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Conventional versus high-speed: Is it worth the effort?

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Abstract

Our paper aims to contribute to the debate on conventional versus HSR in small countries like the Czech Republic, with a well-developed railway network on the one hand and relatively short distances for significant potential time savings on the other hand. The research is based on the relevant investment railway projects implemented during 2007–2013 and 2014–2020. Railway corridors were chosen to cover all open-access routes in the Czech Republic. They cover routes from the capital city of Prague to all regional centres in the eastern part of the Czech Republic – two metropolitan centres of Brno and Ostrava and two regional centres of Olomouc and Zlín. We analyse the impacts of the implemented investment projects on the change of the average travel times and their costs. Our results consider time savings converted to one minute of travel time saved per hundred kilometres of the rail route. We document that modernising conventional railways is a realistic option for a small country like the Czech Republic; on the other hand, HSR represents a rather theoretical option, as the costs of construction are extremely high, and potential benefits in the form of the increased ridership are unclear before it is finished. However, our results correspond to the expected ridership of 10.818 million passengers a year from Prague to Brno in 30 years to achieve economic effectiveness. Regarding daily ridership, we conclude that cost-effective implementation of HSR expects the demand growth from 13,400 to at least 30,000 passengers.

Keywords: High-speed railway, modernisation costs, effectiveness, travel time savings

1 Introduction

The value of time is one of the fundamental elements of transport policy, especially in the last two decades. This concept has gained much attention as documented, e. g. in the meta-analysis of almost 400 European studies (Wardmann et al., 2016). The value of travel time can be expressed willingness to pay for reducing travel time (Athira et al., 2016). However, less often, the value of time is looked at in research from another point of view – how much should be invested in upgrading or building a new railway line if it is desirable to reduce travel times or increase speed. Therefore, it can be asked how much it costs to reduce a travel time by one minute over a 100 km distance in terms of investment costs in a conventional railway line compared to the high-speed railway (HSR). This way of looking at it provides an alternative monetisation of travel time to the standard willingness-to-pay savings.

In the Czech Republic, the concept of HSR has been widely discussed during the last years, especially the route between the capital city of Prague and the second largest city of Brno. There are some estimations of the overall costs for this investment (Ministry of Transport, 2017) and expected benefits, and the first HSR route should become a reality in twenty years. However, does it worth building, or is it better to modernise the existing network to save travel time? We collected data on the modernisation projects on the most important routes in the Czech Republic during the last 16 years; using historical timetables, we compared the original and new travel times and the costs necessary for time reduction and compared them to the expected costs on HSR. Our paper aims to contribute to the debate on conventional versus HSR in small countries like the Czech Republic, with a well-developed railway network on the one hand and relatively short distances for significant potential time savings on the other hand.

2 Methods

The research is based on the relevant investment projects implemented in two consecutive periods of the European Union, namely during 2007–2013 and 2014–2020. In these two periods, investment activities from the Operational Programmes Transport I and II were supported through the European Structural Funds. These Operational Programmes included four Priorities, whereby the first one is focused on the modernisation of railway infrastructure in the Czech Republic.

We use open access data provided by relevant public bodies focused on ridership and financial sources and open-access data to analyse frequency and travel time changes. Data on costs come from the State Fund for Transport Infrastructure (SFTI, 2022) and the National Coordination Body of the Ministry for Regional Development of the Czech Republic (NCB, 2016; NCB, 2022). Next, frequency and travel time data were gained from time schedules (SŽDC, 2008-2019) and data on ridership (2008–2019) from Transport yearbooks (Ministry of Transport, 2008-2019).

First, we deal with identifying relevant investment projects, including the total costs (SFTI, 2022; NCB, 2016; NCB, 2022) on selected railway corridors. The

corridors were chosen to cover all open-access routes in the Czech Republic (including connections where some part is open-access). They cover routes from the capital city of Prague to all regional centres in the eastern part of the Czech Republic – two metropolitan centres of Brno and Ostrava and two regional centres of Olomouc and Zlín. Second, we analyse the impacts of the implemented investment projects on the change of the average travel times to the selected centres. The change in travel time is also accompanied by increasing frequency of connections, partly induced by the responsible railway transport coordinator and railway operators. The consequences of these changes are viewed in the last methodological step via ridership change.

3 Results

The impact of the implemented investment measures on travel time on the selected corridors is shown in Figure 1. A gradual reduction of travel time was achieved in all the analysed corridors. The most significant reduction in travel times was reached at Prague–Pardubice route (more than 25%), while the lowest travel time reduction to Zlín was almost 15%.

