority for Network Industries 2024]. In 2022, parcels accounted for 12.5% of the total market share [Croatian Regulatory Authority for Network Industries 2024].

Since parcel volume growth enhances the productivity and business results of postal services providers, it also contributes positively to the broader economy [Ministry of the Sea, Transport and Infrastructure of the Republic of Croatia, 2014]. In 2022 postal services contributed 0.41% to Croatia's GDP [Croatian Regulatory Authority for Network Industries 2024, Croatian Bureau of Statistics, 2024].

The percentage of Croatia's population with access to the internet is also rising. In 2017, internet access was at 69%, rising to 82% by 2021. The percentage of internet users who purchased items online increased from 42% in 2017 to 70% in 2021 [Lone and Weltevreden 2022 a]. In 2022, internet penetration increased to 83%, but the percentage of online purchasers fell slightly by 2%. Projections for 2023 suggest internet penetration will remain steady, while the percentage of online purchasers will hold at 70% [Lone and Weltevreden 2023b].

LITERATURE REVIEW

The research by Poljičak [2021] examines the influence of GDP and internet customers as independent variables on parcel volumes in Croatia, with parcel volumes as the dependent variable, using quarterly data from 2010 to 2023.

GDP growth is not the only relevant factor influencing postal services, making it impossible to predict parcel volumes solely by observing GDP trends [Ministry of the Sea, Transport and Infrastructure, 2014]. A regression analysis by Van der Lijn et al. [2008] demonstrated that per capita GDP has a statistically significant positive impact on the per capita parcel volume. Similarly, Florens et al. [2002] noted that parcel volumes per household or per capita are higher in countries with greater economic activity, as measured by GDP. Research has shown a correlation between postal turnover and GDP as an indicator of economic activity, with the largest share of postal turnover generated by business users [Kljak et al. 2011, Jimenez et al. 2007].

The Universal Postal Union (UPU) conducted a correlation and regression analysis across the USA, Europe, Asia and Africa, establishing that GDP and trade are the two main economic variables connected to international parcels [Universal Postal Union 2010]. In Croatia, revenues from foreign tourist arrivals show a very positive correlation with tourist overnight stays, which in turn drives export growth. Research on Croatian tourist consumption abroad revealed a medium-strong positive correlation with Croatian exports. A similar medium-strong positive correlation between GDP and exports was also established [Jelušić 2017].

Additionally, research has shown a strong positive correlation between the development of telecommunications and per capita GDP [Zahra et al. 2008].

In the research conducted by the UPU using correlation and regression analysis in the regions of the USA, Europe, Asia and Africa, it was established that along with GDP and trade—two primary economic variables related to international parcel delivery— parcel volumes are also influenced by internet usage. The rise of

remote shopping has led to an increase in the volume of parcels sent to and from households. The study also found that in industrialised countries, households with broadband internet access send and receive around four times more parcels than households without such access. These findings also reveal a correlation between income and internet access. Furthermore, a strong relationship between the intensity of online shopping and income levels was also established [Universal Postal Union 2010].

In Matović and Dobrodolac [2016], additional input variables in forecasting parcel volumes included population size and the number of online stores. Globally, the number of mobile phone users has been steadily increasing. In 2015, there were 4.15 billion mobile phone users worldwide, and by 2018, this number had risen to 4.57 billion [Statista Research Department 2024]. By 2021, the global number of mobile phone users had reached 7.1 billion [Statista Research Department 2024, Lindner 2024]. Research carried out in the USA and Europe suggests that the number of consumers using smartphones for shopping will continue to grow [Groß 2015]. On a global scale, in 2012, 210 million users made retail purchases through mobile devices. This number grew to 379 million in 2013, with projections indicating that it would reach 1.089 billion users by 2018 [Statista Research Department 2024]. The share of global retail e-commerce purchases made via mobile devices has been growing steadily each year. For instance, in 2017, it accounted for 40% and by 2023, it had increased to 54% [Statista Research Department 2024].

MATERIALS AND METHODS

The research conducted by Poljičak [2021], analysed 30 variables in total, grouped into four categories: (1) economic, (2) technical and technological, (3) postal and (4) demographic. Using the forward regression procedure, we identified two variables with a significant impact on the trends in parcel volumes: (1) gross domestic product (GDP) and (2) the number of internet customers.

Parcel volumes have grown at an average quarterly rate of 3.17%, while the average quarterly growth rate of GDP is 0.96%. The number of internet customers has grown, on average, by 3.03% per quarter during the observed period. Figure 1 shows the parcel volumes by quarter in the Republic of Croatia from 2010 to 2023.

