Metamorphoses of Earnings in the Transport Sector of the V4 Region

Pavol Durana 1,*, Katarina Valaskova 1, Roman Blazek 1 and Jozef Palo 2

1 Department of Economics, Faculty of Operation and Economics of Transport and Communications,
University of Zilina, Univerzitna 1, 010 26 Zilina, Slovakia; katarina.valaskova@fpedas.uniza.sk (K.V.); roman.blazek@stud.uniza.sk (R.B.)
2 Department of Road and Urban Transport, Faculty of Operation and Economics of Transport and
Communications, University of Zilina, Univerzitna 1, 010 26 Zilina, Slovakia; jozef.palo@fpedas.uniza.sk
* Correspondence: pavol.durana@fpedas.uniza.sk

Abstract: The transportation sector is a crucial sector of the sustainability of every national economy. Previous studies highlighted the core significance of transport enterprises in European countries over the past 60 years. The long-term sustainability of enterprises is determined by their ability to gain earnings. Thus, earnings are the synonym of significance in corporate life. The purpose of this study was to capture the lever year, the trend, and the slope of the development of earnings in the transport sector before the COVID-19 pandemic. Time series of the annual earnings of the enterprises from the close countries of the V4 region were used during a 10-year period. Buishand’s test sets the change-points of the development and indicated the values of specific central lines. The year 2013 was the lever date for the earnings of 830 Slovak and 1042 Hungarian enterprises. The year 2015 was the year of momentum for 757 Polish enterprises. The development of 397 Czech enterprises was mainly influenced by the year 2014. The results of the Mann–Kendall test detected a positive trend in the series of business finance in all countries. In addition, the Sen’s slope was estimated in the transport sector for the analyzed period 2010–2019.

Keywords: business finance; change-point; earnings; heterogeneity; time series; Visegrad Four

MSC: 62M10; 62P20; 91B74

1. Introduction

Many entities (internal and external) are very interested in knowing the economic results of the enterprises in detail, not only vaguely without accounting relationships [1]. Savova [2] notes that comprehensive financial information may be observed to make effective decisions for all stakeholders. Managers may become dissatisfied with, or even frustrated by, the fact that they are not given proper recognition or an opportunity to achieve financial goals [3]. To achieve the expected earnings from the enterprises, it is necessary to develop and build trusting collaborations among all stakeholders [4]. The earnings of enterprises is an endless hot topic for academicians. Hundreds of studies are published each year. Several researchers [5–11] have dealt with the issue of the sustainability of profits and the transport sector individually in the current period of Industry 4.0.

However, the studies of earnings have not related to the transport sector. The authors of [12–16] solve the problem of earnings management and taxes. The authors also identify the factors that influence earnings on a microeconomic level. Kowal-Pawul and Przekota [17] concentrate on the construction and wholesale and retail trade sectors. Durana et al. [18] disclose the earnings drivers of the selected manufacturers. Stevanovic et al. [19] find out the drivers in the sector of agriculture.

Moreover, last incentives in the transport sector have not focused on earnings. The review by Cirella et al. [20] highlights the importance of innovation systems in the transport...
sector. They focus mainly on the areas of the vehicles, the infrastructure, and corporate makeup. Aldridge and Stehel [21] add intelligent vehicular networks into the vehicle area. Hlatka et al. [22] mention innovative recruitment techniques such as age management. Nyulasziöva and Palova [23] study support systems in the Slovak environment. They suggest creating data analysis systems to optimize the processes of the transport service. Cichosz and Pluta-Zaremba [24] identify ways to improve consulting services, multimodal guidelines, and IT visualization for Polish businesses. Neverauskiene et al. [25] examine the factors that influence the development of intelligent transportation systems in Lithuania. The crucial factors are investments and well-developed infrastructure. Katiniene et al. [26] give instructions on how to not decrease the efficiency of performance and slow down transport processes. Kadlubek [27] predicts the possibilities for the sustainable development of Polish transport for the period 2030–2050. The principles of the advantages and disadvantages of sustainable development in Ukraine are provided by the research by Hens et al. [28]. Transport systems should encourage the requirement of integration into green mobility initiatives. Brizga et al. [29] suggest increasing the fee on fuel to support environmentally friendly infrastructure in Latvia. Vrana et al. [30] analyze Czech transport and its organization. The study demonstrates the changes in long-distance transport on selected routes based on government regulations and their subsequent implementation. Dementiev and Han [31] explore five distinct regulatory regimes. The authors develop the theory of transport deregulation to increase welfare. Ionescu [32] calculates the effectiveness based on tax regulation. Navarro [33] identifies the benefits, challenges, and potential of lean and process management to deal with environmental demands in transport enterprises.

