

Development of passenger transport performance in the Czech Republic - an opportunity for carpooling

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Abstract: Personal transportation is an issue that deserves interest in research activities. There are plenty of situations necessary to deal with. The first one is transportation modes, and the second trend of so-called “de-urbanisation”, which means moving citizens from cities to small towns and villages. This trend very often causes an increased number of individual car trips and, at the same time, the decreasing trend in using public transportation modes. All mentioned circumstances lead to the necessity of finding new approaches how solving situations. One of them is the carpooling system. The goal of the research and this paper is to analyze passenger transport performance by mode and find possible consequences with economy performance. The key data used for analyses will be the total passenger transport performance. It was found out that the development of transportation performance corresponded with economic cycles measured by GDP.

Keywords: carpooling system, transport performance, economic cycles, transportation service

JEL Classification: G32, E01, R40

1 Introduction

Insufficient public transport services, characterised by a certain number of bus and train connections, are a threat especially in small municipalities with lower population density, which are primarily dependent on the financial resources of the region. In order to improve the transport needs of the citizens of under-served municipalities, the application of a carpool system becomes an interesting solution for improving the quality of transport services, especially in the less populated parts of the region.

In the context of carpooling (sometimes also called ridesharing), the approach is generally positive and has high potential in the future, and increasing positive attitudes towards carpooling are predicted (Becker et al., 2017). However, the carpooling system has its limitations. Carpooling poses some risk for the passenger who is not in control of the driving, but also for the driver who is carrying an unfamiliar person in his/her private car. The emphasis on safety, freedom, and privacy consequently reduces the willingness to carpool (Javid et al., 2017). However, the convenience of driving when the driver is alone in the car, the increasing number of car owners, and the difficulty of finding passengers with adequate timing and routes keep the carpooling system low (Anthopoulos & Tzimos, 2021).

The availability of transport links reflects the degree of opportunity and quality of connections between locations or socio-geographical parts of countries and continents. The main prerequisite should be the improvement of the development of transport to-transport, which partly lies beyond the capabilities of transport operators and partly overlaps the competences of infrastructure agencies. It is an approach to the construction and modernisation of transport infrastructure with the general objective of creating sufficient capacity for the growing demand for transport and with the specific objective of creating the conditions for alternative transport systems that will, in their consequences, relieve the burden of growing road transport intensities on the environment and reduce the generally increasing risks of transport for users (Zelený, 2007). Technology is a key enabler of online platforms for ride-sharing systems that facilitate the process of trip matching and lead to an increase in the services offered (Anthopoulos & Tzimos, 2021).

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1.1 Mobility management

Mobility, as the potential of movement, finds its realisation not only in movement as such, but also in means of transport and traffic routes. It is an expression of people's ability and need to move. It is a set of intentions, strategies and choices (Canzler, Kaufman, Kesselring, 2008). Among the factors influencing mobility, Chlaň, Kudláčková (2004) include the following factors:

- Socio-economic factors such as transport supply, housing availability, employment level, availability of recreation places, availability of shopping places, disposable real income, supply and availability of jobs, economic potential of the region, political situation in the area, age structure of the population of the area, lifestyle, etc.
- demographic factors such as infrastructure, education level of the inhabitants of the area, co-communication possibilities, spatial layout, possibilities of alternative modes of transport
- transport factors such as demand for transport, performance of transport infrastructure, organisation of transport services in the territory, conditions of operation of individual modes of transport, functioning of the internal market, constraints on the construction of new infrastructure, quality of transport, safety and reliability of transport, etc.
- - environmental factors, such as environmental impacts of transport, environmental protection, the costs attributed by the public to environmental impacts of transport, congestion, systematic promotion of environmentally friendly modes of transport, etc.

