EVALUATION OF COMPETITIVENESS OF RAIL TRANSPORT ON EXAMPLE OF CONNECTION AMONG REGIONAL CAPITALS IN CZECHIA[1,2]

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Introduction

The issue of evaluation of transport contacts among settlement centres is one of the main fields of transportation-geographic research which is closely related to the study of spatial interaction of centres and origins of which can be traced back to the quantitative revolution period, i.e. the 1960s. The term spatial interaction is often traced to E. L. Ullman, a representative of the US geographic school. In his theory, Ullman (1973) states three independent conditions for the origination of spatial interactions among localities or regions: regional complementarity, intervening opportunity, and transferability. As Johnston et al. (2000) says spatial interactions indicate interrelations between centres or regions which are realized by the movement of persons (e.g. by their commuting to work and school, by migration), goods (e.g. international trade, import of raw materials, etc.), or information and capital.

It is clear that the intensity of interaction is related to the size (importance) of the settlement centres which is the result of the scope of its activity at various levels. However, in a transportation-geographic study it is legitimate to first closely discuss the factor of distance which makes their accessibility easier or more difficult. A number of "standard" models that make use of the concept of distance-decay deal with the increasing intensity of transport relations with decreasing distance between settlement centres (see e.g. Haggett, 2001). In geography, it is most common to represent accessibility in kilometres or minutes (the so called time accessibility). The issue of changes in accessibility (especially time accessibility) and their cartographic representation is a traditional research topic adopted by transportation geographers. For example Nový (1904) created a map of time accessibility of Prague from Bohemia by rail, with the use of the isochrone method. Currently, it is more common to use the method of shrinking maps, which is based on isochrones (e.g. Horner, 2000). The deformation of space by time accessibility and a different form of its representation is demonstrated by S. Kraft (2008) with the example of the South Bohemian region, S. Kraft and M. Vančura (2009) use the examples of accessibility of Prague from micro-regional centres in Czechia. D. Seidenglanz (2007) also deals with transport

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accessibility, as well as M. Horňák (2006) who studies the issue with the examples of Slovakia.

The second important factor that influences the degree of interaction of centres is their size because bigger and larger centres generate and attract more contacts, higher turnover of goods, etc. Size and distance (or proximity) are the most important factors which influence the intensity of interactions between centres and are used in the well-known gravity model and models based on it (see e.g. Haggett and Chorley, 1969, Luoma et al., 1993, Hudeček, 2008, Chmelík, 2008 and others). Nevertheless, in reality two centres with the same population and the same distance generate a different volume of contacts. One of the reasons for this asymmetry is the phenomenon of geographical location, where the location of the centre within a broader system, i.e. physical-geographic confinement of the adjacent territory or the relative size of the centre compared to other settlements in its vicinity, for example, can lead to the acquisition of administrative functions and, thus, to the strengthening of its hierarchical importance (see e.g. the towns of Jihlava, Jeseník and others). It is geographical (or possibly specifically transportation-related) location that introduces significant variability and asymmetry into the relation between the size, importance, distance and interaction of centres (see e.g. Marada et al., 2008). Another factor that conditions the asymmetry of relations is the differentiated attractiveness of centres, which is, however, partially linked to the importance and the location of the centres. This is quite clear when we think of attractiveness taking into account for example the number and structure of jobs. Literature also mentions different potential of centres to generate contacts, the so called emissivity, which is usually related to the income level of citizens (e.g. Rodrigue et al., 2006). But influence can also be found in the transportation possibilities of the citizens, i.e. public transport supply or the level of motorisation.

Therefore, when we deal with transportation relations, there arises a related methodological issue of being able to capture the real interaction between the centres when the data base is insufficient. The existing data on transportation or movement of persons are insufficient, especially in terms of capturing the movement origin and destinations, small territorial scope, sparse monitoring frequency and content limits (we have the numbers of contacts rather than their purpose at our disposal, etc.). J. Hůrský (1978) dealt with the possibility to represent relations between centres describing the possibility to determine transportation divides on the basis of car traffic census performed by the Road and Motorway Directorate of the Czech Republic on the majority of roads and motorways every five years. In terms of the possibility to determine the start and the end of the journey it is the public transport (data about the intensity of supply of various connections in particular) that remain the "most reliable" source of data, apart from commuting data from the Census. However, public transport data lack informative ability in a number of other fields (absence of data about load, influence of transportation planning by the regions and state, technical transportation factors that influence line routes, etc.). This paper tries to overcome these disadvantages, at least partially, by using data on the number of tickets sold acquired from the Czech Railways.

The paper focuses on evaluation of the importance of passenger rail transport in contacts between regional capitals in Czechia. Particular relations are evaluated on the basis of three selected indicators – supply of connections, real demand of rail transport based on data on the number of tickets sold, and model interaction which was completed by applying the gravity model. In the case of interactions between regional capitals in Czechia the above discussed theoretical basis will be present especially in the following points.