Ishikawa and Tarui [34] incorporate essential stylized aspects of the transportation sector into the traditional international oligopoly model and investigate how protectionist strategies differ when transportation costs are endogenous and subject to the backhaul problem. The research by Rothengatter et al. [35] provides detailed discussions of protectionist policies’ impacts during the COVID-19 pandemic on air transport, rail and bus transport, and urban transit, and major countries’ responses to reduce the negative effects. Thang and Zhnag [36] develop model assumptions for lifestyle changes and policy interventions, as well as the expected changes associated with the arrival of the post-COVID new normal, in order to investigate long-term pathways toward deep decarbonization of the transportation sector. Nemteanu et al. [37] propose a model to study the link between insecurity and instability during the COVID-19 pandemic, along with satisfaction in an emerging market. In addition, Nemteanu and Dabija [38] include task performance. Santarromana et al. [39] evaluate the effectiveness of decarbonization and discover that a surcharging mechanism based on the carbon intensity of the electric grid can result in a 20-t reduction in emissions per year while still achieving a profitable financial outcome. Krawczyk and Kokot-Stepien [40] also assess the financial outcome and results of the transport sector. They show the dependence between exchange rates and the financial results of Polish enterprises in the transport sector.

The effectiveness of transport enterprises may be evaluated by a multi-criteria method. Vavrek and Becica [41] use the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) in combination with the Coefficient of Variance method (CV). The research chose five indicators (sales, current assets, total assets, short-term liabilities, and debts) and was carried out in the Czech Republic. Velinov and Cincalova [42] add “Corporate Social Responsibility” (CSR). They indicate that Czech transportation enterprises, which are more likely to internationalize than their competitors, are more likely to engage in corporate social responsibility activities.

Thus, the purpose of this study was to capture the lever year, the trend, and the slope of the development of earnings in the transport sector before the COVID-19 pandemic.

The article is divided as follows: Firstly, the literature review of studies related to the assessment of the transport sector, its development, economic efficiency, and the last incentives is highlighted. Then, the financial dataset used, and the statistical procedures implemented in the present study are demonstrated. The results that cover the creation
of regression models are described in the third part. The obtained findings are compared to similar studies from the emerging market in the Section 4. Conclusions sum up the study, state the weaknesses of the study, and, based on them, add the future directions of the research.

2. Materials and Methods

The main aim was to capture the lever date, the trend, and the slope of the development of earnings in the transport sector before the COVID-19 pandemic in the Visegrad region. This region was chosen because of its similar economic development. The bonds between the transport markets in this region are narrow and integrated [43]. The last reason is to get the macroeconomic point of view on the analyzed issue. The Visegrad Group was also compared, e.g., in the research of [44,45]. Svabova et al. [46], the authors note that the quantification of the earnings may be done by various measures, e.g., EAT, EBT, EBIT, EBITDA. This study selected EBITDA as a financial indicator of the earnings of the enterprises from the V4 region. The mentioned indicator eliminates the difference in economic results of the transport sector because it removes the impact of different tax policies and interest rates, especially the different depreciation and amortization standards. Several other researchers [47–49] confirm the appropriateness of evaluating EBITDA. The preprocessing sample included 4996 earnings that were reported from the Amadeus database realized by Bureau van Dijk (Table 1).

Table 1. Used samples of the transport enterprises.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Slovakia</th>
<th>Czechia</th>
<th>Poland</th>
<th>Hungary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preprocessing</td>
<td>830</td>
<td>775</td>
<td>1941</td>
<td>1450</td>
</tr>
<tr>
<td>Missing values</td>
<td>360</td>
<td>370</td>
<td>1167</td>
<td>394</td>
</tr>
<tr>
<td>Outlying values</td>
<td>7</td>
<td>8</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Processing</td>
<td>463</td>
<td>397</td>
<td>757</td>
<td>1042</td>
</tr>
</tbody>
</table>

Source: own research.