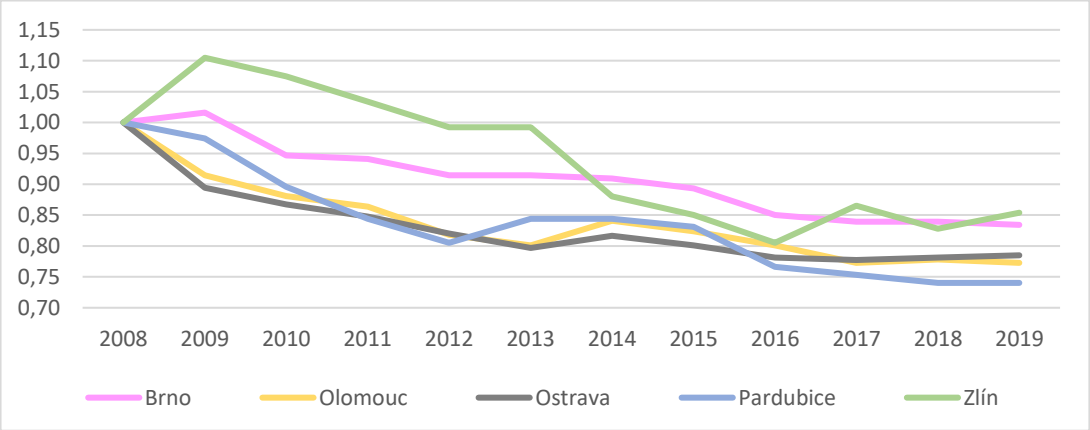

Figure 1: Travel time change (routes from Prague, index: 2008 = 100)
Source: SŽDC (2008-2019), own elaboration

Figure 2 shows the phenomenon of increasing frequency, which cannot be attributed only to the incentive of decreasing travel times but also to increasing competition. The Prague–Pardubice route exhibited the most significant increase in frequency (almost 2.5 times), while Prague–Ostrava only around 1.5 times.

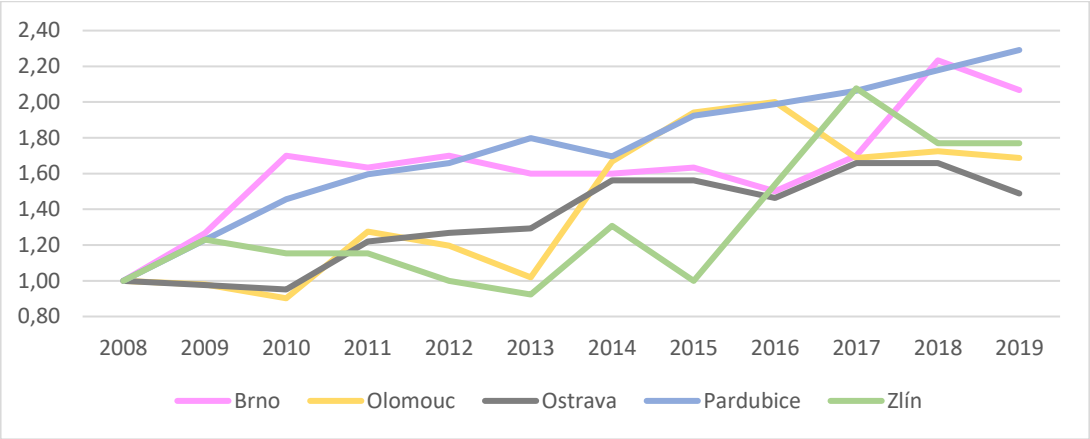

Figure 2: Frequency change (routes from Prague, index: 2008 = 100)
Source: SŽDC (2008-2019), own elaboration

Figure 3 illustrates the impacts on ridership induced by speed and frequency increases and other service quality improvements. Despite the best assumptions of the Prague–Pardubice route, the increase in ridership was the lowest. The highest increase is recorded on the route to Brno (almost five times), and the other routes achieve a comparable increase to about three times. However, the astonishing growth on the Prague–Brno route can be mostly attributed to the entry of a new open-access operator, which also brought higher frequency, lower prices, and better quality of the services.