1/ Because the focus is placed on passenger rail transport, the main differentiation factor of regional capitals, apart from the size of population, is their location within the rail network, and especially the quality of their inter-connection by railway. In some cases, these differences may lead to noticeable differences between real interactions compared to theoretical values determined by the gravity model. The model is based on settlement needs, and does not take strictly into account the quality of the transportation network, which is represented in the model only through time distance by rail. In this context, the differences between the theoretical interaction and the real demand of rail transport may apply especially to relations, where there is a noticeable competition of a quality road connection (motorways, high-speed roads) and, therefore, the real rail transport flow is lower than the model predicts. The results of the Praha − Brno relation is especially interesting because motorway connection tends to be used significantly even despite the existence of a rail corridor. On the other hand, in the case of relations with insufficient links (e.g. Praha – České Budějovice) to the motorway network, it can be supposed that the rail will occupy a significant position in terms of modal-split, i.e. the intensity of real demand will be higher than the model predicts.

2/ Relative location of regional capitals is another factor that influences the symmetry of the interaction. For example, the position of Prague in the center of the radial network of Bohemia supports more intensive use of railway. On the other hand, the towns of Jihlava, Liberec or Zlín lack this advantage even in their corresponding region. Certain "difficulties" in the results of our analysis can be expected when it comes to the proximity of the pair Hradec Králové – Pardubice, whose transport connection is of micro-regional importance, and so the values will be quite extreme. The Moravian-Silesian settlement system is characteristic by a dominant axis Brno – Olomouc – Ostrava but lacks the dominant element similar to Prague in Bohemia.

3/ The most significant differences in supply of connections and real demand can be expected in relations between regional capitals which are connected by rail corridors. We can expect that in these cases (e.g. Pardubice – Olomouc, Ústí nad Labem – Brno) the supply is higher than the demand due to the routes of national and international transit lines.

4/ It is probable that we will find greater consistency in the relation between the number of train connections (real supply) and the number of transported passengers (real demand) because both indicators only apply to rail transportation. Nevertheless, this interrelation will be influenced by a number of factors, see the above mentioned transit connections, the fact that supply is often influenced by technological limitations. Lower relative difference between the maximum and minimum value of the supply of connections, i.e. variability of the set, will also significantly influence the result.

Notes on methodology

Evaluation of passenger rail transportation relations between regional capitals (i.e. 78 relations) is the main topic of the analysis (relating to 2007 due to the accessibility of relevant data). Selection of individual regional capitals, that can be characterised as the most important centres in the settlement hierarchy, corresponds to their administrative borders. The town of Zlín is an exception: the town of Otrokovice was agglomerated to it due to high interrelation of these settlements caused by the localization of the Otrokovice "long-distance" rail station in the II transit rail corridor.

The supply of connections between regional capitals is evaluated as of Wednesday, 21 March 2007, on the basis of an electronic timetable IDOS offered by the CHAPS spol. s r.o. company which contains information about the 2006/2007 railway timetable. Wednesday was selected because it poses no limitations (weekend, national holiday) nor are there any additional measures (i.e. additional trains in peaks on Fridays and Sundays). Apart from the usual direct connections (see e.g. Květoň, Marada, 2008) we also accepted connections with one change while the maximum time accepted for one change was 30 minutes.[1] Connections with more than one change were disregarded because we supposed lower travelling comfort, even though in some relations a connection with two changes is more advantageous than a connection with one (both in terms of travel time and frequency[2]). In order to make the supply of connections relevant to the desired purpose, i.e. connection of regional capitals, we took into account only those connections that were in accordance with the assumption of rational behaviour of the passengers, i.e. use of the fastest and shortest (most economical) routes. Therefore, we accepted entirely long-distance/express trains (i.e. the R, Ex, IC, EC, EN, SC categories). However, there is one exception: cases of relations in which passenger trains are used (the Os and Sp categories) and are competitive in terms of time with trains of higher transportation segment - especially the Pardubice – Hradec Králové and Olomouc – Otrokovice (Zlín) relations. At the same time, we included only connections relevant to the real demand. This means that, for example, in the case of the Praha – Jihlava relation we accepted only the connection via Havlíčkův Brod, the connection via Veselí nad Lužnicí was not accepted. It is necessary to add that one of many possible selection procedures was used, which brings about a certain amount of subjectiveness.

The evaluation of real demand of rail transportation is based on a relativised data matrix that includes the number of addressed tickets sold in March 2007, provided by the Czech Railways company. The construction of the chosen indicator of the real flow is based on the sum of tickets sold in both directions while we tried to include in the total origin/destinations of journeys of all important stations in the delimited regional capital, taking into account the relation that was currently being evaluated.