The purpose filter was used to get the transport enterprises from the NACE H transportation period of 2010–2019. The relevance and robustness of the findings were supported by the exclusive choice of the enterprises that reached a level of total assets of at least EUR 500,000. The research involved the following methodological steps:

1. **Focus on the missing values.**

   The raw dataset of financial data contained the missing values of EBITDA. These enterprises were excluded from the analysis (Table 1). A total of 360 Slovak units, 370 Czech units, 1167 Polish units, and 394 Hungarian units were removed.

2. **Focus on the outlying values.**

   The presence of outliers in raw samples is determined using a variety of approaches and assays. When preprocessing data linked to earnings, Svabova and Michalkova [50] advocate using Dixon or Grubbs tests. The test is chosen based on the size of the sample. For datasets with more than 25 observations, the Grubbs test is preferred. The two-sided Grubbs test is frequently used to examine measures that are suspiciously remote from the main body of the data and come from a normal distribution. The Grubbs may be a very useful tool for detecting single outliers. This test identified 7 Slovak units, 8 Czech units, 17 Polish units, and 14 Hungarian units (Table 1). That is why the final sample was created from 2659 transport enterprises. The processing samples were not balanced, but they reflected the real situation in national economies based on the methodology of the study realized by [51,52].

3. **Focus on the computation of annual EBITDA and portraying its descriptive statistics.**

   There was no panel data used, but it was calculated as an average annual EBITDA. This approach was applied based on [53]. Table 2 shows the identified values of average...
EBITDA in thousand EUR for the entire examined period and region. Figure 1 shows the minimum, maximum, mean, and median values of EBITDA.

Table 2. Computed EBITDA [thousand EUR] of the transport enterprises.

<table>
<thead>
<tr>
<th>Year</th>
<th>Slovakia</th>
<th>Czechia</th>
<th>Poland</th>
<th>Hungary</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>525.601</td>
<td>763.865</td>
<td>550.055</td>
<td>280.051</td>
</tr>
<tr>
<td>2011</td>
<td>566.141</td>
<td>853.448</td>
<td>590.841</td>
<td>281.186</td>
</tr>
<tr>
<td>2012</td>
<td>560.970</td>
<td>895.142</td>
<td>677.046</td>
<td>323.248</td>
</tr>
<tr>
<td>2013</td>
<td>586.439</td>
<td>916.422</td>
<td>754.779</td>
<td>375.798</td>
</tr>
<tr>
<td>2014</td>
<td>653.010</td>
<td>1002.046</td>
<td>827.336</td>
<td>432.666</td>
</tr>
<tr>
<td>2015</td>
<td>707.807</td>
<td>1145.390</td>
<td>954.103</td>
<td>509.153</td>
</tr>
<tr>
<td>2016</td>
<td>687.597</td>
<td>1106.885</td>
<td>984.679</td>
<td>506.459</td>
</tr>
<tr>
<td>2017</td>
<td>676.083</td>
<td>1106.885</td>
<td>984.679</td>
<td>506.459</td>
</tr>
<tr>
<td>2018</td>
<td>666.662</td>
<td>1082.634</td>
<td>949.975</td>
<td>521.709</td>
</tr>
<tr>
<td>2019</td>
<td>644.151</td>
<td>1117.969</td>
<td>1063.798</td>
<td>539.097</td>
</tr>
</tbody>
</table>

Source: own research.

Figure 1. Summary statistics of the transport enterprises. Source: own research.

4. Focus on the lever year.

This point was focused to disclose a significant change-point in the development. It may be labeled as a “lever year” to divide the development into two periods. Heterogeneity will exist if the change-point is involved in the time series. Many approaches for determining homogeneity have been offered. It was preferred that the test of annual EBITDA be robust to compensate for large data gaps. Thus, the Buishand test based on Q or R statistics was chosen. Buishand’s Q statistics allows for one-sided hypotheses as well, whereas Buishand’s R statistics only allows for a bilateral hypothesis. The Buishand test may use variables following any type of distribution, and the test also identifies a year in which there is a shift between homogeneous series, detecting the change-point in the variable mean and drawing central period lines [53]. The null hypothesis $\Delta = 0$ is tested against the alternative hypothesis $\Delta \neq 0$. The $p$-values of both statistics were computed using 1,000,000 Monte Carlo simulations. Based on this step, the following hypothesis was formulated, which was tested individually for each country:

$H_{4,1}$: The time series of earnings of transport enterprises involves a lever year of change.

