RELATIONSHIP BETWEEN THE TRANSPORT PERFORMANCE AND FINANCIAL COVERAGE IN URBAN PUBLIC TRANSPORT IN THE CZECH REPUBLIC

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Resume

The research presented aimed to compare the transportation performance, as measured by vehicle kilometers, to the operating costs incurred by thirteen transport companies in the Czech Republic from 2010 to 2019. This period was chosen to ensure that our research is not affected by the Covid-19 pandemic. The financial coverage of operating costs includes revenues from fares and compensations from city budgets. We utilized data from the annual reports of The Association of Transport Companies of the Czech Republic. Based on the obtained data, we confirmed a positive relationship between the city's population, the extent of transportation performance, and consequently, the total operating costs.
This research examined the conflict between the passenger and urban public transport, supported by the European Union's promotion of sustainable urban mobility plans in regional cities.

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1 Introduction

A transport journey is defined as the travel from a point of origin, such as a residence, to a destination, like a workplace. In this context, the specific modes of transportation a person utilizes are not crucial. A transport journey is invariably linked with the use of some form of transportation. Individuals cover the distances between their points of departure and destinations by walking, cycling, taking the bus, trolleybus, tram, train, metro, passenger car, or motorcycle. The choice of transportation mode is influenced by various factors, including distance, age, personal preferences, economic and social status, the purpose of the journey, and travel costs. The indicator that characterizes the utilization of different transportation modes in people's journeys within the city on a typical working day is the transport division of labour, commonly known as modal split, [1].

The data presented in Table 1 highlight a significant proportion of public transport and passenger cars, dominating transport journeys exceeding two kilometers. For instance, according to Mobility and local passenger transport [8], walking constitutes 54% of journeys covering distances up to two kilometers, while urban public transport and individual car transport are the primary modes of urban mobility for longer distances. The shares of urban public transport and individual car transport in the modal split are both 39% for distances ranging from three to five kilometers. Further, for distances spanning five to ten kilometers, urban public transport accounts for 34%, whereas individual car transport represents 54% of the modal split. The study conducted by Kubik et al. [13] confirmed a notable correlation between the choice of means of transport and journey duration.

In Brno [3], the modal split for individual car transport and public transport was 24.6 % and 64.7%, respectively, in 2010. These figures changed to 31.7% and 57% in 2012, 37% and 52% in 2014, and 31% and 53% in 2019. In Zlin [11], the modal split in 2001 was 76% for individual car transport and 24% for urban public transport. By 2006, this shifted to 41% and 59%, followed by 38% and 62% in 2010, and 34% and 66% in 2015.

Table 1 Transport division of labour (data in %)

	Year	Walking	Cycling	Public transport	Car	Other means of transport
Brno [2-3]	2017	18	1	43	38	
Ostrava [4]	2014		2	30	68	
Pilsen [5]	2014	7	3	51	39	
Olomouc [6]	2018	34	6	27	32	1
Liberec and Jablonec [7]	2017	18		32	47	3
Hradec Kralove [8]	2015	39	18	20	22	1
Pardubice [9]		31	14	22	33	
Ceske Budejovice [10]	2016	22	2	27	49	
Zlin [11]	2015	25	2	24	45	4
Jihlava [12]	2015	35	7	28	30	

According to the survey "Czechia in Motion" [14], a national study of traffic behaviour from 2017 to 2019, cities with populations between 50,000 and 100,000 inhabitants report a 17.8% share of urban public transport and a 33% share of individual car transport, with an average journey length of 8.7 kilometers. In cities with over 100,000 inhabitants, the modal split is 36% for urban public transport and 27.3% for individual car transport, with an average journey length of 8.35 kilometers.

The use of cars in passenger transport has significant adverse effects on the quality of life in cities, including air pollution with CO_2 emissions and other pollutants, noise and vibration, escalating dust levels, higher accident rates, traffic congestions, land appropriation, and land fragmentation, [15-16].

To address these challenges, the creation and implementation of sustainable urban mobility plans are crucial for improving the current state of urban passenger transport. These plans not only aim to solve internal transport issues for residents and visitors but also focus on the transportation of goods within the city and its environs. Their overarching goal is to establish conditions conducive to sustainable development and enhance the overall quality of urban life, [17-18].