Model (theoretical) intensity of interactions between regional capitals was determined with the use of a simple shape of the gravity model in which the substance of the centres is represented by the number of inhabitants (as of 1 January 2007), the distance of the centres corresponds to their time accessibility by rail, and the distance parameter

[1] The highest tolerated values of time needed to change were found, for example in the case of the Plzeň – České Budějovice – Jihlava – Brno – Ostrava relation, with a change in Brno.

[2] For example the Ústí nad Labem – Jihlava relation with the use of change in Kolín and Havlíčkův Brod.

equals 2.2. The model is considered symmetrical assuming that the emissivity and attractiveness of each of the studied centres with substance are directly proportionate to the value of the centre's substance. The value of the distance parameter (the so called resistance function) was determined on the basis of relevant literature (e.g. Řehák, 2004, Halás, 2005) and previous results (Chmelík, 2008). Time distance of centres needed for the construction of the model was evaluated together with the supply of connections. If trains of one line between two centres were used in a systemic way (interval transport – repeated departure times, the same stop policy, etc.) the model made use of the running time of these trains (i.e. mode/the most frequent value[1]). If there were more lines the time distance was characterised by the average of mode values of connections of individual lines.

To enable comparison of the three selected indicators, i.e. supply of connections, real demand and model interaction, the values of individual sets were relativised in relation to the strongest relation in the set, which was assigned the value of 1,000.[2] Then statistical dependence was calculated between the studied sets according to the three given indicators and it was used to determine the relations where the supply corresponds to the real demand and vice versa. At the same time, the evaluation can be used to identify relations where the real demand is significantly below, or above, the level of the theoretical relations based on size-related importance of the centers and their time accessibility by rail, in which qualitative aspects (speed, throughput capacity) of the connection are also included in a mediated way.

Dependence between selected indicators

Simple statistical evaluation provided the values of correlation coefficients for the set of 78 relations monitored on the basis of three indicators; the values can be used to interprete primary conclusions on the relations between the selected indicators. The correlation matrix (see Table 1) shows high dependence between the real supply and the model interaction between the studied relations of the centres. To simplify, we can say that the theoretical intensity of passenger rail transportation streams based on a simple model method sufficiently corresponds to the real contacts of the centres.

Table 1: Pair correlations of selected indicators

Indicator	Supply of connections		Real demand		Model interaction	
Supply of connections	---	---	0.784	0.692	0.740	0.696
Real demand	0.784	0.692	---	---	0.902	0.888
Model interaction	0.740	0.696	0.902	0.888	---	---

Notes: The level of significance of the resulting values of the Spearman's rank correlation coefficient and Pearson's correlation coefficient (italics) is 1%.

Source: the authors' calculations based on Czech Railways data, IDOS 2006/2007.

[1] Mode value of travel time (i.e. time accessibility) corresponds more to the real conditions than the average travel time calculated from all connections in the relation, i.e. even from the less frequent trains (that make more stops) that are used only during the morning and afternoon peak hours.

[2] At the same time this solution is in accordance with the conditions for the presentation of data provided by the Czech Railways company.