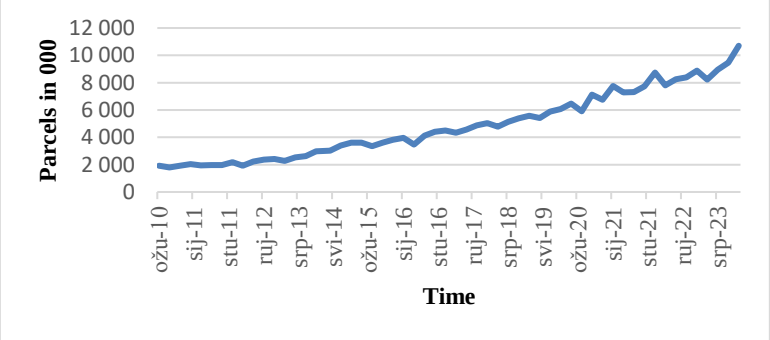

Fig. 1. Parcel volumes in Croatia. Source: Own work [Croatian Bureau of Statistics 2024, Croatian Regulatory Authority for Network Industries 2024].

In the period observed after 2014, GDP tended to grow, which was interrupted by the outbreak of COVID-19 in the first quarter of 2020. GDP experienced an additional decline in the second quarter, but after the second quarter, the positive development trend continued. Figure 2 shows the quarterly GDP trends in Croatia from 2020 to 2023.

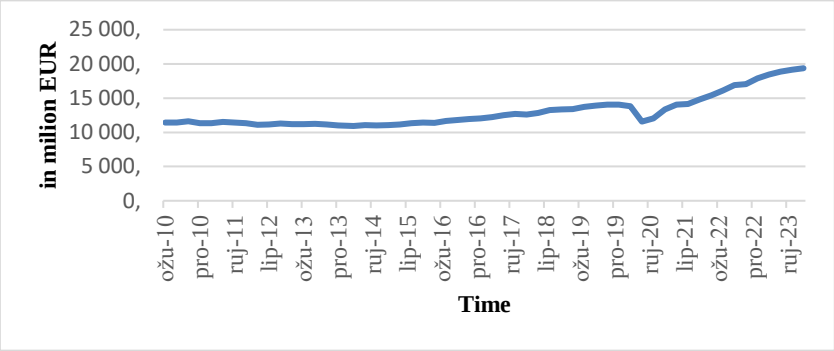

Fig. 2. GDP in Croatia. Source: Own work [Croatian Bureau of Statistics 2024].

The number of online customers fluctuated in the observed period, with a general trend of growth throughout the entire period. Figure 3 shows the number of internet customers in Croatia by quarter from 2010 to 2023.

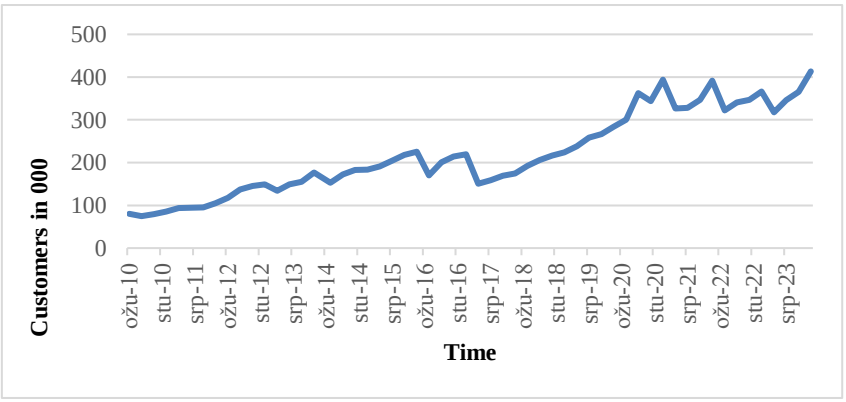

Fig. 3. Online customers in Croatia. Source: Own work [National Bureau of Statistics 2024]

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RESULTS

The observed variables are presented using descriptive statistics. The geometric median is used as an indicator of the average change in variables used in the model. The influence of GDP and the number of internet customers on trends in parcel volumes was examined using a multiple regression model.

A linear regression model was created. The regression coefficients and their accompanying parameters can be seen in Table 1.

Table 1. Multiple regression model

	stand beta	beta	t(53)	P
CONSTANT		-3,884.00	11.19	<0.001
GDP	0.38	0.39	10.67	<0.001
INTCUS	0.67	16.87	18.94	<0.001

Source: Own work.

The linear regression equation has the following form:

$$parcels = -3{,}883.9984 + 0.3865 \cdot GDP + 16.868 \cdot INTCUS \quad (1)$$

According to the estimated model, GDP has a positive impact on parcel volumes– specifically, with each €1 million increase in GDP, an average growth of 0.39 thousand parcels can be expected, assuming the number of internet customers remains constant. (P<0.001). The parameter for internet customers also has a positive impact on parcel volumes. According to the estimated model, for every increase of 1,000 internet customers, an average growth of 16.87 thousand parcels can be expected, assuming the GDP remains constant (P<0.001).