The strategic objective of sustainable urban mobility plans for all cities is to progressively decrease the share of individual car transport and concurrently increase the share of urban public transport in the modal split. For instance, the City of Brno [2] has set ambitious targets, planning to achieve a 30% share of individual car transport and a 54% share of public transport by 2030. The vision for 2050 is even more ambitious, targeting a 56% share for public transport and a 20% share for individual car transport.

Similarly, the city of Ceske Budejovice [10] is directing its urban mobility strategy within the modal split, aiming for a 46% share of individual car transport in 2025, which is expected to further decrease to 41% by 2035. Simultaneously, the city anticipates a rise in the share of urban public transport to 30% by 2025 and 33% by 2035.

Inventions, such as the car, have profound implications for solving economic, political, socio-cultural, and psychological challenges. The car, deemed a pivotal technology for everyday mobility, symbolizes speed and freedom of movement [19]. As the use of urban public transport for daily journeys becomes more prevalent, understanding the motivations of individuals who opt for individual car transport becomes imperative. Simultaneously, there is a need to explore methods and tools to shift the decision-making of these individuals towards a greater reliance on eco-friendly modes of transportation.

Public transport requires public subsidies to be affordable and to exploit its full potential in congestion alleviation [20]. Our calculations suggest that increasing the share of urban public transport in the modal split by 3%, with the current number of transport journeys per person on a typical working day, would necessitate reinforcing the existing infrastructure of urban public transport (including drivers and vehicles) by 11% to 15%. This enhancement would inevitably lead to a significant rise in operating costs. Coupled with the current ticket pricing structure, time coupons, and an increasing number of fare-free passengers, there would be a heightened demand for external funding to cover the costs of urban public transport.

Urban public transport, being an emblematic example of eco-friendly transportation, excels in mass passenger transport and extensively utilizes electric vehicles, such as trolleybuses, trams, electric buses, and compressed natural gas (CNG) as fuel for city buses [21]. It serves as a viable alternative to individual car transport. Strengthening the role of urban public transport in urban mobility requires more than just increasing its performance and implementing various improvements. This intention necessitates a combination with environmentally responsible transport behaviour among urban passengers. Future expectations, regarding a greater role for urban public transport in urban mobility, must grapple with the existing capacity constraints, rising operational costs, and the escalating

***Table 2** The potential and performance of transport companies*

City	Transport performance in mil. of vehicle kilometres per year		Transport performance in mil. of person per year		Number of public transport vehicles		Number of public transport drivers		Length of lines in kilometres	
	2010	2019	2010	2019	2010	2019	2011	2019	2011	2019
Prague[1)]	166.2	167.6	1,343.7	1,656.2	2,255	1,949	4,175	4,280		
Brno	38.3	39.4	353.6	361.7	764	791	1,398	1,396	952	1,069
Ostrava	34.1	31.8	102.6	96.1	647	630	994	1,059	1,068	1,069
Pilsen	15.0	15.5	100.9	125.0	326	359	565	576	487	593
Olomouc	6.2	6.7	57.9	57.0	136	146	240	249	302	331
Liberec and Jablonec	8.7	7.8	35.8	42.0	168	154	248	217	619	444
Usti nad Labem	7.2	6.9	51.3	39.6	145	175	255	241	487	424
Hradec Kralove	6.3	6.0	37.9	38.0	133	130	234	228	314	338
Ceske Budejovice	5.7	5.9	40.2	47.4	138	153	199	227	217	208
Pardubice	5.7	5.8	27.2	33.2	130	144	196	206	588	596
Zlin and Otrokovice	4.8	5.0	35.3	33.7	93	95	187	178	235	288
Jihlava	2.8	3.0	13.7	16.0	61	69	97	101	106	158
Karlovy Vary	2.7	2.5	14.4	15.7	62	92	125	111	286	424

[1)] Only tram and bus

need for compensations from city budgets to offset operating losses.

In the subsequent section of this paper is addressed the issue of capacities and performances within the urban public transport. Following this, the examination of the operating costs of transport performance from 2010 to 2019 was conducted. Instead of operating costs, the study utilizes the category of financial coverage, which encompasses revenues generated from transporting individuals and compensations (Decree 296/2010 Coll. [22]). This choice is made due to the fact that certain urban public transport operators are involved in additional business activities, and their operating costs include expenses related to these diverse endeavours. The data pertaining to financial coverage provide the most accurate insight into the costs associated with operating urban public transport in individual cities. Transport companies responsible for urban public transport operations in the Czech Republic are founded and owned by cities.