Mobility management is defined as "smart travel organization", where the traveller can reach his/her destination easily and with minimal obstacles. Mobility can be understood in different ways and as movement through different types of space, which can be physical, digital or social space (Schwanen et al., 2015). The goal is to maintain high volumes of accessibility while significantly reducing the negative effects of transport on people and the environment. This is a demand-driven approach in transport, requiring new collaborations and a range of tools to promote changes in attitudes and behaviour towards sustainable modes (Schmeidler, 2010). Sustainable modes of transport are defined as walking and cycling, carpooling (paid hitchhiking), car-sharing and public transport. Compared to mobility management, transport system management is mainly characterised by its supply-oriented approach. In addition, it seeks to optimise the capacity of transport corridors through telematics, pricing systems, etc., and focuses more on end-output solutions, whereas mobility management precedes this approach

1.2 Transportation performance and carpooling system

Transport infrastructure, including the road network, is a fundamental and necessary condition for access to mobility. But equally important is the provision of transport services to this infrastructure. It cannot be assumed that every citizen can have their own means of transport and, in particular, children, the elderly and the disabled are often dependent on public transport. This is particularly a problem in peripheral border locations with low population density and an outdated public transport system (Baran & Augustyn, 2021). Quality public transport and thus quality accessibility form part of the fulfilment of citizens' right to access mobility (Schmeidler, 2010). Transport performance is closely related to housing, employment, education, trade and services. It is the solution of these basic human needs that influences the organisation and the way of ensuring their accessibility from the transport point of view (Kudláčková, Chlaň, 2004). Transport performance can be effectively influenced by economic instruments such as charging for the use of roads or internalisation of external costs in transport. A mix of legislative and fiscal instruments, investment policy, subsidies and national and regional development measures is necessary for better decision-making in the field of sustainable mobility (Kudláčková, Chlaň, 2004).

Carpooling simply means a system of carpooling based on an agreement between two or more people to travel together (Gheorghiu & Delhomme, 2018). In the context of mobility management, it is the organization of carpooling by cars or minibuses, with the main objective of increasing vehicle occupancy and also offering flexible time frames, where drivers and co-drivers themselves choose group departures according to their needs. An important side effect is the reduction in the number of trips made by individuals who are transported from the same or a nearby source to a common destination (Aguiléra & Pigalle, 2021). The development of carpooling includes several benefits at the societal and individual level. At the societal level, carpooling significantly reduces traffic and air pollution at the individual level by reducing the cost and length of trips for users as it can also reduce the number of cars on the road (Wang et al., 2019). Thus, it is clear that ridesharing leads to savings in fuel, insurance and vehicle maintenance, and not infrequently, time savings. A further benefit is then the reduction of negative impacts from transport on the air. Carpooling is a complementary measure to the whole system of alternative transport, which is offered as part of the commuting of employees or other target groups in a

given locality (Plíšková, 2007). Carpooling is most often used through websites or applications not only abroad but also in the Czech Republic.

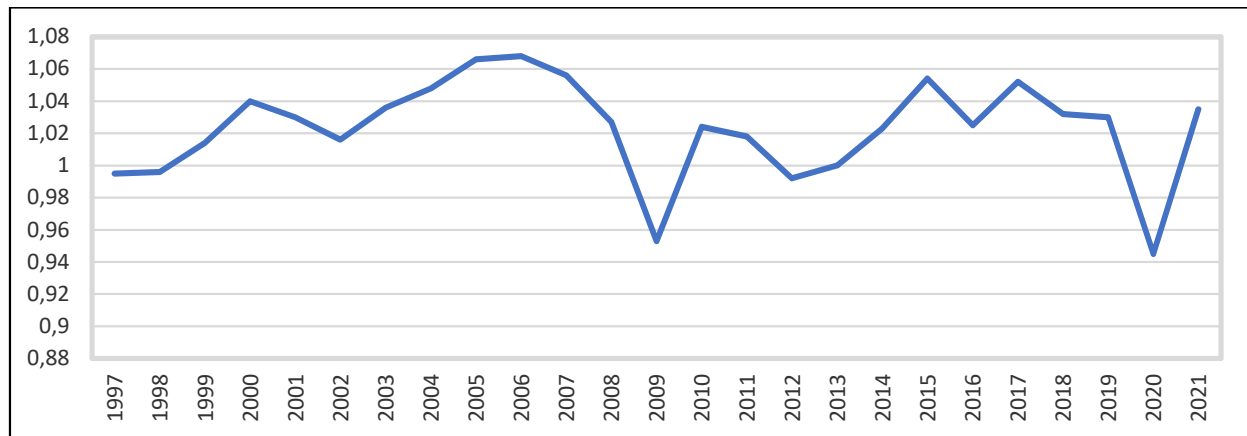
We analyzed in pervious paragraphs mobility management, transportation performance and carpooling system. There are consequences with economic cycles. The reason is quite simple. The right way to analyze any economics data in time period, in our case transportation performance, is to consider economics performance of the country. Obviously, the most common indicator used for this purpose is GDP. Economic cycle is going to be represented by GDP growth rate in period 1997 – 2021.