The following model with a single shift $\Delta$ (change-point) can be proposed:

$$x_i = \begin{cases} 
\mu + \epsilon_i & i = 1, \ldots, m \\
\mu + \Delta + \epsilon_i & i = m + 1, \ldots, n
\end{cases}$$
where \( i = 1, \ldots, m \) is the observation order, \( \mu \) is the mean of the population and \( \epsilon \approx N (0, \sigma) \). In the Buishand range test, the rescaled adjusted partial sums \( S_k \) are calculated as:

\[
S_k = \sum_{i=1}^{k} (x_i + \bar{x}) \quad (1 \leq i \leq n)
\]

Rescaled adjusted partial sums (Q) are obtained by dividing the values of \( S_k \) by the sample standard deviation \( D_x \). The test statistic is calculated as:

\[
Q = \max \left| \frac{S_k}{D_x} \right|
\]

with

\[
D_x = \sqrt{n-1 \sum_{i=1}^{n} (x_i - \bar{x})}
\]

Another statistic test which could be used is the range which computes the difference between the maximum and minimum value of the rescaled adjusted partial sums. The formula is given as follows:

\[
R = \frac{\max S_k - \min S_k}{D_x}
\]

It was given critical values for both homogeneity tests \( R / \sqrt{n} \) and \( Q / \sqrt{n} \) [53].

5. Focus on the trend.

The assumption of the occurrence of the trend was also investigated. It was tested for a positive trend against an identical distribution of time series. The Mann–Kendall trend test was preferred to identify this monotonic trend in the EBITDA of enterprises for the analyzed period 2010–2019. The target is to investigate whether there is a consistent trend in the earnings of transport enterprises. At least 8 to 10 measurements are recommended. Data is not collected seasonally and only one data point per period is required [53]. The null hypothesis is that the data come from a population with independent realizations and are identically distributed. The alternative hypothesis is that the data follow a monotonic (non-null, negative, positive) trend [53]. Based on this step, the following hypothesis was formulated, which was tested individually for each country:

**H_{a2}: The time series of earnings of transport enterprises follows a positive trend.**

The Mann–Kendall test statistic (S) is defined as:

\[
S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \text{sgn}(X_j - X_k)
\]

with

\[
\text{sgn}(x) = \begin{cases} 
1 & \text{if } x > 0 \\
0 & \text{if } x = 0 \\
-1 & \text{if } x < 0 
\end{cases}
\]

where \( \text{sgn}(X_j - X_k) \) is an indicator function that takes on the values 1, 0 or \(-1\) according to the sign of \( X_j - X_k \). The mean of \( S \) is \( E[S] = 0 \) and the variance \( \sigma^2 \) is

\[
\sigma^2 = \frac{1}{18} \left\{ n(n-1)(2n+5) - \sum_{j=1}^{p} t_j (t_j - 1) (2t_j + 5) \right\}
\]
where $p$ is the number of the tied groups in the data set and $t_j$ is the number of data points in the $j$-th tied group. The statistic $S$ is approximately normally distributed, provided that the following $Z$-transformation is employed:

$$ Z = \begin{cases} \frac{S - 1}{\sigma} & \text{if } S > 0 \\ 0 & \text{if } S = 0 \\ \frac{S + 1}{\sigma} & \text{if } S < 0 \end{cases} $$

where $\sigma$ is the standard deviation. It is much easier to present statistics that are closely linked to $S$, and more well-known, as Kendall’s $\tau$, which is given by:

$$ \tau = \frac{S}{D} $$

where

$$ D = \left( \frac{1}{2} n(n-1) - \frac{1}{2} \sum_{j=1}^{p} t_j(t_j - 1) \right)^{\frac{1}{2}} \left( \frac{1}{2} n(n-1) \right)^{\frac{1}{2}} $$

Kendall’s $\tau$ is normalized; that is why it may take values from $-1$ to 1, with negative values detecting a downward trend and positive values with an upward trend in time series [53].