Our focus was on evaluating the level and progression of capacity and transport performance within urban public transport. This analysis serves as the foundation for assessing the current status of transport companies and the reported efficacy of their management. The analytical approach is based on data publicly disclosed by the Association of Transport Companies (Annual Reports 2010 - 2019, [23]).

The capacity analysis relies on data concerning the number of public transport vehicles, the count of drivers, and the length of routes. Information on the number of vehicles deployed during the peak hours was also taken into account. In all the instances, these are the primary data points that significantly reflect the operational foundations of individual companies. The assessment of urban public transport performance is conducted based on transport performance, specifically the vehicle kilometers travelled. Table 2 also includes the commonly used indicator of transported persons, derived by recalculating sold tickets and time coupons. The transported person is considered synonymous with one journey in a means of transport. In our methodology, transport per transfer ticket is calculated as 1.5 transported persons, representing one transport journey within the context of the transport division of labour - the transfer of a person from the place of departure to the destination. It is important to note that this indicator includes free passengers, such as children under five years and seniors aged 70+, traveling based on an identity card. Some cities may also provide free travel to other individuals. Due to discrepancies in carrier-specific data, we do not consider this information suitable for our analysis.

In 2019, transport performance, when compared to the base year 2010, increased by more than 5% only in the cities of Olomouc (8.2%) and Jihlava (7.5 %). Six cities exhibit growth of up to 5%, while five cities experience a decrease in transport performance of up to 10%. An examination of the capacities of transport companies reveals that Ceske Budejovice increased both the number of vehicles (by 11%) and the number of drivers (by 14 %). Other cities, such as Olomouc, Pilsen, Pardubice, and Jihlava, demonstrated changes in monitored parameters ranging from 5% to 10%. Prague, Brno, Hradec Kralove, and Zlin's transport companies showed changes in both parameters from -5% to 5%. In some cases, an increase in one parameter coincided with a decrease in the other. Notable instances include Ostrava, where the number of drivers increased (7 %), while the number of vehicles decreased (-3 %), and Usti nad Labem, where the number of drivers decreased (-5%) and the number of vehicles increased (21 %). Karlovy Vary's transport company experienced a decrease in the number of drivers (- 11%) and an increase in the number of vehicles (48 %). Lastly, Liberec's transport company reported decreases in both drivers (-12%) and vehicles (-8 %).

Based on the provided data and more in-depth analyses, it can be concluded that both the capacity and transport performance of urban public transport remained relatively unchanged from 2010 to 2019, and these patterns appear to be enduring. Notable alterations include the replacement of vehicles, the introduction of ecological buses powered by compressed natural gas (CNG) and electric buses, and an increasing share of low-floor vehicles across all the types of transportation means.

In 2011, transport companies operated 5,491 vehicles, consisting of 2,915 buses (none with CNG), 709 trolleybuses, and 1,867 trams. Of these, 2,521 were low-floor vehicles. By 2019, the reported number of vehicles had decreased slightly to 5,310, including 2,890 buses (603 with CNG), 46 electric buses, 742 trolleybuses, and 1,678 trams. Notably, 4,229 vehicles were now low-floor.

The number of drivers employed by transport companies remained relatively stable, with 9,763 drivers in 2010 and 9,785 drivers in 2019, [23].

Despite the efforts to enhance the urban public transport, the stagnant transport performance is accompanied by a decline in its share in the modal split. Progress in urban public transport is linked to the establishment and operation of integrated transport systems in broader territories, the implementation of transport telematics, the digitization of timetables and check-in systems, the construction of public transport terminals, and the gradual transition to greener modes of urban public transport. While these changes contribute to the attractiveness of urban public transport, they seem insufficient to significantly alter the travel behaviour of the residents in individual cities.

2 The aim of this research

A consistent rise in operating costs is observed in tandem with the transport performance of urban public transport during the period from 2010 to 2019. This increase is attributed to the upward trend in personnel costs, fuel and energy expenses, as well as repair and maintenance costs. The coverage of costs for operating urban public transport relies on two main sources. The first source comprises revenues generated from fares within urban public transport. The second source involves compensations from the city budgets allocated for the operation of urban public transport. To meet escalating costs, compensations must continuously increase, particularly in response to the stagnation or decline in revenues from urban public transport.