2 Methods

The goal of the research and this paper is to analyze passenger transport performance by mode and find possible consequences. Furthermore, to analyze the context of changes in economic performance (in different phases of the business cycle in the Czech Republic) and changes in passenger transport performance by mode. The results will be used of the kind of prove or evidence for application new transportation modes.

The data were drawn from both national accounting and the transport yearbook of the Czech Republic, for the period 1997 - 2021. Based on GDP (year-on-year volume indices), intervals where GDP growths increased and intervals where GDP growths decreased were constructed (Figure 1).

Figure 1 GDP growth rate



Source: Own processing

Consequently, the relationship between GDP development and passenger transport performance was analysed. The relationship between the development of GDP and the different types of passenger transport was examined in more detail by means of correlation coefficients, a measure of correlation that expresses a linear dependence between two variables and takes values from -1 to 1. Attention was paid in particular to the period before the Covid-19 crisis, the period of the covid crisis, which continues with the crisis associated with the Ukrainian war and the energy crisis.

The average growth rates for each interval were determined using the geometric mean

$$\bar{k} = \sqrt[n]{k_1 \cdot k_2 \cdot \dots \cdot k_n} \quad (1)$$

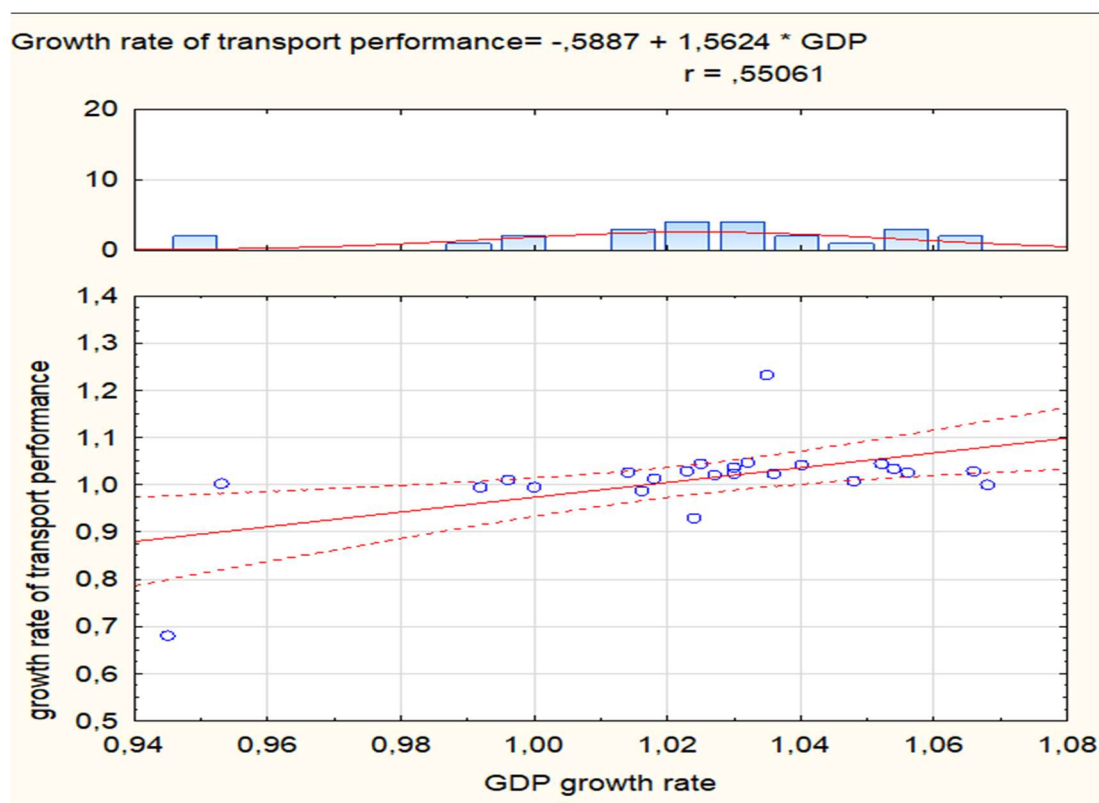
where:

k_i are GDP volume indexes, n is the number of years in the period..

3 Research results

The relationship between the change in passenger transport performance and the change in GDP was verified through a dot plot including the expression of a regression equation with the calculation of the correlation coefficient (Figure 2).

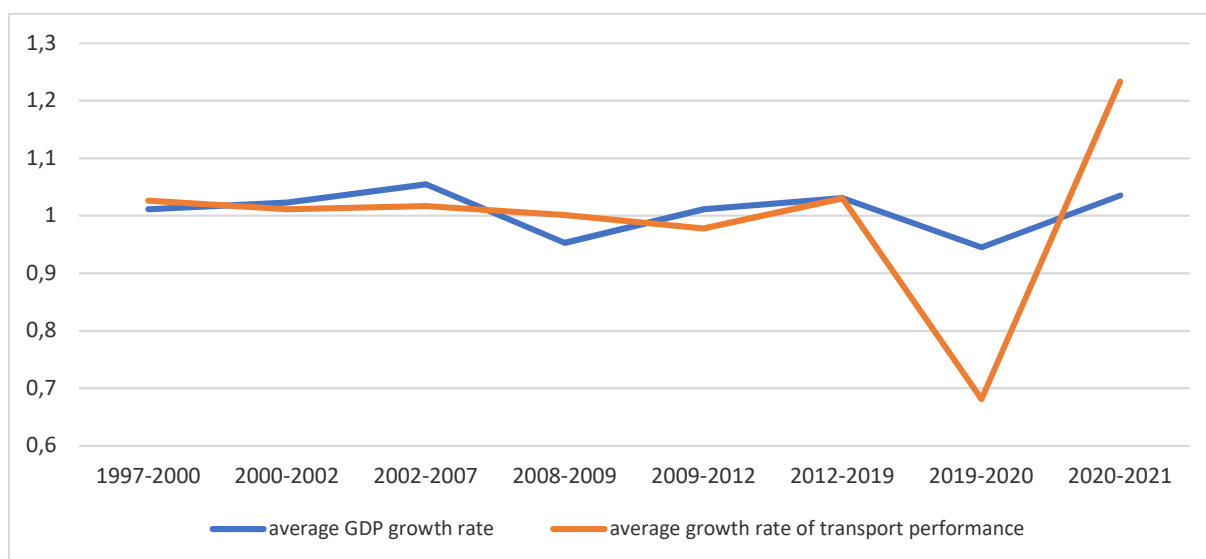
Figure 2 Dot plot of the relationship between growth in passenger transport performance and GDP growth



Source: Own processing

Figure 2 shows that there is a direct linear relationship between growth in passenger transport performance and GDP growth (excluding the effect of prices). This linear dependence is moderately strong, as indicated by the correlation coefficient. If we focus on the intervals that indicate the increases or decreases in GDP, i.e. the growth or decline of the Czech economy, it is clear from Figure 3 that these changes take place in the same direction for the variables under study, but with different intensities. Different intensities can be observed especially in the recent periods related to the Covid-19 crisis and the subsequent slight recovery before the Ukraine-related crisis and the energy crisis.