6. Focus on the slope.

The confirmation of the monotonic trend may be enriched by disclosing the slope. Thus, the last step of the research was to detect the slope, its intercept, and demonstrate the running of the slope. Sen’s slope was run while applying the continuity correction. Sen’s slope estimate $\beta$ for the set of pairs $(i, x_i)$ where $x_i$ is a time series is defined as

$$ Sen's \ slope \ estimate \ \beta = \text{Median} \left( \frac{x_j - x_i}{j - i} \right); \ j > i $$

$\beta > 0$ detects an upward trend in a time series and $\beta < 0$ identifies a downward trend during the period.

XLSTAT Premium was used to get all the computations.

3. Results

The results presented are concerned with the metamorphoses of the Visegrad Four’s transport sector. The final sample of 2659 enterprises was used for the 2010–2019 period. Firstly, the heterogeneity of time series was tested. The hypotheses relate to this part:

$H_0$: The time series of earnings of transport enterprises does not involve a lever year.

$H_1$: The time series of earnings of transport enterprises involves a lever year of change.

The Buishand’s tests were realized for each country. As the computed $p$-value is lower than the significance level alpha, one should reject the null hypothesis and accept the alternative hypothesis, based on Tables 3 and 4. The results were the same for the whole region of the Visegrad group. There is a lever year for the development of EBITDA of transport enterprises in Slovakia, the Czech Republic, Poland, and Hungary. It was proven by $Q$ statistics and $R$ statistics, too.

Table 3. Buishand’s $R$ test.

<table>
<thead>
<tr>
<th>Buishand’s $R$ Test</th>
<th>Slovakia</th>
<th>Czechia</th>
<th>Poland</th>
<th>Hungary</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R$</td>
<td>4.565</td>
<td>4.441</td>
<td>4.435</td>
<td>4.567</td>
</tr>
<tr>
<td>$p$-value (Two-tailed)</td>
<td>0.001</td>
<td>0.000</td>
<td>0.001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>alpha</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Source: own research.
Table 4. Buishand’s Q test.

<table>
<thead>
<tr>
<th>Buishand’s Q Test</th>
<th>Slovakia</th>
<th>Czechia</th>
<th>Poland</th>
<th>Hungary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>4.565</td>
<td>4.441</td>
<td>4.435</td>
<td>4.567</td>
</tr>
<tr>
<td>Change-point t</td>
<td>2013</td>
<td>2014</td>
<td>2015</td>
<td>2013</td>
</tr>
<tr>
<td>p-value (Two-tailed)</td>
<td>0.000</td>
<td>0.005</td>
<td>0.004</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>alpha</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>( \mu_1 ) [thousand €]</td>
<td>559.788</td>
<td>886.184</td>
<td>725.693</td>
<td>315.071</td>
</tr>
<tr>
<td>( \mu_2 ) [thousand €]</td>
<td>672.552</td>
<td>1100.951</td>
<td>987.870</td>
<td>503.929</td>
</tr>
</tbody>
</table>

Source: own research.

The specific change-point was detected for each country using 1,000,000 Monte Carlo simulations. 2013 divided the development of Slovak earnings into two groups. The first central line \( \mu_1 \) was EUR 559,788. The central line \( \mu_2 \) of second group was EUR 672,552 (Figure 2). 2014 divided the development of Czech earnings into two groups. The first central line \( \mu_1 \) was EUR 889,184. The central line \( \mu_2 \) of second group was EUR 1,100,951 (Figure 3). 2014 divided the development of Polish earnings into two groups. The first central line \( \mu_1 \) was EUR 729,693. The central line \( \mu_2 \) of second group was EUR 987,870 (Figure 4). 2013 also divided the development of Hungarian earnings into two groups. The first central line \( \mu_1 \) was EUR 315,071. The central line \( \mu_2 \) of second group was EUR 503,929 (Figure 5).

![Figure 2. Change point of Slovak transport sector. Source: own research.](image-url)

![Figure 3. Change point of Czech transport sector. Source: own research.](image-url)
Secondly, the trend of time series was disclosed. The hypotheses relate to this part:

\( H_0 \): The time series of earnings of transport enterprises follows no trend.