Revenues from urban public transport in the analyzed set of cities varied from 75% to 113% during these years. In contrast, compensations within the same period exhibited an increase from 108% to 208%. Compensations represent a significant expenditure item in the city budgets, significantly burdening them. In 2019, compensations for urban public transport activities accounted for 7.5% to 25.5% of the cities' operating expenses. It can be observed that the transport performance, denoted by the number of vehicle kilometers traveled, increases with the growth of the city's population. Consequently, both total costs and unit costs, attributed to transport performance, experience an uptick. This scenario leads to an increase in the shares of compensations required to cover the expenses associated with the transport performance.

In this paper, the level and development of a relationship between the transport performance and its financial coverage have been examined in depth. Additionally, it is possible to explore similar relationships between the transport performance and individual components of financial coverage, namely revenues from fares and compensations from city budgets.

This research has soughtto model the relationship betweenthetransport performance and its financial coverage, serving as a foundation for projecting the anticipated development of urban public transport.

Q1. To ascertain a statistically significant relationship between the distance traveled in vehicle kilometers and the overall financial coverage of transport performance from 2010 to 2019 for a group of transport companies in regional cities and Prague.

Q2. If a correlation is identified, the objective is to determine the developmental trajectory for individual transport companies during the specified period.

3 Used data and analyses

To fulfill the research objectives, we employed the method of quantitative research on the secondary data. The data was sourced from the annual reports of the Association of Transport Companies of the Czech Republic spanning the years 2010 to 2019. Our analysis encompassed thirteen cities, and a total of 130 items were at our disposal. However, one record was incomplete and consequently excluded from the analysis.

The data were summarized and scrutinized for extreme and missing values. The following variables were employed for the data analysis:

- City
- Year
- Population
- Vehicle kilometres (veh_km)
- Revenues from urban public transport
- Compensation
- Financial coverage.

We assessed the variables for data normality using the Shapiro-Wilk test. Considering that variables, like vehicle kilometres, revenues from urban public transport, compensations, and financial coverage, can attain high values, potentially including extreme values, a logarithmic transformation of this data was carried out. Subsequently, we explored the dependencies between the variables. The regression method, employing a mixed-effect model, was applied to verify the research hypotheses. All the statistical calculations were performed using the statistical software R 3.6.1.

3.1 Model

For the specified research objectives, we constructed a mixed-effects model:

$$log_e(costs_{i,j}) = \beta_0 + \beta_1\, log_e(veh\_km_{i,j}) + b_1 t_i + + b_2\, log_e(veh\_km_i) + u_{i,j}, \quad (1)$$

where $log_e(costs_{i,j})$ is the logarithmic transformation of the data variable, β_0 is the fixed effect intercept, $\beta_1\, log_e(veh\_km_{i,j})$ is the fixed effect slope of the tax base, $b_1 t_i$ is the random-effect of the year, $b_2\, log_e(veh\_km_i)$ is the random-effect slope of vehicle kilometres, $u_{i,j}$ is the error term. Cities were also modelled based on both vehicle kilometres and time, allowing for the hypothesis that the cost per vehicle kilometre may vary across different cities. The Akaike Information Criterion (AIC) and the ANOVA were utilized to assess the model's appropriateness.

4 Results

This section outlines the outcomes of the statistical analysis. Initially, we conducted descriptive statistics to summarize the data. Subsequently, we formulated and scrutinized the statistical model.

In Table 3, one could observe the averages for individual data items, particularly in terms of revenues, compensations, and financial coverage. Additionally, the skewness and kurtosis of individual data itemscould be noted. The potential presence of extreme values in skewness and kurtosis prompted the logarithmic transformation of the variables employed.

In Figure 1, a clear linear dependence of the cost per vehicle kilometre in individual cities is evident. A logarithmic transformation of the axes was applied, considering cities like Prague, which exhibit both higher costs and more vehicle kilometres, compared to other cities. Notably, thedistinct clusters, formed by individual cities are observable in this chart. Prague can be viewed as an extreme case in comparison to cities such as Brno or Ostrava.