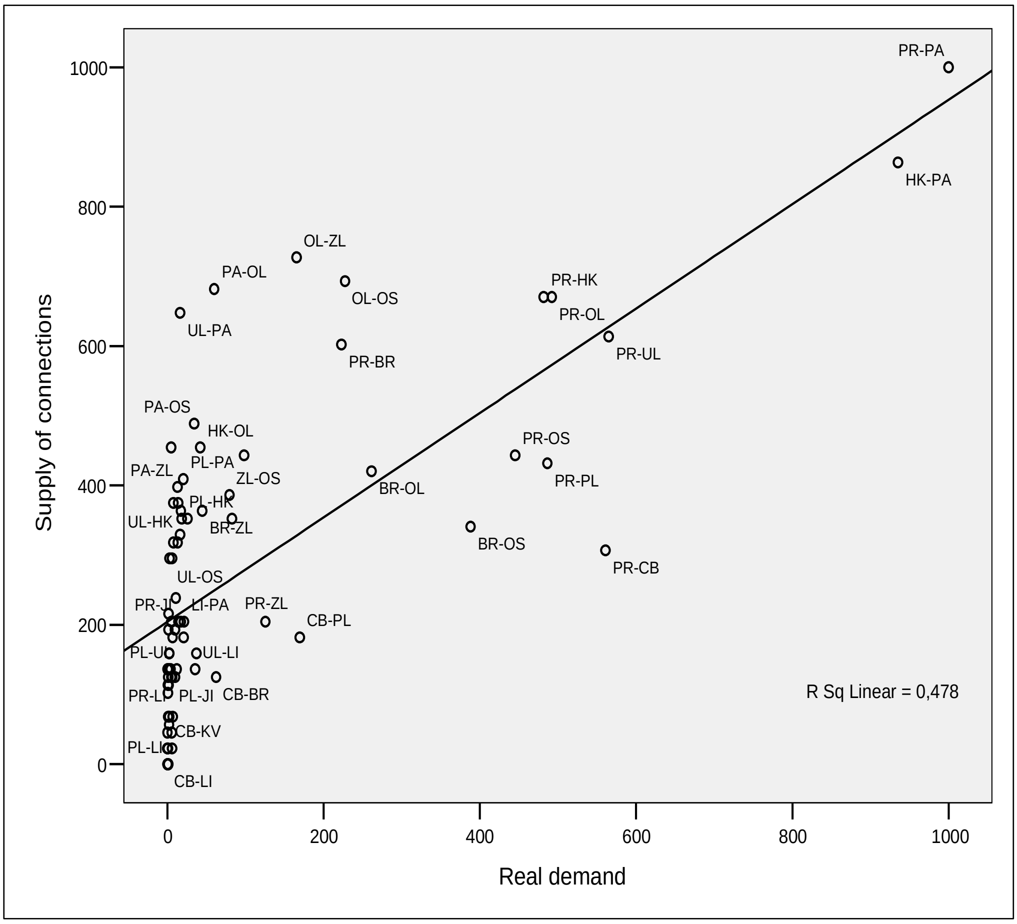
On the other hand, lower dependence shows in the case of relation of both above mentioned indicators with the supply of connection. After a detailed analysis this result is not surprising because of several factors. Firstly, it is related to the methodological procedure when determining the supply of connection between regional centres where capacity of individual connections[1] is not taken into account. This leads to significantly lower variability of the set than in the case of indicators of real demand and model interaction. Secondly, it has to be noted that in a number of relations the supply of connection is markedly influenced by the long-distance transit lines that make their stops in the regional capitals. This means that the supply of connections is often not primarily intended for a contact between two closely situated centers. The scope of their supply significantly increases thanks to their advantageous horizontal transport position (for more see Marada, 2006) which does not necessarily need to correspond to the intensity of transport demand between them. Thirdly, the supply of connections in some cases is influenced by institutional and technological transportation factors that have impact on the line routes. Therefore, it is possible that in some cases the evaluation of supply of connections also includes the connections of regional capitals (especially with a change) in which the real demand is minimal.

Relationship of real demand and supply of connections between regional capitals

The relationship of real demand and supply of train connections among regional capitals in Czechia was evaluated with the use of regression model, whose application led to the explanation of the supply of connection on the basis of real demand. The graphical representation of linear regression of the studied relationship in Figure 1 shows which relations, according to the model, contain an overvalued or undervalued supply of connections.

[1] The capacity of trains is very different for each line. In some cases an “express train” contains only several carriages, while the maximum value is well above 10 carriages. If we assume that a “longer” train is dispatched in accordance with the demand and, therefore, its occupancy rate is much higher, then the lower “closeness” of the relationship of real demand (and possibly also the model interaction) and supply of connections is in accord (because of the fact that the capacity of the supplied connections is not taken into account).

Figure 1: Regressive model of relationship between real demand and supply of connections



Notes: The values of indicators are relativised compared to the strongest relation (assigned the value of 1,000). Centre abbreviations – Prague (PR), České Budějovice (CB), Plzeň (PL), Karlovy Vary (KV), Ústí nad Labem (UL), Liberec (LI), Hradec Králové (HK), Pardubice (PA), Jihlava (JI), Brno (BR), Olomouc (OL), Zlín (ZL), Ostrava (OS).

Source: the authors' processing based on Czech Railways data, IDOS 2006/2007.

The most clear and frequent examples of overvalued connections are those regional capitals that are situated on the rail corridors, which brings along a significant scope of supply which has, as assumed, partly a transit character (national and international, e.g. Berlin – Praha – Brno – Vienna). These are especially relations with Pardubice (connection with Ústí nad Labem, Olomouc, Brno, Ostrava or Zlín) and Olomouc (relation with Pardubice, Zlín[1], Ostrava). The model evaluated some transit connections (usually with a change) via Prague as having an overvalued scope. These are, for

[1] Overvalued scope of connections in the Zlín – Olomouc relation can be caused by the fact that passenger trains were included (see 2 Notes on methodology).

example, the connections of Plzeň with Pardubice and Olomouc which can be used by passengers in an hourly interval. What is also interesting is the overvalued connection of the biggest Czech cities of Prague and Brno, which is influenced not only by transit international lines but probably also by a strong competition of road transport along the D1 motorway, which determines a relatively lower demand of rail transportation (and, therefore, supply of connections in the regressive model).

The regressive model evaluated the supply of connections of some radial connections with Prague, i.e. the connection of Prague with České Budějovice, Plzeň, Zlín and Ostrava, as insufficient. In the case of Ostrava and Plzeň there is a clear and significant transportation potential which is not adequate according to the model, even despite an hourly interval of departures. In the case of connection with České Budějovice the high real transportation flow is probably influenced by the absence of motorway to Prague, which leads to higher competitiveness of train in this particular relation. Similar situation applies to the connection of Zlín and Prague. The results based on real transportation demand show that the supply of connections should be increased in the main Moravian relation of Brno – Ostrava in the Western Bohemia tangential connection between Plzeň and České Budějovice. In this context we have to add that in the case of some relations, the supply (evaluated in this study using the 2006/2007 timetable) has already been increased (e.g. higher concentration of transport in the Praha – České Budějovice and Brno – Ostrava relations).