Figure 1 Average growth rates of GDP and passenger transport performance



Source: Own processing

A more detailed analysis that focuses on the relationship between the change in transport performance by mode and the change in GDP (Table 1) indicates that the strongest statistically significant direct linear relationship was found, as expected, for public transport (correlation coefficient 0.597), which includes rail transport (correlation coefficient 0.619), bus transport (correlation coefficient 0.536).

Table 1 Correlation coefficients of GDP and selected variables

Indicator	Correlation coefficient
Total transport capacity	0.551
Rail transport	0.619
Bus transport	0.536
Air transport	0.433
Inland waterway transport	0.128
Urban public transport	0.462
Total public transport	0.597
Individual car passenger transport	0.401

Source: Own processing

A statistically insignificant dependence of GDP development was confirmed for inland waterway transport and individual car passenger transport. Individual car passenger transport is not only related to journeys to work and thus to the creation of added value in the enterprise, but people are usually transported for other purposes (to the doctor, to the authorities, to school).

Next, attention was focused on the evolution of passenger transport performance by type in the period before the covid crisis, during the covid crisis and then in the last period under review (Table 2).

Table 2. Growth rate of transport performance by mode of transport

period	Total transport capacity	Rail transport	Bus transport	Air transport	Inland waterway transport	Urban public transport	Total public transport	Individual car passenger transport
2012-2019	1.030	1.060	1.023	1.015	0.978	1.016	1.025	1.034
2019-2020	0.681	0.610	0.516	0.158	0.742	0.415	0.418	0.849
2020-2021	1.233	1.023	0.992	2.277	1.304	0.951	1.098	1.276

Source: Own processing

It is clear from Table 2 that all passenger transport performance by type increased slightly prior to the covid crisis, i.e. during the period of economic growth (Figure 3), irrespective of the type of passenger transport, followed by a large drop in passenger transport associated with the closed economy during the “covid period”. Air transport, public transport and urban public transport experienced the highest drops. In what can be described as the post-Covid period, passenger transport performance increased by 23.3%, but public passenger transport only recorded a 9.8% increase. The highest increase can be observed in individual car transport, with 27.6%. This annual increase is significantly higher than the annual growth rate in the period before the financial crisis. This reflects the higher interest of people in individual car transport, whether for various reasons such as higher safety in terms of infection, higher flexibility, etc. It is clear from this analysis that shared transport and its further expansion is important. Particularly in communities with lower transport services, it can be an advantage for citizens when travelling not only to work, but also e.g. to the doctor, to school, etc.

4 Discussion and conclusions

Now, there is the place for research question. How and what can we derive from previous part where we got results of analyses. The answer is quite simple. It would be very unwise not to develop new ways of transportation modes. One of these is ridesharing or better known as carpooling. This mode has different ways of applications but we can actually make the list of advantages but also disadvantages:

Benefits of carpooling:

- Carpools save money by sharing the cost of driving one car. Driving in one car saves on fuel, tolls, parking and vehicle maintenance,
- carpooling eases the burden on the road,
- reduces environmental pollution,

- reduces the stress of driving for those who are passengers,
- provides new social contacts,
- faster travel than using public transport without changing trains,
- comfort for the driver and passengers,
- some companies offer more convenient parking spaces for carpoolers.

Disadvantages of carpooling

- Drivers bear the burden of any lawsuit from passengers in the event of an accident,
- the passenger doesn't know the driver in advance, nor the level of his driving skills. Mutual trust between driver and passenger is necessary.

Given advantages and disadvantages are compilation of authors own ideas and research papers by authors like Bruglieri et al., (2011), Pukhovskiy et al., (2011), Tahmasseby et al., (2016).

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