Table 4 presents the computation of the coefficients for the examined regression model. Notably, if a city had only one vehicle kilometre, the financial coverage would average at 0.02 CZK (0.00084 EUR). Additionally, the regression model elucidates that a 1% increase in

***Table 3** Descriptive statistics of analysed data*

	n	mean	SD	median	min	max	skew	kurtosis	SE
year	129	2014.47	2.87	2014	2010	2019	0.01	-1.24	0.25
population	129	225727.0	316903.8	94559	4853	131531	2.7	6.09	27901.8
veh_km	129	23268.29	42902.21	6242	2431	169830	2.8	6.49	3777.33
revenues	129	571.91	1185.78	142	47	4717	2.92	6.98	104.4
compensation	129	1350.51	3238.58	216	56	14668	3.11	8.22	285.14
fincoverage	129	1922.42	4416.12	372	105	19362	3.05	7.78	388.82

***Table 4** Calculation of the model coefficients*

Model	AIC=- -310.95				
Fixed effects	Value	Std. Error	DF	t-value	p-value
(Intercept)	-3.908	0.3684	115	-10.61	0
log(veh_km)	1.097	0.0407	115	26.93	0
Random effects	Std. Dev				
t	0.0235				
log(veh_km)	0.0164				

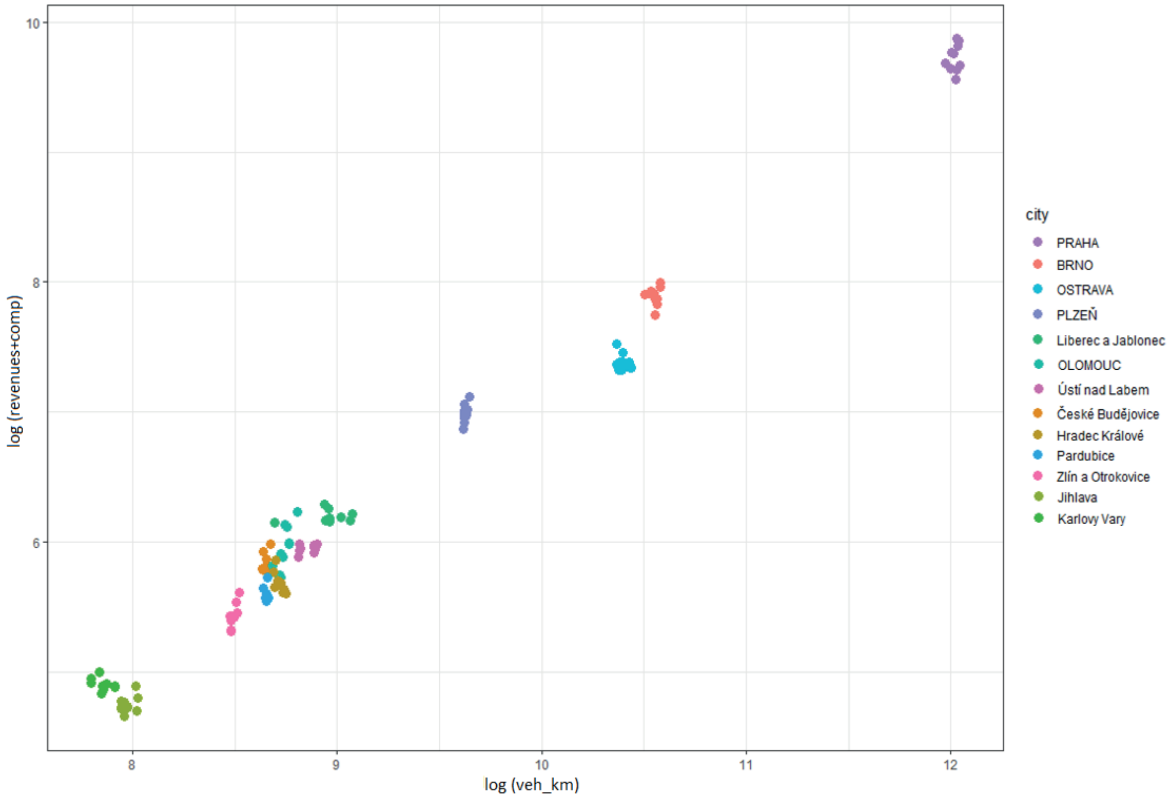

***Figure 1** Dependency of financial coverage per vehicle kilometre in individual cities*

***Table 5** Random effect coefficients of the model*

	t	log(veh_km)
Brno	0.0103	0.0153
Ceske Budejovice	0.0151	0.0193
Hradec Kralove	0.0265	-0.0138
Jihlava	0.0037	-0.0147
Karlovy Vary	0.0201	0.0092
Liberec and Jablonec	0.0318	0.0105
Olomouc	0.0437	0.0029
Ostrava	0.0182	-0.0214
Pardubice	0.0126	-0.0074
Pilsen	0.02	0.0226
Praha	0.0318	0.022
Usti nad Labem	0.0147	0.0067
Zlin and Otrokovice	0.0198	-0.0106