A specific approach should be adopted towards the strongest relations of Pardubice – Hradec Králové and Praha – Pardubice,[1] because their extreme values are influenced by several factors. In the case of the Pardubice – Hradec Králové pair, two regional centres are geographically close and the character of the mobility of inhabitants is everyday commuting, which is different from the other interactions between the other Czech regional capitals. The Pardubice – Praha relation is also influenced by everyday commuting conditioned not only by the job-related attractiveness of Prague but also by the quality supply of the rail connections, influenced by the transportation position of Pardubice on I rail corridor.

Relationship of real demand and model interaction between regional capitals

The next chapter deals with the evaluation of relations of model interaction and real demand between the individual regional capitals in Czechia. Using the gravity model, we specified inter-centre model interactions and these can be compared with the relativised real passenger flows in individual relations. Thus, it is an analysis of theoretical and real interaction of Czech regional capitals in terms of transportation flows served by rail. In this case, the supply of rail transport is not evaluated but based on the facts mentioned above and we assume that it is determined significantly by transportation demand. The graphical representation of linear regression of the studied relationship (see Figure 2) shows us that it is possible to find out from the model in

[1] The regressive model was created without the two strongest relations because we assumed that these extreme values could significantly influence the results (the course of the regressive function). However, this assumption has not been confirmed because the variability of the offer of connections (as a dependent variable) is better explained when assessing 78 relations (coefficient of determination $R^2 = 0.478$) rather than when assessing 76 relations ($R^2 = 0.313$).

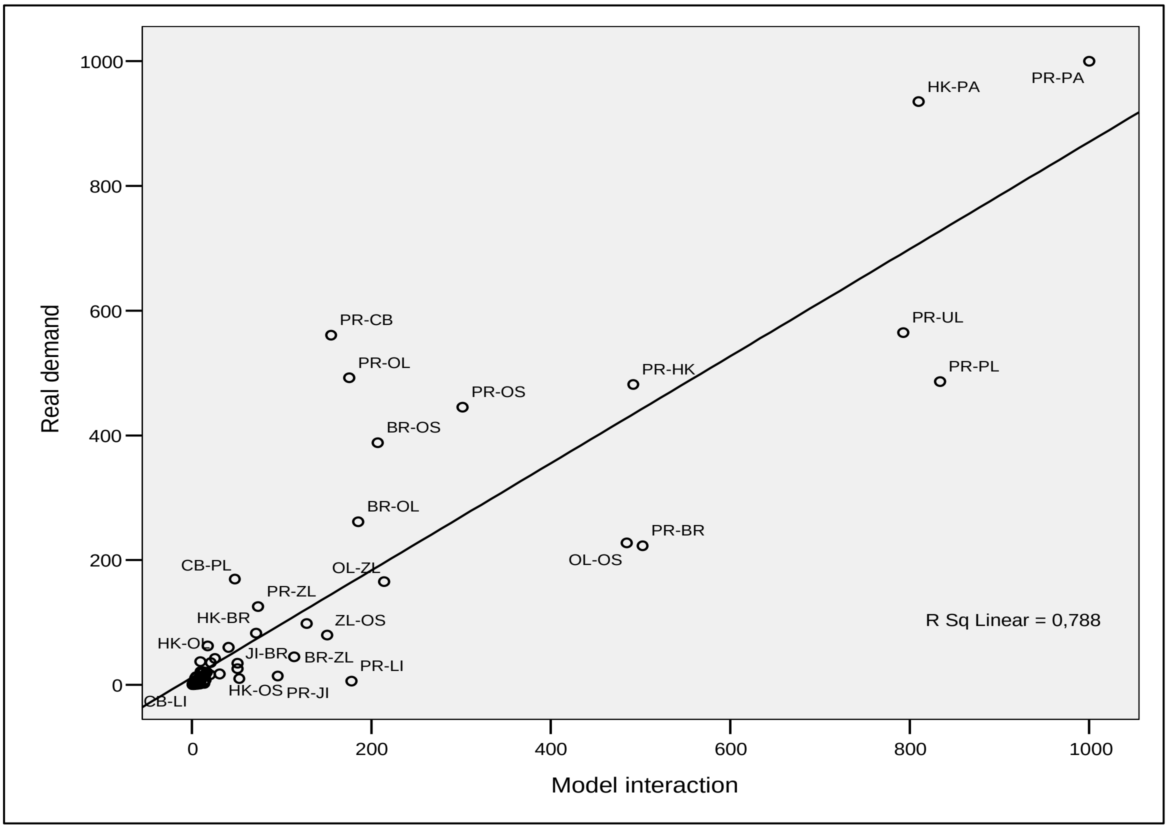
which relations the real demand is undervalued or overvalued compared to the model interaction.[1]