The representativeness of the model is assessed through the use of the determination coefficient R^2, which amounts to 97.27% in the case of the estimated model. This means that the model explains 97.27% of the variation in parcel volume from the arithmetic mean. Consequently, the model is considered both representative and accurate, providing precise estimates of parcel volume based on trends in GDP and the number of internet customers.

The precision of the model estimate is evaluated using the standardised residual, as shown in Annex 1. The standardised residual represents the difference between the actual parcel turnover and the model's predicted values, measured in terms of standard errors. In all four quarters of 2017, the value of the standardised residual exceeds the threshold of 2, which is attributed to the decline in the number of internet customers, while parcel volumes continued to grow.

The empirical F ratio is 982.07, and the empirical level of significance is <0.001, as shown in Table 2. This confirms that the estimated model is statistically significant.

Table 2. ANOVA test

	Sums of squares	df	Mean of squares	F	P
Regression	316,502,150	2	158,251,075	982.07	<0.001
Residual	8,540,402	53	161,140		
Total	325,042,552				

Source: Own work.

The estimated model was tested for multicollinearity using Variance Inflation Factor (VIF) indicators. The VIF value is 2.50, as shown in Table 3, which indicates that the problem of multicollinearity is not present in the estimated model.

Table 3. VIF indicator of multicollinearity

	VIF
GDP quarter	2.50
Numbers of internet customers (000)	2.50

Source: Own work.

On the other hand, it was established through the Breusch-Pagan Godfrey test that the estimated model does not have the problem of heteroscedasticity (F(2,53)=0.34; P=0.33).

DISCUSSION

The results of this research demonstrate that gross domestic product (GDP) positively influences parcel volumes in Croatia. The

finding aligns with research by the Universal Postal Union (UPU), which used stepwise regression analysis to identify key regional influencing parcel demand, achieving a 90% confidence level. The UPU study found that GDP positively impacts parcel demand in Africa, the Asia-Pacific region, Latin America, North America and Western Europe [Universal Postal Union 2010]. Similarly, Van der Lijn et al. [2008] confirmed through regression analysis that per capita GDP has a statistically significant positive impact on per capita parcel volumes, with a 95% confidence level.

In addition to GDP, the number of internet customers also positively influences parcel volume trends. The result corresponds to findings by Matović and Dobrodolac [2016], where online shopping was included as a variable in the regression model to forecast parcel volumes. Further support comes from the Universal Postal Union [2010], which determined via stepwise regression analysis that, in Eastern Europe, the number of internet customers influences parcel demand, with a confidence level of 90%.

The importance of internet customers in parcel volume trends is further corroborated by Naletina et al. [2019], who observed changing shopping habits across Europe. Their research highlights the growing number of online shoppers, a trend mirrored in Croatia, where consumers are increasingly embracing online shopping.

This correlation is also evident in broader research conducted across 37 European countries, including Croatia. The study demonstrated that the percentage of internet users purchasing goods or services online has consistently increased year-on-year [Lone and Weltevreden 2022a, Lone and Weltevreden 2023b]. As a result, the positive influence of internet customers on parcel volumes in Croatia was anticipated and substantiated by the findings of this research.

CONCLUSIONS

The number of internet customers who purchase goods or services online continues to grow, highlighting the critical role of global e-commerce as a driver of parcel volume growth. This growth, in turn, significantly impacts the development of the courier, express, and parcel **(**CEP**)** industry. Alongside internet customers, gross domestic product (GDP) has been identified as another key factor influencing parcel volumes.

Research conducted in 2021 established the influence of GDP and internet customers on parcel volumes in Croatia. Building on this, the current study analysed data up to 2023, including quarters impacted by the COVID-19 pandemic. The representativeness of the model was demonstrated by a determination coefficient (R^2) of 97.27%, confirming the robustness of the estimated model.

The COVID-19 pandemic and associated infection prevention measures led to a surge in online shopping, increasing demand for parcel services despite a decline in GDP. The model's ability to perform effectively during periods of global economic turbulence further underscores its resilience and utility, making it a valuable tool for independent application across varying economic conditions.

Potential limitations of this study are the quality of data for the 30 variables analysed and the eventual saturation of internet customers. While the number of internet customers is expected to grow further, saturation will eventually limit both this growth and its direct impact on parcel volumes.

Future research should focus on identifying additional variables that can determine the saturation point for internet customers within the general population. Additionally, as data from shorter time intervals (e.g., monthly or weekly) become available, more precise parcel forecasting models can be developed. The methodology and findings of this model can also be adapted and applied to other countries for comparative analysis.