vehicle kilometres corresponds to an average increment of 1.1% in financial coverage.

Table 5 reveals that allthecities experienced an increase in their financial coverage over the given period. Particularly, the cities of Olomouc, Liberec, and Prague exhibit the highest growth over time. If the vehicle kilometres remained constant, this growth would average around 4% per year. Notably, the development in Brno, the second-largest city in the Czech Republic, is somewhat surprising, showing a growth of approximately 1% per year over time.

Concerning the financial coverage of vehicle kilometres for specific cities, fluctuations are evident. Some cities, such as Hradec Kralove, Pardubice, Zlin, Otrokovice, Jihlava, and Ostrava, exhibit financial coverage per vehicle kilometre that is, on average, lower than the overall average for the Czech Republic. Contrarily, Pilsen and Prague boast the highest financial coverage per vehicle kilometre, a surprising observation given the size of these two cities. Conversely, Ostrava reports the lowest financial coverage per vehicle kilometre.

5 Discussion

The urban public transport stands as an indispensable mode of mobility within the urban areas. The Transport Yearbooks of the Czech Republic from 1998 to 2013 [24] indicated a 75% share for urban public transport and a 25% share for individual car transport in the all-day transport division of labor in the early 1990s. By 1998, this share had shifted to 60% for urban public transport and 40% for individual car transport. A similar trend is evident in Poland, where the motorization index, i.e., the number of private cars per 1000 inhabitants rose by approximately 125% in 2017 compared to 2000 [25]. According to the national survey, “Czechia in Motion” [14] conducted from 2017 to 2019, cities with populations ranging from 50,000 to 100,000 inhabitants reported a 17.8% proportion of urban public transport and a 33% share of individual car transport in the transport division of labor. Cities with populations exceeding 100,000 inhabitants exhibited a 36% share for urban public transport and a 27.3% share for individual car transport. This trend, suggesting that public transport usage rises with resident population, was supported by Santos et al., [26].

Sustainable urban development necessitates a gradual reduction in individual car transport and an emphasis on environmentally friendly modes of transport, such as urban public transport. The operation of urban public transport, being a public service, is linked to substantial operating costs, covered by revenues from urban public transport fares and compensations from city budgets. In 2019, compensations constituted 51% to 75% of the financial coverage of operating costs. These operating costs persistently rise, while revenues from fares continue to decline. Such a trend results in an escalated demand for compensations from city budgets.

This reality, coupled with the aim to strengthen the role of urban public transport in urban mobility, is inadequately addressed. Operating costs in all the cities reflect funds expended on fuel and energy consumption, repair and maintenance, and personnel costs. Revenues from passenger transport are disconnected from actual expenses, lacking precise market content. The pricing policies of tickets and time coupons, as well as preferential travel opportunities for specific groups, are beyond the control of service providers, falling under the jurisdiction of local councils. These councils, comprised of representatives who are also members of the control bodies of carriers, approve the compensation requirements of transport companies. In this role, driven by tight city budgets, there is a constant pressure to reduce and economize the operating costs. These circumstances underscore a fundamental contradiction between the aspiration to fortify the role of urban public transport in urban mobility and the practicality of incessantly escalating demands for compensations from the city budgets.

Our intention was to compare the intercity transport performance and operating costs incurred in individual years from 2010 to 2019, to predict the further development of urban public transport in the Czech Republic. The acquired data demonstrate a direct correlation between the number of inhabitants of a city, the extent of transport performance, and the absolute amount of operating costs. Research by Ruiz-Montanez [27] supports this, indicating that as a city expands in the number of boroughs, the economic funds required to supportthe public transport must increase in a greater proportion compared to the growth of boroughs. On the other hand, regarding the cost-effectiveness, the key factor is density. Systems with high levels of usage density tend to be more cost-efficient [28], with cities boasting greater population densities generally proving more efficient than the smaller cities [29]. In addition Borjesson et al. [30] concluded that the appropriate level of subsidies for the bus services varies significantly between congested corridors in large cities and smaller cities. This variation primarily arises from the differing impacts of crowding costs, compared to waiting and schedule delays.