Figure 2 clearly shows several clusters made of individual relations which could be analysed in more detail in the future. First, our attention will be paid to selected relations which are assigned higher theoretical interaction by the model than the real demand for rail transport actually is. The typical examples are relations Praha – Brno or Olomouc – Ostrava. In the case of the first relation of the two most important cities in Czechia the relatively lower real demand is clearly influenced by the existence of the D1 motorway, which significantly supports competition between the types of transport (car vs. bus vs. train). Even though the time accessibility by rail on the Praha – Brno route is on average longer only by several minutes, it can be supposed that the railway connection in this relation has a minority status compared to the quality supply by private bus transportation companies. The analysis has also confirmed that. From the model interaction point of view, the Olomouc – Ostrava relation is also overvalued compared to the real demand predicted by the regressive model. However, this fact can be influenced by a relatively low cooperation of these centres, where Olomouc is more closely oriented to Prague and Brno, even despite its relative proximity of Ostrava. The case of Ostrava is analogous. The question is how the currently relatively high-quality rail connection will cope with the opening of the whole of the D1 (D47) motorway.

The regression model also shows pairs of relations for which higher real demand of rail transportation is typical (compared to the previously mentioned relations). However, the model prediction remains higher. These are especially the interactions between Prague and Plzeň, or Ústí nad Labem. We again need to emphasize the importance of the existence of high-capacity road communications which probably significantly condition the competitiveness of rail transportation and subsequent distribution of transportation flows within modal-split. On the other hand, this result can also be influenced in terms of methodology by the “setting” of the gravity model in relation to the size of the population of Plzeň or to the relatively low time accessibility in the Praha – Ústí nad Labem relation, which generates high model interaction.

[1] Similarly as in the case of the regressive model of the relation between the real demand and offer of connections the variant of 76 relations was tested (i.e. without the Hradec Králové – Pardubice and Praha – Pardubice). The assumption of a significant influence of the results by high values of the mentioned relations was not confirmed in this case either because the variability of the real demand is explained in 79 % (R^2 =0.788), and in the case of 76 relations in 65 % (R^2 =0.649), when all relations are included.

Figure 2: Regressive model of relationship of model interaction and real demand



Notes: The values of indicators are relativised compared to the strongest relation (assigned the value of 1,000). See centre abbreviations below Figure 1.

Source: the authors' processing based on Czech Railways data, IDOS 2006/2007.

The Praha – Liberec relation is a typical example where competition of passenger car transport as well as bus transport can be seen. The existence of a high-speed road enables fast connection of these two cities via bus transport. Rail transport is not competitive in this relation due to insufficient railway infrastructure and we cannot expect any change in the status quo in the future.

However, it is also clear that there are relations between regional centres in which the real transportation flow is higher than their theoretical interaction. The Praha – České Budějovice or Praha – Olomouc relations are the most distinct case (but also e.g. Brno – Ostrava and Praha – Ostrava). Higher real demand is influenced by several factors, especially time competitiveness of rail compared to the unfinished or non-existent high-capacity road infrastructure, plus a relatively high-quality supply of rail connections (especially Praha – Olomouc). However, this is not entirely valid from the Praha – České Budějovice relation, and possibly also the Brno – Ostrava relation, where the railway infrastructure is being modernised (or is undergoing project preparation) and time accessibility does not correspond to the level of demand because of the distance in kilometres of these centres.

Selected relation examples: focus on rail transport competitiveness

To conclude, we selected relations which show the most interesting results in terms of evaluation of all three constructed indicators and whose deviation from the tendencies is the greatest. The selection was influenced by several other factors, including the position in the overall evaluation of indicators (see Table 2). Another one was the geographical position of the centre and, last but not least, the transportation-related position, i.e. the location of the centres on different types of communications (the existence or absence of a motorway, rail corridor, etc.). The following relations were selected: Praha – České Budějovice, Praha – Brno, Ústí nad Labem – Liberec, Brno – Zlín and Brno – Ostrava (see Figure 3).

The Praha – České Budějovice relation clearly shows significant differences between the studied indicators. The high rail transport real demand is quite unexpected. This is because of the above mentioned absence of a motorway connection between Prague and South Bohemia which has high impact on the quality of bus transportation on this route. Taking into account the general demand, it would be possible in this relation to enhance offer of connections or create a new conception of transport services, e.g. by an introduction of express trains for important centres on the route (Praha, Tábor, Veselí nad Lužnicí – change in the direction Jindřichův Hradec/Třeboň, České Budějovice), while the micro-regional centres (e.g. Čerčany, Sezimovo Ústí, etc.) would be served by trains of (fast) regional transport. The modernised IV rail corridor should help improve the quality of the transportation solutions in the future.