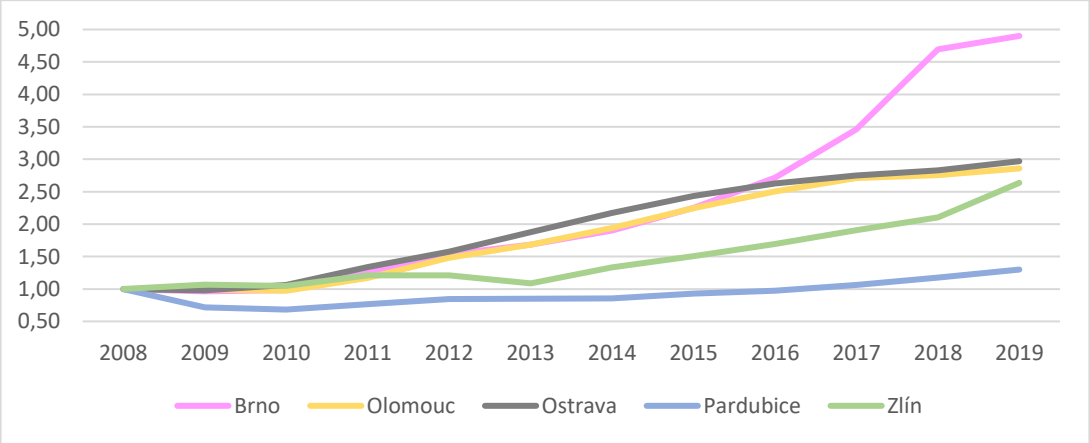

Figure 3: Ridership change (routes from Prague, index: 2008 = 100)
Source: Ministry of Transport (2008-2019), own elaboration

Table 1 shows the computed time savings, costs on modernisation of the existing network and expected cost on HSR. It is evident, that modernising conventional railways is a realistic option for a small country like the Czech Republic. On the other hand, HSR represents a rather theoretical option, as the costs of construction are extremely high, and potential benefits in the form of the increased ridership are unclear before it is finished.

route	distance km	time savings min/100 km		costs		mil. EUR/min./100 km		time savings ratio	cost ratio
		conv.	HSR	conv.	HSR	conv.	HSR		
Brno	254	12,20	32,41	336	6 178	10,84	76,27	2,66	7,03
Olomouc	250	16,00	4,57	314	8 650	7,85	540,63	0,29	68,91
Ostrava	356	15,45	15,64	805	11 480	14,64	173,94	1,01	11,89
Zlín	311	12,54	25,70	653	8 947	16,76	96,20	2,05	5,74

Table 1: Cost comparison for HSR and conventional lines
Source: Own elaboration

4 Conclusions and Contributions

In our paper, we analysed the impacts on frequency, travel time, and ridership achieved by modernising conventional rail. We then compared the relevant costs of modernisation conventional railway with the potential planned costs on implementing high-speed rail on four selected routes (from Prague to Brno, Ostrava, Olomouc and Zlín). The fifth route to Pardubice (part of all the other routes) is not located on the planned HSR railway network.

Our results consider time savings converted to one minute of travel time saved per hundred kilometres of the rail route. The time savings ratio and cost ratio were chosen as the final indicators describing the time and cost savings achieved by implementing HSR compared to modernising conventional rail. We found out that the construction of HSR is not a suitable solution for the Prague–Olomouc route, as the implemented modernisation of the conventional line achieved much higher cost-effectiveness concerning the time saved. Moreover, the time savings by HSR are potentially smaller than those achieved by the modernisation of conventional railway due to the longer distance by HSR. The potential time savings for the Prague–Ostrava route are comparable to those achieved by the implemented modernisation, and the cost-effectiveness is still at a relatively high level. The best time savings ratio and cost ratio is achieved on the Prague–Brno and Prague–Zlín routes (most of this route is identical to the Prague–Brno route). Therefore, this relatively favourable cost ratio concerning the time savings achieved is primarily demonstrated only on the essential part of the planned HSR between Prague and Brno, but the cost ratio is twice as much as the time savings ratio.

The Ministry of Transport (SFTI, 2017) methodology on Cost-Benefit Analysis on railway projects works with the average value of time 14.1 EUR/hour (0.235 EUR/minute) on business trips, long-distance commutes, and other long-distance trips. This value corresponds to the ridership of 10.818 million passengers a year from Prague to Brno in 30 years to achieve economic effectiveness. This limit corresponds to the European Court of Auditors' (2018) results of 9 million passengers a year. Regarding daily ridership, we conclude that efficient implementation of HSR expects the demand growth from 13,400 (Ministry of Transport, 2008-2019) to 30,000 passengers. Thus, future research could concentrate on geographically smaller countries facing short-distances and border effect and analyse a combined model of HSR and conventional railway.

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