The financial coverage per vehicle kilometre in 2019 displays varying levels among studied cities. Prague exhibited a financial coverage of CZK 115.5 (EUR 4.67) per vehicle kilometre. Cities, such as Brno, Liberec, Jablonec, Pilsen, and Olomouc, reported values ranging from CZK 75 to 80 (EUR 3.15 to 3.35), while Ceske Budejovice reported CZK 67.5 (EUR 2.83). Other cities reported financial coverage in the range of CZK 53 to 58 (EUR 2.22 to 2.44), except for Jihlava, which reported a value of CZK 44 (EUR 1.84) per vehicle kilometre.

In the analysis of the dataset, provided by large urban transport companies for the period 2010 to 2019, focusing on stagnant transport performance, we quantified the average annual rate of change in operating costs for this entire set of cities. Subsequently, we calculated the change deviations of individual carriers from the average level.

We have confirmed a statistically significant relationship between the transport performance and its financial coverage for the examined group of carriers. The average year-on-year change in financial coverage per vehicle kilometre was found to be 1.1%. Subsequently, we calculated the average deviation of the development of their costs from the aggregate year-on-year change for individual cities.

We intentionally used the data from before the Covid-19 pandemic. Covid-19 has had a major impact on public transport systems worldwide, necessitating public financial support to maintain services amid drastically reduced ridership and the need for social distancing [31]. In a recent review by Hörcher and Tirachini [20], it is noted, that the pandemic has highlighted the critical need for efficient resource allocation and demand management in public transport. Despite the unprecedented challenges posed by Covid-19, the public transport remains essential in densely populated urban areas due to the spatial inefficiency of alternative modes of transportation. We believe that our results remain relevant and up to date.

6 Conclusion

This researchaimed to evaluate the relationship between the financial coverage of costs associated with the transport performance of urban public transport, focusing on a dataset that includes the capital city of Prague and twelve regional cities in the Czech Republic, with an emphasis on anticipating future developments. The research covered the period from 2010 to 2019.

A statistically significant relationship between transport performance and financial coverage for the examined carriers was confirmed. The average year-on-year change in financial coverage per vehicle kilometre was 1.1%.

Analysis of statistical data from transport companies, encompassing metrics, such as vehicle kilometres traveled, the number of drivers, the quantity of vehicles, and their utilization during therush hour traffic, revealed fluctuating and essentially stagnant transport performance of urban public transport in individual cities throughout this period.

The sustainability of such transport performance is closely linked to escalating operating costs. Those costs are partially offset by revenues from fares, constituting a share that ranged from 23.8% to 43.1% of the total financial coverage in 2019. The second significant component of financial coverage is comprised of compensations from the budgets of individual cities. The perpetual increase in operating costs results in heightened demands for financial compensations from city budgets. This trend is primarily attributed to the stagnation of fare revenues, with some cities even experiencing a steady decline. Such a development is intricately connected to the stagnation of prices for urban transport and the growing number of individuals being transported free of charge.

One of the strengths of our research is the comprehensive dataset spanning a decade, which provides a robust basis for analyzing trends in financial coverage across multiple cities. The use of regression analysis further strengthened our conclusions by identifying significant relationships between the vehicle kilometres and financial coverage.

However, our study has some limitations. The financial coverage data may be influenced by city-specific factors, such as local economic conditions, political decisions, and differing accounting practices among transport companies. Additionally, the focus on financial coverage per vehicle kilometre does not account for other important factors, like service quality and user satisfaction.

In conclusion, our study provides valuable insights into the financial dynamics of urban public transport. While the findings show some trends in financial coverage of urban public transport, they also highlight the need for ongoing efforts to improve efficiency and sustainability. Future research could benefit from a more detailed analysis of the factors influencing the financial coverage, including qualitative aspects like service quality. Addressing the identified limitations through future research and providing a holistic understanding of the demand side of urban mobility will be crucial in developing more comprehensive strategies for urban mobility.

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Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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