The exposed Praha – Brno relations shows strong influence by the D1 motorway, which can explain the low rail transport real demand even despite quality scope of supply of connections. The railway infrastructure will not be changed in the near future (see possible construction of high-speed rail through the Vysočina region), therefore, motivation can come from tariff offer.

The Ústí nad Labem – Liberec relation is a typical tangential connection. It is a relation of two regional capitals in North Bohemian borderland between which there is not motorway or high-speed road connection. The relation of all the three indicators immediately shows low demand that can be influenced especially by a different catchment rate by each centre, significantly influenced primarily by the Prague metropolitan area. At the same time, the relatively low value of model interaction shows insufficient level of time accessibility in this relation.

Table 2: Relations with the highest indicator values

Position of relation	Supply of connections		Real demand		Model interaction	
1.	PR–PA	1 000	PR–PA	1 000	PR–PA	1 000
2.	HK–PA	864	HK–PA	935	PR–PL	834
3.	OL–ZL	727	PR–UL	565	HK–PA	810
4.	OL–OS	693	PR–CB	561	PR–UL	793
5.	PA–OL	682	PR–OL	492	PR–BR	502

6.	PR–HK	670	PR–PL	486	PR–HK	492
7.	PR–OL	670	PR–HK	482	OL–OS	485
8.	UL–PA	648	PR–OS	445	PR–OS	302
9.	PR–UL	614	BR–OS	388	OL–ZL	214
10.	PR–BR	602	BR–OL	261	BR–OS	207
11.	PA–OS	489	OL–OS	227	BR–OL	185
12.	UL–OL	455	PR–BR	223	PR–LI	178
13.	HK–OL	455	CB–PL	169	PR–OL	175
14.	PR–OS	443	OL–ZL	165	PR–CB	155
15.	PA–BR	443	PR–ZL	125	ZL–OS	151
16.	PR–PL	432	PA–BR	98	PA–BR	128
17.	BR–OL	420	HK–BR	83	BR–ZL	114
18.	PL–PA	409	ZL–OS	80	PR–JI	96
19.	PA–ZL	398	CB–BR	62	PR–ZL	74
20.	ZL–OS	386	PA–OL	60	HK–BR	71

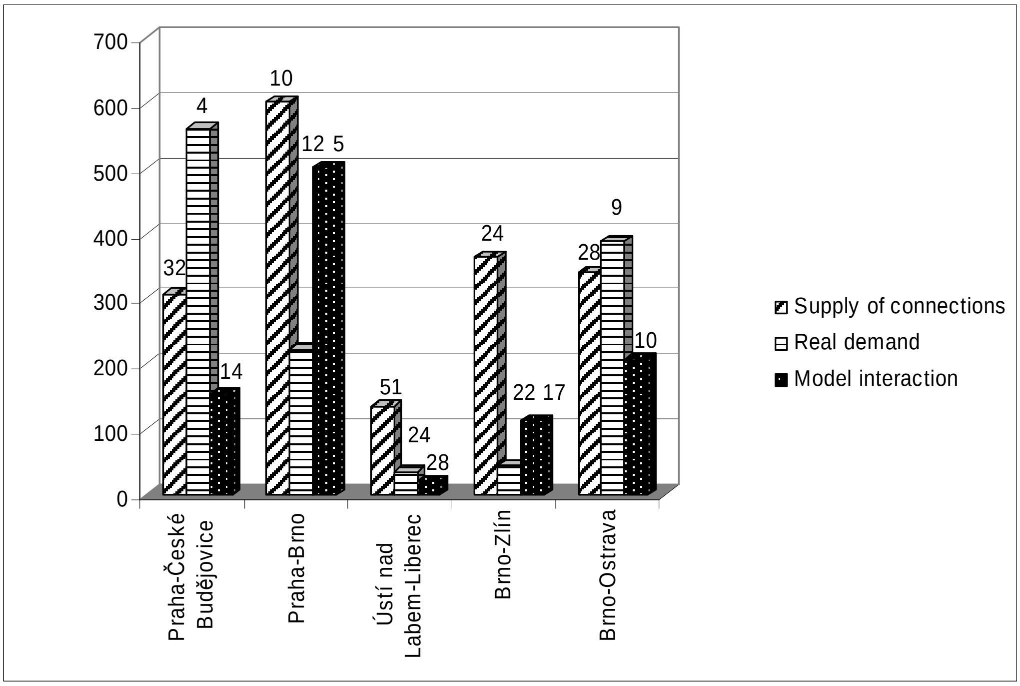
Notes: The values of indicators are relativised compared to the strongest relation (assigned the value of 1,000). See centre abbreviations below Figure 1.

Source: the authors' processing based on Czech Railways data, IDOS 2006/2007.