\( H_{a2} \): The time series of earnings of transport enterprises follows a positive trend.

The Mann–Kendall trend test was realized for each country. As the computed \( p \)-value is lower than the significance level \( \alpha \), one should reject the null hypothesis and accept the alternative hypothesis, based on Table 5. The results were the same for the whole region of the Visegrad group, based on an upper-tailed test. There is a positive monotonic trend in the development of EBITDA of transport enterprises in Slovakia, the Czech Republic, Poland, and Hungary.

Table 5. Mann–Kendall trend test.

<table>
<thead>
<tr>
<th>Mann–Kendall Trend Test</th>
<th>Slovakia</th>
<th>Czechia</th>
<th>Poland</th>
<th>Hungary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kendall’s tau</td>
<td>0.467</td>
<td>0.778</td>
<td>0.822</td>
<td>0.911</td>
</tr>
<tr>
<td>( S )</td>
<td>21.000</td>
<td>35.000</td>
<td>37.000</td>
<td>41.000</td>
</tr>
<tr>
<td>( \text{Var}(S) )</td>
<td>125.000</td>
<td>125.000</td>
<td>125.000</td>
<td>125.000</td>
</tr>
<tr>
<td>( p )-value (one-tailed)</td>
<td>0.037</td>
<td>0.001</td>
<td>0.001</td>
<td>0.000</td>
</tr>
<tr>
<td>( \alpha )</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
</tr>
</tbody>
</table>

Source: own research.
Finally, the slope of earnings development was added to the trend confirmed. The slope (annual magnitude) and the intercept (value in year 0) were calculated for each country (Table 6). The slope for Slovak enterprises was identified at level EUR 17,615 and the intercept was EUR \(-34,865,895\). The slope for Czech enterprises was identified at level EUR 39,345 and the intercept was EUR \(-78,268,202\). The slope for Polish enterprises was identified at level EUR 61,527 and the intercept was EUR \(-123,114,453\). The slope for Hungarian enterprises was identified at level EUR 32,344 and the intercept was EUR \(-64,732,306\).

Table 6. Sen’s slope.

<table>
<thead>
<tr>
<th>Value</th>
<th>Slovakia</th>
<th>Czechia</th>
<th>Poland</th>
<th>Hungary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope [thousand €]</td>
<td>17.615</td>
<td>39.345</td>
<td>61.527</td>
<td>32.344</td>
</tr>
<tr>
<td>Intercept [thousand €]</td>
<td>(-34,865.895)</td>
<td>(-78,268.202)</td>
<td>(-123,114.453)</td>
<td>(-64,732.306)</td>
</tr>
</tbody>
</table>

Source: own research.

Specific Sens’s slope for Slovak transport (Figure 6), for Czech transport (Figure 7), for Polish transport (Figure 8), and for Hungarian transport (Figure 9) are portrayed.

Figure 6. Sen’s slope of Slovak transport sector. Source: own research.

Figure 7. Sen’s slope of Czech transport sector. Source: own research.
4. Discussion

The findings of our research are discussed and contrasted to the conclusions of studies targeted at the transport sector, which must react to a lot of technological and information challenges [54,55]. Fraczek and Urbane [56] applied the macroeconomic approach and multiple linear regression method as provided in the study to focus on the digitalization of the transport sector. They determined the factors for EU countries that have significantly impacted financial inclusion. Popkova et al. [57] solved the digitalization problem in Russia. This study applied an economic approach and preferred the model based on blockchain, big data, the internet of things, and artificial intelligence. Griffin and Krastev [58] prepared a similar model based on smart technologies and deep learning technologies. This research model was designed based on the answers of 6300 respondents.

Kovac et al. [59] highlighted environmental responsibility as a means to higher economic efficiency and higher earnings. It was proven based on 150 Croatian transport enterprises using regression and ANOVA. Poliak et al. [60] assessed the economic efficiency of the transport sector using ANOVA and cluster analysis based on a dataset of 18 EU countries. The study provided a new paradigm of microeconomic factors that influence the competitiveness of the transport sector, specifically transport prices. They recommended
that it be determined precisely and that its expected cost be factored into its optimiza-
tions, and vice versa, in the study by Rozic et al. [61], the authors recommended savings in transportation costs. Poliak et al. [62] further developed conclusions from previous studies. The authors used a two–factor ANOVA to confirm the direction of transportation as the next significant factor in the price calculation. Oliveira et al. [63] added reduction of the logistics expenses. This case study assessed possible earnings in transport by the longitudinal research during the period of the years 2009 to 2017. Ali et al. [64] summed up economic and environmental impact of transport sector on the European economy.