ACKNOWLEDGMENTS

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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Annex 1. Parcel volumes sent and delivered and model estimation

	Observed Value	Predicted Value	Residual	Standard Residual
2010-Q1	1,927.00	1,891.05	35.95	0.09
2010-Q2	1,796.00	1,792.66	3.34	0.01
2010-Q3	1,916.00	1,945.51	-29.51	-0.07
2010-Q4	2,050.00	1,937.13	112.87	0.28
2011-Q1	1,947.00	2,083.44	-136.44	-0.34
2011-Q2	1,959.00	2,166.57	-207.57	-0.52
2011-Q3	1,977.00	2,142.35	-165.35	-0.41
2011-Q4	2,176.00	2,262.26	-86.26	-0.21
2012-Q1	1,913.00	2,388.76	-475.76	-1.19
2012-Q2	2,226.00	2,729.70	-503.70	-1.25
2012-Q3	2,363.00	2,933.22	-570.22	-1.42
2012-Q4	2,427.00	2,962.30	-535.30	-1.33
2013-Q1	2,267.00	2,709.05	-442.05	-1.10
2013-Q2	2,523.00	2,975.56	-452.56	-1.13
2013-Q3	2,622.00	3,035.79	-413.79	-1.03
2013-Q4	2,987.00	3,348.22	-361.22	-0.90
2014-Q1	3,013.00	2,921.18	91.82	0.23
2014-Q2	3,399.00	3,309.72	89.28	0.22
2014-Q3	3,599.00	3,461.85	137.15	0.34
2014-Q4	3,609.00	3,475.64	133.36	0.33
2015-Q1	3,356.00	3,643.66	-287.66	-0.72
2015-Q2	3,599.00	3,958.76	-359.76	-0.90
2015-Q3	3,825.00	4,213.36	-388.36	-0.97
2015-Q4	3,969.00	4,322.67	-353.67	-0.88
2016-Q1	3,479.00	3,483.93	-4.93	-0.01
2016-Q2	4,117.00	4,067.88	49.12	0.12
2016-Q3	4,398.00	4,348.41	49.59	0.12
2016-Q4	4,505.00	4,477.07	27.93	0.07
2017-Q1	4,340.00	3,384.40	955.60	**2.38**
2017-Q2	4,580.00	3,637.03	942.97	**2.35**
2017-Q3	4,880.00	3,880.64	999.36	**2.49**
2017-Q4	5,040.00	3,932.22	1,107.78	**2.76**
2018-Q1	4,790.00	4,321.63	468.37	1.17
2018-Q2	5,140.00	4,715.24	424.76	1.06
2018-Q3	5,400.00	4,921.78	478.22	1.19
2018-Q4	5,580.00	5,074.14	505.86	1.26
2019-Q1	5,420.00	5,431.57	-11.57	-0.03
2019-Q2	5,890.00	5,861.53	28.47	0.07
2019-Q3	6,070.00	6,047.63	22.37	0.06
2019-Q4	6,470.00	6,331.06	138.94	0.35
2020-Q1	5,900.00	6,524.00	-624.00	-1.55
2020-Q2	7,120.00	6,702.34	417.66	1.04
2020-Q3	6,760.00	6,577.96	182.04	0.45
2020-Q4	7,750.00	7,931.46	-181.46	-0.45
2021-Q1	7,290.00	7,057.42	232.58	0.58
2021-Q2	7,310.00	7,120.51	189.49	0.47
2021-Q3	7,730.00	7,680.16	49.84	0.12
2021-Q4	8,740.00	8,689.31	50.69	0.13
2022-Q1	7,800.00	7,772.95	27.05	0.07
2022-Q2	8,260.00	8,393.95	-133.95	-0.33
2022-Q3	8,400.00	8,557.20	-157.20	-0.39
2022-Q4	8,880.00	9,203.78	-323.78	-0.81
2023-Q1	8,230.00	8,603.04	-373.04	-0.93
2023-Q2	8,960.00	9,244.54	-284.54	-0.71
2023-Q3	9,460.00	9,674.67	-214.67	-0.53
2023-Q4	10,700.00	10,574.14	125.86	0.31

Source: own work.

Ana-Mari Poljičak ORCID ID: https://orcid.org/0000-0001-6392-1702
Undergraduate professional study Traffic,
Šibenik University of Applied Sciences, Šibenik, **Croatia**
e-mail: ana-mari.poljicak@vus.hr

Zvonko Kavran ORCID id: https://orcid.org/0000-0002-7714-3769
Faculty of Transport and Traffic Sciences,
University of Zagreb, Zagreb, **Croatia**
e-mail: zvonko.kavran@fpz.unizg.hr

Borna Abramović ORCID ID: https://orcid.org/0000-0001-8675-5778
Faculty of Transport and Traffic Sciences,
University of Zagreb, Zagreb, **Croatia**
e-mail: borna.abramovic@fpz.unizg.hr