The Brno – Zlín relation shows interesting results. These are geographically relatively close centres with high supply of transport connections. However, in this analysis its value has been influenced by the methodology which accepted a change and aggregated data for the towns of Zlín and Otrokovice. It is probable that the absence of a direct connection in this relation because of the closeness of the centres strongly discourages potential passengers, who prefer direct bus connection. Therefore, the value of the real transportation flow is low compared to other indicators. Currently, Otrokovice offer a express train line to Brno (via Břeclav), but its primary objective is to serve centres situated close to each other (Otrokovice – Staré Město, Staré Město – Břeclav, etc.) rather than the connection with Brno. Therefore, the travel time is still relatively uncompetitive.

The best balance between the indicators can be found in the case of Brno and Ostrava, where there is a relatively high supply of rail transportation, as well as demand. Theoretical interaction of centres is slightly lower because it is influenced by worse time accessibility. The current position of rail transport can pose a threat to the opening of a quality north-south motorway connection. Therefore, because of the rail potential, it is necessary to focus on quick modernisation of railway line 300 (Brno – Přerov) which will lead to an acceleration of the existing connection and, possibly, a change in its concept (e.g. introduction of fast express trains).

Figure 3: Comparison of indicators in selected relations of regional capitals



Notes: The values of indicators are relativised compared to the strongest relation (assigned the value of 1,000). Figures above columns show position of relation within a set.

Source: the authors' processing based on Czech Railways data, IDOS 2006/2007.

Conclusion

The performed analyses lead to several general conclusions concerning the relations between the supply of rail connections, real passenger transportation flows and theoretical interactions between centres, based on a gravity model. Generally, the assumptions adopted at the beginning of the paper were in accordance with the evaluation results to a high degree. The following points reflect the conclusions.

1/ In accordance with the first assumption, the real demand is met by an adequate supply of rail connections. At the same time, the assumption of incongruity of relations on rail corridors has been confirmed; in some cases the supply of connections is much higher than the real demand. This situation is influenced especially by express (long-distance) transit lines (low demand in the Pardubice – Olomouc relation and, at the same time, a high number of connections that are not primarily designated to serve this relation).

2/ In relations where there is direct competition of bus and passenger car transportation because of quality road infrastructure (motorways, high-speed roads) it is clear that there is a noticeable discrepancy between relatively high theoretical interactions between centres and lower real rail transportation demand. The Praha – Brno relation is a typical example. On the other hand, in relations without strong road transportation competition (Praha – České Budějovice and Brno – Ostrava), because of uncompleted motorway network, there is a clearly higher value of real transportation flow than in the theoretical interaction. Therefore, it is obvious that the horizontal transportation position of centres in the networks plays an essential role in the competitiveness of road transport.

3/ Rail transportation should focus primarily on quick improvement of the quality of the railway infrastructure (complete rail corridors) in those relations where higher real demand has been identified (selected radial connections with Prague in Bohemia and the main Moravian relation Brno – Ostrava). After motorway network is completed the rail transportation in these sections will be subject to much higher passenger car and bus transportation competition.

The results hint possibilities where simple modelling can be used for transportation planning. The methodology used confirmed often intuitively perceived deficiencies. Relations with inadequate supply of rail connections could be subject to more detailed reassessment and, possibly, their level could be modified, thus improving the quality of transport services. In terms of methodology and to reach better-quality results, we can recommend the construction of an indicator of supply of connections that would include the capacity of the trains supplied, which would undoubtedly help to solve the frequently discussed low variability of the set of supply of connections within this research.

One research issue remains open for the future: to include other modes of transportation (especially passenger car and public bus transportation) into the gravity model when we face absence more detailed (especially direction-related) demand data. In this sense, recommendations for transportation statistics institutions can be formulated.

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EVALUATION OF COMPETITIVENESS OF RAIL TRANSPORT ON EXAMPLE OF CONNECTION AMONG REGIONAL CAPITALS IN CZECHIA

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Abstract: The article is focused on evaluating the significance of rail passenger transport in transport contacts among regional capitals in Czechia representing the most important centres in the settlement hierarchy. The review of the particular connections works with the values of the year 2007 and is based on the relationship between supply and demand for rail passenger traffic. The evaluation is based on the number of rail links within the working day, while assuming that the supply is influenced by the location of the centre in the transport network and its position in the settlement hierarchy. Real demand data represent the number of tickets sold by the Czech Railways. Theoretical size of the interaction is obtained by application of the gravity model. Based on the final evaluation of indicators of supply and demand for rail traffic among regional capitals and their interactions, relations are described where demand is substantially below, respectively beyond the level of real supply and theoretical interaction, which is based on the importance of centres and their accessibility of the railway transport in time. In conclusion, the opportunities for the development of infrastructure in the selected connection in relation to transport planning are outlined, using the obtained results.

Key words: transport interactions, competitiveness of rail transport, relationship of supply and demand for rail passenger traffic, gravity model, regional capitals in Czechia.

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