Varjan et al. [65] ran regression and correlation analysis as realized in the study of V4 to confirm the relationship between the income from excise fees and diesel fuel transport power. The samples for this investigation were derived from the data of transport enterprises in 22 European countries. The study identified six homogeneous clusters of countries with significant dependence within each cluster. Gnàp et al. [66] used a similar division and methodology and broadened this research to include the dependence of transport power and transport infrastructure in 27 European countries.

It is necessary to discuss the studies of intelligent transportation planning and engi-
neering as regards the sustainability of transport enterprises. Lazaroiu and Harrison [67] reviewed and synthesized existing research on Internet of Things sensing infrastructures and data-driven planning technologies in smart, sustainable cities. This study described the big data produced by the Internet of Things as a current crucial factor in transport infrastructure. Woodward and Kliestik [68] empirically evidenced the significance of the Internet of Things in smart city governance, replicating data from Capgemini, CBRE Research, Deloitte, EIU, ESI Thought Lab, and RICS. Adams et al. [69] explored intelligent transportation applications, autonomous vehicle perception sensor data, and decision-making self-driving car control algorithms in smart, sustainable urban mobility systems. They estimated how effective autonomous vehicles will be. Wallace and Lazaroiu [70] performed analysis regarding behavioral intention to use autonomous vehicles, optimizing smart and sustainable urban mobility to reduce the cost of traffic congestion and motor vehicle collisions.

5. Conclusions

The purpose of this study was to capture the lever year, the trend, and the slope of the development of earnings in the transport sector before the COVID-19 pandemic. The year 2013 was the lever date for the earnings of Slovak and Hungarian transport. 2015 was the year of momentum for Polish transport. The development of Czech transport was mainly influenced by the year 2014. A positive trend was detected in the series of analyzed EBITDA for the whole V4 region for the analyzed period 2010–2019. The Sen’s slope depicted the intercept and magnitude that represented the annual increase in EBITDA of enterprises for each country. In the transport sector it is really important to recognize the development of earnings, especially in the upcoming period when the cross-border flows of consumer goods have increased significantly. Currently, the development of EBITDA is not the only important measure to be recognized, but also the supportive plans for the economy made by governments to avoid bankruptcies that transport enterprises had faced.

The first weakness of the present investigation is the use of average earnings before interest, taxes, depreciation, and amortization. The next limitation of the research can be considered the run of homogeneity analysis, change-points, trend, and slopes for the development of earnings over time for unequal numbers of enterprises in the samples. The focus on only one sector and the period before the COVID-19 pandemic means further constraints.

That is why future research may focus on the creation of new models of the Visegrad Four using panel data of average earnings before interest, taxes, depreciation, and amor-
tization. The homogeneity may be supported by the results of von Neumann’s test. The change-points may be compared to the results of the Standard Normal Homogeneity test or Pettitt’s test. The extension may be targeted at other sectors to provide a comprehensive
overview and comparison, and, especially, to map the situation in transport during and after the COVID-19 pandemic to highlight the results.

**Author Contributions:** Conceptualization, P.D.; methodology, P.D. and K.V.; software, P.D.; validation, K.V., R.B. and J.P.; formal analysis, P.D.; investigation, K.V.; resources, R.B.; data curation, J.P.; writing—original draft preparation, P.D.; writing—review and editing, K.V.; visualization, R.B.; supervision, K.V. and J.P.; project administration, K.V.; funding acquisition, K.V. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Acknowledgments:** This research was financially supported by the Ministry of Education, Science, Research and Sport of the Slovak Republic and Slovak Academy of Sciences VEGA 1/0121/20: Research of transfer pricing system as a tool to measure the performance of national and multinational companies in the context of earnings management in conditions of the Slovak Republic and V4 countries.

**Conflicts of Interest:** The authors declare no conflict of interest.

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